THE DEPARTMENT OF FISHERIES AND OCEANS

THE SALMONID ENHANCEMENT PROGRAM

THE EVALUATION OF PHASE I

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PREFACE & ACKNOWLEDGEMENTS

The fact that the Pacific salmon is spawned in fresh water, where it spends the first stage of its life, migrates to sea, where it spends most of its adult life, and returns to end its life cycle in fresh water, creates problems but also provides opportunities. While in fresh water they can be destroyed by habitat degradation whether caused by man or nature and when in salt water can be decimated by predation, both human and natural. By protecting the salmon's habitat, its chances of survival in the early stages of its life can be substantially increased while the control of exploitation (human predation) on the high seas by man can improve the salmon's chances of returning to fresh water to spawn.

Protecting salmon's habitat from human degradation is a form of "salmonid enhancement". Restoring a habitat damaged by man or nature is another form of enhancement. Such "restoration" may be a simple task, such as removing a log jam or blasting a large boulder in a stream, to the construction of fishways to enable salmon to by-pass a large obstruction caused by a landslide. The Hell's Gate fishway is in example of assisting salmon around an obstruction caused by man while the Babine channels are an example of solving a problem caused by nature. Such remedial works are considered a "natural" way of enhancing the salmonids. Their main purpose is to enable the natural stocks to reproduce by enabling the salmon to reach its spawning grounds and hence to "conserve" the stocks. More recently scientists have successfully enriched

lakes where the young salmon are reared by introducing fertilizers, thereby increasing the capacity of the lakes to support salmon. this is another form of "natural" enhancement.

With man's increasing knowledge of the salmon, it soon became apparent that where natural or man-made obstructions could not be removed to enable the salmon to reach its spawning ground, eggs could be obtained from the salmon, fertilized and incubated in "hatcheries". The offsprings could be fed in rearing pens under controlled conditions and released in the wild to go to sea and return as adults to spawn. This form of "enhancement" is known as "artificial enhancement". Hence, enhancement is the conservation of salmon stocks by natural or artificial means by increasing the numbers of salmon that can reach the spawning grounds and increase the chances of survival for the offsprings.

The principal reason for undertaking such enhancement projects is the expectation that their benefits will exceed their costs. The benefits may range all the way from protecting a species from extinction to increasing the numbers available to commercial or sport fishermen. For whatever reason, the enhancement of salmonids by natural and artificial means has been a part of fisheries management on the Pacific Coast since the turn of the century. Although hatcheries were built at the end of the 19th century, it was in the 1950's that enhancement of salmonids became a serious pre-occupation of fisheries managers. The biological research and engineering experimentation carried out in the 1950's and 1960's laid the foundation for the enhancement

"leap" represented by the $150 million Salmonid Enhancement Program (known as SEP) approved by the Governments of Canada and British Columbia in 1977.

The Salmonid Enhancemment Program was planned as a two phase program "to preserve, rehabilitate and enhance natural salmonid stocks". This purpose was not considered an end in itself but a means of achieving the following specific economic and social objectives:

a) Increasing national and provincial income.
b) Creating employment opportunities for Canadians.
c) Improving economic opportunities for Native Peoples.
d) Fostering development of economically disadvantaged communities and regions, and
e) Increasing and improving recreational opportunities.

In terms of salmon stocks, these objectives were translated into a series of targets for each of the five principal species that would eventually double the current (1977) level of production. Phase I was to contribute a net annual addition of 50 million pounds of salmon production with an additional net annual 100 million pounds to be produced by the end of Phase II. Phase I was scheduled for completion in 5 years but as part of the Government's restraint program was extended to 7 years without additional funding.

The SEP is now in its seventh and last year of Phase I but funding for Phase II has not been approved. Instead the Government has provided only

sufficient funding to continue the Program for a two-year transitional phase. The purpose of this phase is to provide time to evaluate the results achieved in Phase I and if satisfactory indicate the future direction of the program. The evaluation should be completed in time to permit the SEP staff to prepare plans for Phase II. The evaluation of Phase I is difficult not only because of the SEP's multiple objectives, not all of which can be measured, but also because of the interaction between enhanced and wild stocks on the fishing grounds. The management of mixed stocks of different strengths is nothing new but the increase in the number and size of enhanced stocks has made the task of fishery management much more difficult.

The evaluation will address the following topics:

a) Achievement of objectives;

b) Rationale;

c) Effects and impacts; and

d) Alternatives.

In addition the evaluation will also cover four sets of issues:

a) Strategic/management Issues;

b) Marketing and Economic Issues;

c) Science Issues;

d) habitat and Environmental issues.

Because of the complexity of the program and its interactions with fisheries management, the evaluation is being conducted in two phases. The

first phase will consist of preliminary work, planning and identification of options for the second phase. The second phase will be the evaluation proper culminating in the presentation of analyses, conclusions and recommendations in a comprehensive report to the Departmental Management Committee. This report contains the conclusions and recommendations of the authors of the first phase of the evaluation. Details of the terms of reference for the first phase are contained in Annex 1.

In carrying out the evaluation the Consultants have undertaken a survey of documents and literature relating to the SEP listed in Annex 2 and interviewed many individuals and representatives of interest groups listed in Annex 3. The interviews were conducted in Vancouver, on Vancouver Island and Prince Rupert. The Consultants also visited several enhancement projects, including one large hatchery, a community economic development project and a public participation project. The Consultants spent six weeks in British Columbia in October and November 1983.

The Consultants wish to thank the many persons in the SEP, in other Branches of the Department of Fisheries and oceans, Pacific Region, several staff members of the University of British Columbia, members of the SEP Board and the SEP Task Group, and representatives of the fishing industry. While it is not possible to thank them all by name, we would like to express our appreciation to a number of individuals who gave extra time and special assistance to us.

Mr. Wayne Shinners, Regional Director/General, Pacific gave generously of his time and arranged for his staff to respond helpfully to our many requests for advice and information. Mr. Ward Faulkner and Mr. Harold Swan met with us on several occasions and allowed us free access to SEP staff and important documentation. Mr. J.R. McLeod gave unstintingly of his time and valuable advice as did Mr. A. Wood. Mrs. Pam McNally cheerfully and competently set up our many interviews and arranged for typing and telephone services. Dr. R. Beamish and Dr. Frank Bernard were especially helpful in providing advice and information on research and in arranging meetings with their staffs.

On the Ottawa scene, Mr. Dan Derousie gave much useful advice and provided documentation for the start of the study. Mr. Nelson Strang and Mrs. Doreen Muir graciously assisted us in obtaining secretarial and other office services.

PART I

THE SALMON RESOURCE

This part of the report is descriptive only. Its purpose is to acquaint the readers with some basic information about the salmon resource and its users and such matters as research and fishery management.

Chapter 1

Historical Catch, Methods of Harvesting and Utilization

The five species of Pacific salmon have been fished commercially for about one hundred years and have been used historically by Native Indians as a major source of food. Since World War II there has also been a burgeoning sport fishing which has demonstrated especially rapid growth in the southern half of British Columbia. The salmon occupy over 2000 streams from small brooks to the mighty Fraser and are made up of some 4000 separate stocks with each individual stock returning to the stream where it was spawned. These particular features have had a profound impact upon the management and protection of the resource.

While it is difficult to document the historic levels of the five species it has been concluded by researchers and fishing managers that the salmon have a combined productive capacity of between 300 million and 360 million pounds per year.

In the early years, the commercial fishing tended to concentrate on the most valuable species in the most accessible areas. Even in these early

stages some over-fishing of certain stocks occurred because of these fishing patterns. By the early 1930's heavy commercial fisheries had occurred on all five species of salmon and substantial declines were noted in many stocks of most species.

An examination of the record of catches since 1930 reveals some rather long term fluctuations. Catches peaked around 1940 at about 180 million pounds and during the remainder of that decade and in the 1950's remained fairly constant at about 150 million pounds per year. During the mid-1960's there was a further decline when the average annual take fell to about 137 million pounds. In the following decade there was some recovery to an average catch of 142 million pounds annually. It is interesting to note, that while there was a decline in the number of pounds of salmon taken in the 1960's, the number of salmon caught increased. Researchers and fishing managers believe this resulted from a decline in the average weight of all species except sockeye. This is attributed to selective fishing which may have resulted in certain genetic changes in the various stocks.

The 10 year average catch of salmon for the period 1971-1980 by sector is tabled below. (Source - Pearse, "Turning the Tide, A New Policy for Canada's Pacific Fisheries")

Commercial Fishery

	Seine		Gillnet		Troll	
	1000's of fish	Percent	1000's of fish	Percent	1000's of fish	Percent
Sockeye	2,003	35	3,045	53	363	6
Chum	1,328	48	1,341	49	21	1
Pink	6,380	69	1,421	15	1,408	15
Coho	492	12	447	11	2,550	61
Chinook	65	4	136	8	1,122	66
All Salmon	10,268	43	6,390	27	5,464	23

	Sport Fishery		Indian Fishery	
	1000's of fish	Percent	1000's of fish	Percent
Sockeye	0		377	6
Chum	0		59	2
Pink	25	.5	37	.5
Coho	615	15	55	1
Chinook	355	21	32	2
All salmon	995	4	560	3

Total for All Fisheries with Percentage Take by Sector

	1000's of fish	Seine	Gillnet	Troll	Sport	Indian
Sockeye	5,788	35	53	6		6
Chum	2,749	48	49	1		2
Pink	9,271	69	15	15	.5	.5
Coho	4,159	12	11	61	15	1
Chinook	1,710	4	8	66	21	2
All salmon	23,677	43	27	23	4	3

Source: Pearse, "Turning the Tide, A New Policy for Canada's Pacific Fisheries."

Traditionally, the bulk of the commercial salmon catch in B.C. has been canned. This was certainly true during the early history of the fishery, through the second World War when canned salmon was regarded as an important

source of food, and until the late 1960's when a trend towards larger volumes of fresh, frozen and cured salmon began to develop.

In the fifties and most of the sixties, for example, about 70% of the catch found its way into the can, the remainder into fresh, frozen and cured products. Chinook, coho and chum were used in these latter products with little emphasis on sockeye and pink for these product lines. Since 1969 and through 1981 the volume of canned salmon declined and, on the average accounted for only 57% of the processed products. There was a corresponding increase in fresh, frozen and cured salmon to some 43% of the total volume as the average. Increasingly, sockeye and pink have been used for purposes other than canning and this trend continues.

Chapter 2

State of the Resource

It has been well established, that in total, the levels of abundance of salmon are substantially less than they were historically. This can be attributed to over-fishing, to subsequently reduced spawning escapements and, to a much lesser degree, to habitat degradation in the fresh water areas. Since about the mid nineteen-sixties the decline appears to have been slowed, arrested or even reversed through better fishery management, though some stocks of chinook and coho are at dangerously low levels. A brief review by species follows.

Sockeye:

Generally, the stocks are slowly increasing or remaining at a fairly constant level in most areas. An exception is the Rivers and Smith Inlet locality where the formerly important runs have been declining until very recently. Also, some of the smaller stocks on the central north coast continue in a depressed state. The large runs to the Fraser River system have been rebuilding since the mid nineteen-forties and appear now to be stabilized at good levels or even increasing somewhat in some cases. In Barkley Sound where large scale lake fertilization experiments in Great Central and Henderson Lakes have proven eminently successful, stocks have increased dramatically, up to ten-fold, since the early nineteen-seventies.

Chum:

Chum salmon, which are less productive than the other species, were in a state of serious decline coastwise during the period 1955 to 1965, a situation which was reflected in very low catches and low spawning escapements. The stocks of the Fraser River system, the largest single chum producer, showed some signs of recovery in the 1970's but have been discouragingly low in recent years. The decline appears to have been arrested in most other areas; in some cases there has been a small increase in the stocks. Exceptions are stocks along the west coast of Vancouver Island northwest of Barkley Sound and on Moresby Island in the Queen Charlotte Islands group where no real recovery is evident in spite of stringent controls on fishing or even complete annual closures to fishing over a period of several years.

Pink:

Pink salmon have a two-year life cycle. Historically there tends to be substantial fluctuation in the volume of the various stocks. In some areas the runs are much stronger or dominant in the even numbered years; in others in the odd numbered years although this pattern has been known to reverse itself on occasion. In some river systems there may be runs only in the odd numbered years. In the Fraser River system, for example, pinks appear only in the odd numbered years and are virtually non-existent in even numbered years. The reverse is true in Masset Inlet. Because of the foregoing factors, the coastwise catch tends to vary widely from year to year. This is one species where no overall long term decline of consequence has been noted, indeed, the stocks in nearly all areas are stable or showing modest increase. Exceptions

are stocks on the Queen Charlotte Islands, on the east coast of Vancouver Island and in some Strait of Georgia streams. These latter have experienced very low returns for nearly three decades.

Coho:

The commercial catches of coho have shown almost constant increase since the turn of the century. Coupled with this, is the rapidly increasing sport fishery take, especially in the southern areas of the province. The increased takes during the past two decades cannot be credited wholly to natural production; some has originated from U.S. natural stocks and from hatchery production in both countries, especially the United States. The general feeling is that escapements of natural stocks are declining in nearly all areas and that stricter conservation measures will have to be applied to halt the decline and put the stocks on the road to rehabilitation.

Chinook:

As with the coho, the chinook catch has risen fairly steadily since the turn of the century. Again, some considerable part of this increase must be credited to enhancement efforts in the United States and to earlier natural production from some U.S. streams, notably the Columbia River. Pearse, in "Turning the Tide, A New Policy for Canada's Pacific Fisheries," suggests that in recent years up to 50% of the catch of chinook has been of U.S. origin in the north and central coast areas and 70% to 90% off the west coast of Vancouver Island.

Departmental data indicate that almost all stocks of chinooks are in a depressed state with continuing declines in the Strait of Georgia and the central coastal areas. Some stabilization has occurred on the Nass and Skeena Rivers and there may have been some small increase in Johnstone Strait and in Rivers and Smith Inlets. On the Fraser River, there is cause for real concern over the formerly important Chinook runs. The same applies to streams flowing into the Strait of Georgia and adjacent inlets.

In nearly all streams escapements of chinook salmon are too small and there is general feeling that exploitation rates must be reduced by as much as 30% to halt the decline of the natural stocks. This is especially true of the Fraser River chinooks which some sound thinking people now consider to be endangered.

Chapter 3

Economic Returns to the Fishing Industry

Commercial Fishing:

The salmon fleet in British Columbia is technologically advanced and is a highly efficient one in terms of mobility and catching capacity. As Pearse reports, "It is now among the world's most advanced small boat fleets."

The number of vessels reporting salmon landings has declined fairly steadily since limited-entry licensing was introduced in 1969 from 6107 vessels reporting landings in that year to 4707 vessels in 1980.[1] However, the fleet composition changed as well and during that same period the number of seine vessels reporting only salmon landings increased from 286 to 316. At the same time the number of combination seiners (fishing salmon and other species as well) increased from 83 to 216. This means that the seine fleet reporting landings of salmon or salmon and other species increased during those years from 369 to 532. The numbers of trollers and gillnetters declined because of buy-back programs between 1971 and 1974 and as a result of their conversion to salmon seiners through "pyramiding" of their licences into larger vessels. This decline does not reflect the true situation because increasing numbers have become combination vessels carrying both troll and gillnet gear.

The table below shows the structure of the salmon fleet and value of landings by gear type in 1980.

Gear type	Number of vessels reporting landings	Landed value of salmon ($Millions)
Gillnet	1065	14.2
Troll	1493	32.6
Seine	316	28.2
Combination*	1833	58.3
TOTAL	4707	133.3

Source: Pearse, Ibid.

* The combination category includes all vessels that fished more than one type of gear for salmon and all salmon vessels that engaged in other fisheries as well.

Average earnings of salmon vessels in 1980 are tabled below.

		Vessels Fishing Salmon And Other Species		
	Vessels fishing salmon only	Salmon	Other species	All vessels
Gillnet	$12,750	$20,970	$ 2,060	$ 18,665
Troll	$21,000	24,700	12,720	22,500
Seine	$84,980	97,150	62,500	115,280
All vessels	$24,980	$30,300	$10,200	$ 31,000

Source: Pearse, Ibid.

During the years 1969-1982, the salmon fleet has dramatically changed in terms of numbers of vessels reporting landings as well as in terms of capital value. This is demonstrated in the table which follows. (Source - "A Status Report on the Commercial Fishing Industry of B.C.," Fisheries Association of British Columbia)

	Number of Vessels	Capital Value of Vessels ($M)	Capital Value of Licences ($M)	Total Capital Value ($M)
1969	6,107	91	0	91
1982	4,563	432	145	580

The table clearly shows that while the number of vessels has been reduced by about 1500, their total capital value has soared by more than 600 per cent. The debt-to-capital ratio for the salmon fleet is about 50/50, that is, of a capital value of $580 million, about $300 million represents debt.

The catching sector is in trouble. There are too many vessels operating on the available resource for all to make any reasonable profit; indeed, many vessel owners are in serious financial trouble. Again, a quote from "A Status Report on the Commercial Fishing Industry of B.C." highlights this point.

"The fishing industry is not much different from other industries facing the current economics squeeze. The financial status of fishermen has taken a drastic downturn from the boom years of 1977, 1978 and 1979. During that period, with the government's tax incentives and the favourable economic outlook, the industry, with their bankers' support, entered into major capital expansion programs. The results were new boats and large new loans. In 1980, 1981, and 1982 the fishing industry returned to more normal conditions, and many fishermen and processors were unable to meet their debt commitments. In 1981, two-thirds of all fishermen's loan accounts were in trouble.

In 1969 the industry was insolvent and the government responded with the Davis Plan. Between 1969 and 1982, landed value increased by $150 million, but the industry undertook a $500 million, largely redundant, investment

program. It caught no more fish. In 1982 the industry is insolvent once again. It can hardly afford to operate at its current capacity; never mind finance through royalties the fisheries development programs (S.E.P. and fleet rationalization programs buy-back) necessary to ensure improved economic performance."

Now let us look at a simple comparison of salmon harvests and landed values in British Columbia as opposed to Alaska.

	BRITISH COLUMBIA	ALASKA
Annual Salmon Harvest	134,745,000 lbs.	558,770,000 lbs.
Annual Landed Values (Av. 1980-1982)	$135,733,000	$396,600,000
Number of Salmon Fishermen	11,000	18,000
Av. Catch per Fisherman (1980-1982)	12,250 lb.	31,043 lbs.
Av. Price Paid to Fishermen per lb. (Canadian $)	1.10/lb.	.71/lb.
Av. Annual Gross Income (Canadian $)	$12,373	$22,041

Note: While tables on earlier pages show numbers of fishing vessels, this table lists numbers of fishermen.

The foregoing shows that the average catch per Alaskan fisherman is more than two and one half times that of a B.C. fisherman. The Alaskans are not better fishermen but because of their much larger resource base and fewer fishing vessels in relation to that resource base they readily out-produce their fellow fishermen in British Columbia. The Alaskans have put a form of area licensing in place and have rather good control over the numbers of fishing vessels, their size and fishing gear. The fishery is of shorter

duration than in B.C. and their fishermen do not travel very far to catch their salmon. As a result of these differences, costs of operating, including fuel expenditures are substantially lower when applied to the volumes of fish delivered.

Some of the original SEP concerns centred on controlling investment and fishing capacity. There was a failure to follow through simply because the mechanisms to effect such control were not put in place, largely because of strong opposition to them amongst most sectors of the fishing industry. The result has been excessive fishing capacity which poses serious problems for the fishing industry and fishery managers, the resolution of which are fundamental to sound fishery management and to planning for future enhancement.

The Processing Sector:

First, it is useful to look at world salmon production to place the British Columbia production in true perspective. This is well illustrated in the table below. (Source - "A Status Report on the Commercial Fishing Industry of B.C.," Fisheries Association of B.C.)

PACIFIC SALMON PRODUCTION, 1977-80 AVERAGE (METRIC TONS)

Country	Average	Per Cent of Catch
Canada	64,492	12.6
U.S.A.	214,332	41.7
Japan	124,113	24.2
U.S.S.R.	110,476	21.5
TOTAL	513,413	

The above table demonstrates very clearly that British Columbia production represents only about one-eighth of the world total of Pacific salmon by volume.

With the foregoing is mind, it becomes evident that the processors in British Columbia cannot be considered as a force in trend setting or in establishing prices for salmon products in the world markets or even on the domestic scene; in fact, in many cases they simply become followers in terms of market prices. They do, however, tend to get a premium over the market price because of their reputation for providing good quality fish.

The processors, generally speaking, are in financial difficulties. Some have been in deficit positions for several years. Others have made small profits, broken even or suffered financial loss over the same period. There are a number of reasons for this unfortunate situation.

(1) In recent years, prices for canned salmon have not kept pace with inflation and interest rates. In fact, prices for canned sockeye and pink salmon have declined in the past two years.

(2) Since 1978, the price of fish to the fishermen (except in 1983 when prices dropped somewhat), and the costs of labour, materials and overhead have increased significantly.

(3) Competition from Alaskan processors who have much lower costs in all respects and almost four times the volume of salmon has affected the

prices and sales of Canadian salmon products, especially canned, in foreign, U.S. and even domestic markets.

(4) The Canadian dollar has strengthened compared to currencies of the traditional foreign markets, especially those of western Europe and Japan. This has been unfavourable to our export-oriented fishing industry.

(5) Salmon from Norwegian fish farms are now having an impact on world markets. This is still marginal in terms of effect but will increase in the next five years.

(6) The tremendous success of the Japanese chum salmon hatcheries has resulted in greatly reduced demand for these fish from abroad and has hit B.C. salmon processors.

(7) From the mid 1970's until two years ago, the processors really subsidized their salmon operations from profits in the herring roe fishery. This situation no longer obtains. The Japanese market for roe herring has declined together with prices for this product.

Chapter 4

Environmental Issues

Because all species of Pacific salmon spend some period of their life cycles in fresh water and in the estuaries of rivers and streams, they become affected by the activities of man in these areas. A lengthy discourse is not required here. The issue is raised only because it has a decided bearing on the decline of many of the natural stocks and can have adverse effects on the enhanced stocks as well.

The freshwater and estuarine habitats can suffer damage, or even destruction, through physical change or interference and through degradation of the quality of the water itself by the introduction of contaminants or pollutants.

1. Physical disturbance can be brought about through such activities as:

   (a) removal of forest cover leading to siltation of stream beds, destabilization of stream channels and flooding or drought conditions because runoff becomes much less controlled;

   (b) gravel removal from spawning grounds for construction of logging and mining roads and for public highways;

   (c) gravel loss caused by higher runoffs as a result of forest cover removal;

(d) construction of dams and/or diversion of water for such purposes as hydroelectric development, irrigation, and domestic and industrial water suplies; and

(e) port development including dredging, dyking and log storage.

2. Water quality can be degraded through the introduction of organic and chemical wastes. Some examples are:

(a) organic wastes from domestic sewers and certain industrial operations which deplete oxygen supplies in the water thereby creating lethal or sublethal effects on salmon and on the aquatic organisms vital to the well-being of the salmon; and

(b) chemical wastes from such sources as oil spills, chemical spills and other industrial wastes and from pesticides or herbicides used in insect control, notably in agriculture, and in controlling weed and other undesirable plant growth.

Unquestionably, portions of the salmon habitat have suffered degradation in varying degree and, in some cases, have virtually been destroyed. Many of those interviewed during the course of this study expressed concern over this problem, even going to the extent of criticizing all levels of government for what was perceived to be lack of adequate policies and programs to maintain effective control. On the other hand, competing resource users, e.g. forestry and hydro question the scientific support for increased levels of protection and its concomitant financial burden on them.

The contribution which environmental degradation has made to the decline of the natural or wild stocks of salmon bears mention here. The general consensus gained from interviews is that degradation of the freshwater and estuarine habitat has contributed about twenty percent towards the decline in the southern half of the province and about ten percent in the northern half of the province. In some isolated instances, of course, there has been almost total environmental destruction.

Environmental degradation tends to be species selective in terms of effects on salmon. Province wide, it is the coho and chum which have been hardest hit. The adverse effects on the other three species have not been as severe.

One of the benefits of SEP, which is not quantifiable but nonetheless positive, is the increase in public knowledge and awareness of habitat problems and the salmon resource which uses the habitat. People from various walks of life serve on the Task Group and on the Advisory Board to SEP including representatives from such industries as forestry, mining and hydro. Certainly, these people have gained a better understanding of fisheries concerns for the salmon resource and its habitat.

The process does not stop there. It extends also to the general public and down into the school system through the public participation and public information elements of SEP. Here again, public awareness of problems with the salmon resource and its freshwater and estuarine habitats has gone through a manifold increase with subsequent support for many Departmental policies and programs. This can only work towards the eventual good.

Chapter 5

Research and Information

Research on Salmon

Some background on fisheries research, especially as it aplies to the salmonids, seems desirable here. The need for research, basic and applied, is fundamental in acquiring knowledge of the resource, in developing methods for managing the various salmon stocks and in designing and implementing enhancement strategies.

Fisheries research in British Columbia has been conducted for seventy-five years and, over the years has received world-wide acclaim and recognition. Originally, research was placed under the direction of a quasi-independent body known as the Fisheries Research Board, where it remained until the early 1970s. At that time, the Board was abolished and its staff integrated with that of the Department.

Over the years there have been changes in emphasis on research with periodic priority shifts between basic or "pure" research and applied research. A major change in research priorities occurred in the mid-1960s when much emphasis became placed upon basic research with subsequent little support for the applied aspects. This, of necessity, resulted in those responsible for fisheries management acquiring additional technical people to assist in managing the fisheries and to conduct investigations of a more practical nature related to development of resource management practices. This brought about competition for financial resources and people, some decline in the quality of advice to fishery managers and a certain loss in the

necessary co-operation and co-ordination between the researchers and those concerned with the practical aspects of managing the fishery.

Pearse, in "Turning the Tide, A New Policy for Canada's Pacific Fisheries," highlighted the problem clearly and accurately in stating the following:

> "These changes adversely affected the capability to respond at a time when some of the most profound developments in the history of the fishery were occurring, e.g.: the establishment of a 200-mile limit, the development of a salmonid enhancement program; rapid development of a multi-million dollar roe herring fishery; the explosive increase of the catching capability of the commercial fishing fleet (as well as in recreational fishing interest and participation); and the increased public awareness of the sensititivy of fish habitat, all aggravated by expanding population and industrial development."

Insofar as the Salmonid Enhancement Program is concerned, there was what turned out to be an additional restrictive element. Funding for research related to SEP was not built into the program except in a a very small way. In retrospect, it is understandable that this occurred. Considerable research and thinking had already gone into salmonid enhancement and a good deal of experience had been gained in the salmon enhancement field in the pre-SEP years. Further, the Biological Station at Nanaimo was judged as capable of

carrying the research load including meeting the SEP commitment to scientific evaluation which was perceived to be a research function. The Station, however, was then going through reorganization and additionally, was plagued by financial and manpower problems. This resulted in some lack of relative research and especially scientific evaluation until the late stages of SEP.

Resolution of this problem now appears to be well in hand. The Station with its highly competent staff is now carrying out the needed research and the scientific evaluation in co-operation with the SEP people and the fishery managers.

Habitat Research

Organizational and program identification of habitat research requirements originated about 1976. Since that time co-ordinated applied research studies involving habitat management and other resource agency staffs have modestly addressed such important topics as the effects of forest harvesting, foreshore disruption and water quality degradation in fish habitat.

In more recent years basic research has also been undertaken in estuarine habitat utilization by salmonids, habitat development technology and the effects of stream flow fluctuations on aquatic productivity.

There are however major shortfalls in the habitat research program. Long term research in the area of incremental and accumulative water quality degradation in such important systems as the Fraser, marine disposal of

industrial and domestic wastes and the impact of pesticides and hydrocarbons on primary and secondary productivity in fresh water and marine ecosystems are a few examples. The inevitable increase in competition for, and potential degradation of aquatic habitats stresses the need for new forward looking research in habitat development technology which must be available if the national goal of "no net loss" to fisheries be realized.

Economic Research

The economics group has suffered some erosion in recent years. While staffed with competent people, the group has not had the resources or the time to deal with longer term issues. Much of the work, while of good quality, has been performed on an ad hoc basis and a good deal of this has been done through contractual arrangement. The effect has been that projects seem to be operated without the cohesiveness of a social and economic research policy.

It is to the credit of the people concerned that the problem has been recognized and steps taken towards rectification. The economists have now been incorporated into the regional planning and economics group where social and economic research policy can be developed and implemented.

Information

This section will deal with three major issues, namely, catch statistics, salmon escapement and spawning data and analysis of the condition of the stocks (stock assessment and identification).

Catch Statistics

In Chapter 6, it is noted that fishery managers, during the course of the fishing season, calculate salmon catches in the commercial fishery by area and type of gear for each day of fishing. These calculations are required to assist in the day-to-day management of the fishery. Also, estimates of catches in the sport and Native Indian food fisheries are made on a daily, weekly, monthly or annual basis.

The published information on commercial catches, however, comes from sales slips that record landings by specific type of fishing gear, area and date, including value of the salmon sold. The quality of information obtained from the sales slips has deteriorated in recent years. Inadequate information is provided about increasingly numerous direct sales by fishermen to the consumers or is not included at all; insufficient or inaccurate data are frequently given about where catches are taken and some sale slips contain false information as to species landed or volume and value of salmon landed. There is no indication of an effective monitoring system to ensure that these abuses are controlled.

In the Native Indian food fishery, catch statistics are derived from interviewing individual Indian fishermen, actual counts of the catch in certain localities or from reports provided by band councils or individual band members. It should not be taken as criticism of staff or their considerable efforts, but the catch information obtained is, as a whole, very weak.

The most reliable catch data in the sport fishery is obtained from creel surveys coupled with boat counts. There is no doubt that the information obtained has improved in recent years but it still is incomplete and does not provide the full statistical base on which to develop a sport fishing policy.

Good catch information is fundamental to sound fishery management, salmonid enhancement and the conduct of basic and applied research. While steps are being taken to improve the quality of commercial catch data, methods to obtain catch information from the sport and Native Indian food fisheries remain weak.

Salmon Escapement & Spawning Data

The abundance of salmon spawners in about 2,000 streams is estimated annually for several important reasons. First, it provides a measure of the success or otherwise of fishery management actions taken to control catching effort in a given year. Second, the information is essential for determining the relationships between the abundance of spawners and the maintenance or rehabilitation of the various stocks. Third, the spawning ground information is widely used in predicting cycle year returns of adult salmon resulting from the spawning ground production so that annual fishing plans can be developed. Fourth, it provides a means of measuring the impacts of salmonid enhancement on the stocks.

Field officers of the Department have been responsible for many years for estimating the numbers of spawners in the streams, rivers and lakes of the province. Additionally, technicians and biologists have, for about three

decades, increasingly used more refined methods such as counting fences and stations, tagging of adult salmon on spawning grounds and applying mathematical formulae to the tag recoveries and even electronic counting methods to improve the accuracy of the counts.

The estimates of spawning abundance, while useful in rather broad general terms, are not sufficiently accurate to be used for scientific analysis. It has even been stated that the quality of the information provided by the field officers has declined over the past ten years. This is attributable to their inability to consistently and fully view the spawning grounds owing to the heavy workload they carry.

The problem has been recognized and the Department is working on a computerized system to assemble and store the spawning data collected. Also, work is proceeding on a catalogue of streams which will contain details of stream characteristics and the history of spawning escapements.

The effectiveness of these measures is dependent on the quality of the information gathered in the first instance and, until there is improvement, the usefulness of the data must remain suspect.

Stock Identification and Assessment

It might be assumed that this is a subject more properly covered under the research section of this report. Certainly, researchers have a major role in this activity. On the other hand, assessment is carried out more or less routinely by fishery managers as an essential element of managing the salmon

fisheries through such activities as collection of catch statistics, tagging programs, sampling of the catches and spawning ground surveys.

While much effort has gone into these activities over the years, a good deal of the information collected has not been collated or analyzed. Pearse, in his report stated:

> "A major flaw in the information system for managing the salmon fishery is the absence of routine analysis and reports on the condition of the stocks. Most of the information collected thus remains unutilized and inaccessible. Individual managers sometimes make their own assessments, but others have no opportunity to participate in the process. And, because the findings are never documented, others cannot judge the results."

Again, this deficiency has been recognized by Departmental management and steps have been taken toward correction. The research station at Nanaimo had been made responsible for assembling the raw and published data, and for collating and analyzing it. Unfortunately, much of the data are in such a confused state that it will take about a year to complete this work.

Chapter 6

Fisheries Management

To the uninitiated, salmon management may appear to be a very precise science or activity surrounded by a certain glamour and mystique. To say that it is a precise science would constitute over-statement. The very fact that all species of Pacific salmon spend varying portions of their life cycles in fresh water and in the ocean and, in both environments are subject to the vagaries of nature and depredations of man, many not fully understood, tends to make salmon management a somewhat chancy business.

Fishery managers have, however, over the years, developed a number of techniques and/or strategies based on research, technical investigations, trial and error and, last but not least, intuition arising from extensive experience which, in a package, constitute a salmon management program. In the case of some stocks these practices have been carried to a substantial degree of refinement and effectiveness. In other stocks, where knowledge is less detailed, management is not always as precise or effective.

To achieve their objectives of maintaining the salmon resource or increasing the various runs, the fishery managers are responsible for the achievement of several major activities annually. These are:

(1) Forecasting the size (in numbers) of returning runs of adult salmon for a given year and setting spawning escapement goals for the various stocks.

(2) Establishing an annual fishing plan prior to the fishing season and then amending the plan weekly or, in some instances, daily through special orders issued pursuant to the B.C. Fishery Regulations as fisheries occur and as actual abundance becomes known.

(3) In certain fisheries, and to the degree possible, attempting to achieve equitable distribution of the catch between the various types of gear and resource user groups in the many fishing areas.

In order to assist them in making the required week-to-week or day-to-day decisions on allowable fishing times and special closures to fishing required as the season progresses, the fishery managers carry out a number of data collection programs as follows:

(1) Collection of salmon catch statistics by area and type of commercial fishing gear for each day of fishing. This gives the managers initial information on the timing and size of the runs and, by extrapolation through comparison with previous cycle years, an early estimate of the volume of salmon escaping the commercial fisheries.

(2) Collection of catch information from the sport fisheries and Native Indian food fisheries on a weekly, monthly or annual basis and, occasionally, daily.

(3) Test fishing using hired gill-netters or purse-seiners in certain precise locations (e.g. Skeena). The test fisheries provide information used for:

(i) calculating the magnitude and timing of the runs;

(ii) calculating escapement of salmon through the commercial fishing areas; and

(iii) racial (stock) analysis based on scale samples or other methodology from the salmon caught to provide an estimate of stock composition in the commercial fisheries and contribution of the different stocks to the spawning escapements.

(4) Conducting counts of salmon in the various spawning streams using counting stations, counting fences or, in most cases, walking or flying the streams to estimate abundance or numbers of salmon spawners of each species.

(5) Observing conditions that affect egg to fry survival on important spawning grounds such as flooding and scouring of river and stream channels, siltation, drying of stream beds through drought or water diversion, winter icing conditions, water temperatures and contamination or pollution of the water.

(6) Making estimates of egg to fry survival and counts of young salmon (fry and smolts) migrating downstream to the sea in important spawning rivers in order to provide an early index of the abundance of the eventual returns of adult spawners.

The Department of Fisheries and Oceans unquestionably has competent, experienced and dedicated fishery managers who, despite claims by selfish special interest and pressure groups within the commercial and other fisheries, have done a commendable job of managing the fisheries under adverse circumstances.

It has been mentioned in Chapter 3 of this report that the commercial fishing fleet is too large in terms of numbers of vessels and catching capability. Simply stated, there are insufficient numbers of salmon for all participants to make a decent living and about one-half of the fleet is having serious difficulty in writing off its debt or even in meeting interest charges on that debt. Coupled with this are the increasing demands of the sport fish sector and the Native Indian food fishing participants for a greater share of the resource. It is quite impossible, given the current level of the salmon resource, to meet these demands.

The result is that in all sectors and, especially in the commercial fishery, the fishery managers are under almost unbearable and, sometimes unreasonable pressure, to provide more fishing time. In years of small salmon runs, this situation is especially prevalent. Being aware of the economic hardships faced by much of the fleet and by the processors, there is a tendency, perfectly human, to give some additional fishing time. This has to be at the expense of the spawning escapements. Generally speaking, spawning escapements coastwise have not been large enough for at least three decades to prevent the decline of most natural stocks and to facilitate the rebuilding of those stocks. This is fully understood by the fishery managers and, fortunately, appears to be receiving increasing recognition by resource users.

It is of paramount importance also to recognize that salmonid enhancement does not present an early panacea for the ills of the fishing industry. There is evidence to suggest that the pre-SEP facilities such as the Babine, Big Qualicum and Little Qualicum spawning channels, the Quinsam, Capilano and Robertson Creek hatcheries and the many fishways constructed to open new natural spawning areas upstream from formerly near-impassable or impassable obstructions have, in terms of the whole salmon resource, done little other than to offset the decline of the natural stocks. As the new facilities constructed since 1978 come on stream, some improvement can be expected but it will fall short of meeting the current level of demand placed upon the resource by its users. With this in mind, the need for more effective management, supported at the highest levels of government, to protect and rebuild the natural or "wild" stocks assumes even greater impact.

There is another issue which the fishery managers must address. This concerns the fishing of mixed natural and enhanced stocks of salmon. It is not a coastwide problem at this time; rather it involves discrete stocks and streams where major enhancement facilities are located. There is a danger that in fishing the enhanced salmon and wild stocks which are intermingled in fisheries along the migration routes to their streams of origin, that the natural stocks, especially those of smaller magnitude will be overfished or wiped out. There are quality problems in some species and stocks when taken near their home streams. This has been recognized and some studies of quality have been undertaken.

At the same time it should be recognized that the costs of attempting to attain perfection in fisheries management are tremendous. Perfection can

never be reached. What is needed is a pragmatic approach to the problems combined with application of research findings, past and future, and the existing know-how, experience and intuition of the fishery managers.

The Native Indian Food Fishery

In terms of overall catch by all users of the salmon resources the Indian food fishing does not put demands of consequence on those resources as it currently takes only about 3% of the total catch. On the other hand, in certain localities, e.g. along the Fraser River, the catch by Indians in their food fisheries is significant, especially since it takes place in some part on already depressed stocks of early run sockeye and chinook. Moreover, the trend over the past two decades has been toward increasing Indian food fish catches.

While the food fishery in many areas is conducted in an orderly manner with smooth working relationships between the Department and local Indian bands, there are other localities, especially in the southern part of the province, where the related fishery management and enforcement problems have assumed a consequential nature. This has resulted in conflicts with other salmon resource users, deterioration of relations between the Department and the Indian bands and a growing sense of mistrust, resentment and frustration on both sides. The reasons for this situation have been well documented and will not be repeated here.

The Canada/U.S.A. Fisheries Agreement

During the early period of their ocean life, young salmon from Oregon, Washington and British Columbia tend to migrate in a northwesterly direction into the Gulf of Alaska, along the Aleutian Islands and even into the southern Bering Sea. On their return migration as pre-spawning adults, fishermen from each country intercept salmon originating in the other country in the offshore troll fisheries, net fisheries along or near the outer coastlines and, in many cases, in the inshore approaches to the rivers of origin.

Canadian fishermen, in some years take salmon of Alaskan origin in their troll fisheries in Hecate Strait and Dixon Entrance and in their net fisheries in the inshore waters adjacent. In troll fisheries in Hecate Strait and along the west coast of Vancouver Island they catch many chinook and coho reared in Washington and Oregon streams. In Juan de Fuca Strait and in the Strait of Georgia, salmon originating in Washington, again mostly coho and chinook, are taken in the troll and net fisheries by Canadians.

Alaskan fishermen take salmon of B.C. origin in both their offshore and inshore fisheries. In some years, substantial numbers of pink and sockeye are caught by seiners in their fisheries along the outer coastline and by nets in their waters along the International Boundary Line near the approaches to the Skeena and Nass Rivers. They also intercept salmon of other species bound not only for northern streams in B.C. but also for those in the south of the province. For example, it is a well established fact that chinook salmon produced in the Robertson Creek hatchery on the west coast of Vancouver Island, were taken in substantial numbers by Alaskan fishermen in 1983.

Washington fishermen in their purse-seine, gillnet and reef net fisheries, take millions of salmon of B.C. origin annually, most of which are pink and sockeye caught under the provisions of the Fraser River Sockeye and Pink Salmon Treaty.

Over the years, there has been an imbalance in interceptions strongly favouring the United States. In 1982, U.S.A. fisheries intercepted about 3.5 million more salmon of Canadian origin than Canadians took of U.S. origin. In that year Alaskan interceptions of salmon originating in B.C. exceeded Canadian interceptions of Alaskan salmon by 1.37 million fish. In the south, salmon interceptions by Washington fisheries exceeded Canadian interceptions of Washington and Oregon salmon by 2.5 million fish. The 1982 catch of salmon originating in British Columbia rivers was 23.622 million fish. Of these, 24.5% were harvested by United States fishermen in their intercepting fisheries.

It can readily be seen that the imbalance in interceptions poses a problem for fishery managers in B.C. In the north, lacking any formal agreement with the United States, it becomes extremely difficult to exert any control over Alaskan catches of salmon originating in Canada, especially in the case of the important sockeye and pink salmon runs of the Skeena and Nass Rivers. Unquestionably, the Alaskans are in a position to benefit from the sockeye production originating in the large spawning channels on Babine Lake and have already done so.

In the south, the major interceptions by U.S. fishermen take place on Fraser River salmon of all species but largely on sockeye and pink. The

latter are managed by the International Pacific Salmon Fisheries Commission which tends to ignore the coho, chinook and chum salmon, often to the detriment of the spawning escapements of these three species.

Canadian fishery managers have catch and escapement goals to meet annually based upon their predictions of the volume of returning runs and readjustments as the fishing season progresses. Their already difficult task is compounded by the interception problem and the lack of a formal fisheries agreement between the two countries to cover all species of salmon.

Enhancement opportunities have been foregone owing to lack of agreement. There is little benefit in enhancing stocks which are subject to substantial interception by United States fishermen. The Fraser River system presents tremendous potential for enhancement of its salmon runs, especially sockeye and pink. It is estimated that Fraser River sockeye catches could be increased by more than 30 million pounds annually and, pinks which occur only in the odd-numbered years, by around 25 million additional pounds of catch through a vigorous enhancement program.

At the moment of writing, the chances for an early agreement do not appear strong. There are resource users and even fishery managers who advocate Fraser River sockeye and pink enhancement, even lacking an agreement between the two countries; others are strongly opposed to this stance. The Canadian negotiators feel that proceeding with enhancement would weaken our case and strengthen U.S. resistance to finalizing an agreement. This is an issue of import with which the authors will not attempt to deal. We only bring it to attention here because of its impact on Canadian fishery management and enhancement.

Notes for Part I

1 With the elimination of the "B" category licences, the fleet declined further and now stands at 4563 vessels.

PART II

THE SALMONID ENHANCEMENT PROGRAM

Chapter 1

Background

In March 1975 the concept of a Salmonid Enhancement Program was announced. Between that time and May 30, 1977, the Fisheries and Marine Service conducted an extensive series of studies and pilot projects directed towards the preparation of a comprehensive and geographically diverse enhancement package. The results of those studies are contained in a document printed in January 1978 entitled simply "The Salmonid Enhancement Program" but because it was bound in green covers became known as the "Green Book." The description of the program contained in this chapter is a very short summary of the principal elements of the "Green Book." On May 30, 1977, the Minister of Fisheries and the Environment announced federal government approval of the first five year phase of a salmon and sea-run trout enhancement program. The program involves the cooperation of the Government of British Columbia under a federal-provincial agreement. As a result planning for Phase I was carried on jointly by the two governments.

The rationale for undertaking such a program was the knowledge that the salmonid stocks of Canada's Pacific Coast were once capable of producing catches of 300 to 360 million pounds of salmon per year. By the beginning of the 1930's, major losses through environmental damage and overfishing had reduced production to about one half of the potential. Improved management practices have reduced this rate of decline but without substantial enhancement, it is believed that the current (1977) production of 145 million

pounds would likely decline a further 20 to 30% by the end of the century. Without the enhancement activities of the past half century, the current level of production would probably be substantially lower than it is. It was also known that fish culture technology could stop this erosion of the resource base and increase production of salmonids by at least 190 million pounds annually. Already, one hundred and seventy separate enhancement projects had been identified, which along with a number of small stream improvements could produce this potential.

Enhancement techniques, many of which were pioneered and proven by Canada, include spawning channels, hatcheries, fishways, stream modification, rearing ponds and incubation boxes. Other techniques such as lake and stream enrichment, Japanese style hatcheries and stock transplants were being developed and have since become part of state of the arts in enhancement.

Chapter 2

Objectives of the Program

The Salmonid Enhancment Program is a multiple objective program to be staged in two phases. The long-term production target of the Program is to increase salmonid production by about 190 million pounds per year over a period of between 11 and 15 years. Phase I comprises the first five years of the Program and its production target is an increase of 50 million pounds per year. The production target was not to be an end in itself but a means of achieving other objectives. These objectives are:

1) increasing national and provincial income;
2) creating employment opportunities for Canadians;
3) improving economic opportunities for Native Peoples;
4) fostering development of economically disadvantaged communities and regions; and
5) increasing and improving recreational opportunities and protecting the environment.

To measure the contribution that each proposed enhancement project would make toward the achievement of these objectives, the following five account system was adopted:

1) National Income
2) Regional Development
3) Native People
4) Employment
5) Resource and Environmental Preservation

All benefits and costs measurable in monetary units are handled in the National Income Account to establish the net national income benefits and the benefit-cost ratios for all economic purposes (commercial, recreational and native food fish production) of a proposed development. The National Income Account provides a measure for assessing forgone national income opportunities of other, multiple objective rankings which have been developed to meet other objectives. "The benefits of meeting objectives under the Regional Development, Native People, Employment and Environmental Accounts are not measurable in National Income "dollars" and their value is largely a matter of judgement."[1]

The "Green Book" contains an explanation of how "judgement" will be applied. For the Regional Development Account, the ranking of projects is based primarily upon three factors:

- the size of the primary fishing revenue impact;
- the probable geographic distribution of that impact in terms of who would likely catch the enhanced production; and
- the socio-economic conditions in the area of impact.

Each project is weighted (high, medium or low) to determine the final ranking of projects in terms of their regional development opportunities.

For the Native People Account, a rating system was designed based on five factors:

- the significance of the project for the Native Commercial fishery;
- the importance of the project for the Native food fishery;
- the employment implications for the Native communities;
- the the potential for developing a sports fishery in Native communities; and
- other factors of a more general character such as attitutdes, potential for training, shore employment, etc.

The Employment Account has two purposes:

- to rank salmonid enhancement project proposals on the basis of primary employment generated; and
- to estimate on a project by project basis, the probability of hiring labour resources which would otherwise be unemployed.

The information generated feeds back into the National Income Account. This exercise is an attempt to account for the fact that the use of these otherwise unemployed resources entails no social cost in terms of foregone national income. This is important in British Columbia where many coastal communities have continuing high rates of unemployment.

The rating system for the Environmental Account is designed to take the following factors into account:

- size of the stock in relation to its historical strength;
- the uniqueness of the stock;
- other methods of stock recovery that have been tried;

- ability to transplant other stocks;
- habitat protection;
- indicator of environmental quality;
- natural means of rehabilitation;
- species interaction;
- disease potential;
- competition with natural stocks of the same species; and
- fisheries management.

Chapter 3

Organization of the Program

The Green Book proposed an Executive Board responsible for the implementation of Phase I, including on-going planning and evaluation. The Board would direct and control operations through a Directorate which would carry out the policies of the Board. The Directorate would be the operating division of the SEP, with a nucleus of professionals and support personnel. The annual funding for the Directorate was projected at $750,000 for 1977/78 increasing to $950,000 in 1981/82. In fact the proposed Executive Board became an Advisory Board of 12 members of whom seven were drawn from the private sector and five were drawn from governments (three federal and two provincial) with the Deputy Minister of the Department of Fisheries and Oceans as Chairman. The Executive Director of the SEP and the Regional Director General of Fisheries and Oceans, Pacific Region, are ex-officio members.

Although not mentioned in the Green Book there is an advisory body to the Board called the Salmonid Enhancement Task Group with nearly 40 members appointed by the Minister to advise the Board. The members of the Task Group are drawn from a large cross-section of the fishing industry, other industries whose operations involve the use of the same habitat used for fish production, the native communities and the public at large. They represent all areas of British Columbia where salmonids are found at one time or other in their life cycle. The Chairman of the Task Group is also a member of the Board; funding for travel and meetings is provided by the SEP.

The Salmonid Enhancement Program is organized into five divisions:

- Finance and Administration;
- Engineering;
- Facilities Operations;
- Special Projects; and
- Program Development and Evaluation.

The Finance and Administration Division is responsible for the control of budgets, personnel and the provision of some support services. The Engineering Division is responsible for the planning design and construction of major salmonid enhancement facilities. The Facilities Operations Division is responsible for the operation and maintenance of all major enhancement facilities including those constructed before the establishment of the SEP. The Special Projects Division is responsible for the planning, design and construction of small enhancement projects, for all Community Economic Development Projects, the Public Involvement Projects and the Public Information Program. The Program Development and Evaluation Division is responsible for program planning, the evaluation of proposed projects, the monitoring of existing projects and the research required in support of the program. The evaluation includes the economic, biological and technical aspects of each project.

In organizational terms the SEP was entirely separate from the Regional Office of the Department of Fisheries and Oceans. The Executive Director reported directly to an Assistant Deputy Minister (ADM) Ottawa (except for a short time when the ADM was resident in Vancouver). At the time of writing, the Executive Director reports to the Regional Director General and other parts of the SEP are being integrated with the regional operations. This

matter will be discussed later in the report. Although the SEP was managed separately from the Department's regional office during Phase I there was considerable cooperation at the planning level between the economic group in the SEP and the regional economists. These two groups have now been fully integrated outside of SEP into a group called the Regional Planning and Economics Branch.

The goal of Phase II was seen as the use of the SEP as a regional economic generator and development tool to "achieve government's economic and social targets."[2] The increased production of salmonids and the distribution of the wealth created by such production were to be the means of achieving those targets. This approach would permit the annual rate of investment in enhancement to be varied in accordance with the availability of funds. "However, it is also clear that investment could be cut off at any state after Phase I, without significant negative economic or biological consequences. From Phase I on, each increment of investment can be discrete."[3] Recovery of both investment and operating costs of the program was considered feasible.

Chapter 4

Production Targets and The Process for Achieving Them

The production targets for Phase I are shown in the report of the Pearse Commission[4] and reproduced below:

Table I-1 Targets for Phase I

Species	Product Target in Millions of Pounds
Sockeye	9.0
Chum	28.9
Pink	3.8
Coho	2.4
Chinook	5.7
Steelhead and cutthroat	0.2
Total	50.0

To achieve these targets a variety of enhancement techniques were to be employed, some by the construction of major facilities, some by public participation through volunteer groups and some through Community Economic Development Projects.

The projected costs of Phase I by object are shown on page 16 of the Green Book and reproduced below.

Table II-2 SEP Phase 1: Estimated Financial Flow

($,000)

Object	Years				
	1977/78	1978/79	1979/80	1980/81	1981/82
a) Fish Production Projects					
i) Minor Projects and Economic Development	700	1,200	2,000	3,000	4,000
ii) Pilot Production Projects	1,200	2,200	2,500	3,000	2,500
iii) Major Projects (Design and Construction)	3,500	9,500	17,000[1]	22,000[1]	29,000[1]
b) Operation of Facilities	250	700	1,500	2,500	4,000
c) Bio-Engineering, Feasibility and Evaluation	1,600	3,600	5,500	6,000	5,000
d) Public Involvement	550	500	300	300	250
e) Economic Studies	450	450	300	300	300
f) Program Direction and Control, Administration	750	850	900	900	950
Total	9,000	19,000	30,000	38,000	46,000

[1] Interchange may be desirable between these three years, if feasibility studies warrant.

The above costs, capital and operating, were considered recoverable.

Once the overall target of producing an additional 50 million pounds of salmonids per year was established, targets were developed for each species which are those given in Table I-1. The process was quite elaborate. The region was divided into eight "geographical areas considering biological potentials, engineering feasibility, site suitability, economic factors such as enhancement unit production costs, commercial values, existing technologies, and the salmon manager's perception of socially desirable

projects."[5] Three Federal-Provincial geographic working groups were established to propose a strategy of enhancement to meet these targets. In addition to the above factors, the Working Groups applied a list of project selection criteria which included saving threatened stocks, extending the fishing season, dispersing the fleet, improving enhancement technology, reducing management risks, minimizing international interceptions, preserving future enhancement options and improving the opportunity for Indian participation.

Three aspects of salmonid technical feasibility considered during the review process are "manageability", "enhanceability" and "technical desirability." Within each of these broad aspects, several criteria must be met if each project is to provide its maximum contribution toward optimal yield and minimum risk. Because these criteria are essential in the evaluation of the success of the SEP, the Green Book's description of these[6] is reproduced below:

"a) Mangeability

Enhanced stocks must be manageable or they should not be enhanced. This means that the stock to be enhanced is demonstrably manageable as a discrete unit at the proposed levels of production; i.e.

- it can be harvested without over-exploitation of other stocks;

- it does not detrimentally interact with other valuable stocks (by predation, competition, etc.);

- it does not exceed the carrying capacity of freshwater or estuarine environments.

b) Enhanceability

The site and stock to be enhanced must be such that unnecessary and out-of-the-ordinary costs and risks are not likely to be incurred;

- there is an available supply of water and land of suitable quantity, quality and accessibility;

- the site can be utilized with minimal disruption of other natural resources and does not require excessive use of technology or power;

- the proposal is not conditional on additional future expenditures to generate net benefits;

- the stock to be enhanced is sufficiently abundant that only a proportion of the stock is required to fully utilize the proposed facility, unless there are special mitigating circumstances;

- the stock, site and proposed technique has its disease potential identified.

c) Technical Desirability

Projects should offer technical as well as social and economic benefits, including:

- contribution to technological development that would improve the efficiency of future program improvements;

- protection and rehabilitation of threatened stocks (maintenance of gene pools) and natural habitat;

- minimization of technological risks; i.e. facilities of low complexity are preferable to those of high complexity;

- maintenance of salmonid production options by assuring that the project will not foreclose future options for that system and by placing high priority on projects in watersheds threatened by other industries;

- maintenance of options for other industries by minimizing impacts on other national resources;

- minimization of opportunity for interceptions of stocks by other countries;

- contribution to knowledge in a way that can be evaluated;

- contribution to stability of annual production;

- minimization of energy needs for operation of facilities.

In addition to the salmonid production targets, the SEP had other targets for Phase I not specified in the Green Book but listed in the Pearse Report.[7] These were:

- to achieve an overall ratio of benefits to costs of 1.5:1, with a net contribution to the national income account of 325 million in 1980 dollars;

- to provide benefits of 200 million in 1980 dollars in the target area which is British Columbia excluding the lower mainland and southern Vancouver Island region;

- to provide the equivalent of 64 person-years of continuing employment for Indians;

- to generate 458 person-years of new employment in the construction and operation of enhancement facilities.

In addition to the above targets, the SEP included a Public Involvement Program (PIP) designed to encourage support from the public in preserving and enhancing the depleted salmonid stocks of British Columbia. The program has four formal goals which are:

1) to promote public awareness of concerns for, and commitment to the protection of stream systems and estuaries as essential elements of a long-term program of salmonid enhancement;

2) to provide the concerned public with factual information on the goals, strategies, methods, implementation plans, costs, benefits, and administrative organization of the SEP;

3) to develop a communication system to ensure that plans for salmonid enhancement reflect the reasonable views and desires of those citizens who will be affected by the program; and

4) to provide opportunities for the public to participate in salmonid enhancement.

The program has four basic components: education, participation, information and advisory. The education component is designed mainly to teach school children the fundamentals of salmon biology, enhancement techniques and resource interaction. The vehicle for teaching is the Educators Package named Salmonid in the Classroom. The Package has been accepted by the B.C. Ministry of Education and is marketed by the B.C. Teachers Federation. The participation component provides volunteers with technical help and material expenses to do a variety of enhancement tasks, such as small incubation projects and stream rehabilitation work. The information component handles all the SEP information needs. The services provided include the Salmonid newsletter available free to all interested parties (circulation 30,000), various SEP fact sheets and brochures, films and slide shows, travelling

displays, TV and radio spots and various promotional devices. Originally two levels of advisory input into SEP planning were envisaged: a regional advisory group called the B.C. Task Group and Local Task Groups at the community level. Finally only one group was established: the Salmonid Enhancement Task Group. Most of the work done by the Education and Information components is contracted out.

Notes for Part II

1 The Salmonid Enhancement Program, Fisheries & Environment Canada, January 1978, page 35, known as the "Green Book".

2 Ibid., page 16.

3 Ibid., page 17.

4 The Commission on Pacific Fisheries Policy, Peter H. Pearse, Commissioner, Final Report, September 1982, page 49, table 5-1.

5 Green Book, page 23.

6 Ibid., pages 25 to 27.

7 Pearse Report, page 49.

PART III

THE EVALUATION OF PHASE I OF THE SALMONID ENHANCEMENT PROGRAM

Chapter 1

Evaluation Based on Pre-Implementation Expectations

Because the time that elapses from the planning of an enhancement project to the return of adult salmon is so long, the success of most of the SEP Phase I projects must still be measured in terms of expectations. This should not have been a serious problem as most of the enhancement facilities constructed during Phase I are similar to those constructed before the SEP was established and the ratio of returning adults to released fry should be predictable. Moreover the SEP includes a mark and recovery program to identify enhanced production and attribute returning adult salmon to a particular facility. Unfortunately, the mark and recovery program was inadequate even for those species that have been successfully marked, the chinook and coho, and totally inadequate for the sockeye, pinks and chums. Consequently, even for those facilities or projects where adults are returning, it is difficult to measure the contribution that enhanced fish make to the fishery. Data on the natural (non-enhanced fish) are not much better. For these reasons, the evaluation of Phase I of the SEP in this chapter is based on the assumptions made at the beginning of the SEP on expected adult returns and their manageability.

Table III-1 below shows the expected production of Phase I.

Table III-1 Targets and Expected Production for Phase I

Species	Target	Production Capacity March 1983 (Millions of Pounds)	Expected Production Capacity by end of Phase I (Millions of Pounds)	Expected Production as Percentage of Initial Targets
Sockeye	9.0	13.1	16.9	187
Chum	28.9	11.6	16.0	55
Pink	3.8	1.4	1.4	37
Coho	2.4	1.4	2.9	120
Chinook	5.7	3.3	5.8	101
Steelhead & Cutthroat	0.2	0.4	0.4	200
TOTAL	50.0	31.2	43.4	87

Source: Unpublished data provided by the Department of Fisheries and Oceans to the Pearse Commission.

By the end of March 1982, projects with a capacity to produce 31.2 million pounds of adult fish were already completed or in operation and more have been completed since. By the end of Phase I in 1984, the productive capacity will have increased to 43.4 million pounds of adult fish per year.

It should be recalled that these targets were based on the assumption that the commitment to the program would be 150 million in 1976 dollars over a five year period. In fact the allocation of funds has been in current dollars and spread over seven years. These funds are expected to provide purchasing power equivalent to 78 million in 1976 dollars, or about 52 percent of the original assessment expected. By the end of March 1982, about $107 million of the $150 million committed by the federal government had been spent and the remainder will have been spent by March 1984. In addition, almost

$4.3 million of the $7.5 million of provincial funding was expended by March 1982 and most will be spent by March 1984. In the meantime, the federal government has allocated sufficient funds to enable the program to continue until 1986 while the results of Phase I are assessed.

In addition to the erosion of funds by inflation and the lengthening of Phase I from 5 to 7 years, the SEP staff estimated that the person-year problem which required contracting-out a variety of activities added $5 million to the cost of the program. It should also be recalled that the lack of an agreement with the U.S.A. on interceptions, prevented serious enhancement on some of the most promising river systems. Initially major projects were allocated $92.4 million or 65.1% of the total projected expenditures of $142 million. Instead they will have received only $67.0 million or 44.7% of the $150 million total by the end of Phase I in 1984, partly because of shifts to smaller projects with a community development orientation.

In spite of all these difficulties Phase I projected production of all species except pinks, is above the targets if one allows for the erosion of funds in real terms. (In other words they are all above 52% of targets.)

So far as the production of juvenile fish is concerned, Phase I must be considered highly successful. The fact that some species were enhanced more than others or that some enhancement techniques were more successful than others is interesting but not overly significant in evaluating Phase I. Their importance is paramount, however, in the process of planning future enhancement.

In addition to the production targets discussed above, Phase I had four other targets:

- To achieve an overall ratio of benefits to costs of 1.5:1 with a net contribution to the national income of 325 million in 1980 dollars.

- To provide benefits of 200 million in 1980 dollars in the target area, which is British Columbia excluding the lower mainland and the southern Vancouver Island region.

- To provide the equivalent of 64 person-years of continuing employment for Indians.

- To generate 458 person-years of new employment in the construction and operation of enhancement facilities.

Table III-2 below gives the anticipated economic achievements of Phase I.

Table III-2 Anticipated Economic Achievements of Phase I

Program Development	Government Cost	Net National Income Benefits	Benefit-Cost Ratio
	(millions of 1980 dollars)		
Major projects	94.8	78.0	1.4:1
Lake fertilization projects	9.0	48.5	2.4:1
Minor projects a)	15.0	-7.3 b)	0.6:1 b)
Community development projects	21.2	-4.8	0.8:1
Public participation projects	0.5	0.9	1.9:1
Provincial projects	11.3	-10.2 b)	0.1:1 b)
Unallocated overhead costs	27.7	-27.7	-
Total c)	179.5	77.4	1.3:1
Original target	211.5 c)	325.0	1.5:1

a) Includes minor engineering projects, small stream improvement projects and pilot projects.

b) Expected production from some projects in these categories beyond Phase I is excluded and therefore the net benefits and benefit-cost ratios are understated.

c) The estimated purchasing power in 1980 dollars of the funds expended during Phase I.

Source: Unpublished data from the Salmonid Enhanced Program provided to the Pearse Commission, reproduced on page 50 of the final report.

Phase I is now expected to generate net national income benefits of 77.4 million in 1980 dollars, about one quarter of the original target. The reduced purchasing power of funds available, higher construction costs and upward revision of harvesting and processing costs of enhanced production are responsible for a large part of the reduced expectations for national income gains. In addition, resources were diverted to enhancing depressed chinooks and away from projects that indicated higher economic benefits. It is difficult to measure precisely the significance of each of these factors and

while they account for a large part of the reason for lower national income expectations, they probably do not account for all of it.

The overall benefit-cost ratio of 1.3:1 also falls short of the projected 1.5:1. The same factors that combined to reduce the projected national income benefits have also reduced the benefit-cost ratio. In addition the minor projects and community economic development projects (CEDP's) were given more funds than in the original plans. Expected production from some projects in these categories beyond Phase I is excluded and therefore the net benefits and benefit-cost ratios are understated. In the CEDP's, the training component is very large and consumed nearly half of the allocated funds. Short-term benefits were foregone in favour of longer-term gains. Given the above problems, the reductions in the overall benefit-cost ratio was inevitable and the drop is probably not out of line with original expectations. What becomes clear as one looks at Phase I is that implicitly if not explicitly, there was a considerable shift in the program from production projects with high benefit-cost ratios to projects with higher social content and lower benefit cost rates.

Benefits to the target area did better but at a projected $78.3 million is still only 40 percent of the original projection. It will be recalled that one of the objectives of the program was to foster development of disadvantaged communities and regions. To meet this objective a rating system was designed primarily based upon: the size of the primary fishing revenue impact, the probable geographic distribution of that impact in terms of who would likely catch the enhanced production and the socio-economic conditions in the area of impact. As discussed previously the reduction in the

purchasing power of the initial funds and the shift from large to smaller projects had a negative impact on the volume of enhanced fish in all areas, although the impact was less severe in the target area. Benefits expected in the disadvantaged regions and communities were affected by most of the factors that reduced the expected national income benefits.

The target with respect to native employment was to provide the equivalent of 64 person-years of continuing employment for Indians. The most recent estimate suggests that only half that number will have been created by Phase I. As the numbers in the original target was very modest, failure to create those person-years of employment cannot possibly be attributed to a reduction in the purchasing power of the original $150 million dollar Phase I allocation. The explanation must lie elsewhere. Two different explanations were given by regional staff members: one that most of the full-time long term public service jobs require considerable skills and have to be filled through the competitive process for which few Native persons appear to be qualified. The other explanation is that the SEP staff members have not tried very hard to meet that target, partly because of their attitudes about Native people, an attitude it is believed is shared by many employees of the Department of Fisheries and Oceans Pacific regional office. This is not something that is easy to come to grips with although in defense of the SEP staff it must be emphasized that the CEDP's in Native communities are contracted out to the Bands and staffed by native people and those projects have created over 300 person-years of continuing employment. The recent appointment of a Native person as a Director of Native Affairs should help to resolve some of these problems. Our knowledge of the problem is insufficient to criticize the failure of the SEP to achieve the Native employment target.

The employment generated in construction and operating enhancement facilities is estimated at 623 person-years, considerably in excess of the target of 458. Most construction was contracted-out so most of the employment is in the private sector while most of the person-years in facilities operations are in the public service. Given the federal government's policy on public service employment, the heavy demands made on person-years by the operation of facilities is creating a serious problem for the Department. When the funds for Phase I were approved they included operating funds for facilities but not person-years. For the construction of facilities, only the planning and design and contracting process were done by the SEP staff; all construction work was contracted-out. On the operations of facilities only one major facility, Little Qualicum, has been contracted-out. On the other hand, all the CEDP's have been contracted-out.

The Special Projects Division includes three separate programs: the Small Projects Program, the Community Economic Development Program and the Public Involvement Program. These three programs have been evaluated by outside consultants for the SEP staff. The title of these reports and names of the consultants are found in Annex 2. The consultants have not only evaluated these programs in terms of their principal objectives but have also attempted to calculate the net benefits and benefit-cost ratios for these programs.

The Small Projects Program is carried out by the engineering and biological staff of the Small Projects Unit (SPU) of the Special Projects Division. The SPU was created to provide technical services to the community Economic Development Program and the Public Involvement Program, and to

undertake short-term projects in stream clearance and fish habitat improvement, in cooperation with the Field Services Branch (DFO) and the fish and Wildlife Branch of the B.C. Environment Ministry. The consultants judged the technical assistance given the SPU to be of high quality given the size of its staff and the demands made upon it. On the projects that SPU has undertaken directly or in joint projects, the quality of the Unit's work was also rated high. The consultants raised some doubt about the usefulness of some of the stream clearance projects. From an economic point of view these projects did well with an overall benefit-cost ratio of 1.18:1 and the spawning area developments having a benefit-cost ratio of 1.7:1. In addition to these benefits, the Small Projects Program posed no manageability problems, and its spawning area developments for chums were considered superior to Japanese style hatcheries. The consultants had some difficulty in understanding the respective roles of the Small Projects versus Major Projects but made no specific recommendation except that their respective roles should be reviewed and clarified. In general we agree with the consultants' evaluation but would suggest that small stream clearance should be handled by the fisheries officers as it used to be. It will be much cheaper.

The Community Economic Development Program (CEDP) was designed to help restore the depleted salmon stocks of British Columbia while at the same time imporoving the self-reliance, independence and social/economic stability of the Native peoples of British Columbia. An experimental program of six projects, the Native Project Pilot Program, funded jointly by the Department of Fisheries and Oceans and Canada Works was initiated in 1977/78. During that year it was decided to include non-native communities with high

unemployment in the Program; the present CEDP evolved from this pilot program. The CEDP has a strong training and community development component. As part of this training and community development component the enhancement work is being done by Bands or community groups. Much of the training has been formalized and is now administered by Malaspina College with funding from the B.C. Ministry of Education.

The consultants evaluated the CEDP in terms of bio-technical aspects, social benefits, economic efficiency and program management and planning. In terms of egg survival rates, quality of hatchery fry, stream clearing work and pen rearing in marine waters, the consultants concluded that the CEDP's bio-technical performance was similar to that of other DFO projects. The consultants noted that the "Bands and community groups can build small scale production facilities and learn to incubate and rear acceptable numbers of healthy fry in about five years." The CEDP has been successful in providing social benefits particularly in Native communities. From April 1977 through March 1982, the CEDP created about 266 person-years of Native employment and 46 person-years of non-Native employment at a cost of $25,000 per person-year counting contract costs only or $37,700 per person-year if administrative costs are included. The program has been satisfying both to project employees and to the communities at large. There has also been substantial training benefits including the creation of a formal training program by Malaspina College. In 4 of the 9 Indian projects, the CEDP is the only economic development project in existence, and many of the programs at other Bands are short-term make-work projects. The CEDP's have also had a positive effect on Departmental-Band relationship in the participating communities.

Although economic efficiency was not a specific objective of the Program, it has apparently been assumed an overall benefit-cost ratio of 1:1 was feasible, or 1.5:1 if labour was shadow-priced. The consultants calculated that the hatchery projects, which accounted for 67% of total contract expenditures, currently achieve a program benefit-cost ratio of 94:1 if labour is valued at full cost or 1.23:1 if Indian labour is shadow-priced. Total expenditures from 1977/78 to 1981/82 have been $7.9 million in project contracts and $3.2 million in administrative costs (1979 dollars). The SEP has supplied about 82% of the funding and Canada Employment and Immigration the balance. It did not appear to have cost any more by having the Bands construct the facilities than having the SEP personnel do so.

The consultant found that the program management was good enough to allow the program to grow from an original six projects to the present fourteen while creating benefits related to all its objectives. The key factors to the success of the management strategy are identified as

- The management structure is flexible, decentralized and responsive to local needs;

- CEDP staff are seen as easy to get along with and quick to react; and

- CEDP personnel have had fairly realistic expectations about the performance of crews, project managers, and contractors.

The consultant noted some problems of which the following are the most significant:

- There is confusion both inside and outside the program about the goals and methods of the CEDP, its relation to the Native community and its relation to SEP as a whole. Few people are certain of the explicit objectives of the program and what constitutes success in meeting them.

- Confusion over CEDP objectives was exacerbated by the lack of a program Head for two years, leading to a general lack of direction in project planning, selection, review and accountability.

- Native Indians believe they don't have enough input into program management.

- Support for the CEDP within other branches of SEP is poor."

The consultant made several recommendations to resolve these problems and we are advised that they are being implemented. In spite of these problems one has to judge the CEDP a success. None of the facilities constructed under the CEDP create any problems for the management of the natural stock, although as for the larger facilities, only a few have seen adult returns.

The Public Involvement Program (PIP) was designed to encourage support from the public in preserving and enhancing the depleted salmonid stocks of British Columbia. The four formal goals of PIP were listed in Part II chapter 4 so they do not have to be repeated here. The consultants conclude that the PIP has been successful and we cannot disagree with that conclusion. In our interviews we found general agreement that the Public Involvement Program was a success although there were some dissenters with certain aspects

of the program. All agreed that the educational component was the best part of the program. Some had doubts about the information component which they felt might be neglecting to tell the public about the problems and raising expectations about the salmonid enhancement program as a whole that may not be realizable. Similarly the interest fostered in communities for involvement in enhancement could create demands for the services of technical expertise and advisory services that may not be able to respond, leaving disappointed people. The local fishery officer may be glad to have people asking his advice about enhancement rather than criticize him for policing the resource but such demands may well interfere with his primary task. While we agree that PIP has achieved its principal goals, these should be re-examined and the current approach to achieving them should be reassessed. Elsewhere we comment on the role of the Salmonid Enhancement Task Group, which was the vehicle for bringing the views of the general public as well as those of interested groups to the Program.

Chapter 2

Evaluation Based on Post-Implementation Information

The opening sentence of the "Green Book" says that the Salmonid Enhancement Program is: "an economic development program which will apply proven fish culture technology to increase the production of Canada's pacific salmonid resource." If one looks at the SEP as a production system separate from the management of natural salmonid stocks, one has to conclude that given all the difficulties outlined in the previous chapter over which the Program managers had no control, Phase I was highly successful, if success is based on expectations.

At the beginning of Phase I program planners made certain assumptions based on their knowledge of past enhancement and fisheries management experience. The most important of these that have a bearing upon the evaluation of Phase I were:

1) the number of returning adults to each enhancement project could be predicted based on known survival rates and their contribution to the fishery could be measured;

2) enhanced fish from each project could be harvested without endangering the natural stocks; and

3) the cost of harvesting and processing the additional production could be controlled.

The first two were not unreasonable assumptions to make given the state of knowledge about fish culture at that time although with the wisdom of hindsight one might have placed more emphasis on an R&D program as an integral part of Phase I. As stated in Chapter 1, only chinook and coho had been successfully tagged with coded wire tags (CWT) and these two species represented only 16 percent of expected production. Although work continued on the development of marking techniques for the other species there was no substantial increase in resources allocated to this particular problem. In spite of this apparent lack of emphasis, sockeye and chums can now be successfully marked with coded wire tags and recent experiments suggest that the technique can be adapted for pinks. Hence the enhanced fish from projects that produce chinook, coho, sockeye and chum salmon can now be identified provided that enough juveniles are tagged before being released. Other methods of stock identification such as scale samples, identification of parasites and electrophoresis are being used with considerable success.

It is generally agreed that enough enhanced chinook and coho have been tagged during Phase I to attribute returning adults to a particular project and enable the enhancement manager to compare the number of returning adults with the expected number based on assumed survival rates. Some doubt has been expressed, however, about the adequacy of the size of the tagging program to determine the contribution which enhanced fish makes to each fishery on their return. This has some significance in relation to the calculation of benefit/cost ratios because of the different values and costs of fish depending on when and where they are caught and by what gear type.

Tags are of little value unless they are recovered and analysed. At the time of writing all tags recovered from both enhanced and non-enhanced fish tagged during Phase I have yet to be analysed although a special effort is being made to accelerate the analysis. Some results are available now but it will be the end of the year before they are all analysed. Analysis of recovered tags for chinooks released from Big Qualicum, Capilano, Quinsam, Robertson and Puntledge has now been completed. Preliminary results for all facilities except Quinsam, indicate that the number of returning adults was at or above the number projected based on assumed survival rates. The data for Quinsam were based on 1974-76 brood years and a contribution period of 1976-80 while data for the other facilities were for three more years; Quinsam data should be interpreted accordingly. Recovered tags for coho from Big Qualicum, Capilano, Quinsam and Robertson were also analysed and preliminary results are mixed. Returns from Big Qualicum and Capilano smolts released from brood years 1971-76 were at or above projections while returns from Quinsam (1974-76) and Robertson (1972-76) were below projections. We may have to wait for another year or two before the results can be properly evaluated.

All the above facilities were constructed before Phase I although their operations have either been expanded and/or improved during Phase I. Of the facilities producing chinook and coho constructed during Phase I we will have to wait until they have completed a full cycle of about 5 years. However, it is generally agreed that the facilities constructed during Phase I are likely to be more efficient than pre-SEP facilities and the egg-to-fry and fry-to-adult survival rates should be higher. It seems reasonable to conclude that for chinook and coho hatcheries, the projected adult returns (catch + escapement) attributable to a particular facility based on assumed survival rates are achievable.

As no tagging of other species was carried out except for chums on a limited basis, it is not possible to assess the success of the enhancement projects that produce those species. The performance of chum enhancement facilities at Pallant, Bella Coola and Big Qualicum were well below the bio-standards established for these facilities while the performance of Thornton Creek facility appeared to be above the standard and Tlupana was close to standard. These results, however, must be interpreted with caution not only because of the experimental nature of the Japanese-style chum facilities but also because of some of the difficulties experienced with the wild chum stocks. Where some juvenile wild chums were tagged, their survival rates were also very low. More research has to be done on the time and size of release as well as other aspects of producing chum in Japanese-style facilities. There is also an urgent need to have a better understanding of why wild chum stocks have no rebuilt following reduction in exploitation rates.

One of the most interesting enhancement experiments is the fertilization of certain lakes that produce sockeye to increase their capacity to rear juveniles. The program is known as the lake Enrichment Program and is expected to account for about half of Phase I production at full capacity. The program began as a 7-year experiment under the direction of the Fisheries Research Branch but funded by the S.E.P.

The Lake Enrichment Program as it became known is still managed by the Research Branch. Twelve lakes have been fertilized and some of the earlier lakes have apparently been successful. There is no aspect of enhancement that is more likely to provoke an argument than to question the success of lake

enrichment. Unfortunately, only two of the treated lakes have post-fertilization escapement counts by fence and pre-fertilization data are in dispute on almost all lakes. Moreover, as the juvenile sockeye are not tagged, there is some doubt about where the fish from a treated lake are caught on the return journey and also how many return as adults in relation to the numbers of juveniles that leave the lake.

One of the success stories of the Lake Enrichment Program most widely discussed is Great Central Lake on Vancouver Island. Although pre-fertilization data may not be perfect, they appear to indicate the number of returning adult sockeye in the neighbourhood of 100,000 to 150,000. Since fertilization, returning adults are estimated at between 600,000 to 750,000. Even if the increase is at the lower end of the scale, it would seem to be so large that its success could not be questioned but, from the scientific standpoint it is. The juvenile sockeye from Great Central Lake leave the freshwater at the same time as those from neighbouring Sproat Lake which has not been fertilized. As the returns of adult sockeye to Sproat Lake have also increased, it is argued that the increase in the returns to Great Central Lake cannot be attributed to enrichment.

Without good pre- and post-fertilization data, it is difficult to satisfy those critics. There is in our view one logical explanation for the increase in the returns to Sproat Lake. When juveniles leave the fresh water system they are subject to heavy predation on their way to sea. As they are accompanied by the juveniles from Great Central Lake on their journey, the large increase in the number of juveniles helps to "convoy" or protect the juveniles from Sproat lake which increases the survival rate of Sproat Lake

juveniles. While this explanation and the very large increase in the production of Great Central Lake convinces the authors of the success of the fertilization of that lake, we are still uncertain about the success of the program as a whole. Hence, until better data on the production of lakes selected for treatment are available before treatment begins, juveniles are tagged before going to sea and a good count of escapement is undertaken, the success of the Lake Enrichment Program cannot be adequately evaluated.

The authors recognize that the high cost of marking fish/estimated at about $15 per adult fish) precludes the marking of every fish from every brood. This, however, is not necessary. What is required is that a scientifically selected sample of juveniles be tagged to establish the numbers of adults that return to the fresh water from a particular enhancement project and the contribution these fish make to each fishery (when and where they are caught and by what gear type). Once these facts are established it should not be necessary to repeat the tagging unless some fundamental changes occur in the facility itself.

So that an adequate evaluation of Phase I can be undertaken we make the following recommendations:

1) the completion of the analysis of recovered coded wire tags (CWT) as quickly as possible;

2) based on the results of the analysis, complete the evaluation of returning adults for each enhancement project against the bio-standards established for that particular species at that facility;

3) increase the size of the tagging program to assess the contribution that the enhanced fish from a particular facility make to each fishery;

4) establish a coded wire tag mark and recovery program for sockeye for all enhancement project but allocate the highest priority to Lake Enrichment Projects;

5) increase the size of the mark and recovery program for chums in all facilities;

6) establish an adequate counting system on all lakes that are candidates to be fertilized to establish pre-fertilized production levels;

7) on fertilized lakes, establish an adequate system of counting escapements until the production of the lake is established.

The second assumption is concerned with the manageability of the stocks including interspecies interactions of enhanced and non-enhanced fish in the form of predation and competition as well as the harvesting of returning adults. It is the latter that concerns us most directly in the process of evaluating Phase I results. It is a complex issue even when one is discussing the pre-implementation planning with respect to the harvesting of projected enhanced fish. It becomes much more complex when the enhanced fish return to the spawning grounds and the fisheries manager is trying to protect the runs of natural fish. In his report, Commissioner Pearse expressed his concern

about stock interaction and discussed the problem in terms of pre-SEP enhancement projects that have been in operation for some years. He accepted that Phase I projects had been better screened in terms of manageability but was still sufficiently concerned about the stock interaction problem that he not only urged caution in future enhancement but also rcommended careful monitoring of existing projects.[21]

There is still considerable controversy among outsiders interviewed and the people involved in the enhancement program about the adequacy of the manageability review process and studies. The research scientists would like to see at least a modest research program on the relationship between enhanced and non-enhanced fish during their full life cycle. The evaluation biologists would like to see more pre-implementation studies to identify potential manageability problems and post-implementation studies to assess the results against expectations. The fisheries manager would like to be given more time to consider the potential manageability problems. There was general agreement by all parties that better data on the state of the wild stocks and an adequate mark and recovery program on enhanced stocks are imperatives for a manageability review.

Pre-implementation manageability studies and reviews are undertaken five to seven years before the candidate project has produced a return of adult salmon. By that time the conditions of the wild stocks may have changed for the worse, the economics of the fleet may have deteriorated placing greater pressure on the fisheries manager for more fish, the responsible fisheries manager may not be the same one who was involved in the review process and the management strategies may have changed. During that time the scale and

technology of the project may have undergone certain changes without these having been taken into account. When all these factors are considered it is difficult to say whether the manageability problem was adequately assessed by the S.E.P. planners for all Phase I projects but on balance we are inclined to conclude that it was. We have some doubts, however, that it was adequately assessed by the fisheries managers for pre-SEP facilities and for early SEP facilities. We believe that this is now being remedied.

In the previous chapter, we discussed ex-post analysis of the Babine enhancement project which has been in operation for over 10 years. There is evidence that in the process of harvesting the large run of enhanced sockeye, several other stocks of sockeye and other species were either much reduced or eliminated so that the overall catch of all species from the entire system is no larger than before enhancement. As a result of recent manageability studies, including a fish quality study to establish how near the spawning grounds the enhanced sockeye could be fished, fisheries managers will be able to change their fishing plans so that non-enhanced stocks can be harvested at a lower exploitation rate and hence a larger proportion of the wild stocks can be permitted to escape to the spawning grounds.

Similarly, in the harvesting of the large sockeye run from the Great Central Lake enrichment project, a large number of immature chinooks were also being caught. By shifting the timing and location of the harvest, the fishery manager was able to avoid catching immature chinooks. We give these as examples of how these mixed stock fishery problems can be resolved even when pre-implementation studies have not identified such problems. Nor are these problems limited to enhanced stocks. As indicated previously in this report,

mixed stock problems have been part of the salmon fisheries management problems for a long time. It is generally agreed, however, that the closer to the spawning grounds that stocks can be fished the easier it is to avoid the mixed stock fishery problem.

The pre-implementation manageability review is the basis for determining the value of the output of the enhancement facilities. Some pre-implementation studies have shown that the fish cannot be harvested without damaging other stocks unless at least a substantial proportion are harvested near the spawning grounds when their quality is inferior. In these cases the value of the output has been discounted accordingly in calculating the benefits of the facility. Although we have not been able to study each Phase I project from a manageability point of view, we are satisfied that the SEP planners screened their projects adequately and Phase I results are not likely to be affected negatively because of avoidable errors made in the manageability review process. This does not mean that manageability problems will not arise. There are also some other kinds of stock interactions that may create problems.

We would, therefore, make the following recommendations:

1) a pre-implementation study be undertaken for every major enhancement project including, where appropriate, a fish quality study;

2) the manageability process be lengthened to provide sufficient time for fisheries field managers to make an adequate contribution to the process;

3) a post-implementation manageability study be completed for all large enhancement projects as soon as a cycle of production is completed;

4) a research project be established by the Research Branch to assess the interactions between enhanced and non-enhanced fish in their entire life cycle; and

5) the work begun recently on a thorough review of the state of the natural stocks must be completed as quickly as possible and an adequate program be established to ensure that the information from the review be kept current in future and co-ordinated by one unit in the Regional Office.

6) Future research, except of the more practical nature be made the responsibility of the Fisheries Research Branch and that it be adequately funded.

7) Steps be taken to improve the quality of escapement data through implementation of an indexed or "key" stream approach which would direct more attention to the major salmon producing streams and give less attention to the minor producing streams.

8) Appropriate measures be taken to make enforcement staff more visible to the public and policing of the fisheries more effective.

The third assumption is concerned with the control of fishing and processing costs, although the former is much more significant as the cost of raw

fish accounts for about 70 percent of the cost of processed salmon. The economic analysis carried out at the beginning of Phase I and summarized in the Green Book demonstrates that based on projected production figures of Phase I, the SEP was capable of generating "enough commercial fishery revenues over a 40 year period ($630 million) to more than adequately cover all the program costs ($250 million)."[3]

These calculations were based on the conclusion that "in general, there is sufficient existing capacity in the fishing industry in B.C. to catch and process more than double the present runs. Consequently, if this is the case, the only incremental costs necessary to harvest the fish runs at this scale of enhancement are the variable costs - labour, fuel, supplies, etc. In short provided that industry is appropriately disciplined to prevent further unnecessary and inefficient investment in capacity, the commercial associated costs will amount to only the increased variable costs of harvesting and processing."[3]

It was sufficiently clear to the planners of Phase I based on past behaviour that the industry would dissipate projected rents in unnecessary investments unless it was prevented from doing so. Hence, in the federal-provincial agreement at the beginning of Phase I, the governments made commitments to control investments in the fleet and processing plants. Neither government has taken any steps to fulfill this commitment and there is nothing to prevent the benefits of enhancement from being dissipated by unnecessary investments.

We have therefore concluded that although the potential benefits of Phase I can be measured once the necessary information has been obtained,

there is nothing to prevent these benefits from being eroded by the lack of control of investments in the commercial fishery. Because there are other aspects of the fleet beside the level of investment, we will discuss the fleet question in Part V where we examine other SEP related and general management issues that have to be resolved for future enhancement. In the meantime, if the government wishes the potential benefits of the SEP to be realized, investment in the fleet must be controlled.

Chapter 3

Evaluation of the Net Contribution of Phase I Production

When the Salmonid Enhancement Program was approved, its production was looked upon as a "net" addition to the production of the natural stocks. Nowhere in the literature were we able to find clarification of what "net" was intended to be. From recent S.E.P. publications and discussions with the S.E.P. staff, we have concluded that all the production attributable to the S.E.P. projects is considered "net." This is because it is not directly responsible for the reduction of the non-enhanced (natural) stocks. Such reduction could only occur if the enhanced stocks could not be harvested without over-cropping the natural stocks but according to the staff, the careful screening of all enhancement projects in the manageability review process makes this unlikely. As for the other stock interactions, their importance is not known, and hence cannot be taken into account. From the narrower perspective of the S.E.P. this reasoning is understandable.

The research scientists take the opposite view. The "net" contribution of enhancement is seen within the context of total natural production (catch plus escapements). Hence, if production from enhancement projects during a certain period total say 2 million fish and natural production falls by 1 million during the same period, the "net" contribution of enhancement is 1 million fish. From the broader perspective of overall fisheries management, one cannot deny the logic of this reasoning.

In the Green Book, the SEP planners looked at the socio-economic impact of the Salmonid Enhancement Program to assess what the state of the nation

would be "with" and "without" the program. Without any action they concluded "that natural production could be reduced by at least 30 percent by the year 2007."[4] They went on to say: "However, since the 1950's this long-term downward trend in natural production has been arrested by man's efforts in the areas of resource management, habitat maintenance and protection, access improvement and enhancement."[4] The planners also recognized that it was becoming more difficult for Pacific Region fisheries managers to find low-cost production and management options. Implied in the above discussion is the notion that enhancement could arrest if not reverse the "inexorable downward trend in natural stocks."[4]

As the natural stocks of all species are still in decline, their exploitation rates will have to be reduced if the downward trend is to be reversed. This will permit higher escapements to the spawning grounds. For chinook stocks scientists have concluded that this would require a 30 percent reduction in the exploitation rate while for sockeye and coho a 5 percent reduction would be sufficient. For chums and odd-yera pinks a 10 percent reduction would be sufficient; even-year pinks can support current rates of exploitation. All these rate reductions can be varied if one is prepared to accept a longer time span for recovery.

Enhancement can play an important part in cushioning the effects of a reduction in exploitation rates on the commercial fleet. Biologists at the University of British Columbia have constructed a model that provides alternative management schemes for harvesting mixed enhanced and natural stocks without over-cropping the natural stocks. As this may lead to more enhanced fish being taken nearer the hatchery gate, its quality may be

somewhat inferior. All this is going to require adjustments to current management strategies and considerably increase its complexity which will probably multiply when all Phase I projects are in full production.

If enhancement is to be a "net" addition to natural production and not its replacement, it must be used to ensure that the existing natural stocks produce at their optimum. It is obvious, therefore, that enhancement must be an integral part of fisheries management. On the basis of current information, it would appear that no more than half of Phase I production can be considered a "net" addition to the production of natural stocks. The blame, if there is any, should not be placed on those who managed the S.E.P. during Phase I. In our view the separation of the S.E.P. from the other fisheries operations in the Regional Office must be considered a contributing factor although there were other factors as well. The deterioration in the quality of the data on the catch and escapements, the inadequacy of the assessment of the natural stocks and their reproductive capacities, increasing pressures by all users of the resource on fisheries managers for more fish, and the reduction in personnel available for protection and conservation are in our opinion far more important.

Chapter 4

Further Evaluation

In Chapter 2 we concluded that the evaluation of Phase I could not be completed on the basis of available information. We further stipulated what information was required and stated what was now being done to obtain that information. Most of that information on stock assessment will be available before the end of April and the rest of the information required should be available before the end of the year. The exception is the information on the section of adult salmon to those enhancement facilities constructed during Phase I but only just entering production. It is not necessary to obtain this information for all projects and all species so there should be enough data available on the production from enough facilities to make an acceptable judgement about the rest before the end of the year. We would suggest that an outside expert be asked to review the information and provide an assessment of its adequacy to evaluate Phase I projects.

Once the information is available, the regional staff can complete the evaluation of Phase I projects. Professionals in the newly organized Regional Planning and Economics Branch and Fisheries Research Branch are capable of doing that evaluation competently. In our view it is not necessary to retain outside experts unless there is doubt about the objectivity of regional staff. If this occurs, an outside expert could be retained to audit the evaluation.

Notes for Part III

1 Green Book, page 3.

2 See Pearse Report, pages 51 and 52 and also a paper prepared by W.E. Ricker entitled, "Impact of Enhanced Populations on Natural Stocks," 1982, unpublished.

3 Green Book, page 57.

4 Ibid., page 44.

PART IV

THE RESEARCH REQUIREMENTS OF THE SALMONID ENHANCEMENT PROGRAM

Chapter 1

Organization and Conduct of Research in the Department of Fisheries and Oceans

This chapter deals principally with the organization of research on salmonids, but also with habitat and economic research and the conduct of those types of research since the commencement of the first phase of the Salmonid Enhancement Program. While there is emphasis on SEP related research, mention is also made of research having bearing on fishery management. The two cannot be treated separately. Research and salmonid enhancement must be regarded as tools of fishery management.

It was stated in Part I of this report that funding for research related to SEP was not built into the first phase of the program except in a relatively small way. Enhancement techniques were available that had already produced acceptable results in other countries as well as in facilities constructed in British Columbia in the two decades preceding the new program. Moreover, the Biological Station at Nanaimo had conducted research on salmonids for many years and possessed a cadre of highly competent and experienced scientists in the related fields of research. However, with their financial and manpower problems, they could not meet the S.E.P. research needs since they were not provided with sufficient additional resources.

Salmonid research and habitat research are the responsibility of the Director of the Fisheries Research Branch in the region. He in turn, reports directly to the Regional Director-General. A discussion of some of the more

important types of research follows except for economic research which is discussed in the next chapter.

A. Research on salmonids

Research on salmon is conducted by the salmon section based at the Biological Station in Nanaimo. A summary of the 1984-85 program of this section is shown below and is indicative in fairly general terms of the types of research being undertaken.

SALMON SECTION

SUMMARY F/Y 1984-85

Program	P/Y	G & S	Cap.	Total	Cont./Term	Student
MANAGEMENT	2	20.0	0	20.0	0	0
GENETICS	7	160.5	64.0	224.5	0.5[d]	1 (PDF)
HYDROACOUSTICS	4	62.0	63.0[a]	125.0	0	1 (PDF)
DYNAMICS	5[b]	82.0	46.5	128.5	0	1 (NSC)
STATISTICS	2	35.0	5.0	40.0	0.5[d]	0
SAMPLING	5[c]	112.0	0	112.0	0	0
BIOLOGY	17[e]	324.0	42.0	366.0	0.5[d]	1 (PDF)
LAMPREY	0	11.5	0.5	12.0	1.0	0
	42 (39 on strength)	807.0	221.0	1028.0	2.5	4

[a] $60K Simrad simulator -- recommended regional purchase.
[b] Sibert on leave to end of 1985.
[c] + 1 P/Y -- new request.
[d] New requests.
[e] +2 P/Y -- new request.

Ten person years of the forty-two shown in the table are directly involved in research related to salmon enhancement. Some examples of research which have direct or indirect implications for salmonid enhancement follow.

1. Stock analysis and identification

(a) Morphometrics and meristics - study of the body parts of the salmon and the numbers of components in the body part, e.g. scales, gill-rakers etc. to determine race or stock.

(b) Electrophoresis - identification of different forms of an enzyme occurring in the body protein of salmon. The results have been usefully applied by fishery managers in determining the stock mix of chum salmon in Johnstone Strait and the Fraser River including catch composition, magnitude of the runs and their timing through the fishery. The scientists are able to provide the information to the managers on a real time basis and at a fraction of the cost of other stock identification methods such as tagging. Experiments are in progress to determine if electrophoresis can be successfully used in identifying stocks of the other species of salmon. The method has one shortcoming; it is not possible at the current state of the art to distinguish hatchery stocks from natural stocks.

(c) Diseases and parasites. In Barkley Sound and Alberni Inlet where adult sockeye from Sproat, Henderson and Great Central Lakes are intermingled in the commercial fisheries it has been possible to establish the lake of origin of these fish through identification of

parasites in body muscle and brain tissue. Sproat lake and Henderson lake sockeye both harbour one variety of parasite; sockeye in the latter are host to a second variety as well. By identifying the lake of origin the weekly and seasonal contribution of each stock race can be calculated, a significant aid to fishery managers. Seasonal changes in stock composition and certain aspects of migratory patterns can also be demonstrated by this means. This breakthrough is especially important in determining the contribution which the Henderson Lake stocks make to the fishery and the spawning escapements. These stocks have increased substantially through lake enrichment and the new technique should help to measure the degree of success of the Lake Enrichment Program.

2. Fish culture research including pen rearing and commercial culture

(a) Fish food experiments - Experiments are being conducted with various types of food that can produce larger and stronger fry and smolts at the hatcheries, referred to as smolt "quality" which is fundamental to survival at sea and to eventual larger returns of adult salmon. The experiments are also aimed at diets which would result in manufacture of fish foods in British Columbia. Currently all feeds used in the SEP hatcheries are imported from the United States.

(b) Size and timing of release of young coho and chinook salmon at hatcheries. It now appears possible to double the numbers of returning coho adults through releasing the young at a larger size and through delaying their release to the stream from the hatchery

rearing ponds. Initial indications are that the results may be even more dramatic for chinooks.

(c) Disease control and treatment. Researchers work with the hatchery managers in treatment of outbreaks of disease with emphasis on prevention rather than cure. Vaccines for such disease as furunculosis and kidney disease in young fish are under development and it is expected an effective vaccine for the former will be produced this year. Methods of applying the vaccines are also under study to minimize shock and resultant mortality of the young fish. This work is important as losses through disease at some SEP hatcheries have been as high as 20%.

(d) Controlled sex differentiation. This research falls into two categories. The first is concerned with increasing the proportion of female adults produced. Thus, the number of eggs harvested and salmon produced in subsequent generations may be significantly increased - a valuable tool in more rapid restoration of certain declining stocks of salmon. The second provides a means of producing sterile salmon for ocean release or for pen culture. Sterile salmon do not undergo sexual maturation and lack the spawning urge. As a result, they continue to live and grow for several years beyond the normal life span. If released to sea, they therefore will tend to make contributions to the various fisheries for a longer period of time than the normal salmon. For pen rearing, sterile salmon have the advantages that quality is maintained the year round and the culturist does not have to be concerned with harvesting prior to sexual maturity.

3. Genetics

Much concern has been generated in some circles, both inside and outside the Department, about hatchery production creating new gene "pools" with possible future ill effects on both the hatchery stocks and the natural stocks of salmon with which they eventually mix in varying degree on the spawning grounds. Studies are in progress to determine the implications so far as the natural stocks are concerned and the genetic consequences of hatchery practices and selective breeding of salmonids.

4. Fisheries management

Research related to fishery management but also bearing on salmonid enhancement is an ongoing process and falls into three categories:

(i) monitoring to provide accurate information about the salmon stocks.

(ii) shorter-term research aimed at problem solving, and

(iii) longer-term research looking to improving future fishery management and enhancement practices.

A list of research projects would include the following.

(a) Salmon biology

This work over the years has centred on the life histories of salmonids, their distribution and evolution, anatomy and development,

physiology, behaviour, ecology and population biology and parasites and diseases. Plans are in progress to prepare a series of technical volumes updating what is known about the biology of Pacific salmon which will include a volume on salmon management.

(b) Stock assessment

A basic requirement for sound fisheries management is an understanding of such matters as salmon stock abundance, catches, catch composition and spawning escapements. Research has been carried out over many years and is now being intensified although the quality of the information available to the researchers has deteriorated. Moreover much of the information collected has not been routinely assembled and analyzed. The same applies to a number of tagging programs on adult salmon stocks conducted in recent years. A stock assesment group comprising scientists and technical people from the Fisheries Research Branch and Field Services has recently been established to correct these shortcomings.

B. Lake enrichment and limnological studies

Lake enrichment or fertilization has already been proven successful in the enhancement of sockeye, the outstanding example being Great Central Lake on Vancouver Island where runs are now four or five times their previous magnitude. It also shows distinct promise in enhancing chinook and coho, not only in the lakes but in the associated drainage streams.

The research in this field is carried by two scientists, five biologists and support staff working out of the laboratory in West Vancouver. These people conduct studies of water quality, nutrients, plankton growth and abundance and utilization of the various types of plankton by resident fishes in the lakes.

When a given lake or lakes are fertilized there are follow-up studies to assess the effects of enrichment on sockeye production. These include evaluation of the growth and survival of juvenile sockeye to the smolt stage by monitoring such factors as temperature, plankton standing crop and the growth and density of competitor fishes. Quantitative comparisons between fertilized and unfertilized lakes are also conducted.

Hydroacoustic surveys are carried out to determine the distribution and relative abundance of lake-dwelling fish populations in lakes which have undergone nutrient treatment. Similar surveys are carried out on untreated lakes to facilitate comparison of juvenile sockeye responses between treated and untreated waters. Midwater trawling is conducted on most study lakes to collect fish to be used for species composition, growth, age and diet studies.

The fertilizers, which are applied from aircraft, are of the commercial agricultural type containing inorganic nitrogen and inorganic phosphorus. They are of the so-called "fast release" variety and require more than one application per year, usually weekly over a period of four months. Experiments are now being conducted using "slow release" fertilizers which would require less frequent application and which might be applied by surface craft rather than aircraft where lakes are accessible by surface transport.

C. Habitat research

Although the habitat research program has been in existence since about 1970, it has not been a strong one and not particularly well-defined until latterly. Since 1980 it has been under the purview of the Fisheries Research Branch and is largely conducted from the West Vancouver Laboratory. There has been no overt linkage between habitat research and the research elements of SEP; rather, the relationship has been an informal one. This situation is changing and co-operation and co-ordination of effort are becoming more evident. The program has been assigned eighteen person years, eight of them research scientists and has an annual budget of $1.1 million. It has four major research projects which are briefly described below.

1. Carnation Creek project on Vancouver Island

This is a fourteen year study which originated in 1970. Its purpose is to study fisheries/forestry interactions with special reference to the effects of logging operations on coastal streams and their fish rearing capacity.

2. Estuarine research

The purpose is to study the effects of logging and other industrial activity including port development on river estuaries. It also involves studies to compare the estuarine habitat requirements of natural fry and smolts and hatchery produced salmon fry and smolts. Major work has been done in the estuaries of the Fraser, Squamish and Nanaimo Rivers and, to a lesser degree, Campbell River on the central east coast of Vancouver Island.

3. Water quality research

This research is concerned with the effects of pollutants and contaminants on water quality and on the marine life therein.

4. The development of techniques for habitat restoration

Portions of some estuaries in B.C. have been damaged or destroyed through industrial activity thereby affecting the fish rearing capacity. Experiments are in progress to repair and restore such areas through the construction of artificial islands seeded with appropriate aquatic plants which will protect young fish and provide an area for feeding.

D. Research by Fishery Managers

Fishery managers also conduct some limited research and investigations on problems related to the immediate operational problems which they face. While it is aimed at fishery management issues, it also has a distinct bearing on salmonid enhancement in terms of devising means of fishing the natural stocks and enhanced stocks without seriously damaging or destroying some of the smaller natural stocks. Some examples follow.

1. Adult salmon tagging programs

These are carried out during the regular fishing season. From these programs, information is obtained on salmon stock size, productivity, timing through the fishery, migration routes and effects of catching effort on the various runs.

2. Test fisheries

These operations, conducted from hired commercial fishing vessels, provide daily estimates of salmon spawning escapements, information which is essential in effective management of the various stocks. Indices for salmon stocks are also calculated to determine timing of the runs and relative abundance. All species of salmon taken are sampled for age, length, size and sex to fulfill requirements for both short-term management and longer-term data inventory.

3. Operation of counting fences

Several counting fences on major producing streams are operated annually to enumerate adult salmon migrating upstream. Additionally, basic biological information including age, length, weight, and sex is obtained.

The research results are usually analyzed and written up in-house but latterly consultants have been hired to write up some of the research findings.

Chapter 2

The Organization and Conduct of Research within SEP

The research conducted within the Salmonid Enhancement Program has been organized by function and/or organizational group, e.g. engineering, hatchery operations and planning. The annual budget for the first phase has been relatively small, approximately $2 million annually. Of this amount, some $600,000 was allocated each year to the Fisheries Research Branch to carry out SEP related research; the remainder was spent on in-house research and contracting-out. Some of the work has fallen into the research and development category and has been carried out at hatcheries and spawning channels, not only by engineering and biological personnel but by hatchery managers and their staffs.

A. Engineering Research

The following are examples of the categories of research and the purpose for which they are carried out.

1. Fishway design. Engineering studies and experiments have been conducted to improve the design and effectiveness of fishways and to reduce costs of construction. For example, new techniques in blasting and rock removal have made the subsequent installation of steel and concrete simpler and less costly.

2. Reconaissance. Studies of terrain, stream hydrology, groundwater hydrology and climatic conditions are conducted to determine the

potential for enhancement facilities and to facilitate the preparation of designs for individual projects.

3. Water quality. Studies are undertaken on general water quality of the stream including the presence of contaminants and pollutants, acidity, temperature fluctuations and the volume of suspended solids in the water to determine the special features for incorporation into the water supply of individual facilities. Similarly, studies are made of groundwater supplies which are essential to most hatchery operations.

4. Effluent Quality. Discharges from hatcheries contain fish wastes and wastes from fish foods. The impact of these on the stream is determined and, where necessary, appropriate treatment equipment incorporated into hatchery design and construction.

B. Operational Research

Many hatchery managers conduct some research to solve problems they encounter in operation of their facility. They also conduct research to improve the efficiency of their facilities and to prevent problems. Some examples follow.

1. Determining conditions for optimum growth in holder channels. this involves studies of water flow rates through the channels, varying the amounts of gravel in some channels and densities of fish in the channels. This has produced significant results in terms of being able to improve the habitat in rearing channels.

2. Pilot Hatchery on Stuart River. This hatchery, a small scale one, was constructed to test the feasibility of fish culture using artesian wells containing high levels of iron. Results to date suggest that this type of water can be used for production with only minimal treatment of the water. These results have application in other localities where this problem is encountered.

3. Homing Imprints. Much of SEP's production requires transporting stocks to a central hatchery site for incubation and rearing and then releasing the young back into thei native streams. In this way, central hatcheries may be able to enhance stream-specific adult returns while retaining economy of scale. It is fundamental to this hatchery concept that adults return to their native streams and not to the hatchery of origin. Little information is yet available, but some preliminary data on straying of chum stocks within river systems and between river systems has been obtained. It has also been determined that chums reared and released into the hatchery streams tend to stray at rates comparable to or greater than stocks released off-site.

4. Reconnaissance and Feasibility Studies. These studies have been conducted at various locations throughout the province to determine, from the biological standpoint, the potential for establishing enhancement facilities.

5. Aeration Techniques. Groundwater used in hatcheries requires aeration treatment to add oxygen and to remove other dissolved

gases, especially nitrogen, from the water before it enters the hatchery. If this type of treatment is not carried out it causes air bubble disease in young fish, similar to the "bends" in humans. A great deal has been learned during the SEP program on how to cope with this problem.

C. Economic Research

Economic research and analysis were conducted during Phase I, both in-house and through outside contracts. Examples of what has been done in the past three years follow.

1. Cost/Earnings Surveys. These surveys are conducted to determine commercial fishermen,s annual costs and earnings. They provide critical information on costs and earnings in relation to capital investment for the several elements of the fishing fleet.

2. Investment Behaviour. These studies of the primary and secondary sectors of the fishing industry are carried out to determine trends in investment, especially following profitable fishing years or a series of such years.

3. An Analysis of Risk Factors Associated with Various Culturing Facilities used in the Salmonid Enhancement Program; Peter B. Scales. Identifies different types of risk associated with SEP facilities. Preliminary study to investigate risk and make a determination as to the potential of constructing an overall risk index.

4. Terminal Value Study, Aquatic Resources Ltd. An analysis of fish quality derived from Skeena River sockeye caught at various distances from their spawning grounds.

5. S.E.P. Economic Impact Analysis, Marvin Shaffer & Associates. This study attempts to estimate the overall direct and indirect income and employment impacts generated from the Salmonid Enhancement Program.

6. An Evaluation of the Small Projects Program, D.B. Lister & Associates Ltd., Kerr Wood Leidal Associates Ltd., DPA Consulting Ltd. An overall evaluation of the Small Projects Program including bio-technical, economic and social assessment.

7. The Economic Impact of Resident Sport Fishing in British Columbia, Marvin Shaffer & Associates Ltd. A study to estimate the direct and indirect economic impacts of resident sport fishing in B.C., distinguish economic impacts from economic benefits, make recommendations concerning improvements in methodology.

8. Price Projections for Canadian Salmon Products 1978-2007, Don Devoretz. Projects future real prices for Canadian salmon.

1981/82

9. Assessment of the Community Economic Development Program, A. Dennis Rank. An evaluation of the overall performance of the CEDP with respect to bio-technical, social and economic impacts.

10. Comparison of Fish and Forest Values to Determine Resource Use Interactions of Salmonid Enhancement Projects. A Case Study of the Toquart Watershed, S. Sydneysmith & Associates Ltd. Discusses the economic aspects of Fish-Foret Interactions using the Toquart Watershed as a case study.

1980/81

11. Employment and Income Directly Associated with Sport fishing in B.C., Edwin Reid & Associates Ltd. Describes attributes of firms providing goods and services to sport fishermen and provides estimates of coefficients which would enable DFO to translate data collected on fishing expenditures from angler surveys into measures of employment and wage payments attributable to sport fishing.

1979/80

12. Criteria for Conducting National Income Account Evaluations of Salmonid Enhancement Program Research Projects, Small Stream Improvement Projects, Public Involvement Projects and Pilot Production Projects, Gregory Research Ltd. Discusses a number of criteria for evaluating the above projects.

Chapter 3

Research Conducted Outside SEP and the Department of Fisheries and Oceans

Research Conducted by the Provincial Government

As part of its contribution to the salmonid enhancement and because of its interest in the production of steelhead and trout, provincial staffs have conducted and continue to carry out related research projects. Examples follow.

1. Genetics and Stock Identification. As in the case of salmon, steelhead stocks are not genetically uniform over large areas and significant differences sometimes occur between adjacent watersheds. The studies are conducted to determine differences in genetic structure and to obtain stock identification baseline data.

2. Disease Diagnostics. These studies are designed to develop means of disease prevention and treatment. Outbreaks of disease are fairly common in steelhead and trout being reared at the various facilities.

3. Headwater Stocking. Hatchery produced steelhead smolts are used to augment wild steelhead populations. Utilizing the rearing area above obstructions which are impassable to adults presents a potential for enhancing wild steelhead stocks. The purpose of this research project is to assess the economic and biological feasibility of stocking steelhead fry in headwater areas.

4. Keogh Pilot for Steelhead Enhancement. The purpose of this project is to examine the benefits and constraints of still unproven steelhead enhancement methods and to develop techniques for estimating the annual harvestable surplus and production capacity of coastal rivers.

Research Conducted at the University of British Columbia

This work is being done under a contractual arrangement with the Institute of Animal Resource Ecology at the university. Four research projects have been carried out and are described briefly below.

1. Lake Enrichment. The purpose of the study is to determine the effectiveness of lake fertilization and particularly the contribution which returning adult salmon have made to the catches and spawning escapements. It has been established that, while catches in the commercial fisheries concerned have increased, some substantially, the results can not be quantified on the basis of data currently available.

2. Ocean Survival of Salmon. This study, consisted of bringing together experts in this field and assembling knowledge about the subject.

3. Fishery Management Methodology. This research has resulted in the development of techniques to determine the fishing mortality on the various species and stocks of salmon. It has useful application in managing the salmon fisheries.

4. Habitat Research. The Institute has worked closely with Departmental habitat people in developing standards which can be used in determining the fish production capacity of stream habitats. This will be helpful in managing the natural stocks and in determining benefit/cost ratios for enhancement projects.

PART V

OTHER ISSUES RELATED TO FUTURE ENHANCEMENT

Chapter 1

Introduction

In Chapter 2 of Part III we outlined what information is required to evaluate Phase I results and when that information could be made available. We also suggested how the evaluation could proceed as the information becomes available. Nevertheless, all the data on the enhanced and natural stocks will be useless if the fisheries managers cannot integrate this knowledge into the annual fishing plans. If, for example, it is known that an enhanced stock of chinooks can only be fished near the spawning grounds without endangering the natural stocks, the fisheries manager should prohibit fishing these stocks in offshore areas. This, however, would have serious implications for the troll fleet and to a lesser extent sports fishermen. Consequently, there will be considerable pressure on the fisheries managers to compromise.

In our interviews, there was general agreement that the combination of fishing pressure from an over-sized commercial fleet and increasing demands from Natives and sportsfishermen constitutes the most serious threwat to natural stocks. The fear was expressed that the economic benefits from enhancement could easily be dissipated by over-investment in the fishing fleet and processing plants. For these resources we wish to make comments on some problems that should be resolved before decisions are made on the scope and nature of future salmonid enhancement. Chapter 2 is concerned with fisheries management issues, particularly the major problem of controlling the size of the fishing fleet.

As indicated in Part I, Canada's landings of salmon accounted for only about 16 percent of total world production between 1952 and 1974. It has since dropped slightly. During that same period world landings declined by 25 percent. At the beginning of the SEP the matter of future world demand was considered and the conclusion reached was contained in the Green Book: "provided population in the market areas grows at the historical rate (1.5 percent per year), salmon prices will not fall and are more likely to increase despite a doubling, over thirty years of Canadian output. This would be the case unless world (non-Canadian) output were to grow at 2 percent per year (an increase exceeding 80 percent over 30 years)[1] A lot of changes in supply and demand patterns are now taking place so the marketing question needs to be re-examined. Chapter 3 contains our comments on marketing issues.

Earlier in this report we commented on the SEP organization and its independence from the other branches of the Fisheries Operations in the Pacific Region. It was generally agreed by the people interviewed that without that independence, not only in administration but also in financing, salmonid enhancement on the scale of Phase I would not have been possible. Until a thorough evaluation of Phase I is completed, one cannot say for certain if that was good or bad, but on balance we believe the benefits were positive. Many people interviewed expressed the view that this independence has created problems and support the recent decision to integrate enhancement within the Regional Office. We agree because in our view the success of future enhancement depends so heavily on the integration of enhancement within fisheries management, Chapter 4 deals with organizational issues.

Although the allocation of fish among the three principal users: commercial fishermen, Natives and sports fishermen is not part of the SEP's responsibilities, it has certain links with enhancement that should not be neglected. For example, some of the Native food fish requirements as well as Native commercial fishermen's needs might be met by targetting a particular enhancement project near an Indian community. This could reduce the pressure on the areas and stocks exploited by the non-Native commercial fleet. Similarly where area licensing and/or gear allocation are being considered, the location of enhancement projects could be useful if properly integrated into an area fishing plan. Chapter 5 deals with these issues.

One of the problems mentioned briefly in discussing the evaluation of Phase I was the large number of person-years required to operate the large enhancement facilities. This problem has serious implications for future enhancement. Chapter 6 contains our comments on this issue.

Chapter 2

Fisheries Management Issues

We are forced to conclude, as many have done before us, that even if all the data recommended in Part III were available and analyzed, the fisheries manager might still not be able to protect the natural stocks. He might be able to do better than he does now but it is doubtful if the information could be integrated into a fishing plan that could be implemented. This is because the information would almost certainly force him to reduce very substantially, if not eliminate, fishing the offshore areas and in the long inshore migration routes, e.g. Johnstone Strait, where stocks are mixed, and bring the fishery much closer to the spawning grounds. Good information, however, may enable him to move in this direction over time. Moreover, if the alternative is no enhancement and eventually no fishery, the trade-off may be more acceptable to those now fishing those offshore and mixed stock areas.

Even without the presence of enhanced fish, the natural stocks would still be in trouble because of the tremendous pressure by all users but particularly by the commercial fleet. The availability of enhanced fish has merely aggravated an existing problem. The reduction of the fleet and its future control is imperative if enhancement is to make any real contribution to the fishery. Enhancement cannot "solve" the fleet problem in the sense that it can provide enough fish to ensure the long-term viability of the current fleet. It can, however, make a useful contribution if fleet reduction and enhancement are both part of an integrated fisheries management program. Neither research to obtain new knowledge nor better data on stock interaction will ensure that the benefits of enhancement will be optimized. Only good fisheries management using enhancement as a tool of management can do that.

Although there is general agreement that the fleet must be "rationalized", i.e. brought more into line with the size and value of the resource, there is little agreement among fishermen and other vessel owners on how this can be achieved. The only point of agreement is that the process must include a "buy-back" program financed by the government and large enough to reduce the fleet size by a substantial margin, if it is to be effective. Except for replacement guidelines based on "volume-metric" measurement of vessels, nobody seems to have any clear idea on how the capacity of the fleet could be controlled after it is reduced. In view of the many different ways that the fishing capacity of a vessel can be increased, attempting to control fishing capacity by controlling the number and size of vessels is unlikely to be sufficient by itself to prevent further unnecessary investment whenever there is a bumper harvest either in salmon or herring.

Commissioner Pearse recognized this problem and recommended the introduction of a new approach to reducing and controlling the size of the fleet. He not only recommended a buy-back to help reduce its size but also a system of bidding for licences that would keep the fleet to the desired size. He also recommended area licensing to help reduce concentration of the fleet on any particular stock and reduce the cost of fishing by making it unnecessary to roam the entire coast burning fuel to participate in every fishery. The concentration of the fleet is a far more serious problem in fisheries management than its size.

As the recommendations included restricting the life of each licence to a period of 10 years (except for "grandfathering" the existing licence holders), the fishermen rejected them. Unfortunately, they have not designed an

alternative scheme that would reduce the fleet and control its expansion in future. Both the Minister's Advisory Council and the Fleet Rationalization Committee recommended a buy-back program financed in large part by the government. The Advisory Council's proposal would reduce the fleet by 959 vessels while the committee,s proposal would remove 632 vessels from the fleet. Pearse recommended removing about 2000 vessels from the fleet which would reduce it by 50 percent.

Pearse recommended a scheme to keep the fleet from expanding which not only included removal of licences and replacement restrictions but also the levying of a royalty on the catch so that the owners of the resource could capture at least a part of the rent before it can be dissipated through unnecessary investments. Neither the Council nor the Committee really addressed this problem adequately. The level of royalty recommended is so low that it could not possibly act as a deterrent from undertaking unnecessary investments and would make a negligible contribution to the owners of the resource. The concept of area licensing is grudgingly accepted but only if it is implemented after the benefits from fleet reduction are realized. In our view this is unrealistic because if all these steps (buy-back, area licensing, replacement restrictions, royalties and enhancement) are not taken in an integrated package, no benefits will accrue to the owners of the resource and the users will continue to dissipate the potential benefits as they have done in the past.

The incomes of salmon fishermen have traditionally been subject to large annual fluctuations so the current depressed incomes cannot be looked upon as the permanent state of the industry. Nor can one have much sympathy for those

fishermen who incurred unnecessary debts when earnings were high that they cannot carry when their earnings are low. Any salmon fisherman who has been in the industry for more than 10 years knows from personal experience the cyclical nature of the business, whether these cycles are the result of a change in the volume or value of the salmon. If he wishes to have stability, he will have to pay for it, either on an individual basis by saving when earnings are high or as a member of a group that finance and manage an income stabilization fund.

We know that the Regional Staff is looking at different methods of reducing and controlling the capacity of the fleet and from some of our discussions with the staff we have found that they are in general agreement with the views we have expressed above. We also agree with their decisions to integrate enhancement planning with regional planning and we are pleased that the process is well underway. What is also required is the integration of enhancement with fisheries management which we hope is one of the objectives of the integration of the SEP with the Regional Office.

As already mentioned, buying out some licences to reduce the fleet is not enough to resolve the "fleet problem." If the Government finances a buy-back program, it should demand in return the cooperation of vessel owners to establish a management program that would solve the "fleet problem" over a reasonable period of time. Such a program would include area, gear licensing and gear allocation. It should also include royalties on the scale recommended by Pearse, although it could start at a lower level, say 50% and be increased over a three to five year period. The industry should be advised during the consultative process that until the program is accepted, no large scale enhancement will be undertaken.

We recommend:

1) The establishment of a buy-back program as recommended by the Minister's Advisory Council to come into effect at the same time but not before recommendations 2 and 3 have been put in place;

2) In consultation with the industry, the establishment of area and gear licensing and gear allocation; and

3) The establishment of a royalty or landings tax on the scale recommended by Commissioner Pearse and phased in over a period not to exceed five years.

Chapter 3

Marketing Issues

No marketing problems have arisen that could be attributed to Canadian enhancement either during or before Phase I. The enhancement of chums was slowed down when the industry experienced marketing problems because of enhancement of chums by Japan which is the principal market for this species. The slowdown in enhancement may have been a blessing in disguise as the chum enhancement projects are experiencing difficulties. According to some industry people, the current volume of good quality chums can still be marketed. At the other end of the value scale, the Norwegians are rearing high quality salmon in ocean pens which compete with the Canadian exports of high quality chinooks and coho.

These fish compete with Canadian salmon for the smoking trade in Europe and in the fresh market in the U.S.A., particularly in the restaurant trade. It is a high quality, high priced product available on a year round basis. Although Canadian salmon of comparable quality may be cheaper it is only available fresh during the fishing season. One exporter we interviewed was not unduly concerned about the current Norwegian production although he admitted he might have to adjust his views should Norwegian production increase to 20 million pieces as has been reported. He was far more concerned about the Alaskan production of sockeye and pink which can be placed on the market at a lower price than Canadian salmon because their costs of catching and processing are lower.

At the beginning of Phase I it was accepted that even a doubling of Canadian production would not affect the price of salmon in traditional markets unless non-Canadian production increased substantially. As world production had been declining for many years, there was no reason to believe that the trend would be reversed. This is still the view held today about the longer term in spite of the recent marketing problems created partly by the recession and unfavourable changes in currency values but also by heavy production in Alaska.

We do not feel comfortable with that view. Recent changes in supply patterns because of enhancement elsewhere and the plans to increase substantially the scale of enhancement could slow down if not reverse the declining trend in world supply. At the same time the widening of the gap between Canadian catching and processing costs and those of its major competitor, Alaska, is cause for concern about our ability to market Canadian salmon even at current levels of production. Shifts in consumer preferences away from the traditional canned product to fresh and frozen have already created and will continue to create problems for Canadian processors and fishermen.

The views concerning future markets expressed in the Green Book resulted from studies of the markets undertaken by and for the Department using two different methodologies. One group of studies was based on interviews with the participants in all stages of production and marketing in Canada and in our export markets. The other group of studies was based on an analysis of the factors that affect demand for salmon using econometric models. These models have recently been updated and improved and the market areas covered

have been extended. Similarly, studies using the interview method are also being updated and the areas covered extended. Both methods are valid although neither can "predict" future markets. They can, however, provide a much better understanding of what is likely to happen given certain conditions. Those responsible for planning future enhancement will have to exercise their judgement to decide what course to follow although the quality and quantity of the information available will be much better than in the past.

If, for example, Norway expands its production as planned, Norwegian producers will be able to supply large volumes (equivalent to current Canadian production) of fresh or frozen, high quality salmon of any size required on a year-round basis. The only B.C. salmon of that quality is troll caught chinooks and coho which is only available fresh during the season. With the limited natural stocks of these species and the increasing demands for them in the sports fishery, their commercial importance will obviously diminish. The cost of enhancing these species appears expensive for the commercial fishery. Provided the feed cost problem can be resolved satisfactorily, existing Canadian hatcheries could provide the fry for fish farming where harvesting costs are much lower and fish of high quality can be produced on a year-round basis that could compete with Norwegian production.

What has become apparent is that rather rapid changes are taking place in demand and supply patterns for salmon and the industry must be very flexible and imaginative. One processor we interviewed was able to shift his production from 75% canned product one year to 75% fresh and frozen the next. This not only requires flexible processing facilities but adaptable fishermen that will bring the quality fish demanded by the fresh and frozen fish trade.

There have also been interesting developments taking place in packaging and marketing not only for high quality fish but for the fish bought at the hatchery gate. Nevertheless, enhancement projects should be planned to reduce the volume of low quality fish caught near the hatchery gate although the current volume is not a serious problem.

We recommend:

1) The continuation of the current market demand study based on the use of econometric models; and

2) The continuation of marketing studies based on interviews with representatives of the elements involved in the production and marketing of salmon with the continuing involvement of the B.C. salmon industry representatives.

Chapter 4

Organizational Issues

We believe that future enhancement will be better served by the integration of the staff responsible for planning, constructing and operating enhancement facilities within the structure of the Regional Office. On the other hand, we do not believe that enhancement suffered unduly because of the separation of the SEP staff during Phase I. Integration will not by itself necessarily resolve such problems as may have been created by separation. This is obvious if one looks at the experience in fisheries research.

At one time fisheries research was undertaken by an independent body: The Fisheries Research Board. Those who have been involved with fisheries long enough will remember when the Board functioned very well in terms of meeting the research needs of fisheries management. A change in the chairmanship of the Board which led to the Board placing more emphasis on pure research tied to the Universities and less on applied research required for fisheries management led to its demise. Although fisheries research was integrated with other departmental operations over a decade ago, it is only recently that the isolation created by the Board has begun to disappear.

It is not so much where research is located in an organization that matters but how the research programs are planned and managed. If the Pacific Region Director General wants the research arm to set its priorities in line with his own he has to specify what these are and involve the research director in the planning process established to map the course of regional fisheries management as a whole. What can be said about research can also be

said about field operations. In discussing the question of integrating enhancement with the other elements of the Regional Office, several staff members said that although other divisions were organizationally integrated they operated more independently of each other in certain matters than the SEP staff did during Phase I. Organizational integration is not an end in itself but a means to achieve the integration of the process of enhancement with fisheries management as a whole. Only the Director General can set the conditions that will achieve this objective. However, the recent integration of the SEP gives him the authority he lacked before to ensure that enhancement becomes an integral part of fisheries management. There is another element of the organizational structure of the SEP which we should like to comment on, we refer to the Salmonid Enhancement Board and the Salmonid Enhancement Task Group.

The Salmonid Enhancement Board which is chaired by the Deputy Minister, Department of Fisheries and Oceans, has a total of fourteen members with representation as follows:

Deputy Minister, DF&O	- 1
Provincial Government of B.C.	- 2
Salmonid Enhancement Task Group	- 1
Native Brotherhood of B.C.	- 1
Fish processing industry	- 1
Forest industry	- 1
Sport fishermen	- 1
Fisheries & Oceans Research Advisory Council	- 1
Commercial fishermen	- 2

ADM, Pacific & Freshwater Fisheries	- 1
Salmonid Enhancement Program	- 1 (Ex-officio)
Regional Director General, Pacific	- 1 (Ex-officio)

The authors interviewed six of the private sector members of the Board, the two provincial government representatives, the Regional Director-General, Pacific, and the Executive Director of the SEP program with respect to their views of salmonid enhancement generally and, more particularly, the operation and input of the Board to the program. This chapter deals with the perceptions of the Board members, especially the non-Departmental members, as to the effectiveness and timeliness of their deliberations and decisions on the SEP program and associated projects.

Almost all of the "outsiders" interviewed expressed concern over the fact that they have become more involved in project approval rather than program issues and program development as a whole. They feel that the Board was not operating as originally anticipated and that it was not providing broad general direction; rather it tended to become involved in specifics. Here again some members were concerned and even frustrated as they felt that, in the case of some projects, they were presented with "faits accomplis" and were therefore in a position of having to give "rubber stamp" approval.

There was also some general concern over what was viewed as lack of effective input by the Board to program budgets though the government budgetary process was recognized as an inhibiting factor in this respect.

The composition of the Board also came under some criticism. Several members felt quite strongly that there were too many public servants as members or ex-officio members. On the other hand, at least two members from the private sector regarded their presence as creating a steadying influence on the Board's deliberations. In the same vein, there was a consensus that too many SEP staff members sat in the room at the Board's meetings and that this tended to inhibit free and frank discussion.

Practically all members regarded the presence of the two Deputy Ministers as a vital element lending influence, prestige and power to the work of the Board. There was some thought that the position of chairman might be handled more effectively by a member from the private sector and rotated annually.

Although we have no strong views on this matter, we make the following suggestions:

1. Reduce the public service representation by two through taking the two ADMs from the Board and making the Regional Director-General a full member in view of the fact that the salmonid enhancement program reporting line is now direct to him.

2. Allow the ADM's to attend as alternates if the Deputy Minister cannot be present.

3. At an early meeting of the Board, pass chairmanship to the private sector, at least on a trial basis.

4. Have the Board focus on program issues rather than project issues looking at such things as:

   (i) major direction of the program,
   (ii) quality of program management,
   (iii) quality of fisheries management, and
   (iv) long-term and future considerations.

5. Do not permit staff members in the Board's meeting. Have them available nearby in the event their particular types of expertise are required.

The Salmonid Enhancement Task Group is an advisory body consisting of forty-five members. It represents a whole diversity of interests, such as chambers of commerc,e municipal governments, the mining and forest industries, hydro, commercial and sport fishermen's unions and associations, fish processors, educators, Native Indians, consumer and the news media.

It was established in the early stages of the program, even before the Salmonid Enhancement Board, to provide the views and advice of a broadly-based non-governmental group on matters within the responsibility of SEP. It now reports to the SEP Board, something which some Task Group members have resented as detracting from or even usurping their mandate.

There was opportunity to interview only two of the members though these were people with full appreciation of the mandate and inputs of the Task Group. Additionally, the authors discussed these issues with SEP Board members, SEP staff and people inside and outside the Department of Fisheries

and Oceans, so it was possible to obtain some consensus on the viability and effectiveness of the Task Group in making contributions to the program.

Generally speaking, most of the people interviewed felt that the Task Group, especially in the early stages of the program, had some influence on program development. Notably, they had been successful with the SEP Board's help in bringing about change in emphasis in the enhancement program from the construction of large capital works (hatcheries) to lake enrichment and to the community development and public participation elements of the first phase.

As in the case of the SEP Board, the Task Group members interviewed felt that they had been required to focus more on project approval, sometimes after the fact, rather than on program priorities and development. When one considers the composition of the Board and the wide geographic distribuion of its members, this problem seems inevitable. In any group of such a size and representing such a variety of interests, it is difficult to obtain a consensus and parochialism is bound to creep in with members pushing for local projects rather than focussing on program operation and development.

The question was also raised during the course of interviews whether some representatives of the Task Group are in a position to get information to their constituents and obtain real input from them. There is also question whether some members even have a constituency. There is a concern whether the Task Group is now relevant now that we are now entering a new, and hopefully modified, phase of salmonid enhancement involving full cooperation and coordination between fishery management, research and enhancement.

Consideration might now be given to disbanding the Task Group and replacing it with three geographic working groups, north coast, south coast and interior. These groups should each have not more than ten members drawn from the fishing industry, the forest and mining industries, hydro, Native Indian bands, and other organizations as may be deemed necessary. They should also include the area manager for each geographic area.

These new groups, in addition to considering salmonid enhancement, should also look at fishery management and research requirements as a package.

The groups might be asked to meet as a whole about once annually and to name a responsible individual from one of the groups to serve as their representative on the SEP Board.

Chapter 5

Allocation Issues

We are not concerned here with the question of how much fish should be allocated to each group of users of the resource or how much to which gear type within the commercial group. We simply want to highlight the desirability of using enhancement to help resolve some of the allocation problems that will arise in the process of meeting the demands for more fish by Native people, not only for food fish but as part of the land claim question, and by the rapidly growing number of sportsfishermen. Similarly, the reduction of fishing licences can be accelerated and the ensuing economic problems reduced if ocean ranching or fish farming can be an integral part of enhancement.

Our interest in using enhancement as suggested above is the result of our conclusion that it is not possible to evaluate the success of the large enhancement facilities constructed in Phase I and therefore no more should be constructed until a full evaluation can be completed. Even if Phase I facilities are technically successful, there are still enough unanswered questions with respect to stock interaction to suggest that for a time enhancement should take a different route. Hence, smaller projects, stream improvement and restoration and lake enrichment (when adequate steps have been taken to measure the success of this enhancement technique) should take priority. All these projects, however, should be planned to help achieve the other management objectives mentioned above.

With the broad area covered in our study and the limited time available, we cannot provide a detailed plan of fisheries management, including enhancement nor do we claim to be saying something new as several of the people interviewed both inside and outside the Department voiced the same view about the course of future enhancement. We wish only to add our voice in support of that approach.

Chapter 6

Person-Year Problem

Elsewhere in the report we have mentioned briefly the person-year problem created by the operation of Phase I enhancement facilities, particularly hatcheries, as they come on stream. The problem arises because these are manned by public servants. Hatcheries require a cadre of skilled personnel on a continuing basis (one could say 24 hours per day 365 days per year - 366 this year!) and a seasonal staff for peak periods. Only one hatchery has been contracted out by the Facilities Operations Branch - Little Qualicum. On the other hand, all hatcheries in the Community Economic Development Projects have been contracted out with apparently acceptable results.

When the SEP was approved by the Cabinet, it was given the funds required for the program but the person-years required to manage the program did not form part of the package. The allocation of person-years was only just adequate during the construction phase of the Program but has become inadequate as facilities come into operation. Reduction in person-years on the engineering side was not sufficient to cover the needs of facilities operations. This has forced the SEP managers to look for ways of contracting-out some of the enhancement activities.

If one takes the SEP as a whole its contracting-out record has been good. In the Engineering Division all construction activities were contracted out. In the Special Projects Division all Community Economic Development Projects, Public Involvement Projects and Public Information were contracted out. In Facilities Operation all tagging of juveniles has been contracted out

using the Program's sophisticated equipment. So far only one major hatchery has been contracted out and it is too early to pass judgement on its success. There have been problems but they probably can be resolved in time. We understand that the operation will soon be evaluated. Most of the research activities were also contracted out.

There is considerable controversy over the contracting-out of the operation of a large hatchery ranging all the way from: "It can,t be done at all because one cannot define in sufficiently precise terms what is being contracted out," to "You can contract-out a hatchery like any other operation but you must work closely with the contractor to avoid problems." There is an in-between view that says: "Why contract-out the entire operation? Why not contract out all the tasks that do not require full-time year-round trained personnel?" For larger facilities, particularly hatcheries, we believe that the latter approach is a more practical one as it will resolve the "staffing for the peak" problem. The course of future enhancement recommended in previous chapters would provide more opportunities for contracting-out and reduce the pressure on the person-year problem.

With the integration of salmonid enhancement with fisheries management, the person-year problem of enhancement should be considered within the context of the entire operations of the Pacific Region. There may be other operations that can more easily be contracted-out than the operation of large hatcheries, although we have no specific suggestions to make on this point.

Notes for Part V

1 Green Book, page 42.

PART VI

THE COURSE OF FUTURE ENHANCEMENT

In the Green Book the goal of Phase II was seen as the use of the S.E.P. as a regional economic generator and development tool to "achieve government's economic and social targets."[1] The increased production of salmonids and the distribution of the wealth created by such production were to be the means of achieving those targets. This approach would permit the annual rate of investment in enhancement to be varied in accordance with the availability of funds. "However, it is also clear that investment could be cut off at any state after Phase I, without significant negative economic or biological consequences. From Phase I on, each increment of investment can be discrete."[2]

The authors of the Green Book did not indicate the basis on which Phase II would be planned. It should have been obvious to them that it would not be possible to do a proper evaluation of Phase I projects at the end of 5 yeras based on "hard" data and that Phase II would be on difficult to justify without such data. They recognized, however, that the program could be slowed down although those who later became the Program's managers did not. In our view the decision to put the program on "hold" for two years was a very sensible one. If our recommendations are accepted, the transition phase would be used to obtain the information necessary to complete the evaluation of Phase I. Until this evaluation is completed no decision would be made on the construction of major enhancement facilities and only the minimum funds would be allocated to planning and design of such facilities.

In our report we have avoided the use of the term "Phase II" and instead prefer to talk about "future enhancement." This is consistent with our view of enhancement as an integral part of fisheries management. This does not mean that enhancement should not be planned but rather that such planning should take place within the broader context of fisheries management supported by an adequate research and development program.

We are pleased to see that the enhancement planning staff has recently moved outside the S.E.P. and been placed directly under the direction of the Director General. The new Branch called Regional Planning and Economics includes the staff previously attached to the S.E.P. and the Economics Group attached to the Regional Office. We are also pleased to note the recent establishment of a salmon stock assessment group comprising scientists biologists and technicians from the Field Services Branch and the Fisheries Research Branch. Similarly proposals to increase coordination of field services, research and enhancement with the other activities of fisheries management. In our field interviews we heard stories about research activities with a vessel without the area manager having been notified that it was coming there and what its purpose was. Such lack of coordination, or should we say common courtesy, is not conducive to cooperation between the various branches of the Regional Office.

In spite of these small but irritating problems we are pleased to see the improvement taking place in bringing the various activities of the Regional Office closer together. We consider such integration of activities, including enhancement, as a necessary condition for the success of future enhancement. Progress being made in the improvement of the salmon data base, stock

assessment and planning can be attributed in large measure to this integration. The integration or better coordination of activities is a necessary but not a sufficient condition to ensure the success of future enhancement.

What lessons can be learned from Phase I and how can they be used to guide future enhancement? The first lesson surely must be that enhancement cannot be separated from fisheries management and we are satisfied that the Departmental Senior managers have learned that lesson and taken the steps necessary to ensure that future enhancement will be part of fisheries management.

The second leson is that research and development must be closely linked with any enhancement activity and must be adequately funded and staffed. If this cannot be done, no enhancement should be undertaken. We are encouraged by recent improvements in the level of cooperation between the researchers and fisheries managers but much remains to be done. Only a real effort by both sides will ensure such cooperation, although the lead must obviously come from Senior Management.

The third lesson is that during Phase I insufficient funds were allocated to obtain the data needed to evaluate the results of enhancement activities or to protect the natural stocks. Although the lesson seems to have been learned in relation to obtaining the data, we are not sure the funds allocated for this purpose and for the evaluation that follows are sufficient. Elsewhere we have recommended that they be increased although not in precise terms. Future

enhancement must be monitored and evaluated and the necessary data obtained on a timely basis.

Another lesson learned from past enhancement activities is that pre-implementation manageability studies can never anticipate all problems. Hence post-implementation are necessary to identify any unexpected problems. Moreover, most of these problems can be resolved by adopting different management strategies. We gave examples of these in a previous chapter. The smaller the projects and the more natural the techniques, the easier the manageability problems are to resolve.

We have concluded that future enhancement should favour the smaller and more natural forms of techniques until the results of Phase I large facilities have been adequately evaluated. We see an important role for lake enrichment but urge that our recommendations concerning the need to obtain data on pre and post-fertilization production for candidate lakes be implemented first. We are pleased to hear that treatment of selected fertilized lakes will be stopped to assess the production capacity of the lakes without treatment. This is a step in the right direction.

We have some difficulty visualizing a clearly defined enhancement program with a span of a specified period of time as was done for Phase I. We believe that enhancement should be part of a planned fisheries management program which would address the fleet problem, the restoration of natural stocks, ocean ranching, fish farming and the allocation of fish to the principal users and to different gear types used by the commercial fleet. The enhancement time-frame should be in harmony with the management requirements and could

have two time horizons: a short-term 5-year span and a longer-term of 10 years. Funding for enhancement projects and associated activities should still be given an identifiable budget.

Notes for PART VI

1 Green Book, page __.

2 Ibid.

ANNEX 1

TERMS OF REFERENCE
EVALUATION OF THE SALMONID ENHANCEMENT PROGRAM (PHASE I)

1. Purpose

The purpose of this paper is to present terms of reference for the first phase of the evaluation of the Salmonid Enhancement Program (SEP). The objective of this evaluation is to provide the Deputy Minister with analyses, conclusions and recommendations on the past performance and future potential of SEP within the context of the department's Pacific salmon management objectives and programs. This will necessarily require an evaluation of the present and proposed approaches to overall salmon management and development.

The evaluation will address the following topics:

1. Achievement of objectives: determination of the stated and implied objectives and intended effects of SEP and salmon management and the extent to which they have been achieved.

2. Rationale: the continued relevance of the SEP program in the light of present conditions and the plausibility of the links between the program's outputs and its intended effects.

3. Effects and impacts: what actually happened as a result of the program, whether intended or unintended.

4. Alternatives: review of alternative means of delivery of the salmonid enhancement program and of alternative programs to achieve the objectives and intended effects.

2. Background

SEP Phase I was initiated by Cabinet decision in 1977-78 and completed in 1983-84. Treasury Board has approved a two-year Planning and Evaluation

Phase for 1984-85 and 1985-86 during which no major new projects will be initiated. The Deputy Minister has requested a proposal for a full-scale, independent evaluation of the program to be completed by the summer of 1984, to provide inputs to a concurrent planning exercise for the preparation of a Cabinet submission for SEP Phase II in late 1985.

3. Outline of the Evaluation

The evaluation study will cover four sets of issues, as follows:

1. Strategic/Management Issues.
2. Marketing and Economic Issues.
3. Science Issues.
4. Habitat and Environmental Issues.

Some thirty-two issues to be addressed have been initially identified, as set out in the appendix.

4. Steps in the Evaluation

The study will be conducted in two phases. The first to start about October 1, 1983, and lasting three months, will consist of preliminary work, planning and identification of options for the second phase (See details in 5 below). The second phase will be the evaluation proper, culminating in the presentation of analyses, conclusions and recommendations in a comprehensive report to the Evaluation and Audit Committee.

5. Work to be Conducted in the First Phase:

a. Major review of literature and information concerning SEP and related programs of the department in the Pacific Region for the purpose of familiarization and, more importantly, assisting in defining the work for the second phase of the study.

b. Consultation with advisors to the Salmonid Enhancement Program, departmental managers and employees and central agency personnel to

determine their perceptions of the past performance of SEP, its role in the department's salmon management program, its impact on other departmental programs in the Pacific Region and vice versa.

c. Consultation with selected groups of users of the salmon resource in the northern and southern portions of the province of British Columbia for the same purpose as in (b) immediately above.

d. Preliminary work on a number of issues related to the four major sections of the study listed in (3) above.

e. Definition in detail of the nature and scope of the second phase of the study and assessment of the time and resources required to carry out the work.

f. Presentation to the Evaluation and Audit Committee of a costed plan for the evaluation study.

6. Organization of the Evaluation Study Team (Phase I)

The study will be headed by an overall project director (C.R. Levelton) who will report to the Evaluation and Audit Committee, which will act as a steering committee for the evaluation. The project director will be assisted by a senior analyst (F.J. Doucet) and supported by two departmental project coordinators (R. Bergeron and F.E.A. Wood) and other analysts, as required, drawn from both within and outside the department.

It should be noted that the conduct of the evaluation study should aim at utilizing analytical work within the department and avoiding duplication, while retaining the essential attributes of independence and objectivity.

A working group of senior departmental officials should be appointed to consult with the project team on behalf of the Evaluation and Audit Committee and to provide a sounding board for emerging findings, conclusions and recommendations. Suggested membership is:

DG Evaluation and Audit
DG Pacific Region
Associate Director General Pacific Region
DG Fisheries Research
DG Fisheries Operations, PFFS
DG Economic Development, FEDM

7. Contractors for the First Phase of Study:

(i) C.R. Levelton - project director and co-ordinator; primary attention to strategic and management issues but involvement in all issues.

C.R. Levelton
3012 Cowan Crescent
Ottawa, Ontario
K1V 8L1
(613) 731-5915 or 623-5224

(ii) F.J. Doucet - review of literature and consultations, primary attention to economic and marketing issues but some involvement in all issues, and assistance in defining the nature, content, resources and time for the second phase of the study.

F.J. Doucet
Chantry Road
Toledo, Ontario
K0E 1Y0
(613) 275-2029

The Evaluation and Audit Directorate will be responsible for arranging the contracts required for the first phase.

(Revised October 31, 1983)

ANNEX 2

LIST OF LITERATURE REVIEWED

1. Alaska Geographic Society, "Alaska's Salmon Fisheries, 1983."

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ANNEX 3

LIST OF PERSONS INTERVIEWED

This is a comprehensive list of persons interviewed during the course of the evaluation. Most were interviewed individually; only a small percentage were met as a group. Because of the complexity of the study very few interviews were of less than two hours' duration and many exceeded three hours. A number of individuals were interviewed more than once. Where this occurred, it is indicated by an asterisk. Titles or affiliation are given as well as the location of each interview.

DEPARTMENT OF FISHERIES & OCEANS

Regional Director/General's Office, Pacific

	1.	W. Shinners, Regional Director/General	Vancouver
*	2.	J.R. McLeod, Special Advisor to the Regional Director/General and first Director of SEP	Vancouver
*	3.	A. Wood, Director of Planning and Economics	Vancouver

Field Services, Pacific

	4.	F. Fraser, Area Manager, Northern B.C. & Yukon	Ottawa
	5.	G. Jaltema, District Supervisor, Prince Rupert District	Prince Rupert
	6.	E. Kramer, Director, North Coast Division	Prince Rupert
*	7.	D. Schutz, Salmon Co-ordinator	Vancouver
	8.	P. Sprout, Senior Management Biologist	Prince Rupert
	9.	D. Wilson, Director, Field Services Branch	Prince Rupert

Fisheries Research Branch, Pacific

	10.	D. Alderdyce, Research Scientist (Salmon)	Nanaimo
*	11.	D. Beamish, Director, Fisheries Research Branch	Nanaimo

	12.	T. Beecham, Research Scientist (Salmon)	Nanaimo
*	13.	F. Bernard, Head, Salmon Section	Nanaimo
	14.	T. Charles, Research Scientist (Stock Assessment)	Nanaimo
	15.	E. Donaldson, Research Scientist (Salmon)	Nanaimo
*	16.	C. Levings, Research Scientist (Habitat)	Vancouver
	17.	L. Margolis, Research Scientist (Parasitology & Stock Identification)	Nanaimo
*	18.	W. Ricker, Chief Research Scientist (ret.)	Nanaimo
	19.	J. Stockner, Research Scientist (Limnology)	Vancouver

Fisheries & Oceans Research Advisory Council

*	20.	W. Johnson, Chairman of FORAC, member of SEP Board, and formerly Regional Director/General, Pacific	Vancouver

Habitat Management, Pacific

	21.	F. Boyd, Manager, Habitat Management Division	Vancouver

International & Intergovernmental Affairs, Pacific

	22.	R. Morley, Advisor, International & Intergovernmental Affairs	Vancouver

Native Affairs Branch, Pacific

	23.	L. Hindle, Director, Native Affairs Branch	Vancouver

Planning & Economics, Pacific

*	24.	M. Birch, Assessment Biologist	Vancouver
	25.	E. Blewett, Chief of Fisheries Economic Analysis Unit	Vancouver
	26.	H. Fletcher, Planning Economist	Vancouver
	27.	D. McDonaldn, Economic Advisor	Vancouver
*	28.	D. Reid, Chief Economist	Vancouver

	29.	W. Shouwenberg, Planning Biologist	Vancouver
	30.	S. Wright, Chief of Program Development & Evaluation	Vancouver

Salmonid Enhancement Program

*	31.	W. Falkner, Executive Director of SEP	Vancouver
*	32.	H. Swan, Associate Executive Director	Vancouver
	33.	J. Boland, Head, Public Involvement Unit	Vancouver
	34.	D. Deans, Chief, Facialities Operations, Special Projects Division	Vancouver
	35.	J. Edwards, Manager, Thornton Creek Hatchery	Ucluelet
	36.	B. Hurst, SEP Ccommunity Advisor	Nanaimo
*	37.	A. Lill, chief Engineer, Engineering Division	Vancouver
	38.	D. Lawseth, Manager, Robertson Creek Hatchery	Port Alberni
	39.	E. Perry, Biological Program Co-ordinator	Vancouver
	40.	K. Sandercock, Chief, Facilities Operations	Vancouver
	41.	B. Wright, Project Co-ordinator	Vancouver

Ottawa Headquarters

*	42.	T. Carey, Senior Advisor, Aquaculture & fish Health	Ottawa
	43.	D. Derousie, Director, Fisheries Operations, Pacific & Freshwater Fisheries	Ottawa
	44.	D. Griggs, A/Director-General, Fisheries Operations, Pacific & Freshwater Fisheries	Ottawa
	45.	B. McEachern, Market Intelligence & Planning Branch	Ottawa
	46.	I. Pritchard, Director, Aquaculture & Resource Development Branch	Ottawa
	47.	D. Tansley, formerly Deputy Minister, DF&O	Ottawa
	48.	G. Vernon, ADM, Pacific & Freshwater Fisheries	Ottawa

SALMONID ENHANCEMENT BOARD

49.	E. Anthony, ADM, Provincial Ministery of Environment	Victoria
50.	C. Atleo, Native Brotherhood of B.C.	Vancouver
51.	B. Buchanan, British Columbia Packers Ltd.	Vancouver
52.	G. Burch, B.C. Forest Products Ltd.	Vancouver
53.	H. English, B.C. Wildlife Federation	Vancouver
54.	B. Marr, Deputy Minister, Provincial Ministry of Environment	Victoria
55.	R. Phillips, Commercial Fisherman	Vancouver

SALMONID ENHANCEMENT TASK GROUP

56.	L. Bell, British Columbia Hydro	Vancouver
57.	P. Gilbert, Council of Forest Industries	Vancouver

UNIVERSITY OF BRITISH COLUMBIA

58.	R. Hilborn, Institute of Animal Resource Ecology	Vancouver
59.	P. Larkin, Dean of Graduate Studies	Vancouver
60.	C. Lindsey, Director, Institute of Animal Resource Ecology	Vancouver
61.	D. McPhail, Professor, Institute of Animal Resource Ecology	Vancouver
62.	T. Northcote, Professor, Institute of Animal Resource Ecology	
63.	T. Parsons, Professor, Department of Oceanography	Vancouver
64.	P. Pearse, Professor, Faculty of Forestry	Vancouver
65.	C. Walters, Institute of Animal Resource Ecology	Vancouver

FISHING INDUSTRY

Fisheries Association of B.C.

	66.	G. Jones, Manager, Fisheries Association of B.C.	Vancouver
	67.	M. Burgess, Fisheries Association of B.C.	Vancouver
	68.	B. Fraser, Cassiar Packing Company Limited	Vancouver
	69.	D. Main, British Columbia Packers Limited	Vancouver
	70.	D. McLeod, Canadian Fishing Company Limited	Vancouver
	71.	E. Safarik, Ocean Fisheries Limited	Vancouver
	72.	S. Shelley, British Columbia Packers Limited	Vancouver
*	73.	I. Todd, Trans-Pacific Trading Limited	Vancouver
	74.	P. Wilson, J.S. McMillan Fisheries Limited	Vancouver

J.S. McMillan Fisheries Limited

	75.	B. McMillan, President	Vancouver

Northern Natives Fishermen's Corporation

	76.	M. Hubbell, Manager, Northern Natives Fisheries Corporation	Prince Rupert
	77.	H. Clifton, Commercial Fisherman	Prince Rupert
	78.	J. Gosnell, Commercial Fisherman	Prince Rupert

Prince Rupert Fishermens Co-operative Association

	79.	M. Florian, Manager, Prince Rupert Fishermen's Co-opertive Association	Prince Rupert
	80.	K. Harding, former Manager, Prince Rupert Fishermen's Co-operative Association	Prince Rupert
	81.	J. Hogan, Commercial Fisherman	Prince Rupert
	82.	R. Pierce, Commercial Fisherman	Prince Rupert
	83.	P. Wallin, Commercial Fisherman	Prince Rupert

MINISTRY OF STATE FOR ECONOMIC AND REGIONAL DEVELOPMENT

84.	D. Bond, Federal Economic Development Co-ordinator for B.C.	Vancouver
85.	A. Charles, Office of Federal Economic Development, Co-ordinator for B.C.	Vancouver

OTHER

86.	W.R. Hourston, former Regional Director-General of Fisheries, Pacific	Vancouver
87.	E. Vernon, Former Deputy Minister, B.C. Department of Recreation & Conservation	Victoria