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PACIFIC REGION
SALMON RESOURCE MANAGEMENT PLAN

VOLUME I
TECHNICAL REPORT

Department of Fisheries and Oceans

15 April 1985

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VOLUME I

TECHNICAL REPORT

Department of Fisheries and Oceans

15 April 1985

PREFACE

This discussion document outlines a salmon resource mangement plan for Canada's stocks of all five species of Pacific salmon. The emphasis is on increasing salmon production to optimum levels by rebuilding natural stocks and, where compatible and complementary, by enhancement. This report is expected to receive scrutiny, comments and suggestions from users, advisors and Department of Fisheries and Oceans (DFO) staff. It is also expected to be revised annually so it can serve as DFO's official statement of the current status of stocks, fishery management, habitat management and enhancement.

Management of Pacific salmon fisheries is entering a period of rapid change. Stock rebuilding strategies presented in this document are sensitive to these changes, and will therefore require regular review and revision. However, assuming that all proposed changes will occur would create an unproductive atmosphere in which nothing would be done while waiting for some resolution so that a baseline or starting point could be defined. For this reason, efforts have been concentrated on those changes that are relatively certain to be executed. Whatever the future of Pacific salmon fisheries, it is clear that management changes will be accomplished only after extensive consulation with users. Once this has taken place, a broad long-range plan for management can then be implemented.

This report consists of two volumes, bound separately. Volume I, Technical Report, includes an introduction to this discussion document on the Pacific Region Salmon Resource Management Plan; a review of salmon stocks and their management for the coast of British Columbia and the transboundary rivers; detailed discussions of management of chinook and coho salmon; and a glossary of technical or specialized terms used in this document. Volume II includes tables summarizing the attributes of North and South Coast stocks and fisheries, a description of the mathematical model used to predict the effects of various management options, and a discussion on policy and objectives relative to the Resource Management Plan.

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1.0 INTRODUCTION

1.1 Historical Perspective

Management of salmon on the Pacific Coast of Canada is the responsibility of the Department of Fisheries and Oceans (DFO). Historically, management considered the supply of fish virtually unlimited. While the capability to harvest fish increased, insufficient attention was paid to limiting the harvest, to the preservation and restoration of the natural habitat that produced the fish, or to variability of natural production. The early signs of reduced stock levels were well documented in historical records even before the turn of the century. In response to this decline, fishermen were able to switch to other areas and other species (e.g., from sockeye to pink). The industry continued to grow despite absolute decreases in stocks.

By the early 1900's, there was evidence that increasing competition for fish, declining stocks, habitat disruptions and oceanic conditions were having very serious effects on the availability of fish. Since then, many actions to protect stocks and habitats and to control harvesting have been implemented, and have produced mixed results. In the 1950's, a program of obstruction removal and fishway installation was implemented. In the 1960's, a number of spawning channels and flow control projects were developed along with the beginnings of a hatchery program. These measures have not been sufficient to arrest the decline of available fish being taken by a large, effective fleet. In the late 1960's, licensing to limit entry to the commercial fishery was initiated to control the size of the fleet. A vessel buy-back program was also established to facilitate fleet reduction and the transition from open entry to limited entry. Proposed measures to control over-capitalization or recapitalization of the remaining fleet were not implemented. As a result, the efficiency of the fleet had greatly increased by the late 1970's in response to increased profitability, stocks were being decimated, and the industry was again in trouble.

In the mid-1970's, DFO embarked on the ambitious task of developing the Salmonid Enhancement Program (SEP). Over the seven years from 1977-1984 $150,000,000 have been invested in SEP, which is intended to increase annual salmon production by approximately 50 million pounds by 1997.

In 1981, Cabinet initiated the Pearse Commission on Pacific Fisheries Policy to find ways to improve the conditions of Canada's Pacific fisheries. In 1982, the Commission recommended a broad array of changes. Many of the changes have been implemented, except for those related to fleet management, which have generated considerable controversy. To deal with the problems of fleet management, a plan was formulated in the spring of 1984. The plan included area and gear licensing, individual allocations, and a buy-back program. This plan, presented to the House of Commons as the Pacific Fisheries Restructuring Act, died on the order paper in June, 1984. However, a buy-back program is still being considered. Any other options to manage the fleet will have to be discussed in concert with industry.

In 1983, the Federal Cabinet decided that an evaluation of Phase I of SEP was a prerequisite to approval of a second phase. The evaluation is now complete. Cabinet also required a review of overall Pacific salmon resource management, including enhancement. This review was to result in a proposal to achieve optimum production through integrated management, production, and use of natural and enhanced stocks. Work was initiated in 1984 on a stock rebuilding plan with which the Canada/U.S. agreement, SEP, habitat management and Federal-Provincial concerns were integrated. The result is this first draft integrated salmon stock management plan for public consultation.

1.2 Pacific Region Salmon Resource Management Plan

The crucial feature of a Pacific Region Salmon Resource Management Plan should be that its two major components (Figure 1.2-1):

1. A fleet management plan, to create an economically viable commercial industry*; and

2. A stock management plan, to rebuild and maintain abundant, healthy stocks capable of providing sustainable harvests;

must be integrated and implemented with one another. They should complement

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* including commercial fishery and processing sector, sport fishery, Indian fishery.

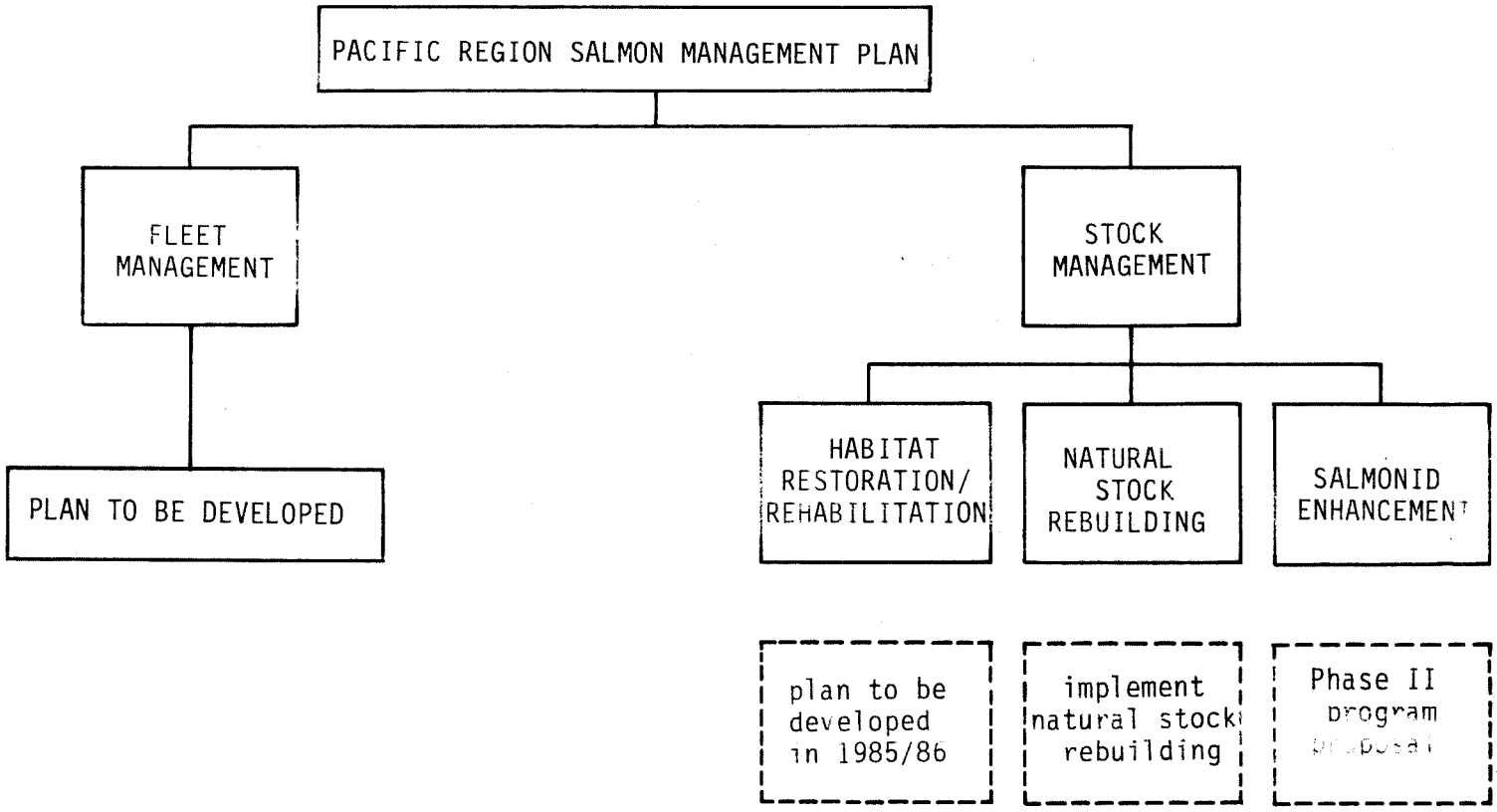


Figure 1.2-1. Pacific Region Salmon Resource Management Plan.

each other to contribute to the success of the overall plan. The latter of these plans is discussed in this document.

Neither stock rebuilding nor partial fleet management will result by itself in a stable and efficient use of these resources. Together they could bring production nearer to its optimum sustainable yield and greatly increase the supply of fish, but they will do nothing to deal with the problems of user allocations, overall fleet management and evolution to an economically efficient pattern of fish use.

There are great opportunities for fisheries user groups and DFO to work together to plan and implement a program to rebuild natural salmon production; to increase production by enhancement; to simplify fisheries management; and to redirect government expenditures. We have the tools to increase production, to maintain and rehabilitate small streams and stocks, to extend fishing seasons, to disperse the fishery, to improve fishery management capability, and to distribute the catch more equitably.

To realize these opportunities requires a co-operative management approach. It also requires a single integrated plan, so involved groups can participate to achieve their goals and to reduce conflicts. Such a management approach will deliver benefits that will greatly exceed their costs. However, the costs of change must be paid to achieve the benefits of change. The costs of stock management and rebuilding will included forgone catch, altered fisheries, and new enhancement. Fortunately, harvest of production from the first phase of SEP will significantly reduce the short-term costs of stock management and rebuilding. Effective co-management will allow sharing both costs and benefits to the best advantage of all involved.

1.3 Pacific Region Salmon Stock Management Plan

The process followed in developing this plan is outlined in the following five questions:

1. Where are we now?
2. Where do we want to be?
3. How might we get there?

4. How will we get there?
5. How did we do?

These questions should form a continuous cycle, by taking into account the answers to Question 5 when answering Question 1 in the next planning cycle so that we keep learning from our activities and redirecting our future activities appropriately.

"Where are we now?" is an inventory of current stock, habitat, enhancement, and fisheries status which is covered in this plan by area and species under the following headings: "Stock Description", "Habitat Status", "Stock Rebuilding Potential", "Current Enhancement Activities", "Fisheries", and "Management Conflicts".

"Where do we want to be?" is a statement of goals. Clearly, consultation is needed to reach mutually agreeable goals. To facilitate preparation of this plan for discussion, it was assumed that the overall purpose of DFO is, "To provide the optimum quantity and mix of social and economic benefits from the Pacific fisheries resources for the people of Canada." Within this context, regional programs can be divided into three basic initiatives: resource (fish and habitat) management; fleet (fishermen) management; and departmental management. At least one purpose of DFO resource management has been clarified by the recent decisions of the Prime Minister, Cabinet, and the Minister of Fisheries and Oceans to agree to the principles stated in the Canada/U.S. Salmon Interception Agreement: "We shall co-operate with the U.S. in management, research and enhancement." The Federal-Provincial Agreement echoes this intent to co-operate over a broad range of government programming. Also, the DFO draft National Habitat Policy encourages co-operative resource management on a broad scale.

In summary, 1) our business is to optimize fish production; 2) over-fishing is not acceptable; and 3) our resource management approach is to be more co-operative.

"How might we get there?" deals with the options available to reach the goals. A number of possible technical options are identified, discussed and evaluated in this plan. It is hoped that by co-management these options can be fine-tuned or augmented, or that new ones will be proposed by resource

users, so that the best possible options are available for consideration. Some possible options are discussed by production area in sections under the headings "Management Strategies for Stock Rebuilding" and "Future Stock Enhancement Activities". Some of these options have been modelled to determine their impacts with regard to stock rebuilding, catch and net present values. These results are included as "Predicted Results".

These analyses are continuing and will be made available when complete as will any other requested analyses. It is anticipated that the new options and analyses will be requested as a result of consultation.

"How will we get there?" is the part of the process that involves the development and selection of preferred options and the decision to proceed with them. This is the most critical co-management activity. It is seen as an integral part of the annual planning process. When made, the agreed actions will be implemented. Implementation of the preferred options is as important as its selection. Without implementation, the planning cycle is meaningless.

"How did we do?" is the evaluation of results and progress achieved. The evaluation, along with information on developments and trends in the region, flow into the next annual planning cycle to answer the question, "Where are we now?"

Because the Pacific salmon resource and fisheries are so complicated, the planning process was divided into steps. First, the fish, fisheries, fisheries management and existing enhancement for sockeye, pinks and chums were examined. For chinooks and coho, the same issues were examined, working backwards from the fisheries. Then Canada-U.S. considerations were added. Next, new enhancement needs and opportunities were integrated. On the basis of compatibility with fisheries management, enhancement activities were classified into four categories:

1. Generally acceptable - minor studies required;
2. Probably acceptable - significant studies required;
3. Unacceptable without fisheries management changes;
4. Unacceptable - rejected.

After this, a qualitative evaluation of habitat potential was integrated. Required research, especially in support of SEP, was also identified as a part of the plan. Yet to be completed for inclusion in future drafts of this plan are: a quantitative estimation of habitat fish production potential by stream; a more complete listing of required and desired research; an evaluation of fish quality and value (re: terminal fisheries); and a detailed evaluation of options for their impacts on stocks, fisheries, catches, values, benefits, and costs.

The goal of this planning activity was to develop a single integrated salmon resource management plan: this is the first draft for public consultation. From this draft it is hoped that an agreement pro tem plan can be developed. This agreed plan is seen as a framework from which a number of key initiatives could be derived. It is seen as a basis for clarifying and catalyzing goals and objectives to guide all those involved with the salmon fisheries, i.e., a basis for a possible co-management contract between fishermen and DFO. The annual domestic and Canada/U.S. fishing plans could relate to and be developed from this plan. It could guide SEP planning and operations, both domestically and with regard to Canada-U.S. commitments. The plan could provide a framework for evaluation of program activities (a statement of aspirations, proposed actions, etc.) and by regular updating, a record of progress (e.g., at meeting production targets, stock rebuilding, enhancement, etc.). The plan could be a basis for the DFO financial planning process which would ensure that funding sought would be for initiatives approved by co-managers.

As activities are completed, the plan could be updated and the focus could shift. For example, this year the focus is on enhancement integrated with fisheries management, so that funding can be sought to ensure continuation of the SEP. In the next draft, the focus may be on habitat management and habitat capacity, or some other issue. Priorities for the annual focus of the plan could be set by co-managers.

1.4 General Implications of Salmon Stock Rebuilding on SEP

The supply of fish is limited by the biology of the species. The maximum sustainable harvest rate depends on the productivity of the stock (i.e., num-

ber of returning adults per spawner). The current depressed state of salmon stocks indicates that maximum sustainable harvest rates have been exceeded in the past. To rebuild natural stocks therefore must involve reduction of harvest rates.

The setting of new, lower harvest rates for natural stock rebuilding has important implications for the salmonid enhancement and habitat restoration/ rehabilitation sub-components of stock management. The reduction in harvest rates means lower catches and greater escapements in the short term. At some point, as escapements get larger, it is likely that further natural stock rebuilding will be limited by the availability of habitat. For this reason, a habitat assessment is required to allow managers to determine optimum escapement levels.

Both natural and enhanced stocks are harvested in the same fisheries. Reducing harvest rates will rebuild natural stocks. For enhanced stocks, which are more productive and usually have sufficient escapements, reduced harvest rates will result in surplus escapement in some enhancement situations. Natural stock rebuilding, therefore, will reduce the benefits originally projected for SEP Phase I, although some benefits will be recouped in terminal or rack fisheries; however, some fish harvested there may be of lower quality and value. More importantly, natural stock rebuilding plans will change the nature of SEP Phase II because:

1. Natural stock rebuilding and enhancement can, to some extent, be substitutes for one another, in that rebuilding stocks by reducing harvest rates will reduce the need to rebuild some stocks by enhancement;

2. Natural stock rebuilding and enhancement can be complementary activities in that SEP can help to ensure that stock rebuilding goals are achieved (by undertaking a broad range of projects such as flow control structures, habitat rehabilitation, habitat stabilization, side channels, or counting fences);

3. Natural stock rebuilding will, in many cases, increase the demand for biological information that SEP could help to meet by under-

taking new kinds of projects (such as building counting fences); and

4. Lowering harvest rates will affect the biological and economic performance of proposed SEP projects, and may cause some projects that are economically feasible under the status quo to be no longer worthwhile and others to be more valuable.

One purpose of this plan and the extensive evaluation of options is to integrate fisheries management and enhancement in order to ensure that natural stocks can be retained and rebuilt, and that fish production can be enhanced. It is for this reason that some SEP opportunities have been rejected and others have been categorized "unacceptable without fisheries management changes". Without these changes, the latter projects would result in further loss of natural production and stocks.

The projects that could be given priority in SEP Phase II are described in this document. In its second phase, SEP could continue to build facilities that contribute directly to the production and harvest of Pacific salmon. However, stock rebuilding activities would take SEP in new directions. These directions include:

1. Planning SEP as an integral part of the salmon resource management plan;

2. Developing and considering SEP projects as options or parts of options for rebuilding and managing salmon stocks;

3. Extensive restoring/rehabilitating salmon habitat;

4. Building more small "natural" projects in diverse locations and situations;

5. Providing information to fisheries managers, e.g., through construction of counting fences; and

6. Designing and operating projects by co-management to extend the fishing season; disperse the fishery; improve management capability;

and maintain and rehabilitate small stocks and streams and increase production.

2.0 NORTH COAST SALMON RESOURCE MANAGEMENT PLAN

2.1 Overview

The North Coast area, for the purposes of this document, encompasses all of the salmon fisheries and stocks from the border of British Columbia and Alaska to Cape Caution. The fisheries data for the area are divided into ten sets, based on regions called Statistical Areas (Fig. 2.1-1). Each Statistical Area has a separate stock rebuilding strategy with one exception: Areas 1 and 2 are combined in some sections of this report since they together include the Queen Charlotte Islands. This section presents a discussion of fisheries management options and the techniques used to evaluate some of the options. In this report, stocks are referred to by species, geographic location (by Statistical Area or portion thereof) and type of management practiced. Both actively-managed and passively-managed stocks may be found in any area or sub-area.

2.1.1 Management of Fisheries

In this section, some of the theoretical aspects of management to escapement will be explored, followed by a discussion of the practical aspects of administration.

Most stocks or stock aggregates in the North Coast are managed to provide a predetermined "target" or optimum escapement. Fishing is allowed only if there is a surplus above this number. The long-term average escapement for most stocks does not usually equal the optimum escapement. There are four factors which keep the long-term average escapement below optimum:

1. Environmental conditions. The return of fish from a brood year (i.e., productivity) is variable because changes in environmental conditions affect survival rates. If the return of salmon is less than average, then less than optimal escapement arrives at the spawning grounds. Conversely, if a surplus is available, that surplus is removed by fishing, and optimum escapement is achieved. The result is that in some years optimum escapement will be reached, but in other years escapement will be less than optimum. Therefore, the overall average escapement will be less than optimum.

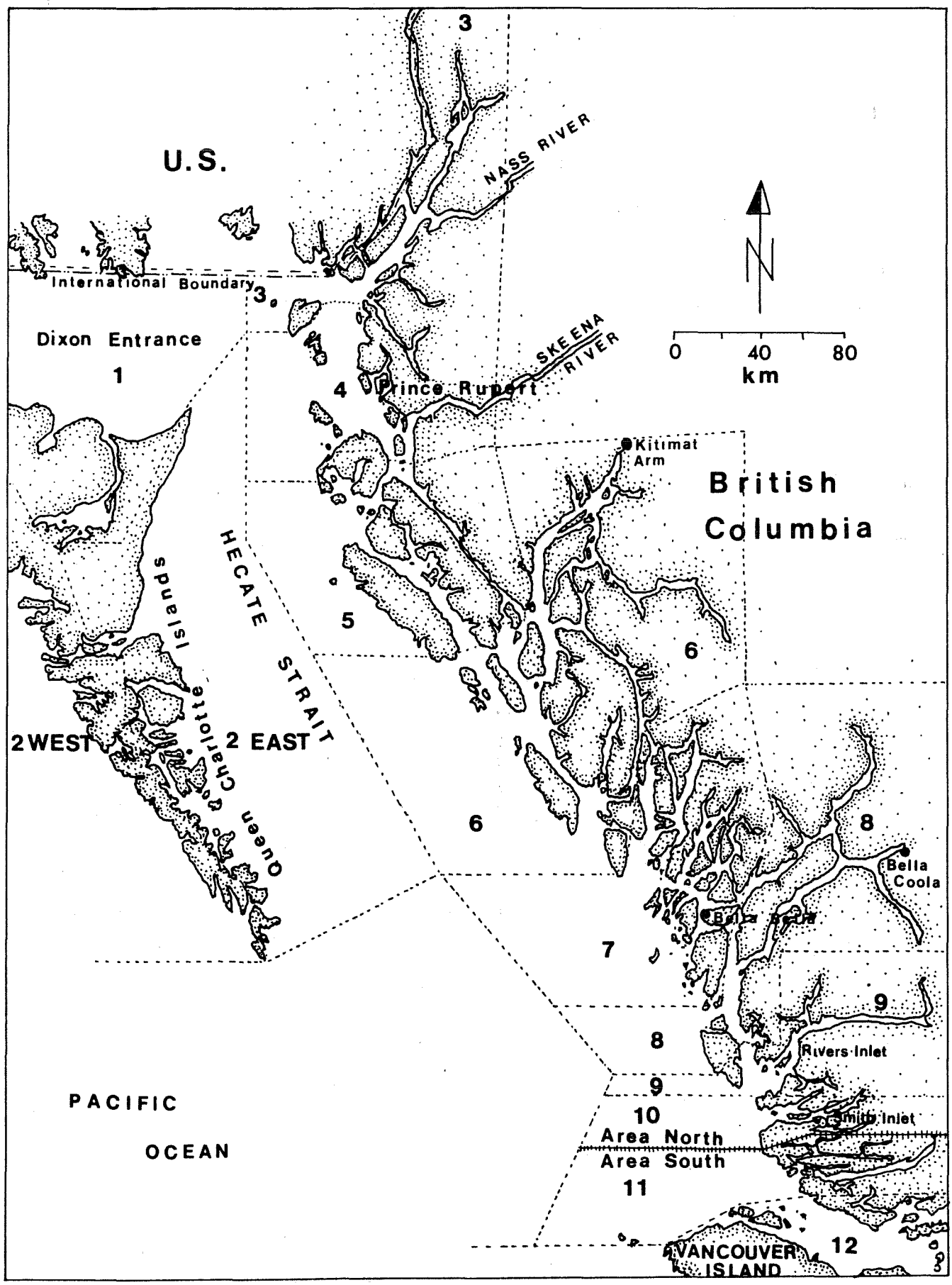


Figure 2.1-1. Statistical Areas of the North Coast.

2. Mixed-Stock Harvest. Fish are often caught incidentally in other fisheries. If the incidental catch is greater than the surplus of that species, the optimum escapement cannot be obtained.

3. Test Fishery Harvest. In order to assess abundance, test fishing operations (either a short commercial opening or chartered boat) are employed. If the test catch is greater than the surplus, the optimum escapement cannot be obtained.

4. Management Uncertainty. Because of management uncertainty, the target escapement is often missed, or does not yield the largest sustainable surplus. Since management does not consistently exceed the target escapement, the long-term effect will be lower average escapements than optimum.

There are also some fisheries which are not managed by assessing escapement, e.g., the Area 6 mixed pink and chum fishery. Rather than managing fishing to meet escapement targets, this fishery is managed to control the abundance of fish.

Pre-season stock expectations and fishing plans for each area are developed by the local Fishery Officer and area biologist and are reviewed with senior managers. The schedule of fishery openings and closures is based on the amount of surplus stock expected, and on the anticipated fishing effort. Following the calculation of fishing expectations, fisheries managers meet with an industry advisory board to discuss and finalize plans. The board consists of advisors from commercial and sports fishermen, and processors. The board advises fisheries management on subjects of common concern: stock strength, fishing plans, fisheries operations, biological programs, policy and direction. Final fishing plans and stock expectations are published in the Pacific Region Commercial Fishing Guide.

During the season, Fishery Officers and biologists meet to evaluate each fishery. Catch, vessel distribution and their type and number are reviewed daily. These data, together with other information such as test fishery catches, charter boat catches and escapement estimates, if available, provide a picture of run size and timing. Based on this information the fishing plans

are reviewed and changed in-season. Pre-season forecasts of stock strength and proposed fishing plans in the Commercial Fishing Guide are subject to change after further consultation with fishermen, or if stock returns are not as expected. Time and area limitations such as one-day fisheries with restricted boundaries are common means of matching the anticipated catch with the expected surplus. The key point in the administration of the management plan is that it is a consultative process. Selection of strategies for stock rebuilding must also be subject to full discussion and consultation.

2.1.2 Rebuilding Potential

Current escapement levels and targets (cumulative totals of all the streams in each area) are presented by Statistical Area and species in Table 2.1-1. Many of the differences between actual and target escapements can be attributed to passively managed stocks which will probably remain low even under most rebuilding options. However, chum stocks throughout the North Coast are most in need of rebuilding, particularly in Areas 5 and 6, and the Queen Charlotte Islands (Areas 1, 2E and 2W). However, the target escapements are in question (Section 2.2, Statistical Areas 1 and 2).

Table 2.1-1. Cumulative targets and current escapements for the North Coast (thousands of fish).

Statistical Area	Chum		Odd[1] Pink		Even[2] Pink		Sockeye	
	Target	Current	Target	Current	Target	Current	Target	Current
1	85	37	0	3	1,000	237	55	34
2E	642	171	0	12	1,000	230	30	1.6
2W	126	62	0	.4	500	141	10	3.5
3	106	37	306	468	312	355	220	216
4	70	28	1,000	1,956	1,000	837	900	1,045
5	36	7	270	110	270	164	50	18
6	508	57	1,356	416	1,356	656	62	21
7	608	122	426	294	426	165	23	3
8	325	94	1,475	1,420	1,475	205	139	58
9	141	36	347	124	347	100	1,000	640
10	83	44	76	45	76	9	200	200
TOTAL	2,730	695	5,256	4,848	7,762	3,099	2,689	2,240

[1], [2]: See glossary

2.2 Statistical Areas 1 and 2 (The Queen Charlotte Islands)

The Queen Charlotte Islands (Fig. 2.2-1) include three Statistical Areas: 1, 2E and 2W. Area 1 consists of the waters of Dixon Entrance at the north end of the Queen Charlotte Islands and Masset Inlet. The major salmon-producing systems include the Ain, Yakoun and Naden rivers, and Davidson Creek. Area 2E is located on the east side of the Queen Charlotte Islands and includes all of Hecate Strait adjacent to the boundaries of Areas 4, 5 and 6. The major salmon-producing systems in the area are Lagins, Lagoon, Pallant, Skedans, Big Goose Bay, Windy Bay and Deena creeks and Copper and Salmon rivers. Area 2W is located on the west side of the Queen Charlotte Islands. The major salmon-producing systems in the area are Bonanza, Gregory, Kaisun, Security, Tasu, Browns Cabin, Mercer, Seal Inlet and Tartu Inlet creeks. Detailed tables of stock attributes and current fishing patterns can be found in Appendix 1.

2.2.1 Stock Description

Stock descriptions are presented below by area (rather than by species) for each Statistical Area, since they are so large geographically that treating their stocks by species would result in a fragmented document. (All other Statistical Areas include stock descriptions by species).

2.2.1.1 Area 1

Two pink and two chum stocks are actively managed in Statistical Area 1. In addition, there are several small pink and chum stocks that are managed passively. There are also three small sockeye stocks in Masset Inlet and one in Naden Harbour.

The main actively-managed pink stock in Statistical Area 1 originates in the Yakoun River near Masset Inlet. The stock is dominant in even years and virtually absent in odd years. It accounts for approximately 50% of Area 1 pink escapement in even years and 70% in odd years. The Naden/Davidson systems in Naden Harbour are also actively managed. Management is driven by the dominant run. The remaining 12 other stream systems that support pink stocks in Area 1 are managed passively. Most Area 1 pinks migrate past Noyes Island

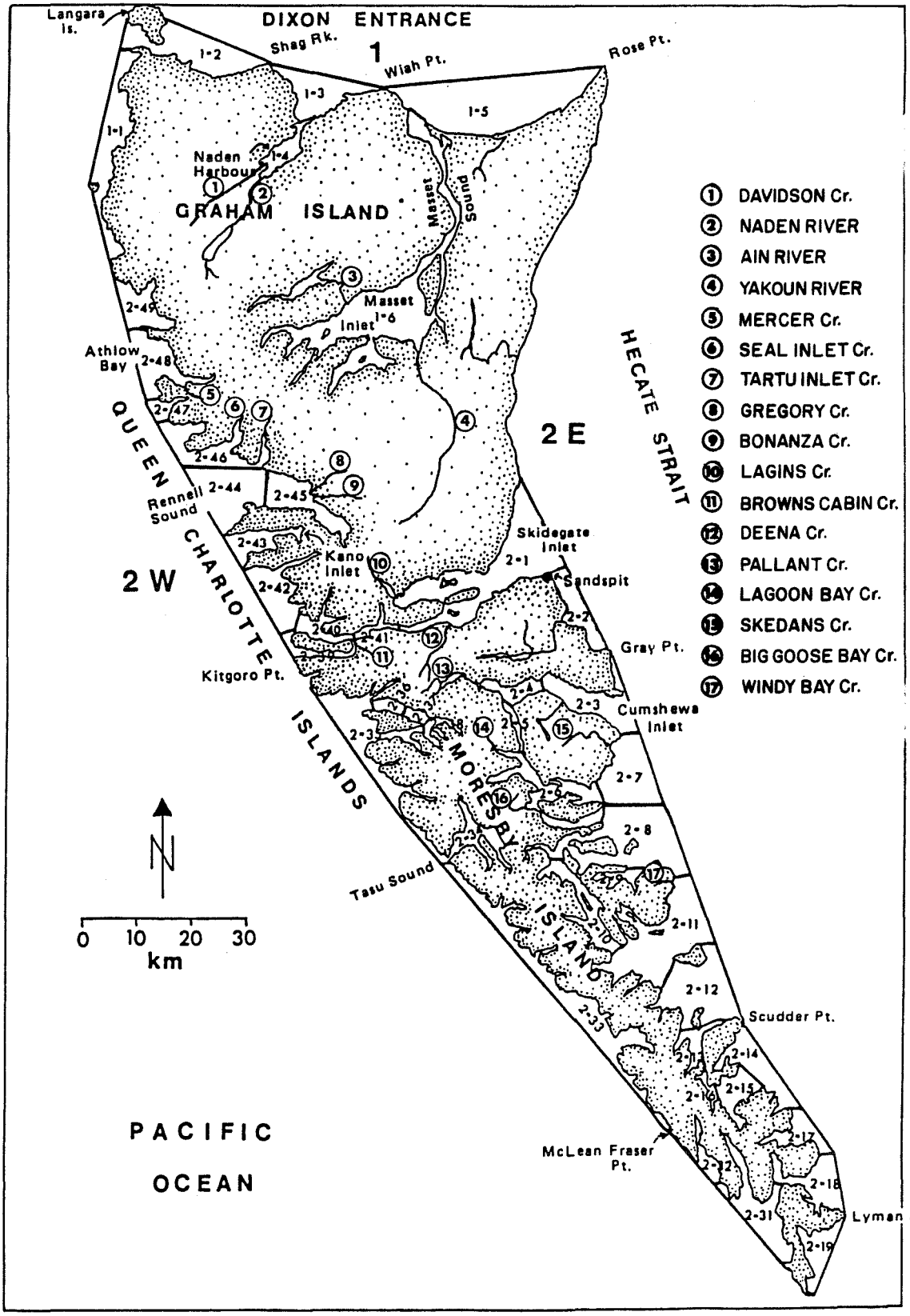


Figure 2.2-1. The Queen Charlotte Islands.

(Alaska) into the vicinity of the Area 1 troll and net fisheries, and are present in Dixon Entrance from early June until the end of September. Spawning activity covers the period between early August and mid-September.

Average ten-year escapements of the even-year Yakoun pink stock have been highly variable. Escapement increased from approximately 115,000 in the 1950's to 380,000 in the 1960's and then declined to 140,000 in the 1970's. The decline continued into the 1980's with an average escapement for 1980 and 1982 of 175,000. However, there was a dramatic increase in escapement in 1984 to approximately 1.1 million. An estimated total run size of 2,400,000 for the Yakoun stock in 1984 is one of the largest on record. Target escapement for the Yakoun pink stock lies between 650,000 and 750,000.

Even-year escapements of pink salmon to the Naden and Davidson systems in Naden Harbour have fluctuated widely over the 1950-1984 period. The Naden pink stock has been the dominant run until recently, with decade averages ranging from approximately 90,000 in the 1950's and 1960's to 45,000 spawners in the 1970's and only 15,000 in recent even years. Alternatively, even-year escapements to Davidson Creek were unrecorded in the 1950's, averaged only approximately 5,000 in the 1960's and have increased to 40,000 - 50,000 on the average throughout the 1970's and 1980's. An escapement of 125,000 pinks was recorded in 1980 for Davidson Creek, which has now replaced the Naden River as the dominant pink salmon producer in Naden Harbour.

The two actively-managed chum stocks in Area 1 originate in the Ain and Naden rivers. These two stocks account for approximately 70% of the total Area 1 chum escapement. Nine chum streams are managed passively. Area 1 chums move east from the Pacific Ocean and south from waters adjacent to southeast Alaska into Dixon Entrance. Escapements of Ain and Naden chum stocks decreased between 1950 and 1983. The average chum escapements in the 1980's for the Ain and Naden stocks were 20,125 and 4,275, respectively, as opposed to 45,000 and 20,000 in the peak decades of the 1950's and 1960's, respectively. The target escapement for Naden is 10,000 - 20,000. Target escapement for Ain is uncertain but has been estimated at 25,000 chum salmon.

Only the Yakoun River supports a chinook stock. Escapements in the Yakoun averaged approximately 1,800 fish in the 1950's and increased to over

4,000 in the 1960's. Since this peak, escapement has declined to less than 1,000 fish. In 1984 the lowest chinook escapement on record was observed - only 300 fish.

Sixteen systems support coho populations in Area 1. Masset Inlet, which contains 8 coho stocks, and Naden Harbour with 5 stocks, comprise the majority of escapements. Spawning populations are generally small to moderate; many of the systems have an escapement of less than 2,000 fish. The Yakoun, Awun and Ain rivers have the largest escapements in Masset Inlet, while Naden River and Lignite and Davidson creeks are the largest producers in Naden Harbour. Escapements have fluctuated since the 1950's, increasing from an average of approximately 14,000 to nearly 58,000 in the 1970's. Escapements have recently declined to approximately 23,000.

2.2.1.2 Area 2E

Twenty-seven stocks (14 pink and 13 chum) are actively managed in Area 2E. In addition, several small sockeye, pink, chum and coho stocks are managed passively. The area is dominated by even-year pink stocks which have had an average annual escapement of approximately 500,000 from 1947 to 1983. The chum escapement averages 200,000. The two sockeye stocks (Copper River and Mathers Creek) are small and have a total average annual escapement of approximately 15,000. There are no reported chinook stocks in Area 2E.

There are 14 pink stocks actively managed in Statistical Area 2E. The largest of these originate in Pallant and Skedans creeks. The 14 actively-managed stocks account for approximately 80% of the total escapement of all Area 2E pinks. Stocks originating in 43 additional stream systems account for the remaining escapement. On their return to spawning areas, approximately 80% of Area 2E pinks migrate south through the outside waters of southeast Alaska, through Dixon Entrance, and then into streams in Area 2E. The remaining pinks move directly into Dixon Entrance, bypassing southeast Alaska. The pink stocks are present in Area 2E between early July and early September. Spawning activity peaks in late August.

Ten-year average escapements of even year pink stocks increased from approximately 400,000 in the 1950's to over 600,000 in the 1970's. Recent

escapements have been much lower, averaging 230,000 fish in 1980 and 1982. The target escapement for Area 2E pinks is at least 665,000. The target escapement in some streams is not calculated.

There are 13 actively-managed chum stocks in Area 2E. The largest of these originate in Lagins, Pallant, Lagoon and Deena creeks. Together the 13 stocks account for approximately 65% of the total escapement. Stocks originating in 70 additional systems account for the remaining 35%. Most Area 2E chums migrate through southeast Alaska and Dixon Entrance. There has been no consistent trend in the ten-year average escapement for Area 2E chums between 1950 and 1979. Average escapement estimates for 1980 to 1983 are approximately 170,000. The target escapement for Area 2E is not calculated.

Seventy-four stream systems reported coho escapements in Area 2E in 1983; however, the majority of these systems had fewer than 500 fish. Annual escapements to the rivers are variable. The major spawning rivers are the Tlell and Copper rivers and Mathers, Deena and Pallant creeks. Ten-year average escapements for coho have declined from approximately 76,000 in the 1960's to less than 30,000 in the 1980's.

2.2.1.3 Area 2W

Thirty stocks (14 pink and 16 chum) are actively managed in Statistical Area 2W. In addition, many smaller pink and chum stocks are managed passively. The area is dominated by even-year pink and chum stocks, which have had average annual escapements of 180,000 and 100,000, respectively, between 1947 and 1983. The two sockeye stocks from Mercer Lake and Fairfax are small, and have an average annual escapement of approximately 5,000. No chinook salmon stocks have been reported in Area 2W.

The largest pink stocks originate in Bonanza, Browns Cabin and Kaisun creeks. The 14 actively-managed stocks account for approximately 65% of the even-year pink escapement. Stocks originating in 25 additional stream systems account for the remaining 35%. Approximately 65% of Area 2W pinks migrate south through the outside waters of southeast Alaska into Dixon Entrance. The remaining 35% move directly into Area 2W from the Pacific Ocean. Queen Charlotte Islands pink stocks are present in Area 2W between late July and early

to mid-September. Spawning activity peaks in late August. Ten-year average escapements of even-year pink stocks between 1950 and 1979 have ranged from 310,000 in the 1950's to 128,000 in the 1960's. Recent even-year escapements have been approximately 140,000. The target escapement for Area 2W pink is at least 439,000. Target escapement in some streams is not calculated.

There are 16 actively managed chum stocks in Statistical Area 2W. The largest of these originate in Tasu, Seal Inlet and Louscoone creeks. Taken together these 16 stocks account for approximately 60% of the total escapement. Stocks originating in 41 additional systems account for the remaining 40%. Most chums migrate into Area 2W by way of southeast Alaska and Dixon Entrance. There has been a steady decrease of escapement from 180,000 in the 1950's to 55,000 in the 1970's. Escapement estimates for 1980 to 1983 average 62,000. The target escapement for Area 2W chum is approximately 126,000.

Although coho escapements have been recorded at various times in over thirty stream systems in Area 2W, less than 10 systems consistently report spawning populations. Current escapements are small, seldom exceeding 250 in each system. There has been a decrease in escapements in Area 2W from averages of over 4,000 in the 1950's and 1960's to approximately 1,000 in the 1970's and 1980's.

2.2.2 Fisheries

In the Queen Charlotte Islands (Areas 1, 2E and 2W), net fisheries can be separated into two categories: ocean fisheries for passing sockeye and pinks bound for areas other than the Queen Charlotte Islands, and inlet fisheries harvesting chum and pink salmon originating from the Queen Charlotte Islands. Each type of fishery is discussed separately by area below.

2.2.2.1 Ocean Fisheries

There are two ocean fisheries in the Queen Charlotte Islands: one in Area 1 in the vicinity of Langara Island, at the northwestern tip of the Q.C.I., and the other in Area 2W off Rennell Sound.

Management of the Area 1 ocean fishery has undergone recent changes. The fishery catches mostly Skeena River stocks, but also catches smaller numbers of Nass River, Fraser River and Alaska stocks. Recently, the Area 1 fishery has been managed in conjunction with fisheries in Areas 3 and 4 which are the major sources of stocks for Area 1 fishermen. Openings in Area 1 generally coincide with openings in Areas 3 and 4. Beginning in 1982, a catch limit of 5,000 was imposed for net-caught chinook to curtail the escalating interception of this species.

DFO limits the Area 2W fishery to a three-week period coinciding with the peak abundance of sockeye and pink salmon. During this period, fishery openings do not exceed two days per week, and a catch limit of 5,000 chinook is imposed. In 1983, additional fishing time was permitted in peak weeks because of the low incidence of chinook in the catch, and because relatively good catches of pink and sockeye were made. The fishery occurs in the last two weeks of July and the first week of August. The catch is considered to be primarily of Fraser River stock.

2.2.2.2 Inlet Fisheries

In the Queen Charlotte Islands, the management of local salmon fisheries relies largely upon frequent stream and inlet assessments by patrolmen, Fishery Officers and guardians conducting stream walks, aerial surveys and vessel patrols. Estimates of fish abundance are based primarily on observations of fish holding in spawning streams or jumping in the inlets. Daily escapement tallies have only been available in Pallant, Mathers and the Yakoun River systems during years in which counting fences have been installed. In addition, a test fishery is used in Cumshewa Inlet to assess the catch per unit effort at standard sites as a relative index of abundance, to be used in combination with daily Pallant and Mathers fence counts. Quality assessment is an important consideration for terminal chum fisheries; quality is evaluated through Indian food fisheries, test fishing, packer sales slips and visual observation on the fishing grounds and in inlets prior to fisheries. Preseason expectations play a minor role in in-season management except for enhanced stocks (e.g., Pallant) or in instances where counts of juveniles have been performed (e.g., Yakoun).

In the Queen Charlottes discrete terminal fisheries exist, and the interception of passing local stocks can be minimized although not eliminated. In addition, because Queen Charlotte chum salmon are fall spawners, mixed-stock fishery problems with pink salmon are largely non-existent.

Chum salmon in Area 1 are fall spawners arriving after 28 September; therefore, these fish are generally not susceptible to the earlier pink and sockeye salmon fisheries. There are no ocean fisheries in Area 1 after the sockeye and pink salmon fisheries, since there are not usually any major chum salmon runs which pass by the Queen Charlottes. In 1976 and 1977, an outside fishery in Virago Sound and Masset Sound was opened to intercept a significant number of passing stocks. Local Queen Charlotte chum salmon stocks were likely intercepted in the outside fishery (local chum salmon are generally harvested in terminal fisheries). Queen Charlotte chum salmon stocks are also intercepted in the southeast Alaskan fall chum salmon fisheries.

In general, the Queen Charlotte Islands sockeye salmon stocks have not been productive. There are no directed commercial fisheries on these stocks, although most stocks are taken in Indian food fisheries. In the past, Queen Charlotte sockeye stocks have been intercepted in the Area 1 sockeye salmon net fisheries at Langara Island, which are directed at intercepting passing Skeena (Area 4) and Nass River (Area 3) stocks. Interception of local Queen Charlotte sockeye salmon stocks has recently been minimized by restricting the net fisheries for passing stocks to peak weeks in order to reduce exploitation of weaker stocks, namely chinook salmon and local Queen Charlotte sockeye and pink salmon. The current management approach reflects historic trends; the majority of the sockeye catch is transient fish, and local stocks are reserved almost exclusively for the Indian food fishery.

Although there is no clear trend in total run or escapement (1970-1982) for Area 1 sockeye stocks, catch has declined from 1970 to 1979 with a slight increase in the early 1980's. Harvest rates are not particularly high and are generally controlled by Indian food fisheries. However, in 1978 and 1979, 20-25% of the catch of Area 1 sockeye was attributed to the Alaskan fishery at Noyes Island.

Masset Inlet (Area 1) The three sockeye salmon stocks in Masset Inlet originate in the Yakoun, Ain and Awun rivers. Outside interception of these stocks is not anticipated to be significant because of their early arrival. Yakoun stocks arrive first, peaking in mid-May while Ain and Awun fish peak in early June. The late part of the Ain and Awun runs may be subject to minor interceptions in the Langara Island fishery in July. The terminal fishery in Masset Inlet is managed to produce an aggregate annual escapement of 60,000 sockeye, but escapements have been well below this target, so the fishery has been closed. The only existing fishery is the Indian food fishery which operates primarily in the inlet and takes all three stocks. These stocks provide early season fishing opportunities for the natives.

The pink salmon fishery in Masset Inlet is driven by the abundance of the Yakoun even-year stock, which is the largest producer in the area and in the Queen Charlottes. The Mamin and Datlamen stream systems were also significant producers prior to the 1970's with escapements of 40,000 - 90,000, but escapements have declined to less than 10,000 in recent years. Other smaller stocks include Kumdis, Dinan and McClinton creeks and the Ain and Awun rivers. The terminal net fishery is managed based on total abundance of pink salmon in Masset Inlet and a target abundance of 710,000 for the Yakoun River. Fish abundance is estimated from stream and inlet assessment, food fishery data and test dip fisheries. The dark, tea-coloured water in the streams and inlet preclude accurate visual estimates of population. Managing the pinks by controlling Yakoun stock abundance results in over-harvesting of smaller pink stocks in the inlet. The Mamin stock is only partially vulnerable to interception since it arrives slightly earlier than the other stocks. A modified boundary across half the inlet was established in 1984 to minimize capture of the weaker stocks. However, it is unlikely that stocks are distinctly separated within the inlet; they are more likely a mixed group. The pink salmon fishery in Masset Inlet coincides with the Yakoun chinook migration run. In 1984, interception of Yakoun chinook salmon was minimized through a request for the voluntary release of this species. Fleet co-operation was good. The Masset Inlet pink salmon stocks are also intercepted in the U.S. fishery at Noyes Island, in the Canadian Area 3 net fishery and in the Area 1 net and troll fisheries.

The Ain and Awun rivers are the major chum salmon producers in Masset

Inlet. The terminal fishery is actively managed, and based on the abundance of Ain River fish. The escapement goal is 25,000. The Awun River stock is smaller, with an escapement goal of 20,000 fish. Stocks have been generally depressed over the last decade, and the fishery has been closed in Masset Inlet and Sound to allow the stocks to rebuild. Prior to the existence of a small chum salmon fishery in 1984, the last commercial chum salmon net fishery in Masset Inlet occurred in 1973. There is also an Indian food fishery which harvests up to 1,000 chum in Masset Inlet regardless of abundance. The chum salmon in the terminal fishery are semi-bright, although some quallas occur in the native food fishery catches.

Naden Inlet (Area 1) The Naden River stock is the only sockeye salmon run into Naden Harbour. Peak arrival of the run occurs in early July. The late portion of this stock is intercepted in the Area 1 net fishery at Langara Island up to 23 July. The terminal inlet fishery is managed to produce an escapement target of 20,000 but, due to low escapements, it has not been open. This stock is harvested in the Indian food fishery.

Naden River and Davidson Creek are the primary pink salmon producers in Naden Harbour. Although escapements to Davidson Creek have increased substantially in the last decade, they have declined in the Naden system. Management of the terminal fishery is based on whichever stock is most abundant. Naden Harbour has not been fished since 1970 in order to allow the stocks to rebuild. Once the escapement goal is reached, fisheries in the harbour would also intercept smaller stocks of Lignite pink salmon and Stanley Creek chum salmon. Naden Harbour pink salmon stocks are intercepted in U.S. fisheries, Area 3 net fishery and the Area 1 troll and net fisheries.

The terminal chum salmon fishery in Naden Harbour is based on the management of the dominant Naden River stock, with a target escapement of 25,000. Lignite, Davidson and Stanley chum salmon stocks are intercepted by this same fishery. Stanley stocks arrive considerably earlier than the other stocks, and only the last portion of the run is vulnerable to the fishery. The last chum salmon fisheries in Naden Harbour were in 1973 and 1978. Since then, the fishery has been closed to allow stock rebuilding.

Copper Creek (Area 2E) There is an Indian food fishery on the Copper River sockeye salmon run. These fish are in silver bright condition and are managed to produce an escapement of 30,000. Simple restrictions on the fishery are used to regulate the harvest. There is some indication that spawning habitat may be limiting. Although there is potential for enhancement, this would raise the issue of allocation of surplus between the Indian food fishery and the commercial fishery. This stock spawns very early in the season (during May) so interception in outside Canadian and American fisheries is not a concern.

Even-year pink salmon runs to Copper Creek have averaged between 72,500 and 94,000 in the past three decades. However, escapements averaged only 12,500 in 1980 and 1982. There is a terminal fishery for surplus over the escapement target of 75,000. This stock is intercepted in the Area 1 and Area 3 net and troll fisheries, and by the southeast Alaskan fishery.

Mathers Creek (Area 2E) There is a small run of sockeye salmon into Mathers Creek. There are no fisheries directed at this stock. It may be intercepted in outside fisheries.

Skidegate Inlet (Area 2E) The Deena Creek even-year pink salmon run is the actively-managed pink salmon run in Skidegate Inlet. Smaller passively-managed stocks include those from Honna River, and Lagins, Haans, Slatechuck, Sachs and Tarundl creeks. The terminal fishery is managed to produce an escapement of 100,000, based on abundance of the Deena stock. There has been no terminal fishery for 10 years. Despite efforts to rebuild stocks through closure of the terminal fishery, the stocks remain below the escapement target. Since the habitat is relatively good, the low abundance of the stocks is likely attributable to interceptions in U.S. and Canadian (Area 1 and 3) fisheries.

Management of Skidegate Inlet chum salmon is based on two groups of stocks which are separable by their temporal distributions. The Deena, Honna and Tarundle stocks have early runs, and about 75% have escaped by mid-September. The chum fishery in Skidegate Inlet is usually delayed until the pink salmon run has escaped. The early chum salmon group can be discretely managed by openings in the first week of September. Current management is

primarily directed at the later-arriving chum salmon runs, including the Lagins, Slatechuck and Indian Cabin stocks, which are fished from late September to mid-October. There are minor interceptions of the later portion of the earlier runs in this fishery.

Generally the fishery is open in the outer area of Skidegate Inlet. The quality of the chum salmon catch is mixed, with 30% bright, 40% qualla and 30% dark taken. In some years, the fishery has been at least partially terminal to allow separate management of different stocks. This results in 100% of the catch being of poor quality (dark). Fleet composition shifts from gillnetters in the outside fishery where the fish quality is best, to seine fisheries in the more terminal areas, where quality is poorer.

Deena and Honna chum stocks could be better manipulated by more terminal openings within Skidegate Inlet. Separation of Lagins and Slatechuck stocks has been attempted through boundary modifications in Long Arm. Assessment of these management actions requires further investigation into timing and migration patterns of the various chum salmon stocks within the area. Skidegate chum salmon stocks are also intercepted in U.S. fisheries. Stocks arriving earlier are likely intercepted in the outside Canadian (Area 1 and 3) pink salmon fisheries.

Interception of Deena Creek coho salmon in the early to mid-October chum fishery has been minimized by closing off, by voluntary compliance, the outer area of Skidegate Inlet and the area on the south side of Maude Island near the mouth of the Deena.

Skidegate Inlet has been documented as a migration route for other Area 2E and 2W chum salmon stocks. Therefore, it is likely that interception of these stocks occurs in the Skidegate Inlet fishery. More terminal openings may minimize the interception of other stocks, but migration routes and interception rates should be further investigated by a tagging study.

Cumshewa Inlet (Area 2E) Pallant and Mathers creeks produce the two main pink salmon stocks in Cumshewa Inlet. The management of the terminal fishery is based on the most abundant stock. Management of this fishery is complicated by poor assessment of stock size, and may be improved with a test fish-

ery. These stocks are also intercepted in Canadian Area 1 and 3 and southeast Alaskan fisheries.

Although the enhanced Pallant run drives the developing chum fishery, management of the enhanced but weaker Mathers chum stocks is attempted through time and area restrictions within Cumshewa Inlet. Balanced enhancement of Mathers chum and coho salmon with Pallant production must take place if both stocks are to remain viable. It is assumed that the lower production of the unenhanced Chadsey and Carmichael chum stocks will result in over-harvesting and low stock levels.

In 1982 and 1984, test fishing studies were conducted in Cumshewa Inlet as a method of assessing chum abundance. This test fishery should continue to be used as a measure of stock abundance to aid management of the fishery. Tagging studies in 1980 and 1981 indicated that Cumshewa Inlet is mainly a terminal area and is not used by transient chum stocks. Minor interceptions of Cumshewa Inlet stocks occur in the southeast Alaskan fisheries and outside Canadian fisheries. Stock reconstruction studies indicate that about 10% exploitation rate occurs on Area 2E chum salmon stocks in other Area 2E and 2W fisheries.

Skedans (Area 2E) The Skedans Creek pink salmon run is fished in a discrete terminal fishery, with no passively-managed stocks. Management of the fishery is based on an escapement target of 75,000. The Canadian Area 1 and 3 and the southeast Alaskan pink salmon fisheries intercept these stocks.

Selwyn Inlet (Area 2E) The terminal pink salmon fishery in Selwyn Inlet is managed to produce an escapement of 20,000 based on the abundance of the Big Goose stock. Other pink salmon streams in the inlet are low and inconsistent producers. These stocks are probably over-harvested in terminal fisheries directed at the Big Goose stock. Big Goose pink salmon escapements have generally been below target and the fishery has been closed. Better assessment of stock size through a test fishery would improve management. Selwyn Inlet pink salmon are intercepted in outside Alaskan and Canadian (Area 1 and 3) fisheries.

Chum salmon spawn in all the streams feeding into Selwyn Inlet with the Lagoon Creek stock by far the largest. The fishery is based on managing for the most surplus stock which is usually the Lagoon stock. Typically, Selwyn chums concentrate and hold for a period of weeks at the head of the inlet, making it difficult to catch high-quality fish in this area. In 1984, the management strategy was to fish the outer area of the inlet, where higher quality but less abundant fish were taken in a pre-season gillnet survey. The commercial fishery began when the majority of the escapement requirement was estimated to be holding seaward of the fishing boundary. Outside abundance was identified as surplus. Unfortunately, passing fish may mix with the Selwyn stock in this area, and the abundance estimates are questionable.

Separation of chum stocks within Selwyn Inlet could be improved through fishing boundary modifications, such as permitting fishing in Lagoon Inlet or Sewell Inlet so that escapement goals could be set for terminal fisheries for each stream. Although this approach would reduce harvest rates for smaller stocks, and improve management of the Lagoon Creek stock, the quality of the fish would be poor. The total catch would be comprised of dark salmon. About 10% of the Selwyn Inlet chum salmon are intercepted in other Area 2E net fisheries, such as Skidegate Inlet, based on stock reconstruction reports. The Selwyn chum salmon are also intercepted in U.S. fall chum fisheries.

Darwin Sound (Area 2E) Crescent Inlet Creek and Echo Harbour Creek support the largest pink salmon runs in Darwin Inlet. The Salmon River and Anna Inlet Creek stocks are fished passively. The terminal fishery is directed at any surplus over the escapement goals of 20,000 for Crescent and 10,000 for Echo Harbour Creek. Better estimates of stock abundance from a test fishery in the inlet would improve management for each stream. These pink salmon stocks are intercepted in the Canadian Area 1 and 3 fisheries and the southeast Alaskan fishery.

Salmon River and Crescent Inlet Creek are the main chum salmon producers in Darwin Sound; the Salmon River is the more productive and consistent run. The management of the terminal fishery is based on the most abundant stock, with an escapement target of 25,000 chum for the Salmon River. Boundary modifications in the Klunkwoi Bay and Crescent Inlet areas are used in management of these stocks to protect holding fish. However, estimates of their abund-

ance are poor. Lockeport and Sedgewick bays have also been identified as holding areas for resident and migrating chum salmon. Fisheries in Darwin Sound intercept other Area 2E chum stocks which are migrating by. The Darwin Sound stocks are intercepted in other Area 2 net fisheries at an estimated rate of 10%. U.S. interceptions also affect these chum stocks.

Tlell Inlet (Area 2E) There are small runs of even- and odd-year pink salmon into the Tlell River, which have averaged 4,300 and 1,800, respectively, from 1970 to 1979. The target escapement is 10,000 and, since escapements have been well below this objective, there has not been a terminal fishery on this stock. There is a sport fishery for coho salmon which harvests approximately 500 coho salmon annually in the Inlet. About 1% of the sport catch is pink salmon. Enhancement of coho salmon to provide for the sport fishery and commercial troll fishery is a potential option which may affect pink salmon production. Generally, the habitat is good and management changes are unlikely. Pink and coho salmon from the Tlell are intercepted in Canadian and American troll and net fisheries. Modifications to these fisheries could affect returns of Tlell pink and chum salmon.

Juan Perez Sound (Area 2E) Ten pink salmon stocks spawn in streams of Juan Perez Sound. Three stock groups are managed in separate terminal fisheries. These include the Windy Bay, Gate Creek (Tar Island Creek) and the two Matheson Inlet stocks. These stocks are managed to produce escapements of 70,000, 20,000 and 55,000, respectively. Scudder Point stocks also have the potential for being managed; however, escapements have been below the target of 25,000 and no terminal fishery has been open. The remaining five stocks are very small. Interception of the passively-managed stocks in the terminal fishing areas is not anticipated to be significant. All the stocks are intercepted in both the Canadian (Area 1 and 3) and U.S. net and troll fisheries.

The Sedwick Creek chum salmon run is the only actively-managed stock in the Juan Perez Sound chum fishery. It is managed to produce an escapement of 10,000, and the fishery is open when surplus is anticipated. There are 15 other chum salmon stocks in the passively-managed mixed-stock fisheries. These stocks are intercepted in other Area 2E fisheries. They are also intercepted in the U.S. late pink salmon and fall chum salmon fisheries.

Atli Inlet (Area 2E) There are five streams in Atli Inlet supporting chum salmon. The largest producer is Powrivco Creek, followed closely by Sandy and Moore creeks. The terminal fishery is based on total abundance, and managed to produce an aggregate escapement of 8,000 fish. Recent returns and assessment of the streams suggest that the target escapement should total 13,700 for Atli Inlet. These stocks are intercepted in other Area 2E fisheries. Southeast Alaska also intercepts them in the fall chum salmon fishery.

Skincuttle Inlet (Area 2E) There are 13 chum salmon stocks in Skincuttle Inlet. Bag Harbour is probably the dominant stock. The terminal fishery is managed to produce an escapement of 50,000 to 60,000, and any surplus is harvested. These fish are also intercepted in other Area 2E chum fisheries and in the southeast Alaskan fishery.

Area 2W Fisheries for pinks in Area 2W are confined to the major bays and sounds in an attempt to minimize stock mixing. Once in the terminal areas, various Management Units are regulated to further separate pink stocks, and to direct fisheries toward particular stocks. The success of this approach varies; in some bays, stocks can be well separated. In others (e.g., Englefield Bay), stocks mix at the head of the bay, and it is difficult to fish for separate stocks.

Virtually all of the bays and sounds along the west side of the Charlottes contain spawning streams for pinks. Since returns to these areas have been sporadic and generally low, fisheries for local pink stocks have been recently curtailed. Small catches have occurred in Englefield Bay and West Skidegate Inlet.

Fisheries for local chum stocks in Area 2W are confined to the bays and sounds. Outside fisheries are not permitted; Management Units within the terminal areas are regulated to separate stocks. Many of the sounds support several stocks with overlapping timing, and separating stocks is not always possible. In these cases, exploitation of the weaker stocks is minimized by imposing specific boundary changes; also, fisheries are delayed to allow increased escapements of weaker stocks.

2.2.3 Current Enhancement Activities

Two major hatcheries (Pallant and Mathers creeks) are located on the Queen Charlotte Islands. In addition, there are several smaller facilities. The production capacity of the facilities is presented in Table 2.2-1. Ain, Awun, Eden and Mercer Lakes were fertilized in 1979 in an attempt to increase sockeye production. However, the attempt was not particularly successful and fertilization of these lakes was not repeated. There are also two fishways on Fairfax and Naden Creek to assist salmon to move upstream.

2.2.4 Habitat Status

Tables 2.2-2 to 2.2-13 summarize information on habitat history, status, and outlook for stocks in Statistical Areas 1 and 2. These tables are based upon data provided in this report and its appendices, and were cross-checked against other sources. Status Summary ratings (High, Medium, Low) are provided for the five categories described below:

1. Current Target Achievability: the ability of the habitat to meet the anticipated escapement target and subsequent rearing requirements on the basis of current status and future outlook;

2. Current Status: a more specific assessment of the ability of the habitat, considering current status alone, to meet target or higher escapements and subsequent rearing requirements;

3. Future Outlook: a rating of the influence that future development (or lack of it) will have on the capability of the habitat to meet target or higher escapements and subsequent rearing requirements;

4. Natural Production Potential: a rating of the production potential of the habitat to meet target spawning and rearing requirements within the natural constraints that have always applied to that habitat, taking into account changes that have occurred as a result of human activity, and natural recovery over time.

Table 2.2-1. Production capacities of major hatcheries and small enhancement facilities located on Queen Charlotte Islands (production capacity is based on SEP biostandards).

Facility	Species	Production Capacity		Target Stock(s)
		Releases	Returns	
Major Hatcheries				
Pallant Creek Hatchery	chum	6,080,000	152,000	Pallant
	coho	215,000	3,200	Pallant
Mathers Creek Hatchery	chum	790,000	15,800	Mathers
Small Enhancement Facilities				
Masset Hatchery	coho	200,000	7,500	King, Wilson, Ghost, Gold
Skidegate Incubation Box	coho	25,000	750	Slatechuck
	chum	100,000	800	Tarundl
	sockeye	15,000	135	Copper
Sachs Creek Incubation Box	coho	200,000	1,220	Sachs, Haans
	chum	200,000	640	Sachs, Haans
	pink	1,000,000	1,000	Sachs
Sewell Creek Incubation Box	coho	100,000	1,220	Sewell Head
	chum	200,000	960	Sewell Head, Little Goose, Big Goose

Table 2.2-2. Statistical Area 2E sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	55	30	6

MANAGEMENT STYLE: Active / Passive / Unknown — 100%

NUMBER OF STREAMS: 6

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging over past 40 years with moderate - low impacts.
Current Status	Logged areas recovering well.
Future Outlook	Stable until next cutting cycle.
Natural Habitat Production Potential	Unchanged from current.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium	High	High	Low	Medium

CONCLUSION Minor fishery. With target escapement near 60% of historic highs recovery of stocks may be slower than for chum and pink.

Table 2.2-3. Statistical Area 2W sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	9	10	3.5

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 3

HABITAT NOTES

Historic Status, Production Constraints and Development History	Mostly pristine. Dam on one creek (Right Creek).
Current Status	As above.
Future Outlook	No change.
Natural Habitat Production Potential	High.
Improved Production Potential	May be enhancement potential.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	Low	Medium

CONCLUSION Minor stock - pristine systems.

Table 2.2-4. Statistical Area 1 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,000	645	240

MANAGEMENT STYLE: Active 75%; Passive ____; Unknown ____

NUMBER OF STREAMS: 15

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most of economically accessible timber removed at lower elevations. Impacts from logging have aggravated natural flow instability on some streams.
Current Status	Logging impacts still present. Moving from lower river to higher elevations.
Future Outlook	Recovery from forestry is beginning but will take 15 - 20 years before better conditions are apparent.
Natural Habitat Production Potential	Will improve as recovery of streams proceeds.
Improved Production Potential	None identified.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	Medium	Medium	Medium	Low

CONCLUSION Target is about 35% of recorded high so even with only moderate habitat recovery in the 15 - 20 year time horizon, targets should be met.

Table 2.2-5. Statistical Area 2E pink habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,500	1,000	242

MANAGEMENT STYLE Active 80% (14)
Passive
Unknown

NUMBER OF STREAMS 70

HABITAT NOTES

Historic Status, Production Constraints and Development History	Forestry: Approx. 50% of watersheds have had some logging over the past 40 - 50 years. Mostly low impacts, with spot problem areas. Approx. 50% pristine, which will remain so. Mining: Minor activity, low impacts.
Current Status	Most logged areas recovering. Spot problems of sedimentation and rapid runoff - some natural. 75% of area pristine or recovering well.
Future Outlook	Remaining stable at present status, with about 15 - 20% of watersheds being impacted. Major long-range issue for logging is rate-of-cut which is automatically linked to runoff control and natural recovery.
Natural Habitat Production Potential	Remains high.
Improved Production Potential	None identified.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	Low

CONCLUSION Since target is about 65% of historic high and since current escapements are low, target achievement may take time, but this is not readily attributable to habitat.

Table 2.2-6. Statistical Area 2W pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	840	500	140

MANAGEMENT STYLE Active 65%
Passive
Unknown

NUMBER OF STREAMS 53

HABITAT NOTES

Historic Status, Production Constraints and Development History	Forestry: Low level of activity, mostly at low elevations with low impacts. Some spot problems, yet high profile. Mining: One Creek (Tasu) - low impact. Most streams still pristine.
Current Status	Most of area undeveloped.
Future Outlook	Economics of forestry at higher elevations questionable. No significant change from pristine - on area-wide basis.
Natural Habitat Production Potential	No change from historic pattern.
Improved Production Potential	None identified.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	Unknown

CONCLUSION Habitat is not a limiting factor.

Table 2.2-7. Statistical Area 1 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	270	85	37

MANAGEMENT STYLE Active 70%
Passive
Unknown

NUMBER OF STREAMS 10

HABITAT NOTES

Historic Status, Production Constraints and Development History	Dominated by Ain and Naden rivers, 70% of total. Most of economically accessible timber removed at lower elevations. Impacts from logging have aggravated natural flow instability on some streams.
Current Status	Logging impacts still present. Moving from lower river to higher elevations.
Future Outlook	Recovery from forestry is beginning but will take 15 - 20 years before better conditions are apparent.
Natural Habitat Production Potential	Will improve as recovery of streams proceeds.
Improved Production Potential	None identified.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	Medium	Medium	Medium	Low

CONCLUSION Target is about 35% of recorded high so even with only moderate habitat recovery in the 15 - 20 year time horizon, targets should be met.

Table 2.2-8. Statistical Area 2E chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,115	642	172

MANAGEMENT STYLE	
Active	65%
Passive	
Unknown	X

NUMBER OF STREAMS	90

HABITAT NOTES

Historic Status, Production Constraints and Development History	Forestry: Approx. 50% of watersheds have had some logging over the past 40 - 50 years. Mostly low impacts, with spot problem areas. Approx. 50% pristine, which will remain so. Mining: Minor activity, low impacts.
Current Status	Most logged areas recovering. Spot problems of sedimentation and rapid runoff - some natural. 75% of area pristine or recovering well.
Future Outlook	Remaining stable at present status, with about 15 - 20% of watersheds being impacted. Major long-range issue for logging is rate-of-cut which is automatically linked to runoff control and natural recovery.
Natural Habitat Production Potential	Remains high.
Improved Production Potential	None identified.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	Low

CONCLUSION With target at 50% of M.R.E., habitat would not appear to be a constraint.

Table 2.2-9. Statistical Area 2W chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	920	127	62

MANAGEMENT STYLE: Active 60%; Passive; Unknown

NUMBER OF STREAMS: 64

HABITAT NOTES

Historic Status, Production Constraints and Development History	Forestry: Low level of activity, mostly at low elevations with low impacts. Some spot problems, yet high profile. Mining: One Creek (Tasu) - low impact. Most streams still pristine.
Current Status	Most of area undeveloped.
Future Outlook	Economics of forestry at higher elevations questionable. No significant change from pristine - on area-wide basis.
Natural Habitat Production Potential	No change from historic pattern.
Improved Production Potential	None identified.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	Unknown

CONCLUSION Target is substantially lower than probable habitat capability and habitat is not a limiting factor.

Table 2.2-10. Statistical Area 1 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	15		

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 1*

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most of economical timber removed from lower elevations.
Current Status	Logging moving to higher elevations.
Future Outlook	Improving.
Natural Habitat Production Potential	Will improve as forests regenerate.
Improved Production Potential	Probably re-colonization.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium	Medium - High	High	Medium - High

CONCLUSION The only chinook producer in Queen Charlotte Islands. An historically important producer.

* Yakoun River

Table 2.2-11. Statistical Area 1 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	164	*	*

MANAGEMENT STYLE	
Active	
Passive	X
Unknown	

NUMBER OF STREAMS	15

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most of economically accessible timber removed at lower elevations. Impacts from logging have aggravated natural flow instability on some streams.
Current Status	Logging impacts still present. Moving from lower river to higher elevations.
Future Outlook	Recovery from forestry is beginning but will take 15 - 20 years before better conditions are apparent.
Natural Habitat Production Potential	Will likely improve as recovery of streams proceeds.
Improved Production Potential	Stabilize logging roads. Small-scale restoration likely.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium	Medium - High	Medium - High	Medium - High

CONCLUSION

* No data provided.

Table 2.2-12. Statistical Area 2E coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	361?		30

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 77

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most of economically accessible timber removed at lower elevations. Impacts from logging have aggravated natural flow instability on some streams.
Current Status	Logged impacts still present. Moving from lower river to higher elevations.
Future Outlook	Recovery from forestry is beginning but will take 15 - 20 years before better conditions are apparent.
Natural Habitat Production Potential	Will improve as recovery of streams proceeds.
Improved Production Potential	Probably plenty of opportunities for small-scale restoration.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium	Medium	Medium - High	High

CONCLUSION An historically high producer, but M.R.E. is questionable.

Table 2.2-13. Statistical Area 2W coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	42		2? *

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 36

HABITAT NOTES

Historic Status, Production Constraints and Development History	Forestry: Low level of activity, mostly at low elevations with low impacts, some spot problems - yet high profile. Mining: One creek (Tasu) - low impact. Most streams still pristine.
Current Status	Most of area undeveloped.
Future Outlook	Economics of forestry at higher elevations questionable. No significant change from pristine on area-wide basis.
Natural Habitat Production Potential	No change from historic pattern.
Improved Production Potential	Probable scope for local restoration.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High - Medium	High	High	Medium - High

CONCLUSION No identified habitat reason for stock decline.

* Question validity of C.A.E.

5. Improved Production Potential: a rating of the potential for production from apparently good habitat not currently being used by fish because of theoretically correctable natural problems such as obstructions and natural flow instability. Improved production might result from barrier removals, fishway facilities, artificial stabilization of flows, or artificial recolonization of inaccessible, unused habitat. Data for this aspect of the study are probably the sketchiest. A more detailed review of existing sources would lead to a refinement of the ratings.

2.2.5 Management Conflicts

Generally, the terminal fisheries for Queen Charlotte pink and sockeye salmon stocks have been eliminated to permit stocks to rebuild. Terminal fisheries for chum salmon have been open more consistently, and are based on observed fish abundance. Despite these measures, stocks are not rebuilding naturally. There are a number of conflicts that have arisen largely because of mixed-stock fisheries that intercept Queen Charlotte stocks, and because of management uncertainties.

2.2.5.1 Mixed-Stock Fisheries

Local Queen Charlotte pink, sockeye and chinook salmon are intercepted in Area 1 by ocean net and troll fisheries for passing Nass and Skeena stocks. The passing stocks are significantly larger and can withstand higher exploitation rates than can the local stocks. Queen Charlotte pink salmon stocks are also intercepted by the Area 3 net fishery during migration.

Generally, southeast Alaska has been experiencing exceptional returns of pink salmon in recent years, and catch has increased substantially. Returns of pink salmon to the Queen Charlottes have generally been decreasing. These stocks are relatively close geographically, and are exposed to similar environments; therefore, the differences in production are probably related to harvest rates. Canadian pink salmon are likely intercepted in the southeast Alaskan fisheries, which have increased harvest rates to take advantage of the additional production. The smaller Canadian stocks cannot withstand the high harvest rates to which they are being exposed. Sockeye, chum, coho and

chinook stocks from the Queen Charlotte Islands are also intercepted in U.S. fisheries. Better estimates of the interception rates should be determined for all species.

Interception of Queen Charlotte chum salmon stocks in Canadian and American fisheries in outside waters is not believed to be significant. However, local terminal inlet fisheries intercept the chum stocks originating in each inlet, as well as other passing Queen Charlotte chum salmon stocks. This is particularly evident in Skidegate Inlet, which serves as a migration route for a high proportion of Area 2E chum salmon. Inlet fisheries target on the most abundant stock, thereby over-harvesting the weaker stocks. In some cases, the fisheries could be moved closer to specific streams to manage specific stocks, but fish quality at harvest generally deteriorates when this is done.

2.2.5.2 Management Uncertainties

Management of the terminal fisheries in the numerous inlets and bays is complicated by the fact that several stocks originate from various streams, so that even in terminal areas, the fisheries are for mixed stocks. In addition, assessment of the stocks is often limited by the tea-coloured stain in streams and poor visibility in the inlets. Estimates of both stock abundance and spawning escapement there are very poor. Test fisheries (one day openings) are used to estimate fish abundance when many fish are observed holding in the inlets. However, in situations where stock size is low, a test fishery could exploit a high percentage of the run, and the target escapement may not be achieved. In most cases the optimum escapement is unknown.

2.2.5.3 Effect of Canada/U.S. Agreement

The international agreement calls for a Canadian catch ceiling on pink salmon near the Alaskan border. This could result in a shift of effort to local Queen Charlotte pink salmon stocks once the fleet has caught its limit in the troll fisheries in Area 1 (Dixon Entrance) and Areas 3X and 3Y. Although management of the stocks would be improved through terminal fisheries, the depressed state of the pink salmon stocks on the Charlottes will require fishery closures until stocks have rebuilt and are capable of supporting harvests.

2.2.5.4 Environmental Constraints

Low productivity and high environmental variability have contributed to the inability of the Queen Charlotte stocks to successfully rebuild, even though fishing for local stocks in the Queen Charlotte Islands has been limited. Although outside interceptions are likely limiting stock returns, the severe environmental conditions also limit fish production. Therefore, restrictions in management alone may not be adequate to rebuild all the Queen Charlotte salmon stocks.

2.2.6 Management Strategies for Stock Rebuilding

In recent years, management of the terminal fisheries has been aimed at rebuilding the stocks. However, the influence of outside fisheries such as the Langara nets, Dixon Entrance troll, Area 3 net and Alaskan net and troll fisheries has prevented stocks from rebuilding. A better understanding of the interception rates of Queen Charlotte fish in Canadian and Alaskan fisheries would provide an improved basis for management. There are three strategies (other than enhancement, which is treated in Section 2.2.9) that management could adopt to help rebuild Queen Charlotte fisheries:

1. Reduce interception in mixed-stock fisheries;

2. Reduce management uncertainty; and

3. Control fishing effort.

The Area 1 ocean net and troll fisheries target on Area 3 and 4 stocks. Therefore, management of these fisheries will be linked to rebuilding plans for the Nass and Skeena stocks. From the perspective of the Queen Charlotte pink salmon stocks, it would be best to minimize their harvest in mixed stock fisheries and to harvest the local stocks terminally. Although recent interceptions of Queen Charlotte pinks in Alaska are significant (10 to 20%), they are not expected to change. Considering the exceptionally high returns of pinks to southeast Alaska, the U.S. fisheries must continue to harvest the surplus as soon as it is available in the approach waters. The management of small, mixed-stock chum salmon fisheries could be improved by moving the fish-

eries closer to terminal streams so that the stocks could be managed separately. This would reduce uncertainties regarding stock abundance and may also reduce interception of passing stocks.

The current lack of realistic target escapements and accurate estimates of fish abundance reduces the ability to manage the Queen Charlotte salmon fisheries effectively. In order to improve target escapements, it is recommended that escapement surveys be standardized, and that historical catch and escapement data be evaluated. In-season estimates of fish abundance could be improved by establishing permanent counting fences or standardized test fisheries in the various inlets. In the inlet fishing areas, interception of passing stocks could be better understood by investigating stock migration timing and routes with tagging studies. These strategies would reduce management uncertainties.

Many of the fisheries on local stocks take a small surplus. Limiting the number of vessels (effort) in a selected area would control the harvest. If fisheries are moved toward terminal areas, there may not be enough room to accommodate the present fleet. This possibility is being addressed in the Fleet Management Plan. The predicted consequences of applying these strategies to some selected Queen Charlotte fisheries are described in Section 2.2.8.1, Predicted Results, Management Options.

2.2.7 Future Stock Enhancement Activities

Future enhancement projects for the Queen Charlotte stocks are described below. The Yakoun River spawning channel, Yakoun River fence and Pallant and Mathers expansions are compatible with proposed management practices, and have been evaluated in some detail. The remaining proposed projects require further investigation and assessment and are simply described but not evaluated. Accompanying each project title is its project number from Lill et al. (1983)[1].

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[1] Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

2.2.7.1 Yakoun River Spawning Channel (Project No. 1 - 12)

The Yakoun River has produced widely fluctuating numbers of pink salmon, ranging from more than a million spawners to less than 100,000. Although the reasons for this fluctuation are not clear, flooding is thought to be a major contributor to variable egg-to-fry survival. Variable marine survival rates due to environmental conditions or to commercial fisheries could also be significant factors. Downstream pink fry enumeration studies are required, along with a re-examination of past data, in order to elucidate limiting factors and to verify if, in fact, fry production is less than expected. A long-term research program is currently underway in Masset Inlet to examine factors in the estuarine environment which may be counter-productive to pink salmon survival. Results of the above two studies should be completed and recommendations made regarding large-scale enhancement proposals on the Yakoun River. Construction of a spawning channel is proposed to address effects of flooding. This project is experimental in nature. For this reason, the project should begin with a capacity for 14,800 spawners, which would have an expected return of 100,000 adults. If this initial channel is successful, then the facility should be expanded. Reconnaissance is required to choose a site.

2.2.7.2 Yakoun River Enumeration Fence (Project No. 1 - 11B)

During the 1984 season, a temporary fence was constructed on the Yakoun River to recover tags from pink salmon for the Canada/U.S. tagging program. Along with the tag recoveries, daily fence counts were made. These counts were used by fisheries management to determine run strength and, on that basis, open a commercial fishery in Masset Inlet for the first time in 12 years. Early in the run, a stock size of 2,000,000 pink salmon was estimated from counting fence data collected in the 1960's, allowing for an earlier opening and an estimated catch of 600,000 salmon. The fishery eventually caught 700,000 pinks with a total escapement of 1,100,000.

Construction of a fence is proposed in the Yakoun River; the fence could be used to manage the Masset Inlet pink fishery. The fence has the potential to enumerate all species within this drainage, depending on the type of fence and its time of operation. Brood stock collection for the King Creek Chinook Hatchery could also be carried out at the fence.

2.2.7.3 Masset CEDP Expansion (Project No. 1-14A)

A facility is proposed to expand the Community Economic Development Project (CEDP) to produce 1,000 chinook salmon. Reconnaissance is required.

2.2.7.4 Pallant and Mathers Creeks Hatchery Expansions (Project No's. 2E-4C, 2E-4B); Pallant Estuary Rehabilitation (Project No. 2E-4B); Braverman Creek Colonization (Project No. 2E-4E)

These projects would increase production through expansion of both the Pallant and Mathers Creek Hatchery facilities. The Mathers Creek facility would cease to be a pilot facility and would become a permanent production facility. The two expansions were evaluated independently and in combination. The objective of these projects would be to increase terminal net fisheries for chum. Increases in numbers of the returning coho and pink salmon would also result in increases in a developing terminal sport fishery.

In addition, the causeway in the Pallant Creek estuary will be breached. This will allow for fuller utilization of this estuary which has been restricted for a long period of time.

The proposed project expansion would affect both facilities. Mathers Creek would produce 40,000 more chums and 25,000 more pinks. Pallant Creek would produce 72,000 more chums, 5,000 more coho, and 100,000 pinks. There would be an additional 2,000 coho produced by Braverman Creek as a result of out-planting fed fry from the Pallant Creek facility. To offset the impact of the chum fishery on Mathers coho, it is also proposed to out-plant coho fry into Mathers Lake. This would result in an eventual production of 2,000 adult coho.

2.2.7.5 Skidegate Inlet Enhancement (Project No. 2E - 9)

Reconnaissance and manageability studies are required prior to recommending any further enhancement for Skidegate Inlet.

2.2.7.6 Copper River Coho Enhancement (Project No. 2E - 2A)

The Copper River coho stock traditionally supported a trophy fishery with

very strong runs. In recent years, the stock size has been gradually declining. Enhancement options to stop this decline and stabilize the run have been proposed. At present, the best option appears to use the Pallant Creek Hatchery to hatch and out-plant fry. Juveniles could be pen-reared in Skidegate Lake. Potential production is 25,000 adult coho and 500 steelhead.

2.2.7.7 Tlell River Coho (Project No. 2E - 1)

As in most areas on the coast, Tlell River spawning adults have experienced a decline. In an attempt to stabilize the stock, enhancement is proposed. Possibilities for consideration are side channel development and/or incubation boxes. Field reconnaissance is required.

2.2.7.8 Skidegate Lake Enrichment (Project No. 2E - 2B)

Further inventory and reconnaissance by the Lake Enrichment Group will be required in order to determine whether this system will benefit from lake enrichment.

2.2.7.9 Skidegate CEDP Expansion (Project No. 2E - 2C)

An expansion of the Skidegate CEDP facility is proposed. The incremental production would be 3,200 chum and 1,500 coho.

2.2.7.10 Coates Creek Colonization (Project No. 2W - 7A)

Coates Creek is located on the west coast of the Charlottes. There is a barrier at the mouth which prevents passage of fish to a large watershed which appears to have very good spawning and rearing potential. Blasting the falls and transplanting coho to the upper watershed is proposed. The donor stock should be a composite of disease- and parasite-free stock preferably from similar west coast streams.

2.2.7.11 Major Chum Facility in Tasu Sound (Project No. 2W - 1)

At present there are no SEP facilities in the 2W subdistrict. As in the rest of the Charlottes, chum stocks on the west coast of the Islands have been

on the decline. Few net-fishing opportunities are present because stocks are depressed. In order to offer increased commercial opportunities for net fishermen on the west coast of the Charlottes, a major chum facility is proposed for Tasu Sound at the recently abandoned townsite. Limited fisheries in this area over recent years indicated a high potential for catching fish of reasonable quality. This facility would produce a terminal net fishery which should affect mainly Tasu Sound fish. However, small numbers of enhanced Cumshewa chums were caught in a commercial fishery in Tasu Inlet in 1984. Studies would be required to verify this and examine fish quality. There would also be contributions to other interception fisheries in the North Coast and S.E. Alaska. SEP has indicated that development in this isolated location will be extremely costly, and should be assessed further.

2.2.7.12 West Coast Charlottes Reconnaissance

Because so few enhancement opportunities have been identified on the West Coast of the Charlottes, and because stocks are in a depressed state, a reconnaissance trip to investigate further opportunities is planned. SEP plans to do a benefit/cost analysis on West Coast inlets and compare them to Tasu Sound. The advantages of the latter proposal lie in the relative freedom from fishery management problems, the existence of a discrete terminal fishing area where a large fleet can operate, and the simplicity of stocks in this area. These factors would minimize the effects of enhancement on adjacent wild stocks. Possible areas for review are Rennell Sound, Van Inlet, Kano Inlet and Peel Inlet.

2.2.8 Predicted Results for Management Options

Since fisheries in the Queen Charlotte Islands can be separated into several major areas, various options for rebuilding were examined by modeling for Masset Inlet and Cumshewa Inlet. The predicted consequences of management decisions are described below. The Base Case and the various management options to reduce outside interceptions, move fisheries toward terminal areas and reduce uncertainty by standardizing test fisheries or building fences were assessed for each area and are discussed in the following sections. Variations in harvest rates of Area 1 ocean net and troll fisheries were examined to determine rebuilding options; in addition, moving chum fisheries closer to

terminal areas was evaluated for several of the Queen Charlotte inlets and also considered the reduced quality of the harvest. Reduced interception in Alaskan fisheries has not been considered.

2.2.8.1 Masset Inlet

The predicted results for management options for Masset pink salmon are summarized in Table 2.2-14 and Figure 2.2-2. The Base Case (Option 1) for Masset pink salmon did not include a terminal fishery. A terminal fishery was conducted in 1984, because an exceptionally high return was identified after installation of an enumeration fence. Generally, pink salmon runs have not been large enough to sustain a terminal fishery, nor have the runs been closely monitored with a fence. Given outside interception rates of 20% in Alaska and 6% in Areas 1 and 3, the Yakoun escapements were projected to fluctuate at 20 - 30% of their target level. The other pink salmon stocks in Masset Inlet were also projected to remain at low levels.

If Canadian interceptions outside the islands were reduced to 1% (Option 2), the Yakoun stock would increase slightly but still remain well below target escapements. Although escapements would be slightly improved, catches would decline and the Net Present Value (NPV) would be less than under the Base Case. Given the current state of the stocks, any annual test fishery, including one (Option 3) based on reduced management uncertainty (from a fence or standardized test fishery), would lower escapement and result in a decline in stock levels. Although the NPV of this option is higher than under the Base Case due to the increased terminal catches, it is not sustainable because the escapements and catches would decline. Management through more terminal fisheries was not considered because the stocks appear to mix throughout the inlet and there is no opportunity to fish them separately. The low productivity and high variance in that productivity limits the ability of pink salmon in Masset Inlet to rebuild from changes in management actions alone.

2.2.8.2 Cumshewa Inlet

Cumshewa Inlet pink and chum salmon are managed separately because of the differences in their migration timing. The existing enhancement facility is projected to enhance only chum salmon from Pallant and Mathers creeks and some

Table 2.2-14. Summary of Base Case and management options for pink salmon in Masset Inlet.

Option	Escapement Trends (% of Target)			Catch Trend (Mean)	NPV* of Catch (thousand $)
	Yakoun	Mamin	Others		
1. Base Case	fluctuates 20% - 30%	fluctuates 20% - 35%	gradual increase 1% - 7%	stable (69,000)	2,232
2. Reduce Outside Interception	fluctuates 20% - 40%	fluctuates 20% - 43%	gradual increase 1% - 8%	stable	2,192
3. Reduce Management Uncertainty (Yakoun Fence)	fluctuates 20% - 8%	decline 25% - 9%	decline 1% - 5%	declines	2,691

* NPV = net present value

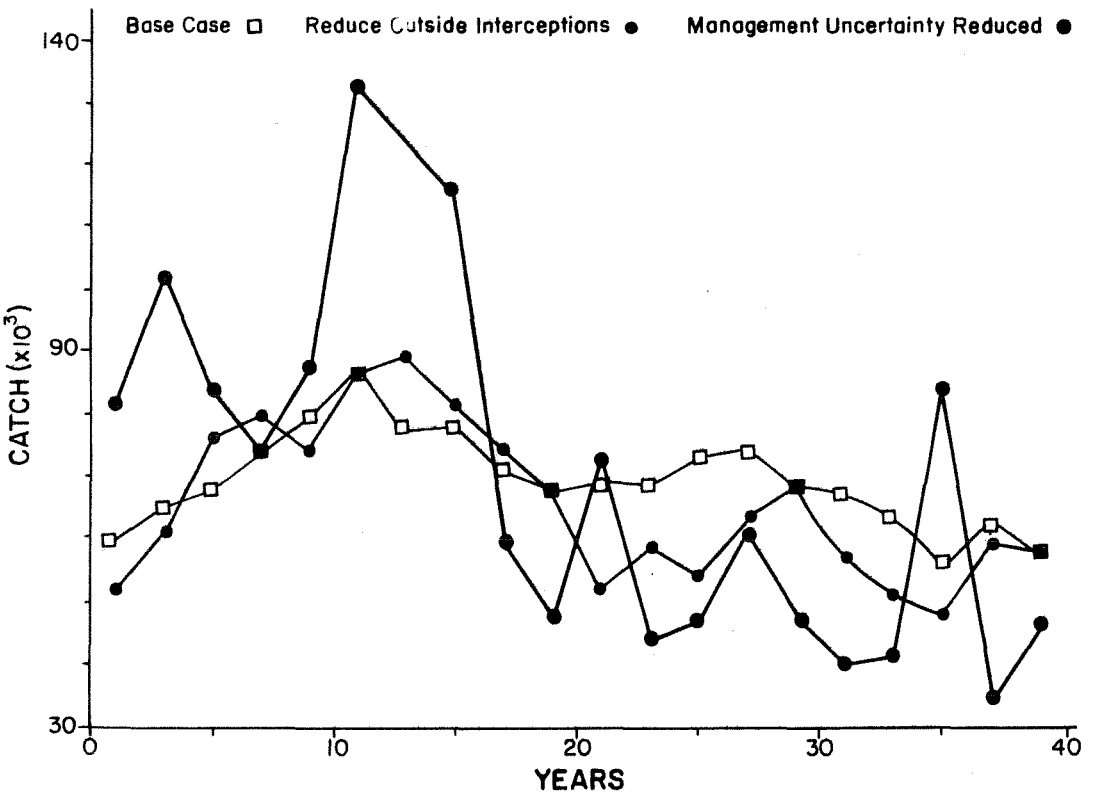


Figure 2.2-2. Predicted results of management options for catch of Masset pink salmon.

coho from Mathers. Although Pallant pinks were incubated in the hatchery during its earlier years, the facility is now operating at full capacity with chum salmon. Therefore, the Base Case (Option 1) includes enhanced and natural chum salmon stocks and only natural stocks of pink salmon. Additional production from the years when pink salmon were enhanced was taken into account in the analysis. There have not been any terminal fisheries for pink salmon because escapements have been below target. Terminal fisheries for chum salmon have been conducted in the inlet to capture surplus returns of the enhanced stocks. A standardized test fishery has been established to minimize the uncertainty in estimating stock abundance. The pink salmon stocks are intercepted in Alaskan and outside Canadian fisheries at exploitation rates of 10% and 6%, respectively. Interception of Cumshewa chum stocks in these fisheries is minimal (<1%).

More significant interception (approximately 10%) of the chum salmon stocks occurs in other Area 2E and 2W fisheries. Under the Base Case, even-year pink salmon escapements to both systems are projected to increase, and to fluctuate from 50 - 80% of target escapements, while chum salmon escapements to Pallant Creek will exceed target levels, and chum escapements to Mathers will remain stable at 25% of target levels (Table 2.2-15). The other chum stocks in the inlet (Chadsey and Carmichael) will quickly decline if the terminal fisheries are continued. Catch of pinks will remain relatively low (Fig. 2.2-3) while catch of chum salmon is predicted to increase in the first ten years and then stabilizes (Fig. 2.2-4).

The only management option that was evaluated in the model was reductions in the interception fisheries (Option 2), with Canadian interceptions of pink salmon outside the barrier islands reduced to 1%, and Area 2E and 2W interceptions of chum salmon reduced to 5%. These changes resulted in a slight increase in the escapement of pink salmon and no change in the escapement of chum salmon. Pink salmon catch declined marginally, while the chum salmon catch shifted from other Area 2E and 2W fisheries to the terminal fishery in Cumshewa Inlet. The value of the chum fishery declined slightly because quality of the catch was lower in the terminal area than in the interception areas.

Table 2.2-15. Summary of Base Case and management options for pink and chum salmon in Cumshewa Inlet.

Options	Escapement Trends (% of Target)							NPV* of Catch (thousand $)
	Pallant Chum Natural	Mathers Chum Natural	Other Chum Natural	Pallant Chum Enhanced	Mathers Chum Enhanced	Pallant (E)** Pink Natural	Mathers (E) Pink Natural	
1. Base Case	Stable (150%)	Stable (25%)	Declines (0%)	Stable (100%)	Stable (100%)	Fluctuates (50% - 80%)	Fluctuates (60 - 75%)	9,576
2. Reduce Interceptions	Stable (150%)	Stable (26%)	Declines (0%)	Stable (100%)	Stable (100%)	Fluctuates (70 - 95%)	Fluctuates (60 - 90%)	8,813

* NPV = net present value
** E = even-year

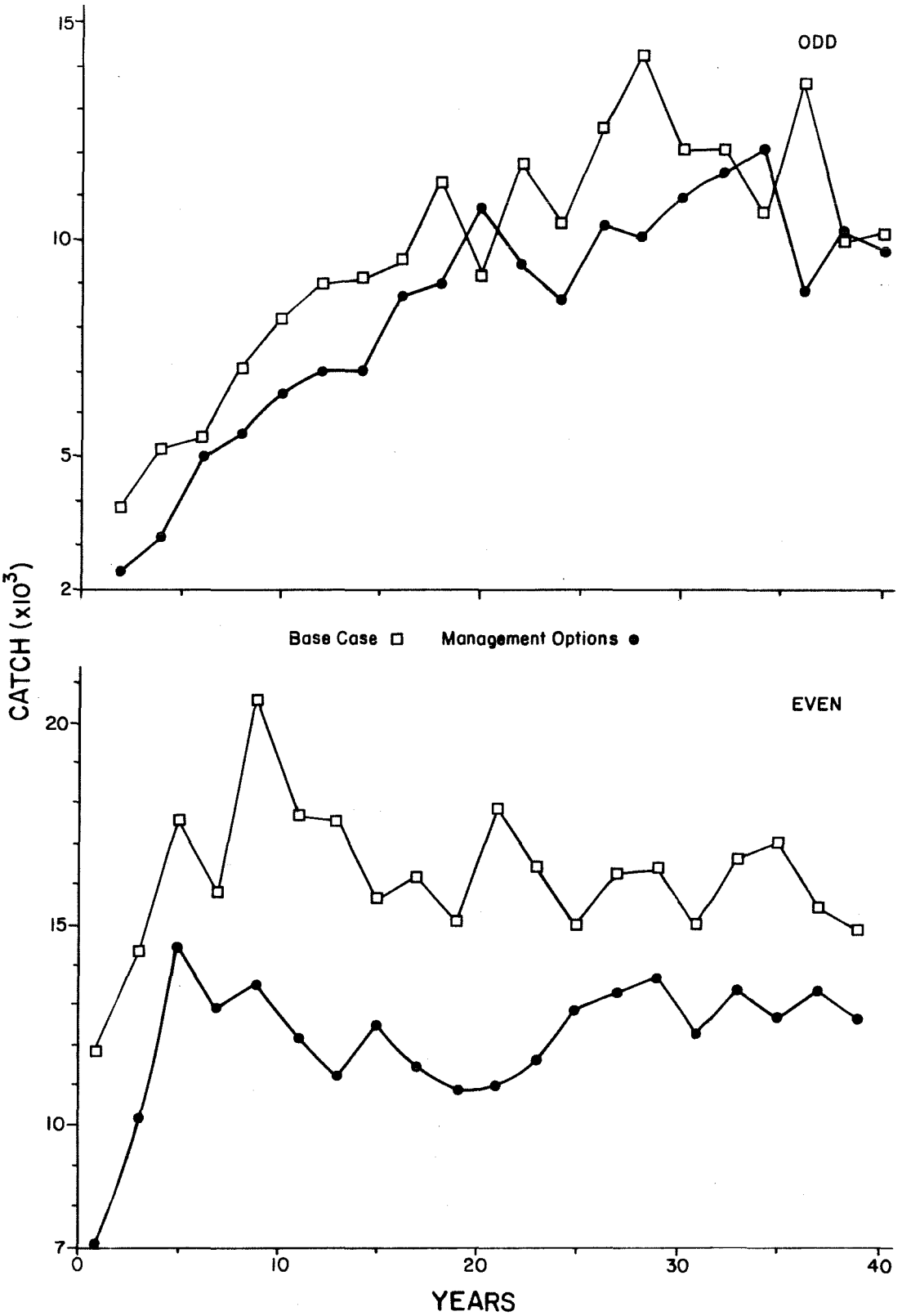


Figure 2.2-3. Predicted results of the Base Case (Option 1) and management (Option 2) for catch of Cumshewa even- and odd-year pink salmon.

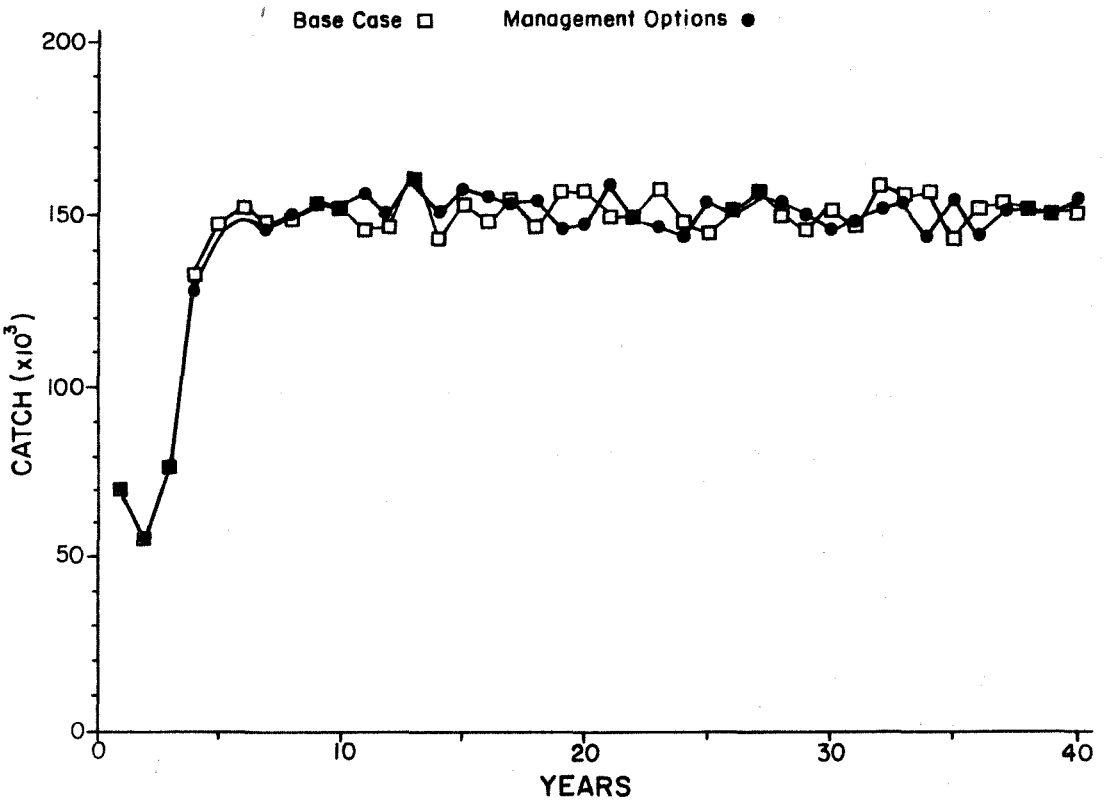


Figure 2.2-4. Predicted results of the Base Case (Option 1) and management (Option 2) for catch of Cumshewa chum salmon.

Although attempts have been made to separate chum salmon stocks in the Cumshewa terminal fishery through boundary modifications, there is likely substantial mixing of stocks. Therefore, the option of more terminal fisheries was not considered feasible. Reducing management uncertainty was not examined in the model since the existing standardized test fishery will continue to provide improved estimates of chum salmon abundance. Pink salmon escapements are below target and therefore could not sustain terminal harvests, even if management uncertainty were reduced.

2.2.9 Predicted Results for Enhancement Options

In the following sections, enhancement options are described for Masset and Cumshewa inlets.

2.2.9.1 Yakoun Spawning Channel

The Base Case (Option 1) scenario for Masset Inlet pink salmon was compared to the proposed Yakoun Spawning Channel option, since none of the other management options resulted in stock rebuilding. The results are summarized in Table 2.2-16 and Figure 2.2-5. It was assumed that escapements of enhanced stocks that exceeded the channel capacity would spawn in the river with the same productivity as the natural stocks. It was also assumed that management uncertainty would be reduced to 10% because a fence would be required to divert spawners into the channel, and improved escapement estimates could easily be made.

Enhancement (Option 2) would result in an increase in pink salmon escapement to the Yakoun River. The natural stock would gradually rebuild and is projected to reach about 60% of target within 40 years. The other pink salmon stocks in Masset Inlet would slowly decline due to increased exploitation in the terminal fishery. Total catch is predicted to increase rapidly in the first 10 years and gradually thereafter; the largest proportion of the catch would occur in Alaska.

In addition to the direct benefits of achieving pink salmon stock rebuilding and increased catch, enhancement may also provide indirect benefits for sockeye salmon, which may be accommodated in the spawning channel. How-

Table 2.2-16. Summary of Base Case and enhancement options for pink salmon in Masset Inlet.

Option	Escapement Trends (% of Target)			NPV* of Catch (thousand $)
	Yakoun	Mamin	Others	
1. Base Case	fluctuates (20% - 30%)	fluctuate (20% - 35%)	gradual increase 1% - 7%	2,232
2. Yakoun Spawning Channel Without Fence	fluctuates (20% - 30%)	declines (20% - 1%)	declines 1% - 0%	5,067
3. Reduce Management Uncertainty (Yakoun Fence)	gradual increase (30% - 60%)	gradual decline (0% - 9%)	declines (2% - 0%)	2,691

* NPV = net present value

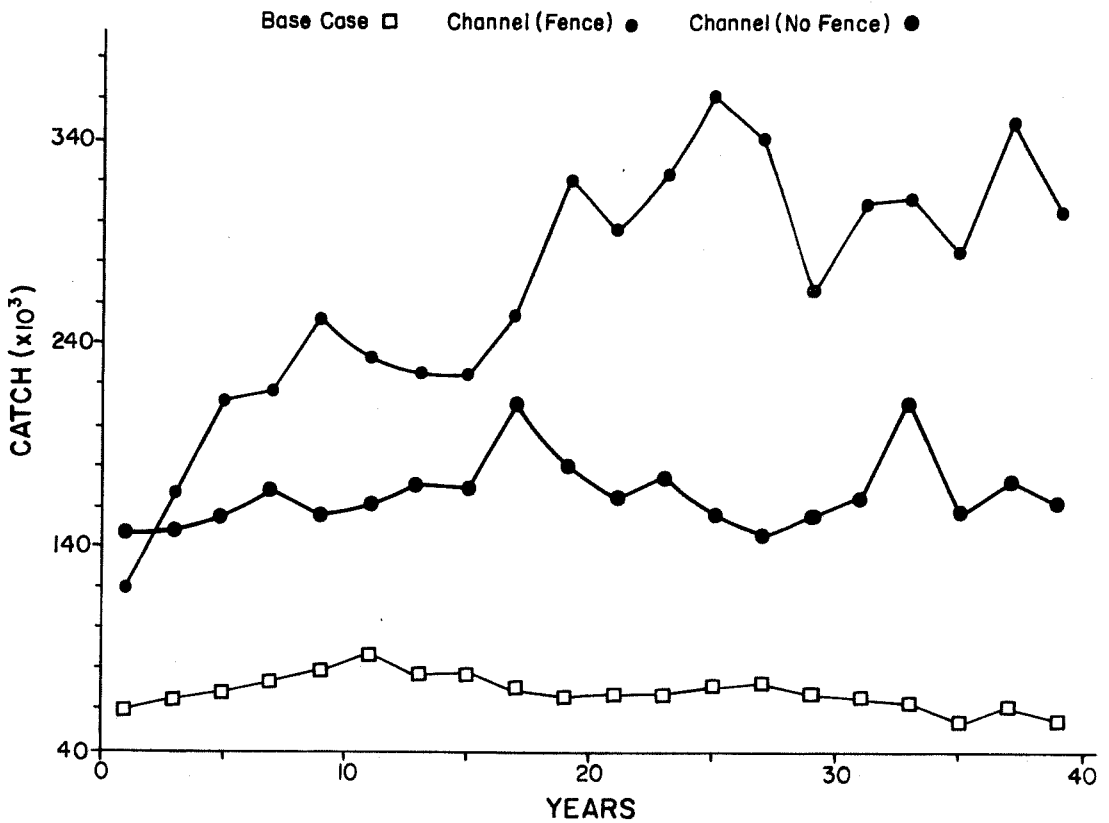


Figure 2.2-5. Predicted results of the Yakoun spawning channel options for catch of Masset pink salmon.

ever, this additional production was not evaluated for two reasons. First, since the spawning channel will only be operated in even years, sockeye salmon would only be affected every second cycle. Second, sockeye salmon might not be produced by the channel. Their fry would either have to swim upstream to the lake (contrary to the behaviour of fry emerging from natural spawning grounds upstream of the lake), or they would rear in the estuary, where there is no information that would permit prediction of their survival. The effects of this enhancement on sockeye salmon should be evaluated during the experimental phase.

Based on the modelled results, the Yakoun Spawning Channel is predicted to result in increased escapements and increased catch. If the experimental stage proves successful, the facility could be expanded to increase the sustainable catch greatly in the terminal area.

2.2.9.2 Yakoun River Fence

Installing a fence to decrease management uncertainty in Masset Inlet (Option 3), was evaluated in both the Base Case and the Yakoun Spawning Channel options. As discussed above, there is no terminal fishery in the Base Case; however, a fence implies that there will be less uncertainty in test fisheries. On average, a test fishery in Masset Inlet would reduce the escapement, resulting in a decline in stock size. Although the fence was useful in 1984 when the return was exceptionally large, returns would generally be too low to open even a test fishery.

When considering the spawning channel model, it was assumed that a fence would be installed, thus reducing the uncertainty in managing the terminal fishery. If a fence were not installed, escapements to the Yakoun River would remain low (< 30% of target) and average catch would be about 40% lower than if the fence were installed. Therefore, to rebuild the stock and increase escapements to the target level, a fence must be part of the spawning channel development.

2.2.9.3 Pallant and Mathers Creek Hatchery Expansions

The Base Case (Option 1) was compared to the enhancement options of Pallant Expansion (Option 2), Mathers Expansion (Option 3) (Figs. 2.2-6 and

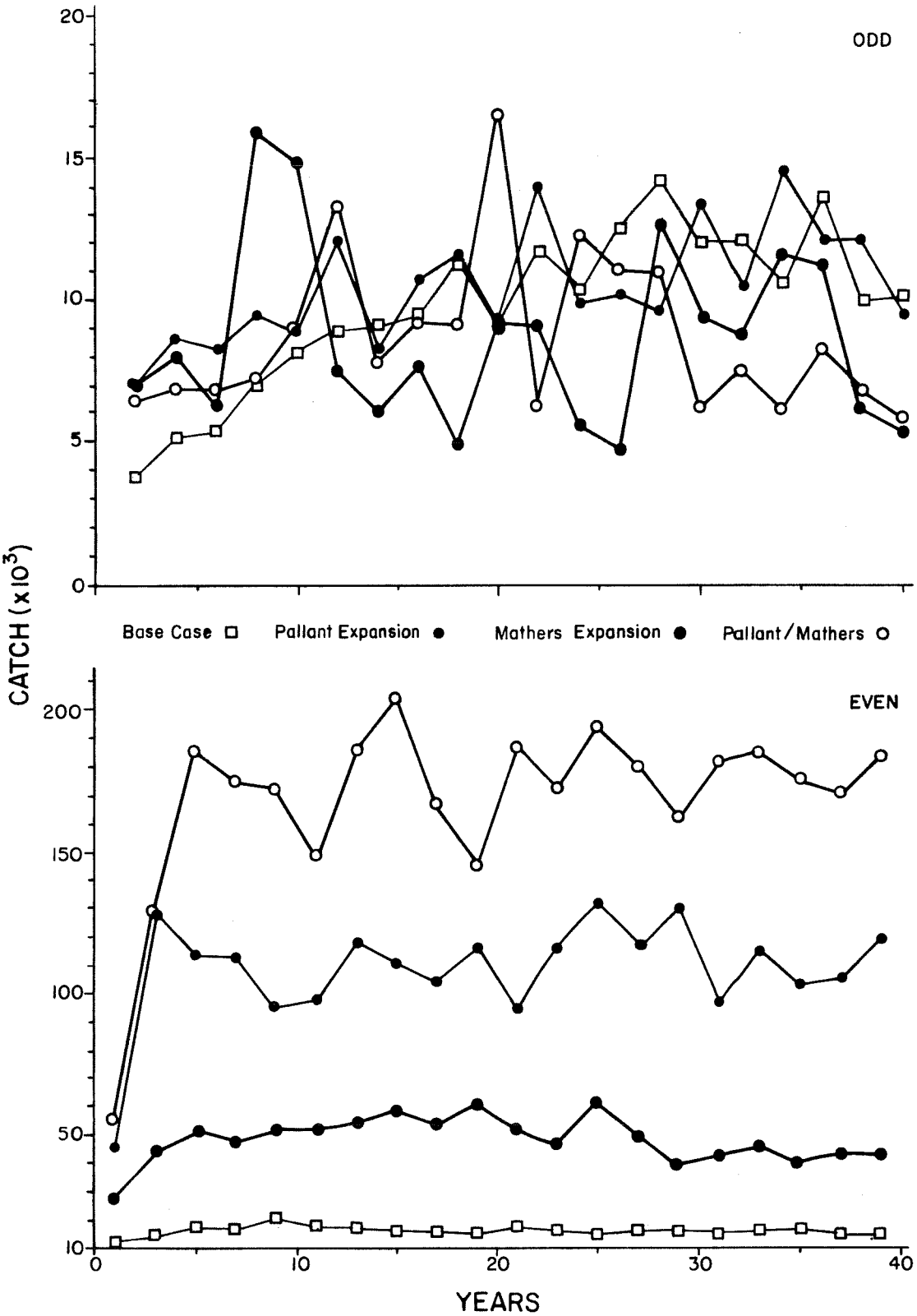


Figure 2.2-6. Predicted results of the Pallant and/or Mathers Expansion options for catch of Cumshewa even- and odd-year pink salmon.

2.2-7) and Pallant/Mathers Expansion (Option 4) (Table 2.2-17). In these options, the terminal fishery was included for pink salmon in order to harvest the surplus of the enhanced stocks.

The option of expanding only the Pallant facility would reduce Mathers pink and chum salmon stocks. Pink salmon in Pallant Creek would achieve target escapements within two cycles, after which they would stabilize at about 150% of target, while Mathers pink salmon would be at about 3% of target. Pallant chum salmon stocks are projected to immediately stabilize at about 150% of target while Mathers chum salmon escapements would quickly decline to about 18% of target and remain constant. Catches were predicted to increase during the first five years and gradually stabilize thereafter.

Expansion of the Mathers facility would permit the Mathers stocks to achieve higher escapement levels compared to the Base Case and the Pallant expansion. Even-year pink salmon in Mathers are projected to achieve target escapement within five cycles, and would stabilize at about 116% of target. Pallant even-year pink salmon stocks would decline from about 40% of target to 20%. Chum salmon escapements to Mathers Creek would quickly increase from 6% to over 50% of target within 10 years and then remain relatively constant. Pallant Creek stocks would stabilize just under target levels. Catches of pink and chum salmon would be slightly greater than in the Base Case.

Expansion of both facilities would provide a better balance between the natural escapements to Pallant and Mathers Creeks, especially for even-year pink salmon stocks. Even-year pink salmon stocks from Pallant Creek would achieve target escapements within 2 cycles, and stabilize at a level 20% higher than target. Mathers even-year pinks would stabilize at about 60% of target escapement. Chum escapement to Pallant Creek would continue to exceed target by 30%, compared to 50% in the Base Case. Chum salmon escapements to Mathers Creek would stabilize at 50% of target, rather than at 25% of predicted for the Base Case. Catch of pink salmon would increase in the first 5 cycles and then stabilize. Catches of chum salmon would increase over the first 12 years, and then stabilize at a level higher than observed in the Base Case or separate expansion options.

All three proposed enhancement options in Cumshewa Inlet provide greater catch and higher NPV than does the Base Case; the combination (Option 4) pro-

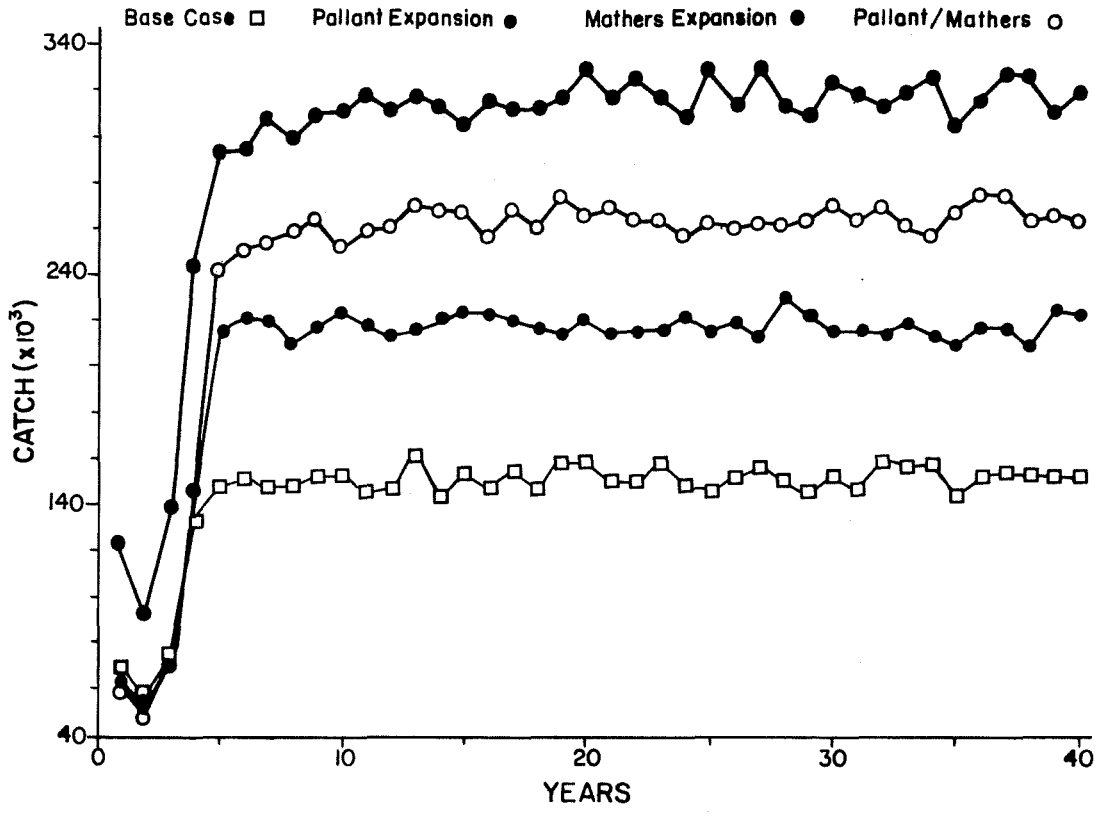


Figure 2.2-7. Predicted results of the Pallant and/or Mathers Expansion options for catch of Cumshewa chum salmon.

Table 2.2-17. Summary of Base Case and enhancement options for pink and chum salmon in Cumshewa Inlet.

Option	Escapement Trends (% of Target)									NPV* of Catch (thousand $)
	Pallant Chum Natural	Mathers Chum Natural	Other Chum Natural	Pallant Chum Enhanced	Mathers Chum Enhanced	Pallant Pink Natural	Mathers Pink Natural	Pallant Pink Enhanced	Mathers Pink Enhanced	
1. Base Case	Stable (150%)	Stable (25%)	Declines (0%)	Stable (100%)	Stable (100%)	Fluctuates (50 - 80%)	Fluctuates (60 - 75%)	0	0	9,576
2. Pallant Expansion	Stable (150%)	Stable (18%)	Declines (0%)	Stable (100%)	Stable (100%)	Gradual Increase (100 - 150%)	Declines (15% - 3%)	Stable (100%)	0	14,665
3. Mathers Expansion	Stable (116%)	Stable (70%)	Declines (0%)	Stable (100%)	Stable (100%)	Gradual Decline (37 - 17%)	Increases (62% - 124%)	0	Stable	12,374
4. Pallant/Mathers Expansion	Stable (130%)	Stable (50%)	Declines (0%)	Stable (100%)	Stable (100%)	Stable (120%)	Stable (60%)	Stable (100%)	Stable (100%)	18,149

* NPV = net present value

vides the greatest NPV. Based on the options evaluated, the Pallant/Mathers Expansion also results in the most beneficial effects on the stocks, by maintaining Pallant stocks at or above target levels, and increasing Mathers stocks to higher levels than observed in the Base Case. Independently, the two separate expansion projects would result in a decline of the other stocks in the system. Therefore, the combined expansion of Pallant and Mathers facilities is the best proposed option. It may be possible to further improve the benefits of this option by altering production between the facilities to minimize over-escapement to Pallant. These potential refinements to the proposal should be evaluated further in the detailed project proposal.

2.3 Statistical Area 3

Statistical Area 3 is the most northerly of all marine statistical areas adjacent to the British Columbia coast (Fig. 2.3-1). The area includes five salmon producing regions: Nass River, Portland Inlet, Portland Canal, Observatory Inlet and Work Channel. Major sockeye and pink fisheries operate off Dundas Island and throughout Portland Inlet. A detailed list of stock attributes and fishing patterns can be found in Appendix 1.

2.3.1 Stock Description

Statistical Area 3 contains 16 actively-managed stocks and 110 passively managed stocks. The actively-managed stocks include one sockeye, seven pink, and eight chum stocks.

The Nass River supports all the sockeye stocks found in Statistical Area 3. The sockeye run to Meziadin Lake represents approximately 60 - 85% of all Nass sockeye. The Meziadin stock is actively managed in Statistical Areas 1, 3 and 4, and intercepted by Alaskan fisheries at Noyes Island and Cape Fox (Fig. 2.3-2). The Meziadin stock passes through these fisheries from late May to late July, and most of the escaping adults are counted through a fish ladder adjacent to Meziadin Falls between early July and mid-September. Escapement of sockeye through the Meziadin fence has increased since the mid-1960's and averaged over 183,000 for the 1980-1984 period. The current escapement represents over 91% of the target escapement. The passively-managed sockeye stocks in the Nass River system appear to be declining or maintaining their small contribution to the total run.

The major pink stocks originate in the Kwinamass, Khutzeymateen, Iknouk and Ishkeenish rivers. These rivers support both odd- and even-year pinks; however, returns to the Kwinamass and Khutzeymateen are largest in even years and returns to the other two rivers are largest in odd years. These stocks are primarily harvested by Portland Inlet fisheries. Recent tagging studies have revealed significant interceptions of these stocks in the Area 1 troll fishery and Alaskan fisheries at Noyes Island and Cape Fox (Fig. 2.3-3). Escapement estimates for the 1980-84 period suggest that the above four rivers represent approximately 80% of the annual 300,000 pink escapement to Area 3

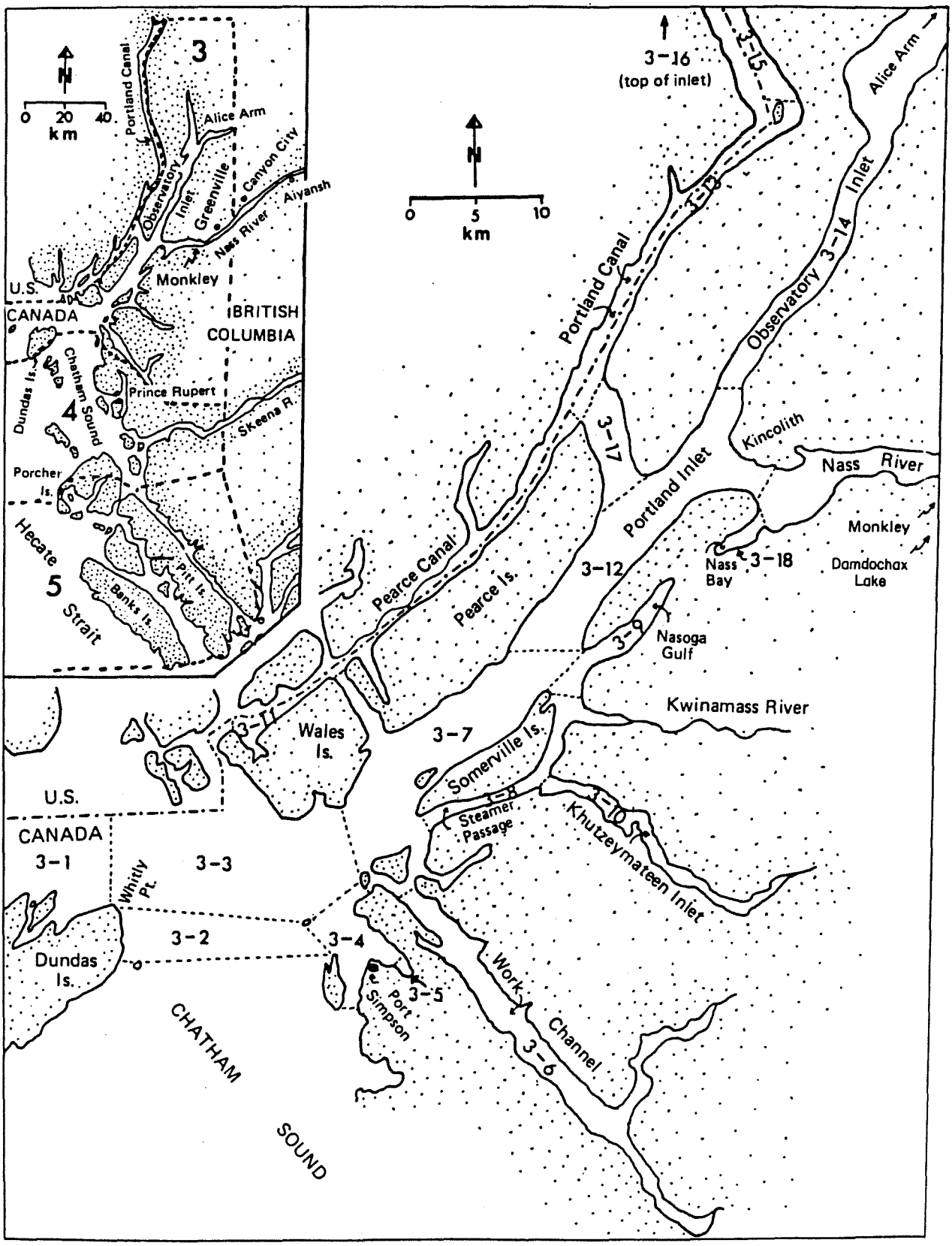


Figure 2.3-1. Statistical Area 3.

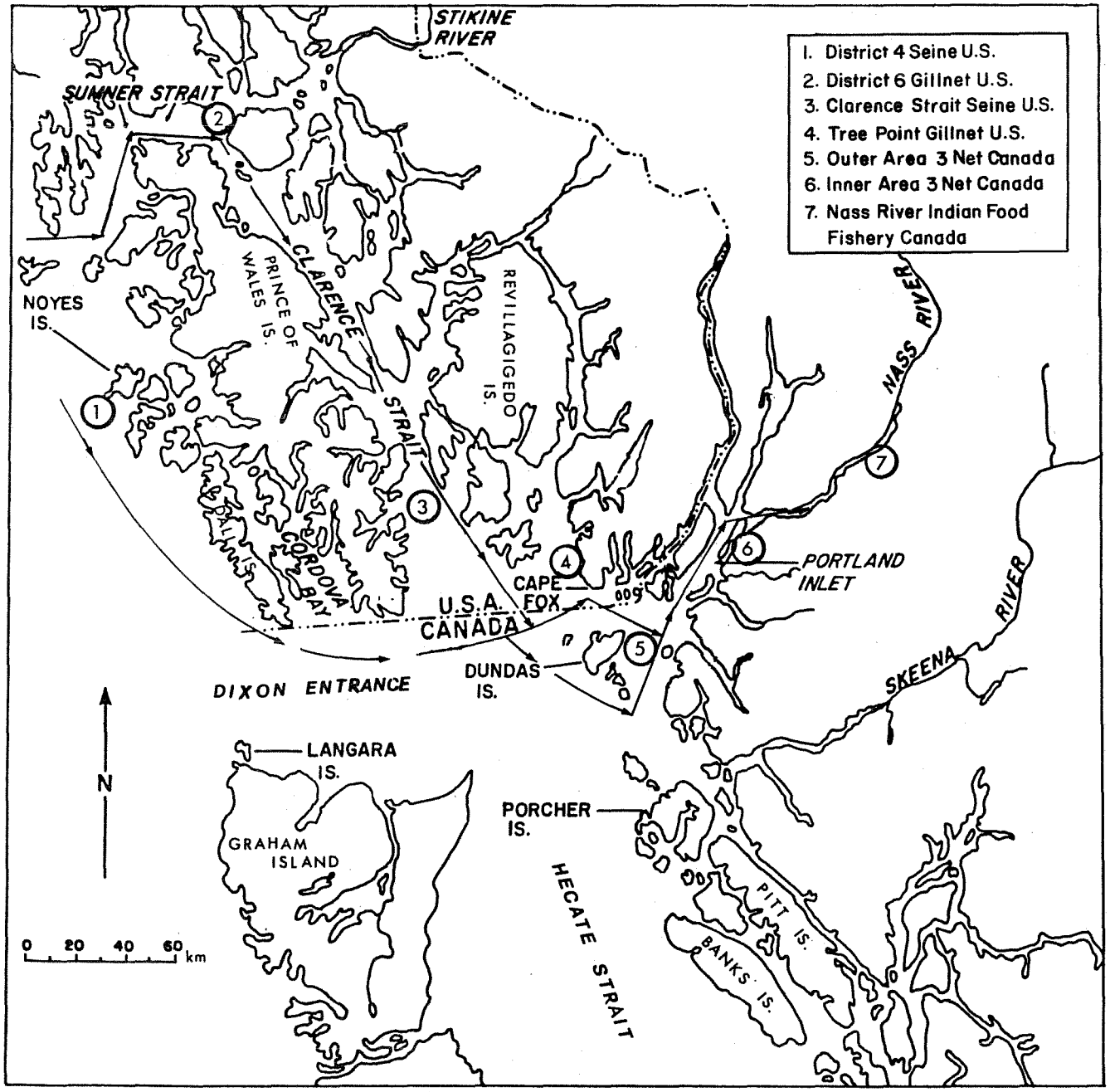


Figure 2.3-2. Migration routes of Nass River sockeye salmon stocks.

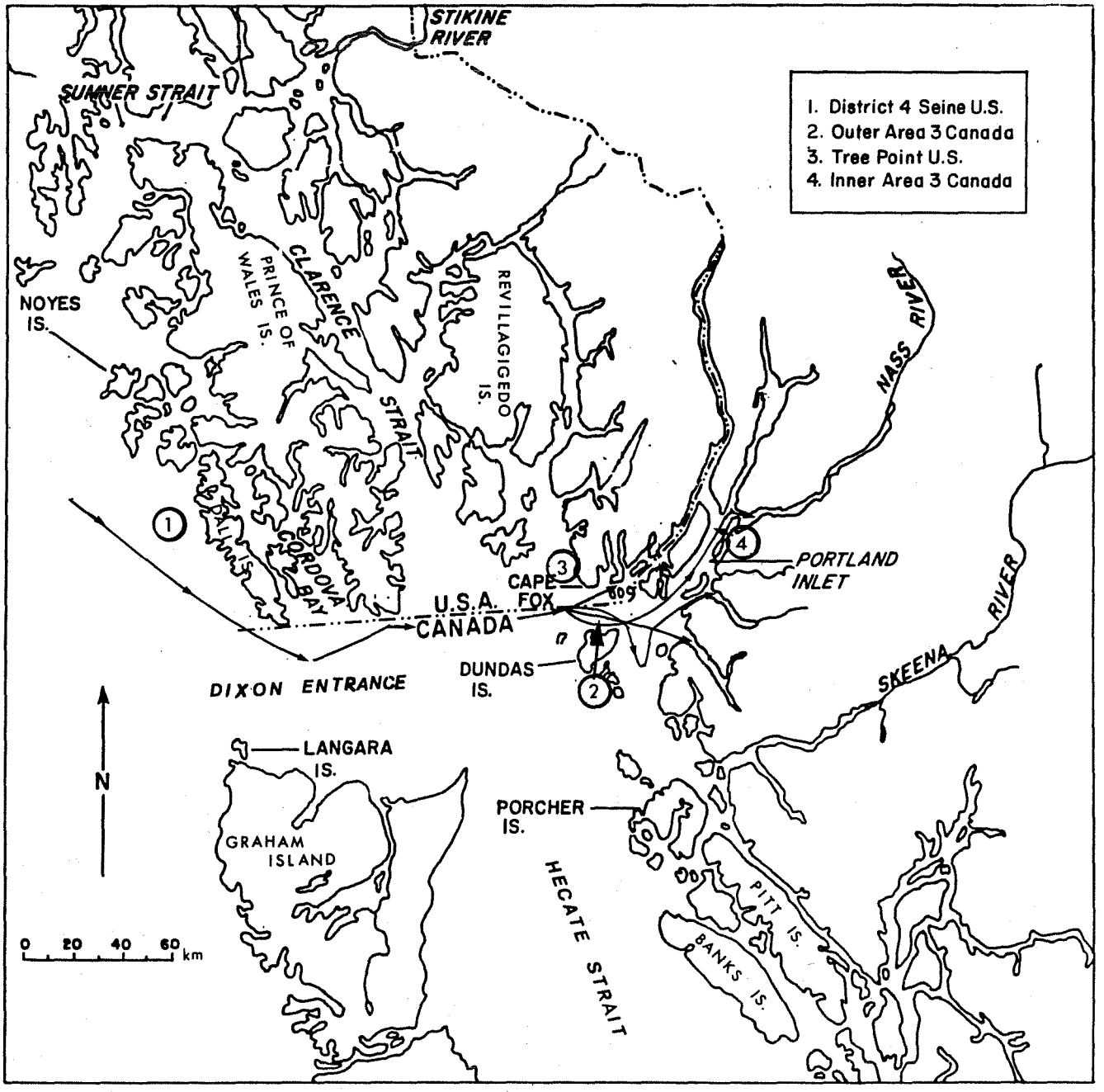


Figure 2.3-3. Migration routes of major even-year pink salmon stocks returning to Area 3.

streams, and recent escapements are very close to the targets set by fishery managers.

Portland Canal and Observatory Inlet contain all the actively-managed chum stocks in Statistical Area 3. These stocks are harvested by terminal fisheries and interception fisheries in Portland Inlet, Observatory Inlet, Hastings Arm and Alaskan fisheries at Cape Fox and Noyes Island. Observatory Inlet chum stocks are thought to achieve 50% of the target escapement, but Portland Canal chum stocks are severely depressed. Total Area 3 chum escapement averaged only 36,000 during the 1980-84 period.

No individual chinook stocks are actively managed in Area 3. Due to the depressed levels of all chinook stocks, no directed fisheries have existed since 1979. Approximately 30 chinook stocks in Area 3 are harvested incidentally in the S.S.E. Alaskan net (Noyes Island, Cape Fox, and Clarence straits) and troll fisheries, and the northern British Columbia net and troll fisheries (Areas 1, 3, 4 and 5). The timing of these fisheries varies from stock to stock; however, one or more stocks are likely present in all fisheries during the season. Nass stocks are intercepted in the Area 3 fishery in June and July, while Portland Inlet stocks are intercepted in July and August. Escapement estimates during 1980-1984 period for the major stocks (Kwinamass, Khutzeymateen, Damdochax, Cranberry, Ishkeenish, Kwinageese, Meziadin and Tseax) are well below levels recorded in the 1960's and 1970's.

There are no individual coho stocks which are actively managed in Area 3. In total there are 63 stocks; 34 are found within the Nass River drainage. Stocks are believed to be intercepted in the Alaskan fisheries at Cape Fox and Noyes Island and also in the S.S.E. Alaskan troll fishery. Canadian fisheries which intercept these stocks are the Area 1, 3, 4 and 5 gillnet, seine and troll fisheries. The time of entry of the stocks in the various fisheries is not known. Escapement estimates of coho are difficult to obtain due to the variability in time of entry, and the length of time that these remain in each system prior to spawning. Coho escapements in Area 3 have been relatively stable over the past 15 years, and are increasing in some areas. This is most likely due to the shortening of the fishing season in recent years; fewer fisheries have been held after the first week in September and the peak escapement timing for most coho stocks is late September.

2.3.2 Fisheries

In Area 3, management is primarily directed at Nass River sockeye and pink salmon; optimum escapement is determined for each species, and the fisheries are managed to arrive at these levels. Optimum escapement is also calculated for other species, but management of these species is largely designed to reduce interceptions of them while targeting on sockeye and pinks.

The sockeye fishery usually begins in mid- to late June. Abundance is determined by the Nass River test fishery and catch estimates. Beginning in mid- to late July, pink salmon abundance becomes the primary management indicator for determining fishing times. Concern for depressed chum stocks limits fishing opportunities in terminal areas such as Observatory Inlet.

Area 3 can be divided into four smaller management areas, each including several Management Units (M.U.): Dundas Island and Chatham Sound (M.U. 3-1, 3-2 and 3-4), Portland Inlet and approach area (M.U. 3-3, 3-7, 3-9, 3-12 and 3-17), Observatory Inlet (M.U. 3-14) and Portland Canal (M.U. 3-11, 3-13, 3-15 and 3-16). Depending on target stock(s) and timing and abundance of incidental stocks, these areas can be opened simultaneously or independently of each other. Within each area, small refinements may occur, e.g., closing M.U. 3-9 in Portland Inlet and the approach area if Kwinamass stocks are weak, or moving stream mouth boundaries seaward. For the outer portion of Area 3 (M.U. 3-1 to 3-4), the strategy is to co-ordinate the management of returning Skeena sockeye and pinks with Area 4 management.

Area 3 supports both seiners and gillnetters. Proportions of species catch by gear type have changed. During the 1960's, gillnetters caught the largest proportion of sockeye, chum, coho and chinook; currently, seiners catch the highest proportion of all species. Gill nets are permitted to be used first in Area 3 (at present this is the last week in June) while seines may not be used until mid-July. Both gillnetters and seiners fish in the same areas, except for M.U. 3-12, which is for gill nets only. Current management strategies specific to individual species are presented below.

2.3.2.1 Sockeye Salmon

Sockeye stocks returning to the Nass River are the target of commercial

fisheries in Area 3. They are composed predominantly of Meziadin and (to a much lesser extent) Upper Nass stocks (Bowser, Damdochax and Fred Wright lakes). These stocks begin entering the fishing areas in May and peak abundance occurs by the end of June or the first week in July. The majority of Nass River sockeye are usually through the outside fishing areas by mid-July (M.U. 3-1 to 3-4), although substantial numbers may still be in inside areas (M.U. 3-7 and 3-12). In-season escapement estimates are provided primarily by a gillnet test fishery on the lower Nass River. Escapement and catch in combination with run timing information determine the fisheries pattern until mid-July.

Skeena River sockeye also migrate through Area 3 and may be sought by fisheries. Enhanced Babine stocks (Pinkut) appear in Area 3 by the first week in July. By mid-July, both Pinkut and Fulton stocks are present and catches in the outside of Area 3 (M.U. 3-1, 3-2 and 3-4) may be composed mainly of these stocks. Skeena sockeye abundance declines by the end of July.

2.3.2.2 Pink Salmon

Pink salmon returning to Area 3 are divided into seven stock groups based on management of fisheries: Kwinamass, Khutzeymateen, Work Channel (three stocks), Iknouk, Ishkeenish, Observatory Inlet (five stocks) and Coastal (four stocks). These pink stocks and stock aggregates are the target of fisheries in Area 3. Of these stocks, the Kwinamass and Khutzeymateen are the first to enter the commercial fishery, while the Iknouk, Ishkeenish and Coastal stocks are the latest. However, from the end of July to roughly the third week in August, timing of runs overlap and force the fisheries (with the possible exception of coastal stocks) to be managed as one stock. The largest stocks (Khutzeymateen, Kwinamass, Ishkeenish and Iknouk) drive the system. Where practical, fisheries are managed for specific stocks and, when weaknesses in stock strength are detected, adjacent management units may be closed or inlet boundaries changed to reduce exploitation rates.

As with sockeye, Skeena River pinks also migrate through Area 3, and may be the target species in particular weeks and areas. Skeena pinks are assumed to enter Area 3 by the third week of July, while Area 4 coastal pinks may still be present in Area 3 by the first week in September. Area 4 pink stocks

are thought to be largely confined to the outer areas of Area 3 (M.U. 3-1, 3-2 and 3-4). Southeast Alaska pink stocks also migrate, in part, through Area 3. Timing overlaps with Area 3 stocks, and Alaskan pinks are present in varying proportions from the end of July to the end of August.

2.3.2.3 Chum Salmon

In Area 3, chum stocks are divided into two stock aggregates which may be directly managed: Portland Canal (four stocks) and Observatory Inlet (five stocks). Generally, fisheries in Area 3 are not specifically for chums; chum catches are usually incidental in sockeye and pink fisheries. Chum strength in Portland Canal (M.U. 3-11, 3-13 and 3-15) and Observatory Inlet (M.U. 3-14) could be assessed by a commercial fishery, but these openings would only occur at the same time that other areas were open for sockeye or pink fishing. The exploitation rates for fishes taken incidentally are sufficiently high to harvest all surplus chums. In-season chum stock assessment is based on incidental catches and stream and sanctuary observations of escapement, and on run expectations.

2.3.2.4 Chinook Salmon

There are no commercial net fisheries specifically for Nass River chinook stocks. Seine fisheries in Area 3 are delayed to conserve chinooks, while gillnet fisheries have mesh restrictions to reduce interception. The chinooks enter Area 3 in April, and are usually through the Area by mid-July. Six Indian bands intercept chinooks in food fisheries in Area 3: Port Simpson and Kincolith in tidal waters, and Greenville, Canyon City, Aiyansh and Kitwancool in non-tidal waters. Catches by these fisheries have remained stable in response to concern for the depressed stocks. A sport fishery in Area 3 also intercepts chinooks; however, stock origins are unknown.

2.3.2.5 Coho Salmon

There are no commercial net fisheries specifically for coho in Area 3; all catches are incidental to sockeye and pink catches. Any management is indirectly applied by limiting exploitation in sockeye and pink fisheries.

2.3.3 Current Enhancement Activities

The Kincolith hatchery is the only enhancement facility in Statistical Area 3. The small hatchery, targeting on the Kincolith chinook and coho stocks, plans to release approximately 300,000 fry annually. Projected adult returns generally range from 1,400 to 1,500. In addition, a fishway, located one-quarter of a mile up the Meziadin River, was built in 1966 to assist sockeye in bypassing a series of falls.

2.3.4 Habitat Status

Habitat descriptions for Area 3 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.3-1 through 2.3-5, respectively. For a description of the tables, see Section 2.2.4.

2.3.5 Management Conflicts

Table 2.3-6 lists the major factors in the current management approach in Area 3 which reduce potential production. Major production is lost through mixed-stock commercial fishing in Area 3 and interception fisheries in southern southeast Alaska. Environmental factors such as floods and freezing during egg incubation periods also reduce the productivity of many stocks. Uncertainties in sockeye escapements further reduce production. Uncertainties in estimates of run size, spawning escapements, optimum escapement, run timing and harvest rates are also potentially important, but their impacts on production are not known. Sport and Indian food fisheries, particularly for chinook, can also constrain rebuilding.

Fishing plans recently negotiated between Canada and the U.S. will help reduce the interception problem with local stocks. These fishing plans will also change the approach to stock management and will reduce some of the mixed-stock problems. There are several sections of the agreement that apply to Area 3 sockeye and pink stocks.

The U.S. will limit its purse seine fishery in District 4 in a manner that will result in a maximum four-year total catch of 480,000 sockeye salmon prior to U.S. statistical week 31 during the period 1985-1988, and will limit

Table 2.3-1. Statistical Area 3 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	327	286	216

MANAGEMENT STYLE: Active 90%; Passive; Unknown

NUMBER OF STREAMS: 15

HABITAT NOTES

Historic Status, Production Constraints and Development History	Dominated by Meziadin River runs improved by fishway in 1960's. Logging: Low impact - spot problems 1960-1975. Mining: Low impact. No other significant impacts. Natural unstable flows on some streams.
Current Status	Low level forestry. Natural flow fluctuations. Spot mining and transportation - low impact.
Future Outlook	Largely unchanged from present status.
Natural Habitat Production Potential	No significant change from historic highs.
Improved Production Potential	Possibilities for additional obstruction removal/bypass on Meziadin System.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	Low/Medium

CONCLUSION Since stock is dominated by one stream, few benefits are likely from any minor stream improvements.

Table 2.3-2. Statistical Area 3 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	400	308	300

MANAGEMENT STYLE Active 80%
Passive
Unknown

NUMBER OF STREAMS 54

HABITAT NOTES

Historic Status, Production Constraints and Development History	Four dominant stocks account for 80% of fish. Logging: Low impact - spot problems 1960-1975. Mining: Low impact. No other significant impacts. Natural unstable flows on some systems.
Current Status	Low level forestry. Natural flow fluctuations. Spot mining and transportation - low impact.
Future Outlook	Largely unchanged from present status.
Natural Habitat Production Potential	No significant change from historic highs.
Improved Production Potential	Uncertain, but limited data and topography suggest that a number of streams have obstructions fairly close to their mouths.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Medium	Medium

CONCLUSION Fishing is closely co-ordinated with Nass sockeye fishing. Target is below the likely high, and there are no habitat problems to suggest that this should not be reached.

Table 2.3-3. Statistical Area 3 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	399	106	37

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 30

HABITAT NOTES

Historic Status, Production Constraints and Development History	Four dominant stocks account for 80% of fish. Logging: Low impact - spot problems 1960-1975. Mining: Low impact. No other significant impacts. Natural unstable flows on some systems.
Current Status	Low level forestry. Natural flow fluctuations. Spot mining and transportation - low impact.
Future Outlook	Largely unchanged from present status.
Natural Habitat Production Potential	No significant change from historic highs.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Medium	Medium

CONCLUSION Habitat does not appear to be a constraint although current escapements seem low in relation to recorded highs (which may be questionable).

Table 2.3-4. Statistical Area 3 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	117*	37	10

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 18

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging: Low impact - spot problems 1960-1975. Mining: Low impact. No other significant impacts. Natural unstable flows on some streams.
Current Status	Low level forestry. Natural flow fluctuations. Spot mining and transportation - low impact.
Future Outlook	Largely unchanged from present status.
Natural Habitat Production Potential	No significant change from historic highs.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	Unknown

CONCLUSION Habitat does not seem to be the problem. Natural habitat could produce more than target if MRE is anywhere near accurate.

* Questionable data.

Table 2.3-5. Statistical Area 3 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	146		67

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 45

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging: Low impact - spot problems 1960-1975. Mining: Low impact. No other significant impacts. Natural unstable flows on some streams.
Current Status	Low level forestry. Natural flow fluctuations. Spot mining and transportation - low impact.
Future Outlook	Largely unchanged from present status.
Natural Habitat Production Potential	No significant change from historic highs.
Improved Production Potential	Local restoration.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	Medium - High

CONCLUSION Indications are that this area can be managed well as a target fishery.

Table 2.3-6. Factors which reduce production, and their estimated effects on production by species for Area 3.

	Effects on Salmon Stocks				
Constraints	Sockeye	Pink	Coho	Chum	Chinook
Mixed stock fisheries	moderate	high	high	high	high
Alaska interceptions	high	moderate	unknown	unknown	unknown
Indian food fishery	moderate	low	moderate	low	high
Sport fishery	low	low	moderate	low	moderate
Uncertainties - run size - optimum esp. - spawning esp.	moderate	moderate	moderate-high	high	high
Environmental	low	moderate	unknown	moderate	unknown
Seine catch of juvenile chinook	-	-	-	-	high

its drift gillnet fishery in Districts 1A and 1B in a manner that will result in an average annual harvest of 130,000 sockeye salmon. Canada will limit its net fishery in Areas 3-1, 3-2, 3-3, 3-4, and 5-11 in a manner that will result in an average annual harvest of 900,000 pink salmon, and will limit its troll fishery in Area 1 in a manner that will result in a maximum two year (1985 and 1986) total troll catch of 1 million pink salmon. However, when 300,000 pink salmon are caught by trolling in Area 1 in any one year, sub-areas 101-2 north of 54° 35' North, 101-3 and 101-6 will close to pink salmon trolling. The result of the agreement will be in some years to shift fishing to more terminal areas to harvest Nass and Skeena area stocks.

Both Parties agreed in 1985 to jointly reduce interception of these stocks to the extent practicable, and to undertake assessments to identify possible measures to restore and enhance these stocks. On the basis of such assessment, the Parties shall instruct the Commission to identify long-term plans to rebuild stocks.

2.3.6 Management Strategies for Stock Rebuilding

Sockeye stocks returning to Area 3 are dominated by Meziadin River production. Undoubtedly, Meziadin sockeye have higher productivity than non-Meziadin stocks, but since they are managed as a single unit the result is less than optimum production from non-Meziadin stocks. If the passively-managed sockeye stocks are to be rebuilt, the overall exploitation rate must be reduced to reflect their lower productivity.

A similar mixed-stock problem exists between passively- and actively-managed pink stocks. Few of the pink stocks in Area 3 are depressed; most stocks are at or above optimum levels. The rebuilding of passive stocks would require fishermen to forgo catches of actively-managed pink stocks, harvesting pinks at a rate more appropriate to the less productive pink stocks. This mixed-harvest problem will not be reduced with the Canada/U.S. agreement. The effect of setting limits to Canadian fisheries in Management Units 3-1, 3-2, 3-3 and 3-7 will shift fishing effort to more terminal areas such as M.U. 3-7 and 3-12, plus Area 4. However, the stocks are still mixed in these areas and will be fished in stock aggregates. The major benefit would be to include the Skeena-bound fish in the stock aggregation.

The incidental harvest of chums in pink and sockeye fisheries is probably the most important factor depressing chum stocks. A rebuilding program to increase chum escapements would require reductions in pink and sockeye catches, or additional area closures and mesh restrictions, or both. Once chum stocks recover, harvest rates must not be allowed to exceed appropriate levels for chums. The merits of this option require investigation in view of the pink catch which will be forgone each year.

2.3.7 Future Stock Enhancement Activities

Future enhancement projects for Area 3 that are compatible with management practices are described below. Accompanying each project title is the project number from Lill *et al.* (1983)[1].

2.3.7.1 Tseax River Chinook Hatchery (Project No. 3-1A)

Non-tidal sports fishing for chinook salmon has been an important and visible fishery for the past 15 years in the Nass area. The general decline in chinook abundance in British Columbia has affected Nass stocks to the point where angling has been drastically curtailed in most streams. Management actions have eliminated all directed Nass chinook commercial fisheries and reduced known domestic interception fisheries. These actions, coupled with the anticipated reduced troll catch in Alaska with the Canada/U.S. salmon treaty, are expected eventually to rebuild these stocks. However, there is a high demand for quality recreational fishing for chinooks. This demand can be met with enhancement assistance. The choice is essentially one of virtually closing the area to all chinook fishing and re-building stocks through management over the next two decades, or maintaining this high-value fishery while rebuilding at the same rate with SEP assistance.

Construction of a central hatchery at the Tseax River near New Aiyansh is proposed. Chinook eggs would be taken from the Cranberry, Tseax and Ishkeen-

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[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

ish Rivers, incubated and reared at the hatchery, and planted back at the parent streams at appropriate times. Additional work involves rock obstruction removal in the upper Tseax River to provide new spawning and rearing areas. Large amounts of warm, clean water are available and there are at least four sites offering gravity-feed potential for a facility.

The facility would have a capacity for 250,000 chinook eggs, resulting in about 185,000 3-4 g fry to be planted. This would result in a total adult production of 2,000 to 4,000 fish. These adults would be caught by directed sports fisheries in the Ishkeenish, Tseax and Cranberry Rivers; Indian food fisheries at the Nishga villages of Kincolith, Greenville, Canyon City and New Aiyansh; Area 1 and 3 domestic commercial fisheries (as incidental catches); and Alaskan commercial fisheries. Detailed technical evaluations of alternative sites are required as well engineering and biological field surveys.

2.3.7.2 Observatory Inlet Chum Facility (Project No. 3-22A)

Observatory Inlet has four major chum stocks: Kitsault, Illiance, Stagoo and Kishwan. These have been major contributors to the commercial fisheries in Area 3, both in the non-directed outside fisheries (which target on pinks) and in directed terminal harvests in Observatory Inlet. Pink salmon stocks in Area 3 have grown dramatically in recent years and provide an important portion of the coastal seine catch. The pink fishery has resulted in a high incidental catch of Observatory Inlet chums. Directed terminal fisheries are now seldom possible and the stocks have become depressed. It is economically desirable to maintain the pink fishery, but because of their high value, loss of the chum stocks is costly. Current chum escapements to all Observatory Inlet streams average 21,500 compared with an optimum of 45,300. As management action is not a desirable option, the best alternative is to strengthen these stocks through enhancement.

A central hatchery located at Kitsault is proposed. Eggs would be taken from the Illiance, Kitsault, Stagoo and Kishwan rivers, incubated and reared at the Kitsault facility, and planted at the parent streams. The Kitsault facility would be integrated with Portland Canal chum enhancement, most of which would be undertaken by Alaska. Production from the facility would contribute to seine and gillnet fisheries in lower Area 3 (Dixon Entrance and

Portland Inlet); Observatory Inlet terminal seine and gillnet fisheries (once stocks have been rebuilt); and Southeast Alaska net fisheries (particularly the Tree Point gillnet fishery).

This facility would produce approximately 80,000 - 90,000 adult chums and have a minor additional chinook and coho production. As a first stage, it is suggested that the facility have a maximum capital cost of $1,000,000. Using SEP standard costs, 3,000 kg of juveniles released as 1 g fry would cost $900,000 in capital and $425,000 in annual operating costs, and would produce 60,000 adult chums. The facility could be reduced in size if necessary and costs might be reduced if a PIP or CEDP project became possible.

The fishery which has caused the Observatory chum declines is also partly responsible for a decrease below minimum escapements in Portland Canal chum stocks, most of which are Alaskan. Portland chums are mostly taken in the Tree Point gillnet fishery in Alaska, the Area 3 seine and gillnet fishery in Dixon Entrance and Portland Inlet, and very occasionally in the U.S. and Canadian portions of Portland Canal. Alaska is interested in enhancing Portland Canal chums, but is concerned about Canadian interceptions. Other stocks include Work Channel chums, particularly from Quotoon Inlet, which is also under consideration for enhancement by transplanting eggs above the falls.

Discussions have already taken place between Canadian and U.S. fisheries authorities on a joint Portland Canal and Observatory Inlet chum enhancement package. The threat of uncontrolled Canadian interception of Portland chums has prevented Alaska from proceeding to date, and experimental chum facilities in other parts of lower S.E. Alaska have recently been stopped because of Canadian interceptions. The Canada/U.S. treaty will now facilitate development of a joint chum enhancement plan along with appropriate fishing plans. It is expected that the conduct of the fisheries will generally remain as they are but with improved catches and escapements. When surpluses occur, they will be harvested by terminal fisheries in Portland Canal and Observatory Inlet as they have been in the past. Canadian involvement in Portland Canal terminal fisheries would depend on Canadian contributions to chum production there but, in general, the agreed enhancement and management package would be designed to give each country the benefits of its own enhancement.

2.3.7.3 Bear River, Clements Creek (Project No. 3-27, 3-26)

There is little knowledge about enhancement potential in the Portland Canal area. The only projects are minor, and include:

1. Installation/operation of incubation boxes or pits, possibly in the small feeder streams in the Bear Estuary area. Suggested brood stock source would be chum salmon from Fish River; and

2. Stream rehabilitation in Bear Estuary feeder streams and Clements Creek. These efforts would be very small in scale and would not have major benefits.

A maximum of 3,000,000 eggs is suggested for the Fish River chum transplant incubation project. Presuming an unfed fry release, about 20,000 adults would be produced.

2.3.7.4 Port Simpson-Quotoon (Project No. 3-20)

This project involves transplanting eggs from Toon River summer chum stock above an obstruction on the Thulime River. Production from the transplant was tentatively estimated at 3,500 total adult chums from transplant of 500,000 eggs.

2.3.7.5 Tseax River Rehabilitation (Project No. 3-1C, 3-1E)

Two small-scale projects include alleviation of an obstruction on the upper Tseax River and diversion/channelization of the Vetter River. The upper Tseax Falls are a partial obstruction which pink and chinook do not pass but coho and steelhead do. The obstruction could be alleviated by blasting at the falls or by improving an existing side channel around the falls. Engineering ground surveys are required to define the method of alleviation.

The Vetter River breaks off from the Tseax mainstem downstream of the upper Tseax Falls, and drops over a 3 - 4 m falls. Below this point, the Vetter disappears into the lava bed; the length of channel that dries varies with flows. This situation may result in loss of coho, steelhead, and possib-

ly chinook juveniles (not documented to date). Diversion of surface water back into the Tseax mainstem may be possible, or the Vetter could be connected by a channel to the Nass. The need for this project is unclear, and both approaches require biological and engineering field work.

2.3.7.6 Nass Stream Rehabilitation Package (Various Project No's.)

There are a number of small-scale steam improvement/maintenance projects that could be useful if completed. Several that are considered important include:

- Gingit Creek (3-2B): Annual beaver control (pink and coho);
- Zoulzap Creek (3-3): Add spawning habitat, beaver control (pink);
- Diskangieg Creek (3-4): Stream clearance (coho);
- Anliyen Creek (3-8): Flood control/dyking (coho);
- Kwinyarth Creek (3-9): Annual beaver control (pink);
- McKnight Creek (3-13): Culvert repair (steelhead);
- Ansedagan Creek (3-28): Annual beaver control (chum, coho, pink);
- Ginlukuk Creek (3-29): Spawning gravel addition (coho);
- Cranberry (3-31): Blasting of chute/rock (causing chinook and coho injuries).

2.3.8 Predicted Results for Management Options

The following analyses were conducted using a preliminary computer model, and the results and conclusions are therefore preliminary. Re-analysis is in progress and will be presented in the next edition of this report.

Two options suggested for sockeye management in Area 3 involve either fishing at a rate directed by returns of Meziadin River stocks (Option 1) or at a rate directed by non-Meziadin stocks (Option 2). Catch forecasts for these options are summarized in Table 2.3-7. Net present values indicate that Option 1 is preferred. However, it does require acceptance of gradual decline of non-Meziadin stocks. Option 2 would become more attractive if some upriver site such as the Meziadin Fishway would be used to harvest forgone Meziadin production. This would require fish quality studies to determine if other opportunities exist.

With regard to pink salmon, a similar problem exists between actively and passively-managed stocks. In addition, this problem affects chum stocks in the area. Current procedures allow the actively-managed pink salmon stocks to drive the management plan. Under this scenario, pink salmon catch averaged 474,817. For chum salmon, on the other hand, catch average is 24,602 (Table 2.3-8). If the situation is changed so that actively-managed chum drive the management, pink salmon catch averages 275,433 and chum salmon catch averages 36,983.

Table 2.3-7. Catch forecast for Nass River sockeye stocks.

Options	Meziadin Stocks				Non-Meziadin Stocks			
	Catch		Escapement		Catch		Escapement	
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend
1. Meziadin Driven	288,563	stable	198,166	stable	31,143	declining	26,320	declining
2. Non-Meziadin Driven	149,172	stable	188,334	stable	56,923	increasing	80,118	increasing

Table 2.3-8. Options for pink and chum management in Area 3.

Options	Active Pink Stocks				Passive Pink Stocks			
	Catch		Escapement		Catch		Escapement	
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend
Pink Driven	446,020	steady	225,880	steady	28,797	declining	18,138	declining
Chum Driven	299,916	steady	208,773	steady	45,517	declining	58,497	declining

Options	Active Chum Stocks				Passive Chum Stocks			
	Catch		Escapement		Catch		Escapement	
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend
Pink Driven	16,715	declining	11,646	declining	7,887	declining	5,556	declining
Chum Driven	28,927	increasing	37,240	increasing	8,056	steady	14,652	declining

2.4 Statistical Area 4

Statistical Area 4 includes most of Chatham Sound, and is bounded by the mouth of the Skeena River and mainland coast to the east, and Stephens and Dundas islands to the west (Fig. 2.4-1). Almost all major salmon stocks caught in Statistical Area 4 originate in some part of the Skeena River watershed. Major sockeye and pink fisheries operate throughout Chatham Sound and are concentrated at the mouth of the Skeena. Detailed tables of stock attributes and current fishing patterns can be found in Appendix 1.

2.4.1 Stock Description

Statistical Area 4 supports five actively-managed sockeye stocks, nine actively-managed pink stocks, and 14 passively-managed stock groups.

Sockeye stocks are divided arbitrarily for management purposes into two categories: Babine stocks and non-Babine stocks. Only Babine stocks are actively managed. Approximately 90% of the total annual escapement of Skeena sockeye are counted through the Babine fence as fish pass it on their way to spawning areas in and adjacent to Babine Lake. Details on run timing and interception fisheries can be found in International Tagging Program and domestic reports. In general, Babine sockeye pass through major area fisheries between late June and early August, and spend 18-30 days in fresh water prior to reaching the Babine fence. Major migration routes are shown in Figure 2.4-2.

Sockeye escapement through the Babine fence has increased dramatically since the completion of the Fulton and Pinkut spawning channels in 1968. From 1980-1984, the average annual escapement to the Babine fence was over 1,000,000, which exceeded target escapement. However, most of this escapement consisted of enhanced stocks; therefore, even though the aggregate escapement goal was exceeded, not all stocks in the area met their escapement goals.

Actively-managed pink stocks include even- and odd-year runs to the Babine, Lakelse and Kitwanga rivers and coastal systems, and odd-year runs to Kispiox River. All Skeena pink stocks are currently larger in the odd-year cycles, although even-year stocks were dominant prior to the 1960's. Odd-year

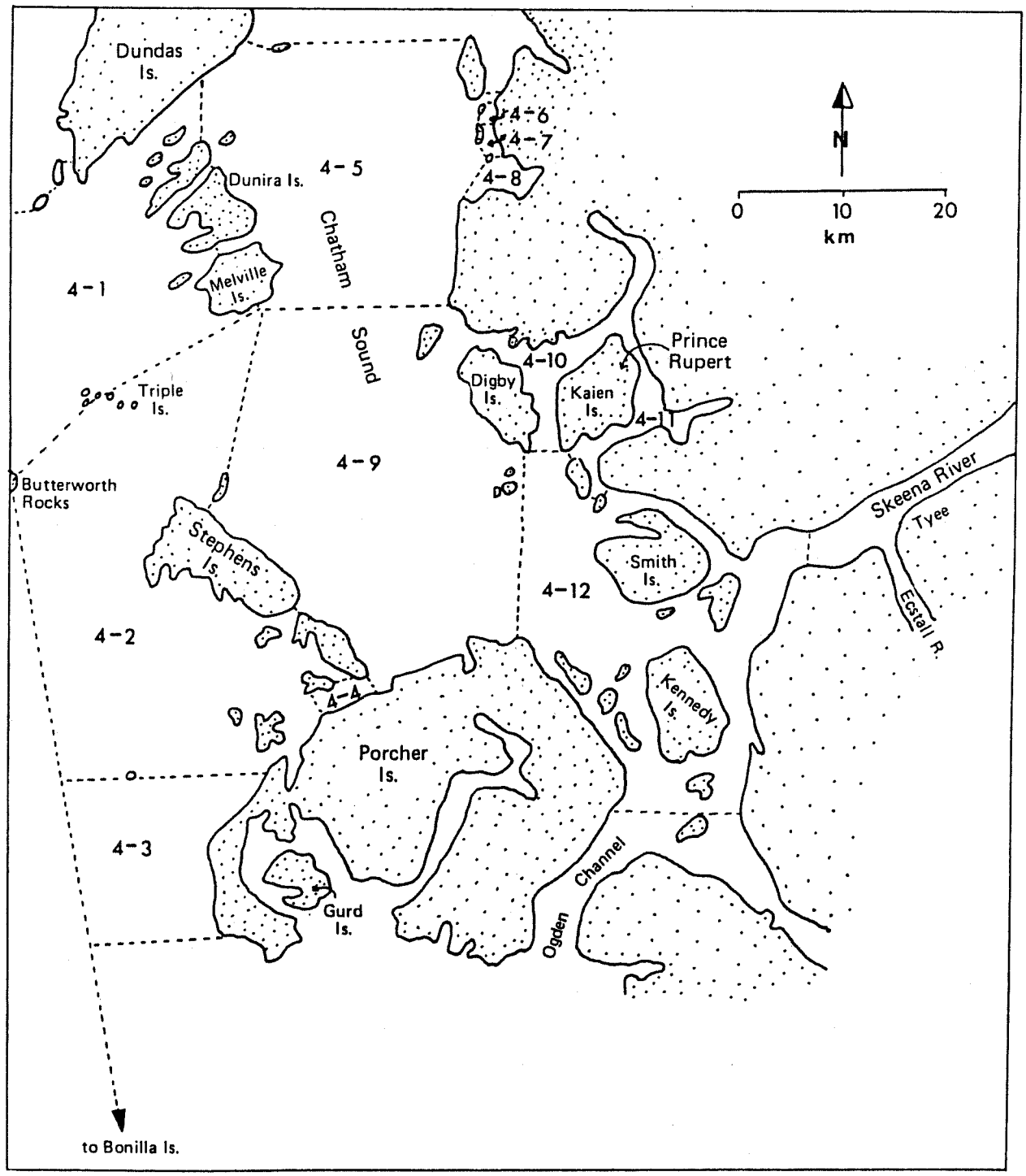


Figure 2.4-1. Statistical Area 4.

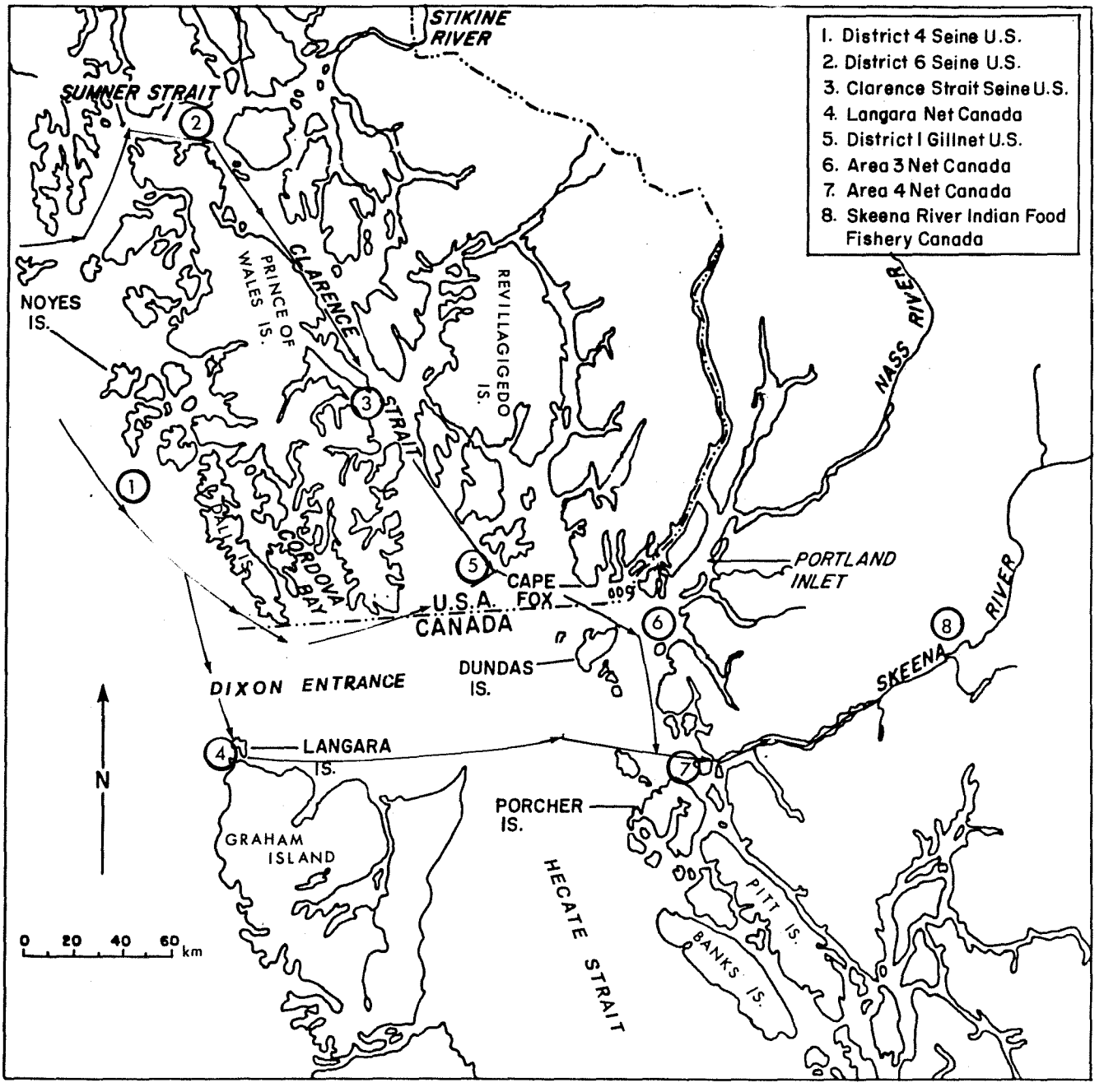


Figure 2.4-2. Migration routes of Skeena River sockeye salmon stocks.

and even-year average pink escapement to the above rivers in recent years were 1,669,000 and 734,000, respectively. Major migration routes for the even-year pink stocks are shown in Figure 2.4-3. Insufficient tagging data exist to document the odd-year pink stocks' migration route. Estimates suggest that recent escapements have approached or exceeded target escapements for most actively-managed Skeena pinks. Many of the passively-managed pink stocks are below target escapement.

Area 4 is not a major chum producing area. The Ecstall River and the mainstem of the Skeena River are the major spawning areas for chum. Neither of these stocks is actively managed because their run timing and distribution overlap with both the sockeye and pink fisheries.

Area 4 has seven major chinook stocks spread throughout the Skeena River drainage area. None of these stocks is actively managed. However, efforts have been made in current fisheries in Area 4 to reduce the incidental catch of all chinook stocks. Chinook escapements to all stream systems are well below historic levels, although in recent years escapements have improved slightly. The run timing corresponds with the timing of the sockeye fisheries, and high incidental catches of chinooks still do occur.

Coho-producing stream systems are found throughout the Skeena River drainage, as well as in most small coastal streams. No individual stocks are actively managed. Escapement estimates indicate that coho stocks are seriously depressed in Area 4. One of the causes of the decline is the sockeye and pink fisheries, which have a high incidental catch of coho.

2.4.2 Fisheries

In Area 4, fisheries are managed to provide optimum escapements of major sockeye and pink stocks bound for the Skeena River. However, in an attempt to protect the minor (usually less productive) stocks, exploitation rates in certain times and areas are restricted. This results in surplus escapements of more productive stocks in some years.

Fishing plans are based on the forecast of total stock; open days are calculated as a function of the target escapement for the week, predicted

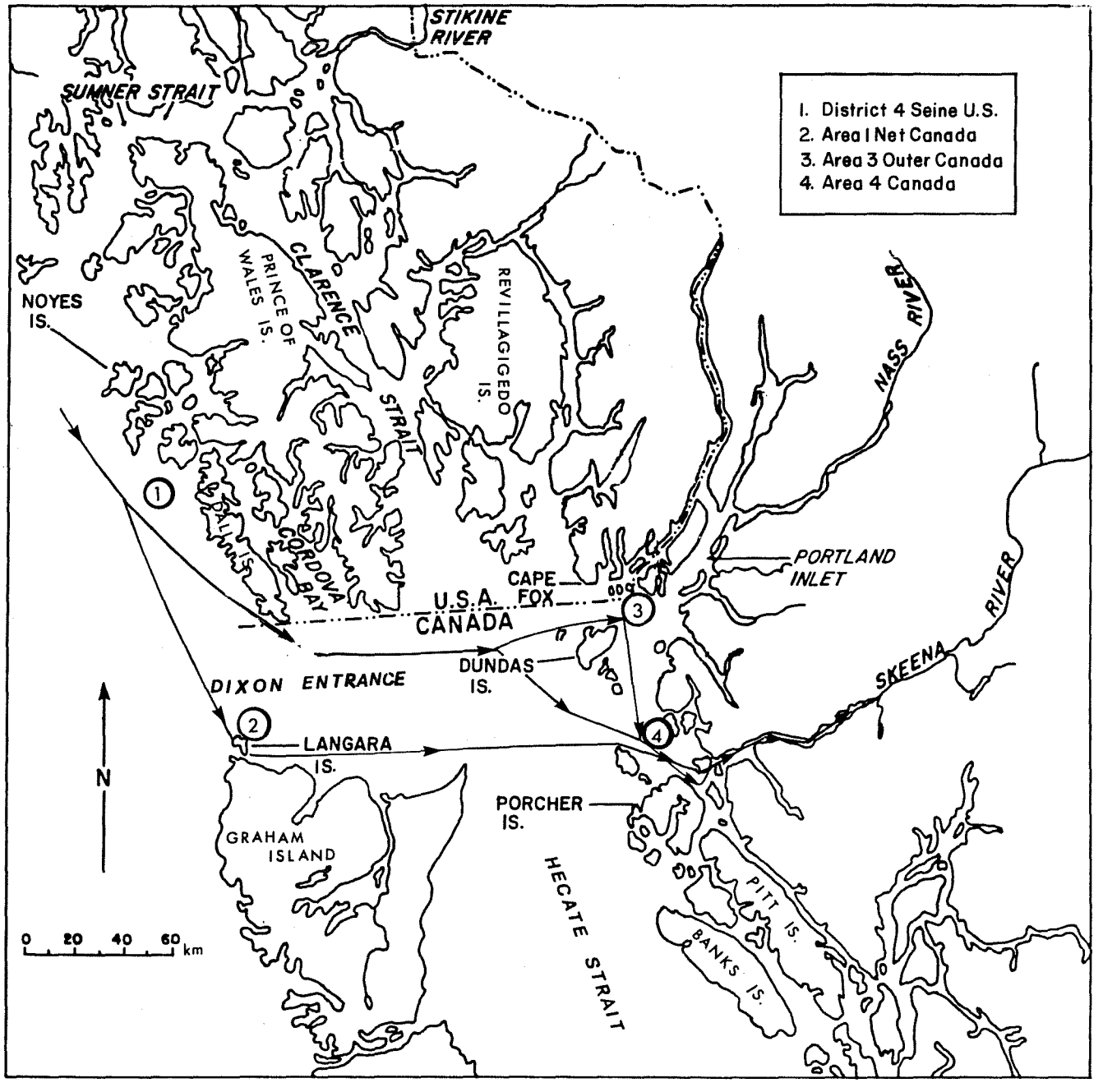


Figure 2.4-3. Migration routes of Skeena River even-year pink salmon stocks.

effort and catchability coefficient. Cumulative catch and escapement during the season are combined with pre-season estimates to forecast the run size. This forecast, in addition to the target escapement and predicted effort sets the number of days that fishing is permitted during opening week. Escapements are estimated by a gillnet test fishery on the lower Skeena River.

Generally, fishing is not permitted prior to the first week in July. This is to conserve early Skeena sockeye and chinook stocks which are depressed. Fishing is normally scheduled for the first week in July to coincide with the run of the enhanced sockeye stocks. Directed fisheries focus on pinks from early August until the end of August. The fisheries are managed according to the abundance of sockeye and pinks returning to the Skeena River. Pre-season weekly escapement targets determine the amount of fishing effort permitted. Strategies for individual species are discussed below.

Area 4 is divided into a number of Management Units; however, during the commercial fishery, virtually all Management Units are opened to fishing. Area subunits are not opened or closed independently of each other. The exceptions to this are the closure of M.U. 4-4 to all gear during the weeks that seiners are permitted in Area 4, and late in the season when coastal pinks are the target. When fishermen are harvesting coastal pinks, the inside areas of Area 4 may be closed to conserve Skeena pinks, coho, and possibly late runs of sockeye, while the outside areas are open to harvest coastal stocks.

Area 4 is currently a gillnet fishery area. Seiners are allowed to fish in Area 4 during the peak of the run of enhanced sockeye stocks (usually the third to fourth week of July). The number of days of seine fishing permitted depends on run size. In years when sockeye are abundant, seiners may be permitted to fish for more than one week in Area 4. Recently, seiners have also been permitted to harvest pinks when gillnetters have not been capable of exploiting the available surplus, or were reluctant to harvest pinks.

2.4.2.1 Sockeye Salmon

Sockeye stocks from Pinkut Creek and Fulton and Babine rivers are the major stocks taken by the commercial net fishery in Area 4. Other stocks are caught incidentally. Sockeye catches in this fishery usually peak in the

third to fourth week of July, and decline rapidly thereafter. Openings are not allowed to exceed four days per week. A "window" or closure in fishing is implemented usually after the second day of fishing to permit the faster-migrating species such as steelhead and chinook to escape. The fishery is then continued for the remaining two days.

The recent Canada/U.S. agreement will set a ceiling on U.S. interception fisheries for Canadian sockeye stocks prior to U.S. statistical week 31. This should allow more fish of Canadian origin to enter Area 3 and 4, and perhaps require more extensive fishing.

2.4.2.2 Pink Salmon

Pink stocks returning to Area 4 can be divided for management purposes into three major stock groupings by run timing: early runs (Babine, Kitwanga, Kispiox, Upper Skeena), mid-season runs (Lakelse and Kitsumkalum) and late runs (Coastal). These groupings are sufficiently separated by time (or area) to allow for directed fisheries. Each run grouping can also be separated to some extent by time and/or area to allow for further directed fisheries. As for sockeye, weekly escapement targets are set and the fishery is managed to arrive at these weekly levels. In-season strength is estimated by the Skeena River test fishery.

The recent Canada/U.S. agreement, which provides a ceiling on Canadian catches in the Area 1 troll fishery and in net fisheries in Management Units 3-1, 3-2, 3-3, 3-4, and 5-11, will result in increased catches having to be taken in Area 4 in some years.

2.4.2.3 Chum Salmon

There are few chum stocks in Area 4 (Coastal and mainstem Skeena). Any chum catches are incidental to sockeye and pink catches, as there are no directed fisheries for chum stocks. Management is mainly confined to mesh size restrictions to minimize chum catches and thus avoid over-exploitation.

2.4.2.4 Chinook Salmon

Since the early 1970's, net fisheries for chinooks have been discontinued. More recently, specific sub-areas in Area 4 have been closed to fishing during times when seiners are permitted in Area 4. Other restrictions such as banning beach tie-offs for seines in certain areas, the "window openings" noted earlier, and mesh size restrictions have also been implemented.

2.4.2.5 Coho Salmon

Coho stocks are thought to be depressed, and there are no directed coho fisheries. Coho catches are incidental to sockeye and pink catches. This stock is managed primarily, by limiting the exploitation rate of fisheries specifically for sockeye and pink salmon.

2.4.3 Current Enhancement Activities

The Pinkut and Fulton sockeye spawning channels are the most important salmon enhancement facilities in Statistical Area 4. The three channels (two at Fulton and one at Pinkut) have been in operation since the late 1960's, and are currently the major contributors to the Area 4 commercial sockeye fishery. All three channels are in tributaries of Babine Lake. Together the three channels require 300,000,000 eggs annually. This results in an approximate release of 152,000,000 sockeye fry, and predicted returns of 1,458,000 adults to the channels. Approximately half of the Area 4 sockeye escapement is to the spawning channels. The production of the Pinkut and Fulton enhanced sockeye stocks has made it difficult to manage some of the other non-enhanced Area 4 sockeye stocks whose runs coincide with those of the Pinkut and Fulton stocks. Several other small enhancement facilities also contribute to the Area 4 fishery (Table 2.4-1), and fishways have been constructed on the Salmon River and at Moricetown Falls to facilitate the upstream movement of salmon.

2.4.4 Habitat Status

Habitat descriptions for Area 4 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.4-2 through 2.4-6, respectively. For a description of the tables, see Section 2.2.4.

Table 2.4-1. Production by small enhancement facilities in Area 4 (production capacity based on SEP biostandards).

Facility	Species	Production Capacity		Target Stock(s)
		Releases	Returns	
Terrace Hatchery	coho	50,000	750	Copper
	chinook	350,000	8,380	Kitsum Kalum, Cedar Copper
Kispiox Hatchery	coho	85,000	3,900	Kispiox
	chinook	195,000	4,060	Kispiox
Toboggan Creek Hatchery	coho	100,000	3,000	Toboggan
	chinook	100,000	15,000	Morice
Emerson Creek Hatchery	chinook	115,000	550	Emerson
Fort Babine Hatchery	coho	30,000	4,500	Babine
	chinook	30,000	140	Babine
Eby Strait Hatchery	coho	530,000	8,500	Lakelse

Table 2.4-2. Statistical Area 4 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,890	900	1,045

MANAGEMENT STYLE	
Active	90%
Passive	10%
Unknown	
NUMBER OF STREAMS	59

HABITAT NOTES

Historic Status, Production Constraints and Development History	Stock dominated by Babine Lake system and tributaries and associated major enhancement. Forestry: 80 years of moderate impacts. Spot intensive impacts. Mining: Major activity on Babine Lake - low impact. Other developments minor.
Current Status	Moderate forestry activity - low impacts. Mining expansion possible - low impacts.
Future Outlook	No real change from current.
Natural Habitat Production Potential	Habitat is not the constraint. No habitat reasons why M.R.E. could not be achieved.
Improved Production Potential	May be further opportunities to open new spawning areas.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	Medium

CONCLUSION The stock is so dominated by major facilities that the main concern must be maintenance of water quality in Babine and other rearing lakes. Additional production from minor natural stocks becomes academic if management must be to dominant stock.

Table 2.4-3. Statistical Area 4 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	4,290	2,000	2,793

MANAGEMENT STYLE	
Active	60%
Passive	40%
Unknown	

NUMBER OF STREAMS	76

HABITAT NOTES

Historic Status, Production Constraints and Development History	Lakelse system averages 50% of production. Logging: 80 years of moderate impact. Intensive in Lakelse drainage for past 20 years but impacts still low. Urban: Residential/recreational use could be a problem at Lakelse. Flows: Some natural instability compounded by logging.
Current Status	Watersheds stabilizing from logging activity.
Future Outlook	Good lead time for forestry/fishery and residential/recreational/ fishery joint planning.
Natural Habitat Production Potential	Habitat could probably support historic highs.
Improved Production Potential	Not needed, according to management goal, but few opportunities for improving on natural habitat.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	Low

CONCLUSION Targets are below current escapements and well below historic highs. Since natural habitat could produce more fish than managers call for, habitat does not seem to be the real issue.

Table 2.4-4. Statistical Area 4 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	86	70	28

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 40

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging: 80 years of moderate impacts. Intensive from 1955-1975 with major impacts on some producers (e.g., Kalum). Transportation: Mainstem corridor - low impact. Upper Skeena B.C. Rail - low impact. Agriculture: Limited to Smithers/Telkwa area - low impact. Mining: Low impact. Urban: Low impact.
Current Status	Most streams recovering from poor logging practices. No other significant impacts.
Future Outlook	Plenty of lead time for sound forestry/fishery planning. Possible low spot - impacts from mining and transportation. Some diking for flood control.
Natural Habitat Production Potential	Should approach historic maximum with recovery of streams from logging impacts. Protection emphasis rather than restoration.
Improved Production Potential	None identified.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Low	Unknown

CONCLUSION Managed passively because of importance of other species. Improved production would probably not be desirable.

Table 2.4-5. Statistical Area 4 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	92	75	23

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 56 Total, 16 Major/Sig.

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging: 80 years of moderate impact. Intensive from 1955-1975 with major impacts on some producers (i.e., Kalum). Transportation: Mainstem corridor - low impact. Upper Skeena B.C. Rail - low impact. Agriculture: Limited to Smithers/Telkwa area - low impact. Mining: Low impact. Urban: Low impact.
Current Status	Most streams recovering from poor logging practices. No other significant impacts. Estuary development impacts unknown.
Future Outlook	Plenty of lead time for sound forestry/fishery planning. Possible minor impact if Kemano II proceeds. Some diking for flood control. Natural flow instability in Terrace area compounded by logging - should rehabilitate in 15 to 20 years. Possible spot impacts from mining and transportation.
Natural Habitat Production Potential	Should approach historic maximum with recovery of streams from logging impacts.
Improved Production Potential	

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	Low

CONCLUSION Protection emphasis rather than restoration. Major chinook problem is mixed-stock management, with resolvable problems with native fishery at Moricetown.

Table 2.4-6. Statistical Area 4 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	237	436	35

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 120

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging: 80 years of moderate impact. Intensive from 1955-1975 with major impacts on some producers (i.e., Kalum). Transportation: Mainstem corridor - low impact. Upper Skeena B.C. Rail - low impact. Agriculture: Limited to Smithers/Telkwa area - low impact. Mining: Low impact. Urban: Low impact.
Current Status	Most streams recovering from poor logging practices. No other significant impacts. Estuary development impacts unknown. Probable loss of some small stream habitat.
Future Outlook	Plenty of lead time for sound forestry/fishery planning. Possible minor impact if Kemano II proceeds. Some diking for flood control. Natural flow instability in Terrace area compounded by logging - should rehabilitate in 15 to 20 years. Possible spot impacts from mining and transportation.
Natural Habitat Production Potential	Should approach historic maximum with recovery of streams from logging impacts.
Improved Production Potential	Probably plenty of opportunity for local restoration.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High - Medium	High - Medium	High - Medium	High	High

CONCLUSION Habitat is not the reason for stock declines.

2.4.5 Management Conflicts

The major conflicts that management must resolve for Area 4 include problems caused by mixed-stock fisheries and management uncertainties. These are discussed below.

2.4.5.1 Management Uncertainties

Run Size Run size is estimated using a combination of pre-season forecasts, and cumulative catch and escapement. The accuracy of pre-season forecasts is very poor. As a result, in-season indicators are extremely important in managing the fishery. Escapement is estimated by a gillnet test fishery on the lower Skeena River. On the average, the estimate of sockeye escapement is within 20% of the actual value while pink escapement is within 30%. Upstream, sockeye escapement is determined by counting fish passing through the Babine fence, and other species' escapements are estimated from foot and aerial surveys of streams. The errors in these estimates affect the decisions for fisheries; when run size is underestimated, fish may be forgone and, conversely, when run size is overestimated fisheries may take place that should not have.

Spawning Escapements Estimates of sockeye escaping to the Babine Lake system are very reliable. As noted earlier, a fence across the Babine River counts each passing sockeye. Roughly 90% of the Skeena sockeye escapement spawns in the Babine Lake system. This contrasts with estimates for other species. Spawning escapements are estimated mainly by foot surveys, though some fixed wing aircraft and helicopter surveys are conducted. The reliability of these methods is uncertain, and the results at best reflect relative abundance rather than actual value. Coho are probably the most poorly estimated.

Target Escapements Estimates of target escapement for sockeye and pink salmon are derived from standard stock-recruitment analysis. Estimates for other species are from Fishery Officer surveys, and are largely based on available habitat and some assumed spawning and/or rearing capacity. The methodology is not standardized and varies between officers. Accurate estimates of catch and escapement are fundamental in determining optimum or target escapements through stock and recruitment analysis.

Timing The timing of sockeye runs for aggregate stocks is determined from weekly catch and escapement data. The timing of individual sockeye and pink stock runs is estimated from the results of the current International Tagging Program and previous tagging programs. Estimates of run timing for other species are inferred from catches, test fisheries and information on spawning time. For most of the species and many of the minor sockeye stocks, timing information is sparse and can only be considered a best guess.

Area 3 Interceptions Sockeye and pinks (probably other species as well) bound for the Skeena migrate through Area 3, and are caught there by commercial fisheries. The proportion of Skeena fish in Area 3 varies annually, but in some years the diversion through Area 3 can be quite high.

Southern Southeast Alaska Interceptions The recent Canada/U.S. agreement includes fishing plans that will control major sockeye interception areas significantly in S.E. Alaska. Alaska has very large catches of pink salmon, of which about 5% are thought to be bound for Area 4 streams.

2.4.5.2 Mixed-Stock Fisheries

As discussed earlier, there are substantial overlaps in timing between the stocks; thus when one stock is the target, other stocks will be harvested incidentally. Because each stock has a different rate of productivity, the harvest rate cannot always match the optimal rate for each stock. In Area 4, the mix of stocks with different productivity rates has been further complicated by the production of enhanced sockeye stocks from the spawning channels in Babine Lake.

The Fulton and Pinkut systems currently have escapements of four to six times the number of adults observed prior to the operation of the spawning channels. The increased numbers of adults returning to the channels has resulted in more intensive fisheries in Area 4 to crop the surplus. Although the additional exploitation is confined to times of peak abundance of the enhanced stocks there are still fish from unenhanced stocks in the fishing areas during this period. These fish appear to be harvested at levels too high to allow for rebuilding.

In some years, large returns of pink salmon create mixed-stock problems with chum, coho and steelhead runs. The overlap between pink and sockeye stocks has caused some difficulty in recent years when one stock is harvestable and the other requires some conservation measures. Although the directed chinook net fishery on the Skeena has been discontinued, a substantial number of chinook are incidentally caught during the sockeye fishery. These are the mid- to late-running chinooks migrating to the Kalum, Ecstall, Babine and Morrice rivers.

2.4.6 Stock Rebuilding Potential

Management of sockeye fisheries in Area 4 is a compromise between producing target escapements of the major and most productive sockeye stocks, and producing target escapement of the smaller less productive stocks. Exploitation rates in enhanced sockeye stocks are lower than required for target escapement but even so, the less productive stocks are depressed. Given current fishing patterns and the desire to optimize sustainable yield for the entire area, these less productive stocks will remain depressed.

2.4.7 Management Strategies for Stock Rebuilding

Strategies for rebuilding stocks include reducing management uncertainties and altering mixed-stock harvest. See also Section 2.4.5 for a review of problems treated here.

2.4.7.1 Management Uncertainties

Options for reducing management uncertainties are described first:

1. Improve in-season escapement estimates: Improvements to the in-season test fishery escapement index can and should be made for both sockeye and pink stocks.

2. Improve stock identification and timing information: The identification of specific stocks in commercial fisheries (especially depressed stocks selected for rebuilding) needs to be improved. Tagging studies conducted as part of the Canada/U.S. agreement provide much of this information.

2.4.7.2 Mixed-Stock Harvest

As mentioned previously, all fisheries on Skeena stocks along their migration routes involve mixed-stock harvests, some of which should be modified. These fisheries include:

1. Alaska net (Noyes Island, Clarence Strait; Cape Fox);
2. Northern B.C. incidental net and troll (Area 1);
3. Northern B.C. directed net (Secondary Area 3 and 5, Primary - Area 4); and
4. Indian Food Fishery (Area 4 and in-river fisheries).

For the purpose of this discussion, Skeena stocks are divided into two timing groups:

Group I - mid-June to early August - Babine and non-Babine sockeye
- early pinks (Kispiox, Kitwanga and Babine)
- first half of chum run

Group II - early Aug. to early Sept. - late pinks (Lakelse, Kitsumkalum)
- coastal pinks
- second half of chum run

The principal exploitation of stocks in Group I and Group II occurs in the northern B.C. directed net fisheries. Therefore, options for rebuilding involve modification of harvest rates in these fisheries. Management of these fisheries involves producing the aggregate escapement of the target stocks. Options for rebuilding include:

1. Modification of aggregate escapement goals to increase escapement of non-target stocks;

2. Modification of the operation of enhancement facilities on Babine Lake to reduce the pressure in terminal areas; and

3. Exploitation of enhancement opportunities for non-target stocks so they can withstand the current exploitation pattern.

A mixed-stock problem also occurs when early pinks are abundant and late timing sockeye are weak or, conversely, when pinks are weak and sockeye are abundant. The trade-off between sockeye and pink should be evaluated to provide managers guidance in making in-season decisions.

2.4.8 Future Stock Enhancement Activities

Following is a description of proposed enhancement projects that are viewed as compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983).[1]

2.4.8 1 Upper Babine River Spawning Channel (Project No. 4 - 1B)

The Upper Babine River has historically been one of the major sockeye producers in the Babine Lake system. Escapements to the upper river have ranged from as many as 411,000 to as few as 33,000 spawners. The trend in recent years has been declining escapement; the 1980 - 1984 average was 110,00. The 1970-1979 average escapement to the Upper Babine River was 175,000, while the 1960-1969 average was 176,000. Recent declines have been attributed to increased exploitation by intensive commercial fisheries for enhanced Fulton River and Pinkut Creek sockeye stocks. In an attempt to rebuild this declining stock to optimum levels, a 7,000-m^2 uncontrolled spawning channel at Fort Babine has been proposed. This channel would have the potential to produce 46,000 adult sockeye.

2.4.8.2 Morrison River Channel (Project No. 4 - 3)

In recent years, this tributary of Babine Lake has had sockeye escapements well below historical levels. Average escapements have declined from about 20,000 in the 1960's to 10,000 in the 1970's, while the average for the 1980's is down to 3,900. The decline is the result of the increase in fishing for enhanced Fulton and Pinkut stocks. A 1,000-m^2, flow-controlled side channel has been proposed for the Morrison River, whose main objective is to

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January, 1985.

increase the productivity of the system through improved egg-to-fry survival rates. The channel could produce about 7,500 adult sockeye.

2.4.8.3 Morice/Nanika

There are a number of related initiatives which have the potential of significantly affecting sockeye production from this system. These could include:

1. Reduction of Moricetown food fishery;

2. Ongoing fertilization of Morice Lake (Project No. 4 - 11C); and

3. Installation and operation of an incubation system to give higher egg-to-fry survival in the Nanika River.

At present, only a technical review of existing data is recommended.

2.4.8.4 Fort Babine CEDP Expansion (Project No. 4 - 1A)

Chinook and coho stocks in the Babine River have declined dramatically; some of the lowest escapements were recorded in the early 1980's. As a result, a CEDP project was initiated at Fort Babine in an effort to supplement the natural production of this system. At present the facility has an egg target of 50,000 each for chinook and coho. The existing facility can be expanded to handle an additional 250,000 chinook and coho eggs in cassettes, incubators and floating raceways. An expansion of the existing CEDP facility would result in a total adult production of 4,000 to 5,000 chinooks and coho.

2.4.8.5 Upper Skeena Central Facility (Fulton River)(Project No. 4 - 1D)

It is proposed to use the existing infrastructure at the DFO Fulton River facility in the development of a central hatchery to enhance Babine, Morice and Bear chinook stocks. Co-operative programs can be established with Toboggan and Fort Babine groups. Chinook fry would be out-planted back into the various donor systems at varying sizes up to 5 g.

2.4.8.6 Kispiox CEDP Expansion (Project No. 4 - 24A)

The Kispiox River, like most Skeena tributaries, has chinook and coho stocks which are presently depressed. Chinook average escapements in the Kispiox River have declined from 7,500 during the 1950's to 500 during the 1980's. Coho average escapements during this same period have declined from 4,200 to 340. The decline of these stocks has been primarily attributed to interception in the northern troll fishery and Area 4 commercial fishery. In addition, large numbers of these fish are caught in sport and native fisheries on the Skeena. An expansion of the existing CEDP hatchery to increase chinook and coho capacity has been proposed in order to speed rebuilding these stocks.

2.4.8.7 Kispiox Fishway (Project No. 4 - 24B)

As described above, coho escapements in recent years have been seriously depressed on the Kispiox River. There is an obstruction upstream of the Nangeese confluence on the Kispiox River, preventing access to 30 km of potential habitat above the obstruction. Construction of a 4-m rock fishway is proposed to alleviate this partial obstruction.

2.4.8.8 Kitsumkalum CEDP Expansion (Project No. 4 - 33)

The Kitsumkalum River has historically been the major chinook producer in the Skeena River. This stock is especially important, as it has consistently produced much larger fish than all other chinook stocks in the Skeena as well as most of the Pacific Coast. Chinook escapements to the Lower Kitsumkalum River have not declined as in other systems; this is believed to be due primarily to the early timing of the run of this stock. The majority of the stock passes through the commercial fishing area before intense fishing begins. At the present time, two CEDP facilities are located on the Kitsumkalum. The major facility is located on Deep Creek, and the smaller is at Site II. Expansions of both these facilities to accommodate additional chinooks (Cedar, Copper and Kitsumkalum stocks) and coho are proposed. The objectives of this expansion are:

1. To increase escapements, and ultimately production, of chinooks in the Cedar, Copper and Kitsumkalum Rivers and coho in the Kitsumkalum River to optimum levels; and

2. To tag chinooks and possibly coho for management information purposes.

2.4.8.9 Kitsumkalum Side Channels (Project No. 4 - 33)

Scattered along the Lower Kitsumkalum River are several side channels currently not utilized. Rehabilitation of three of these side channels totalling 8 km in length has been proposed. This would provide additional rearing and spawning area for both coho and steelhead. This project could possibly be combined with the Kitsumkalum CEDP operation.

2.4.8.10 Fort Babine Spawning Channel (Project No. 4-2)

The Upper Babine River has historically been one of the major sockeye producers in the Babine Lake system. Escapements to the upper river have ranged from 33,000 to 411,000 spawners. The recent trend has been toward declining escapement; the 1960-1969 average was 176,000, the 1970-1979 average was 175,000 and the 1980-1984 average was 110,000 spawners. Recent declines have been attributed to the increased exploitation rates resulting from the intensive commercial fisheries for enhanced Fulton River and Pinkut Creek sockeye stocks. In an attempt to rebuild this declining stock to optimum levels, a 7,000-m^2 uncontrolled spawning channel at Fort Babine has been proposed. The increased survival from the egg to fry stage associated with spawning channels may be enough to offset the high exploitation rates on this stock. The channel would have the potential to produce 46,000 adult sockeye.

2.4.8.11 Fort Babine CEDP Expansion (Project No. 4-12)

Chinook and coho stocks in the Babine River have declined dramatically to some of the lowest escapements recorded in the early 1980's. As a result, a CEDP project was initiated at Fort Babine in an effort to supplement the natural production of this system. At present, the facility has a target egg take of 50,000 eggs for both chinook and coho. It is proposed to expand the existing facility to handle an additional 250,000 chinook and coho eggs in cassette incubators and floating raceways. This expansion would result in a total adult production of 4,000 to 5,000 chinook and coho.

2.4.8.12 Area 4 Stream Rehabilitation Package

There are a number of small-scale stream improvement/maintenance projects proposed for Area 4. These include:

- Maxan Lake: Storage (benefit coho, chinook, steelhead) (Project No. 4 - 7);
- Moricetown: Fishway modifications (all species except chum) (Project No. 4 - 11D);
- Buck Creek: Stream improvement (all species except chum) (Project No. 4 - 9);
- Owen Creek: Annual beaver control (coho) (Project No. 4 - 13);
- Morice River: Borrow pit rehabilitation (coho) (Project No. 4 - 14);
- Canyon Creek: Storage development (coho, steelhead) (Project No. 4 - 17);
- Skeena Sloughs: Improve access (pink, chum, coho) (Project No. 4 - 18);
- Chicago Creek: Culvert access (coho, steelhead) (Project No. 4 - 20);
- Shandilla Creek: Culvert access (coho, steelhead, pink) (Project No. 4 - 21);
- Clifford Creek: Culvert access (coho) (Project No. 4 - 27);
- McQueen Creek: Log jam removal (coho) (Project No. 4 - 29);
- Williams Creek: Log jam removal (sockeye, coho) (Project No. 4 - 34F);
- Goat and Glacier Creeks: Remove gravel buildup (coho) (Project No. 4 - 35);
- Alwyn Creek: Annual beaver control (coho) (Project No. 4 - 39);
- Khyex River: Stream clearance, barrier removal (all species except sockeye) (Project No. 4 - 33);
- Prudhome Creek: Blasting/fishway repair (coho, sockeye) (Project No. 4 - 47B);
- Upper Bulkley River: Obstruction;
- Exstew/Esker Slough: Rehabilitation (pink, chum plus chinook and coho rearing) (Project No. 4 - 40).

2.4.9. Predicted Results for Management Options

Group 1 stocks have been managed to produce an aggregate sockeye escapement of one million fish with the intention of allowing about 900,000 fish for spawning escapement and about 100,000 fish for the Indian food fishery. If the stocks were divided appropriately, it would result in 770,000 spawners to the Babine system and 130,000 spawners to the non-Babine system.

Results of the Base Case (Option 1) model as described above indicated the escapement target of Babine sockeye was exceeded consistently, while non-Babine sockeye declined dramatically (Table 2.4-7). Pink salmon escapements were steady at slightly below target levels. On the other hand, catches remained steady, averaging 1,880,000 for sockeye salmon, 315,000 for pink salmon and 7,700 for chum salmon. The results of such a management approach were anticipated by management staff, who raised the aggregate escapement target for the Skeena in an attempt to arrest the decline in non-Babine sockeye. Option 2 involved determining how far the target escapement must be raised to allow non-Babine sockeye to rebuild, and to document the effects on the pink and chum salmon stocks present in this mixed stock fishery. This model was run with an aggregate sockeye escapement target of 1,500,000 sockeye. The results of the model (Table 2.4-7) indicated that both Babine sockeye and pink stocks would over-escape the target levels by up to 600,000 and 200,000, respectively. However, both non-Babine and chum stocks started rebuilding immediately. Unfortunately the NPV declined from $347,000,000 to $264,000,000. This decline in value could be attributed directly to the decline in catch of sockeye and pink catch in the terminal fisheries of the Skeena.

Some of the sockeye catch forgone in the terminal fisheries could be recovered if fisheries were established at the Babine fence. Such a fence operation could be applied to both Option 1 and Option 2. The results indicated that even when the reduced quality of sockeye was taken into account, the NPV could be increased to $370,000,000 (Option 3) or $289,000,000 (Option 4). The only change in escapement was that the 770,000 target for the Babine sockeye stock was met consistently.

Management options for Group II stocks have yet not been analysed.

Table 2.4-7. Comparison of management options for Skeena Group I stocks.

Options	Escapement Trends: Stocks				Catch Trend (Thousands of Fish): Species			NPV* at 10% (millions of $)
	Babine Sockeye	Non-Babine Sockeye	Early Pinks	Chum	Sockeye	Pink	Chum	
1. Base Case (no fence fishery)	steady over-escapement of about 120,000	declining from 15% to 5% of target	steady average at 83% of target	steady average at 15% of target	1,880	315	7.7	347
2. No Fence Fishery	steady over-escapement of about 500,000 - 600,000	building from 29% to 56% of target	steady over-escapement of 120,000	building from 20% to 77% of target	1,510	304	12.3	265
3. Fence Fishery added to option 1	steady at target 770,000	declining from 15% to 5% of target	steady average at 83% of target	steady average at 15% of target	2,000	314	7.25	370
4. Fence Fishery added to option 2	steady at target 770,000	building from 29% to 56% of target	steady over-escapement of 120,000	building from 20% to 77% of target	2,010	304	12.3	289

* NPV = net present value

2.4.10. Predicted Results for Enhancement Options

Two projects are proposed for the enhancement of sockeye in the Skeena River system: one on the upper Babine River, and the other on the Morrison River. Both of these stocks are part of the stock aggregate that is most important to the Skeena River fishery. The upper Babine River stock runs slightly later than the enhanced Fulton and Pinkut stocks, while the Morrison run is precisely between the runs for the other two stocks. Both of these projects are designed to develop unmanned spawning channels in order to increase the productivity of the stocks, and allow them to withstand the harvest rate being applied to Fulton and Pinkut stocks. A simulation of the upper Babine River spawning channel (Project 1) was run through the model, and its impact was a slight increase in the exploitation of early pink and chum salmon stocks. Results are summarized as follows:

		Sockeye	Pink	Chum	NPV* at 10%
Base Case	Catch	1,879,163	315,111	7,666	$347,000,000
Enhancement Project 1	Catch	1,912,918	301,593	7,075	$349,000,000
		Babine Sockeye	Non-Babine Sockeye	Early Pink	Chum
Base Case	Escapement	893,292	13,099	418,171	11,654
Enhancement Project 1	Escapement	893,889	12,288	397,611	10,487

* NPV = net present value

Most chinook stocks have passed through the commercial fishery by this time and, therefore, are not affected. Compared to the Base Cases analysed above, this option increased NPV from $347,000,000 to $349,000,000.

Limited opportunities presently exist to help non-Babine sockeye; management action is the only immediate possibility.

2.5 Statistical Area 5

Statistical Area 5 includes Pitt Island, Banks Island and the southern end of Porcher Island (Figure 2.5-1). There are two primary salmon producing areas in this area; Principe Channel between Banks and Pitt Islands, and Grenville Channel between Pitt Island and the mainland. Sockeye and pink fisheries operating in the region are directed primarily at passing Skeena stocks. A detailed list of stock attributes and fishing patterns can be found in Appendix 1.

2.5.1 Stock Description

Most of the area's 89 sockeye, pink and chum stocks are passively managed during the fishing season. However, several small pink stocks are actively managed in late summer by opening or closing terminal net fisheries. An overview of the stocks is presented below by species.

All 19 sockeye stocks found in Area 5 are small with recent escapements of less than 2,000 fish to any lake system. Eleven sockeye stocks are found in Principe Channel. The stocks approach via two principal migratory routes; approximately 80% come from the north, through the Noyes Island (Alaska) and Area 4 fisheries, and the remaining 20% arrive via Area 1 in the northwest. Area 5 sockeye runs occur from early June to early August, and peak in mid-June. Recent management estimates suggest that sockeye production in all Area 5 systems is depressed. The 1980-1984 average escapement for all Area 5 sockeye streams was approximately 17,400, only 35% of the target escapement for the area.

The most productive of the 40 pink stocks in the region originate in Upper Grenville Channel streams. The next most productive areas are Ogden Channel between Porcher and Pitt Islands, and Porcher Inlet. These three areas account for approximately 70% of the 160,000 even-year and the 110,000 odd-year pink escapement. Pink stocks approach Area 5 on three principal migratory routes: north through Hecate Strait; south east through Area 1; and land-falling near Noyes Island (Alaska), before moving south through Areas 1 and 4. Escapement timing of Area 5 pinks is from early August to mid-September, and peaks in late August. Escapement estimates suggest that all

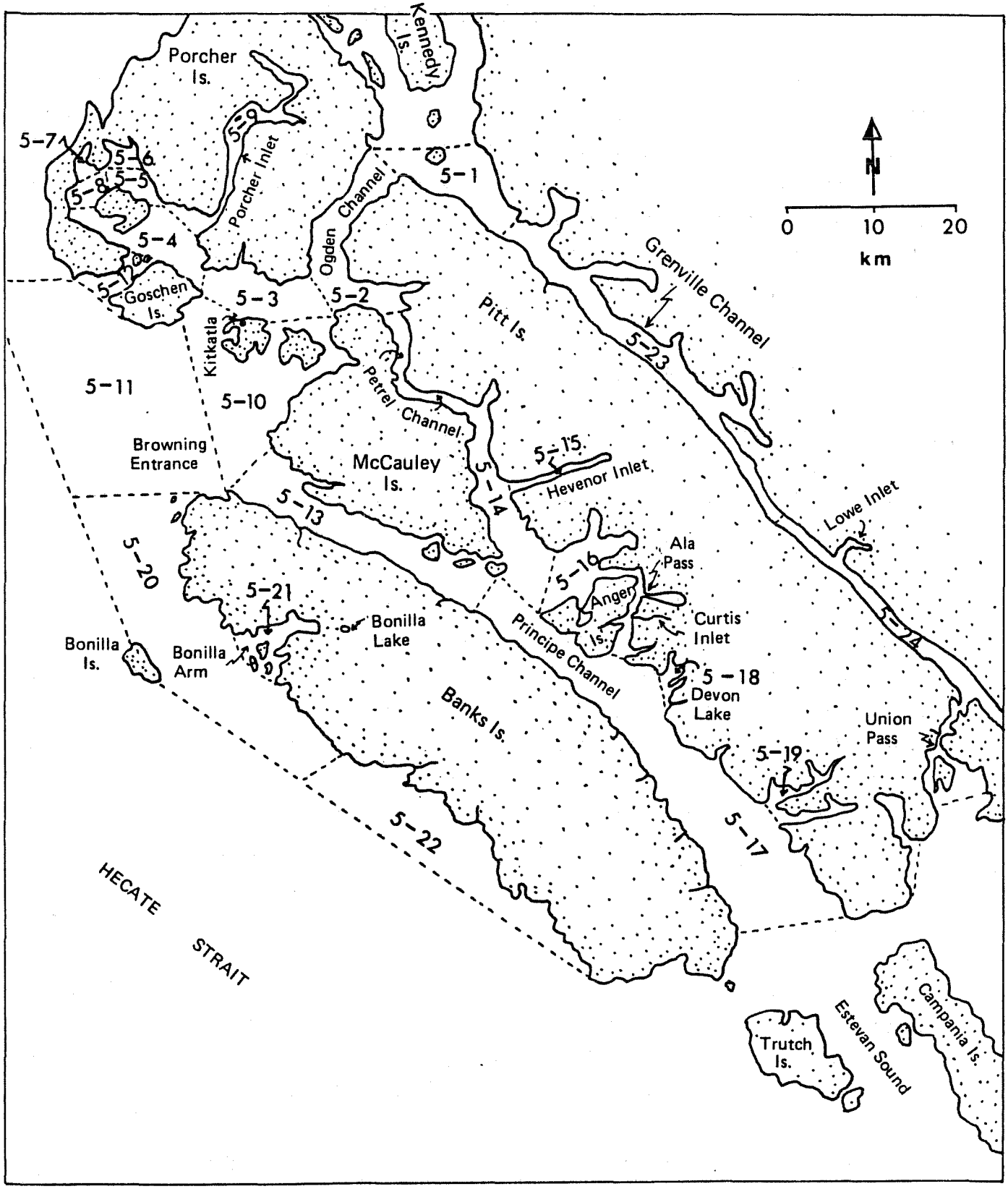


Figure 2.5-1. Statistical Area 5.

Area 5 pink stocks are depressed. The 1980-1984 average escapements were only 50% and 39% of the target escapements for even-year and odd-year stocks, respectively.

Thirty chum stocks are scattered throughout Area 5; all are currently depressed. None of the Area 5 chum streams had an escapement of more than 2,000 fish in 1980-1984. The 1980-1984 average escapement for all Area 5 chum streams together was approximately 7,300, only 20% of the target escapement for Statistical Area 5.

Area 5 has extremely limited potential for chinooks. There are only two chinook stocks present in Area 5; annual escapements of each are about 25 spawners.

Fifty-four coho stocks exist in Area 5. All of these stocks are well below historical levels. The target escapement of 55,500 has not been achieved since the 1960's. The 1980-1984 average escapement was about 11,000. There are no directed fisheries for these stocks; however, large incidental coho catches do occur in the directed pink fisheries during August and September.

2.5.2 Fisheries

From roughly the first to second week in July to mid-August, the fishery in Area 5 is based on the abundance of Skeena River sockeye and pink stocks migrating through Area 5. Consequently, openings in Area 5 generally conform with openings in Area 4. During this period, local stocks are managed in a fashion to reduce exploitation rates, while permitting fisheries for the more abundant Skeena stocks. Optimum escapements are established for all local stocks. It is not until Skeena stocks are through Area 5 that management is switched to local stocks. At this time (usually mid- to late August), pinks, chums and coho are the predominant species. Management is mainly directed at pink stocks, and various Management Units are closed to protect local chum and coho stocks. Generally, Area 5 is closed to net fishing by mid-September.

Area 5 can be divided into two areas based on fisheries management: one area includes the major channels considered to be migration routes for Skeena

stocks (M.U. 5-1, 5-2, 5-3, 5-10, 5-11 and 5-12) and the second area include the inlets and bays where local stocks predominate (M.U. 5-4, 5-5, 5-6, 5-7, 5-8, 5-9, 5-13, 5-14, 5-15, 5-16, 5-17, 5-20, 5-22, and 5-23). Commercial fisheries in the second area may be held periodically throughout the season to assess local stock abundance, e.g., at the top of Principe Channel, Petrel Channel, Ogden Channel, Porcher Inlet and the northwest shore of Banks Island.

Area 5 supports both gillnet and seine boats. Gillnetters currently catch the majority of the sockeye, coho and chum; seiners catch most of the pinks and chinook. Proportions of species caught by each gear type have fluctuated, but have remained fairly stable. The only exception is a decline in the proportion of gillnet pink catch. Gillnetters and seiners fish in the same areas; however, gillnetters usually begin fishing by the end of June or early July, while seiners begin in mid-July. The current fisheries management strategy for each species is discussed below.

2.5.2.1 Sockeye Salmon

Virtually all stocks are depressed and no directed fisheries are proposed in current fishing plans. Stocks run earlier in Area 5 than do Skeena sockeye but overlaps do occur, and catches of local sockeye are incidental in fisheries for Skeena stocks. Local sockeye are assessed by Indian food fisheries in early June and later by observations of abundance in local inlets and spawning streams.

2.5.2.2 Pink Salmon

Until mid-August, catches of local pinks are incidental in fisheries for Skeena pinks. By the third to fourth week of August, Skeena stocks are largely through Area 5, and management will be directed toward local pink stocks. No stock or stock aggregate consistently drives the fishery; abundance is assessed through information on catch and escapement. Depending on which stock(s) is abundant, Management Units will be regulated to maximize the harvest of the target stock(s) and avoid interceptions of non-target stocks.

2.5.2.3 Chum Salmon

Until the end of August, catches of chums are incidental to Skeena sockeye and pink catches. Local chums are late and arrive in the fishing area by the end of August. Recent information, however, suggests that the chums may arrive earlier and then delay in the major inlets and channels before moving into the local streams. A high proportion of the chums caught in July - August are probably passing stocks bound for the Central Coast and possibly Area 4. No local chum stock or stock aggregate is consistently the target of commercial fisheries. Abundant stocks would be harvested by regulating management units to confine fishing to the areas where the target stock is predominant and other stocks are least abundant.

2.5.2.4 Chinook Salmon

There are only two chinook stocks in Area 5. All catches are incidental, and are composed of passing fish. Recently, the early openings in the outside areas of Area 5 (M.U. 5-20, 5-22) were closed to net fishing to reduce relatively high chinook catches. Additionally, seine fisheries openings have been delayed to mid-July to further reduce interceptions of chinooks and to coincide with seine openings in other northern areas.

2.5.2.5 Coho Salmon

Coho stocks are thought to be depressed, and there are no fisheries specifically for this species. Catches are incidental, and management consists of reducing exploitation of coho during directed pink fisheries.

2.5.3 Current Enhancement Activities

There are no salmon enhancement facilities in Statistical Area 5. The major components of the Area 5 sockeye stock originate from Union Pass, Bonilla, Curtis, Lowe and Devon Lake. Lowe Lake was fertilized in 1979; in 1980 Bonilla, Curtis, and Devon were also fertilized. All four lakes continue to be fertilized.

2.5.4 Habitat Status

Habitat summaries for Area 5 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.5-1 through 2.5-5, respectively. For a description of the habitat tables, see Section 2.2.4.

2.5.5 Management Conflicts

Table 2.5-6 lists factors in the current management of Area 5 which reduce production, and provide estimates of their effects on each species. The mixed-stock fishery for Skeena stocks, primarily in Ogden Channel and Browning Entrance, exerts considerable influence on local stocks, and significantly reduces production. The loss is probably greatest for sockeye, whose timing overlaps most with Skeena sockeye stocks, and is less for pinks, which have some separation in run timing. However, recent tagging results indicate that Area 5 pinks arrive earlier than previously thought, and then hold in various locations where they are intercepted in fisheries for Skeena pinks. Uncertainty in spawning escapements and in run timing during the season also reduce production. With the exception of the Indian food fishery on sockeye, which has a moderate impact, all other constraints were judged to have little effect on production.

2.5.6 Stock Rebuilding Potential

The rebuilding potential for sockeye stocks is uncertain, since it may not be possible to achieve the target escapement of approximately 50,000 through changes in fishing patterns. Pink and chum stocks may have the potential to rebuild; however, rebuilding both species may be impossible because of the trade-off between pink or chum catches.

2.5.7 Management Strategies for Rebuilding

Strategies for rebuilding stocks include reducing management uncertainties, and reducing the harvest of mixed stocks.

2.5.7.1 Management Uncertainties

Management in Area 5 has been severely constrained in the past by lack of

Table 2.5-1. Statistical Area 5 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	160	50	18

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 33

HABITAT NOTES

Historic Status, Production Constraints and Development History	A number of small streams. Entire area virtually undeveloped.
Current Status	Pristine.
Future Outlook	No change foreseen.
Natural Habitat Production Potential	No change from historic status.
Improved Production Potential	Unknown

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Medium	Unknown

CONCLUSION A clear example of declining escapements and virtually no change in habitat status.

Table 2.5-2. Statistical Area 5 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	350	270	150

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 66

HABITAT NOTES

Historic Status, Production Constraints and Development History	Entire area virtually undeveloped.
Current Status	Pristine.
Future Outlook	No change foreseen.
Natural Habitat Production Potential	No change from historic status.
Improved Production Potential	Unknown

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	Medium	Unknown

CONCLUSION A clear example of declining escapements and virtually no change in habitat status.

Table 2.5-3. Statistical Area 5 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	110	36	7

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 57

HABITAT NOTES

Historic Status, Production Constraints and Development History	Entire area virtually undeveloped.
Current Status	Pristine.
Future Outlook	No change foreseen.
Natural Habitat Production Potential	No change from historic status.
Improved Production Potential	Unknown

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Low	Unknown

CONCLUSION A clear example of declining escapements and virtually no change in habitat status.

Table 2.5-4. Statistical Area 5 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
	400		

MANAGEMENT STYLE

Active	
Passive	X
Unknown	

NUMBER OF STREAMS: 1

HABITAT NOTES

Historic Status, Production Constraints and Development History	An isolated minor stock on Kumealon Creek. Entire area virtually undeveloped.
Current Status	Pristine.
Future Outlook	No change foreseen.
Natural Habitat Production Potential	No change from historic status.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	

CONCLUSION

Table 2.5-5. Statistical Area 5 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	129	55	11

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 51

HABITAT NOTES

Historic Status, Production Constraints and Development History	A number of small streams. Entire area virtually undeveloped.
Current Status	Pristine.
Future Outlook	No change foreseen.
Natural Habitat Production Potential	No change from historic status.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	High

CONCLUSION A clear example of declining escapements and virtually no change in habitat status.

knowledge of the key management variables (Table 2.5-6). Information about the timing of local stock runs and abundance is needed. Options that would provide some of this information include the use of chartered gillnetters to test for quality and abundance, and installation of sockeye counting fences on Bonilla, Devon and Curtis lakes to assess local stock timing and improve reliability of spawning escapements.

2.5.7.2 Mixed-Stock Harvest

The mixed-stock fishery for Skeena stocks (primarily in Ogden Channel and Browning Entrance) affects local stocks and results in production losses. Forgoing some catch of Skeena stocks in these locations would allow the area to be managed on a more stock-specific basis, and these fish could be recovered in the Area 4 fishery. It is anticipated that this recovery would be 100% effective for sockeye, but only 50-75% effective for pinks. The management of local stocks could be improved by such a step, since some of the management uncertainty is removed. There are disadvantages associated with moving the fisheries. One of these is the increased catchability of stocks which reside in the terminal fishing areas for longer time periods, and thus are more vulnerable to commercial gear. Also, fish generally deteriorate more quickly the closer they are to their natal stream. In part, some of these disadvantages can be reduced by implementing appropriate boundaries, and by being aware of fish movements.

Another option would be to manage areas such as Ogden Channel or Browning Entrance to produce harvest rates appropriate for the local stocks. Although attractive in principle, this would be difficult to implement, since it is difficult (if not impossible) to differentiate between local and Skeena stocks.

2.5.8 Future Stock Enhancement Activities

Area 5 does not have high enhancement potential. Poor physical qualities, low brood stock numbers, inaccessibility, and fishing constraints limit enhancement opportunities. The few opportunities identified are confined to stream rehabilitation. This involves the addition of spawning gravel to streams where good quality spawning habitat is severely limited or absent.

Table 2.5-6. Factors which reduce production, and their estimated effects on production by species for Area 5.

Factors	Effects on Salmon Stocks			
	Sockeye	Coho	Pink	Chum
Mixed stock fishery	moderate	moderate-high	moderate	moderate-high
Uncertainty				
Run size	high	high	high	high
Optimum escapement	high	high	high	high
Spawning escapement	high	high	high	high
Timing	high	high	high	high
Indian food fishery	moderate	low	low	low
Environmental	moderate-high	low	moderate-high	moderate-high

Poor quality habitat may be depressing stock productivity in Area 5. As well, local sockeye, chum and pink are intercepted in varying proportions in fisheries for more abundant and productive Skeena stocks. The combination of incidental mixed-stock harvests and low productivity is probably responsible for the present low escapement. Increasing returns of local stocks may best be obtained by reducing interception fisheries in Area 5, and by improving spawning habitats.

Specific enhancement opportunities reviewed include spawning area improvement for Porcher Inlet streams (Project No. 5 - 1B), Curtis Creek (Project No. 5 - 2) and Kumealon Inlet (Project No. 5 - 8). These three projects each involve replacement or addition of gravel to various sites where good quality habitat is unavailable. In Porcher Inlet, enhancement is directed at pink and coho, while in Curtis Creek it is aimed at sockeye, and in Kumealon it is mainly for pink salmon. The Kumealon project includes side channel development as well. These projects could be operated as a community development project with the Kitkatla Band. However, these projects have high risk; their success depends on additional adults escaping the fishery. Because of this concern, enhancement is not recommended at this time; however, this decision should be reviewed, particularly if enhancement priorities change.

2.5.9 Predicted Results for Management Options

The following analyses were conducted using a preliminary computer model. The results are therefore preliminary. Re-analysis is in progress and the results will be presented in the next edition of this report.

Rebuilding of local Area 5 sockeye stocks is possible by moving fisheries to more terminal areas. Modelled catch and escapements for Area 5 sockeye fished under the current management regime and a management regime that favours terminal fisheries predict an increase in the average annual catch of sockeye from 17,487 to 32,601. To accomplish this rebuilding plan, catches in Area 5 would drop initially to 5,000-6,000 for the first four years but build to about 90,000 by year 20. On the other hand, escapement would increase immediately from 14,000 to 23,000, and build steadily to 103,000 in year 20. The NPV of this rebuilding option is $1,820,000 *vs.* $1,360,000 for the *status quo* plan.

Rebuilding options for pink stocks are made more difficult by run timing overlaps with chum stocks, which are lower in productivity than pink. However, basic improvements in local stock management can still occur by elimination of the fishery in Ogden Channel and Browning Entrance where the stocks are mixed with Skeena stocks. Table 2.5-7 summarizes the results of analysis of three options for management of pink and chum in Area 5.

Option 1: Manage Area 5 stocks with Skeena fish but based on Area 5 stock strengths.

Option 2: Manage Area 5 stocks in local areas with pink salmon driving the management.

Option 3: Manage Area 5 stocks in local areas with chum salmon driving the management.

Option 2 results in improved catches and escapements for both pink and chum stocks in the area. Peak catches for pink salmon are in the range of 650,000 - 700,000 and for chum salmon in the range of 26,000 - 30,000.

Table 2.5-7. Comparison of pink and chum management options in Area 5.

	Catch				Escapement				Net Present Value Millions
	Pink		Chum		Pink		Chum		
Option	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend	$
1	459,858	up	352,491	up	8,727	level	8,569	down	13.5
2	524,878	up	403,441	up	15,825	up	15,123	up	25.9
3	241,469	level	387,420	down	26,627	up	39,986	up	8.2

2.6 Statistical Area 6

Statistical Area 6 has been divided into the following seven sub-areas for the purpose of fisheries management and stock description:

1. Gardner Canal
2. Kitimat Arm
3. Douglas, Ursula and Devastation Channels
4. Fraser Reach and Graham Channel (Fraser/Graham)
5. Laredo Sound
6. Campania Sound
7. West Coast Aristazabal Island.

A detailed description of stock attributes and current fishing patterns can be found in Appendix 1. Figure 2.6-1 provides a map of the area and the location of the management units.

2.6.1 Stock Description

An overview of the stocks found in each of the sub-areas is given below.

2.6.1.1 Gardner Canal

There are two sockeye stocks in the Gardner Canal sub-area. The actively-managed stock, Kitlope, has been enhanced by the Lake Enrichment Program. The target escapement is 20,000. Although escapements averaged much higher in the 1950's and 1960's (24,000 and 41,000, respectively), they have dropped to about 10,000 in recent years. There is one very minor passively-managed sockeye stock in this sub-area. The target escapement is 500, and in recent years escapements have been about 10% of the target.

Kemano is the only actively-managed pink salmon stock in the Gardner Canal sub-area. There are nine passively-managed pink stocks. The target escapement for Kemano pink stock is 150,000. Escapements were building over the past three decades, but a flood in 1980 reduced the 1982 escapement to about half of the target. The escapement rebounded in 1984 to 240,000; thus, Kemano even-year pink stocks are considered healthy. Historically, the odd-

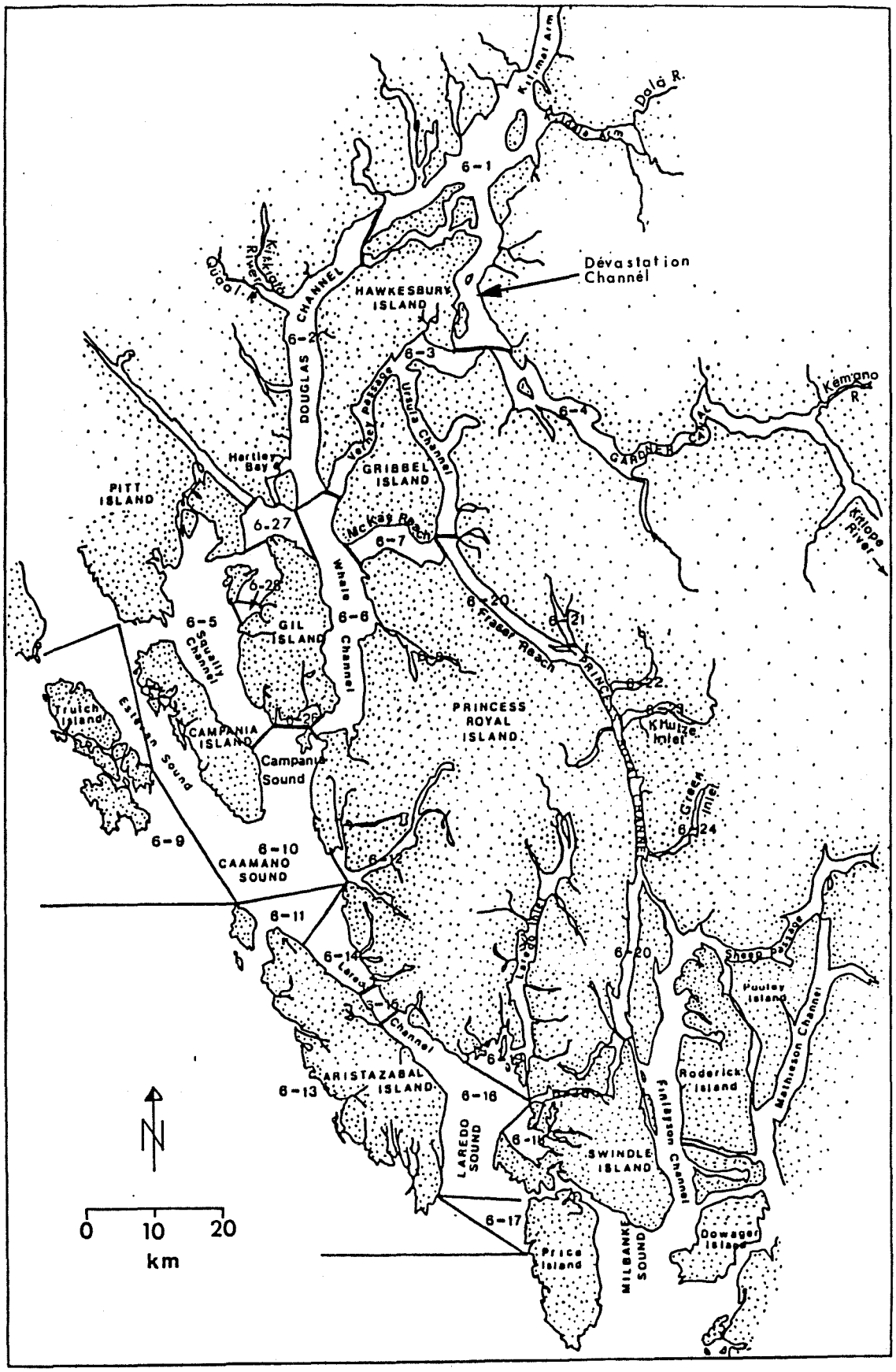


Figure 2.6-1. Statistical Area 6.

year stock has been depressed, but recent escapements (120,000 in 1983) indicate the odd-year stock is building towards the 150,000 target. As a result of Alcan's hydro-electric development on the Kemano River, there is now a more constant minimum flow in the river. We believe that this has improved over-wintering conditions and led to an overall increase in productivity in the Kemano pinks. The escapement target for the combined passively-managed pink stocks in Gardner Canal sub-area is 50,000. Both odd- and even-year stocks are severely depressed (less than 10% of target escapements).

The Gardner Canal sub-area has only one actively-managed and nine passively-managed chum stocks. Kemano chum, the actively-managed stock, has an escapement target of 75,000. Although escapements recently have fluctuated below half the target level, Kemano chums are very healthy relative to other Area 6 chum stocks. As with pinks, the constant minimum flow provided by the hydro-electric diversion appears to have improved over-wintering conditions and consequently chum productivity.

The Kitlope and Kemano rivers are the major producers of the seven chinook producing streams in the area. Current escapements are estimated at less than 10% of the target of 27,400. The Gardner Canal sub-area represents 39% of the Area 6 target.

The Gardner and Kitlope rivers are the main coho producers of the ten streams in the area. Current escapement levels are about 10% of the recommended target of 85,000. This target represents 31% of the total for Area 6.

2.6.1.2 Kitimat Arm

Fourteen passively-managed sockeye stocks in Kitimat Arm support local Indian food fisheries only. There are no actively-managed sockeye stocks. The combined target escapement for the passively-managed stocks is 2,500. Escapements are fluctuating near the target.

There are two actively-managed stocks and six passively-managed stocks of pinks in the Kitimat Arm sub-area. The Kitimat River and six of its tributary streams collectively shelter one of the actively-managed stocks. The combined escapement target for the group is 220,000. Historically, the even-year cycle

has been fairly strong, especially through the 1960's. The odd-year cycle has not recorded escapements above 16,000 in the past three decades. Currently both cycles are severely depressed, near 10% of the target. The other actively-managed stock is the Dala, with an escapement target of 40,000. Both cycles are presently depressed at about 25% of the target. The escapement target for the passively-managed group is 57,000, but both cycles are depressed, with recent escapements near 10-20% of the target.

The actively- and passively-managed groupings of chum stocks in the Kitimat Arm sub-area are the same as for the pink stocks. The combined target escapements for the Kitimat system is 137,500. Escapements are extremely depressed and fluctuating with some as low as 1.5% of the target. The Dala chum stock is depressed, but not as badly as the Kitimat system stock. The target for the Dala stock is 25,000, but escapements in recent years (1980-1983) have ranged from 1,500 to 4,500. The passively-managed group is even more depressed than chum stocks in the Kitimat system, with recent escapements as low as 350 and a target of 26,500. There is a chum hatchery on the Kitimat system, but the start-up has been slow due to the lack of brood stock.

The Kitimat and its tributaries are the major chinook producers, with additional production from the Dala and Kildala rivers. Current escapements are at 11% of target, but hatchery production is expected to boost escapement to the target of 40,125 within a few cycles. This sub-area represents 57% of the Area 6 target.

The Kitimat River and tributaries form the bulk of the 16 streams sheltering coho in the sub-area. Stock levels of coho are currently less than 20% of the target (83,000). This target represents 30% of the Area 6 total. The Kitimat hatchery has taken 600,000 and 800,000 coho eggs in 1983 and 1984, respectively. The total production could exceed 50,000 adults from each brood. A proportion will be intercepted in various troll or net fisheries, but the returns should go a long way towards rebuilding the Kitimat River coho.

2.6.1.3 Douglas, Ursula and Devastation Channel

The four passively-managed sockeye stocks in this sub-area support local Indian food fisheries. The target for the combined group of stocks is

13,000. Escapements are depressed and stable below 30% of the target.

There are three actively-managed pink stocks (Quaal, Kitkiata and a collection of 15 streams) and no passively-managed pink stocks in the sub-area. The Quaal is the major producer, with a target escapement of 200,000. Until severe floods in 1980, escapement to the Quaal had been near target. The stock should recover quickly because of its high productivity. Escapements to the Kitkiata and the collective group of 15 streams are currently 50-60% of the target (50,000 for the Kitkiata and 81,000 for the group).

There are three actively-managed chum stocks (referred to as the Douglas chum group) and 13 passively-managed chum stocks in this sub-area. All are very depressed. The actively-managed group consists of Foch Creek, Giltoyees and Quaal River stocks. Foch Creek chums have a target escapement of 10,000. The recent range of escapements is 200 - 3,500, with no trends evident. Giltoyees chum, with a target of 15,000, have fluctuated from 2,000 - 10,000 since 1980. Quaal chum have had two escapements of 15,000 (1981 and 1982) but have otherwise been stable around 5,500. The target escapement is 25,000. The passively-managed stocks have a combined target of 16,850, but chum escapements have declined over the past three decades to around 1,000.

Chinook production in this sub-area is minor, with recent escapements only from the Giltoyees. Current escapements for the three streams are only 4% of the optimum of 2,000. The sub-area total for chinooks is only 3% of the Area 6 target.

The Quaal is believed to be the major coho producer of the 20 streams in the sub-area. Stock levels are currently at 20% of the target of 45,000. This target represents 15% of the Area 6 coho total.

2.6.1.4 Fraser Reach and Graham Channel

There are no actively-managed sockeye stocks in the Fraser/Graham sub-area. The passively-managed group of four sockeye streams has a target escapement of 3,100. Escapements are down, but appear to be increasing. In recent years the range of escapements has been from 75 - 1,000.

There are five actively-managed and ten passively-managed pink stocks in the Fraser/Graham sub-area. The combined target escapement is 160,000 for the actively-managed stocks, and 29,000 for the passively-managed stocks. The escapement target by stock is as follows:

Pink Stock	Target Escapement
Khutze	70,000
Green	25,000
Canoona (Indian)	25,000
Scow Bay	15,000
Soda	25,000

In general, both odd- and even-year pink stocks are depressed, especially the even-year stocks. Khutze River odd-year stocks reached the target escapement in 1983, but the even-year stocks are less than 5% of the target. Green River stock nearly achieved the target in 1983 (odd cycle) but the even-year stock is severely depressed; the 1982 escapement of 400 is just over 1.5% of the target. Canoona (Indian) River even-year run is depressed (10% of target), but seems to be increasing slowly. The odd-year run is also depressed, but escapements are near 50% of the target. The Scow Bay Creek even-year cycle is in better condition relative to other stocks in the sub-area, since it is steady at about 1/3 of the target. The odd-year cycle is also depressed, but seems to be increasing; recent escapements were 60% of the target. The final actively-managed pink stock in this sub-area is in Soda Creek; it has a later run than the others. The even-year cycle was fairly strong and building in strength, until the 1980 floods reduced the run to only 750 fish in 1982.

The combined escapement target for the Fraser/Graham passively-managed pink stocks is 28,800. The even-year stocks are depressed and fluctuating below 5,000. The odd-year stocks are also depressed and fluctuating, but at a slightly higher level. Escapements were 13,000 in 1983.

Chum stocks in the Fraser/Graham sub-area are extremely depressed and fluctuating. The two actively-managed stocks, Green and Khutze, have target escapements of 15,000 and 30,000, respectively. Between 1980-83, Green

escapements ranged from 300 - 16,000. Average escapements over the past three decades have ranged from 20 - 50% of the target. Khutze is severely depressed, with some recent escapements below 1% of the target. The 13 passively-managed streams are depressed and fluctuate near 10% of the combined target escapements of 20,200.

Chinook production is minor in the Fraser/Graham sub-area, with recent escapements only from the Khutze. Current chinook escapements for the three streams in the sub-area are 3% of the target of 1,050, which represents 1% of the total Area 6 target escapement.

The Canoona River is consistently the largest coho producer of the 13 streams in the sub-area. Current coho stock levels are thought to be 10% of the current target of 12,900, although the sub-area represents only 5% of the Area 6 target.

2.6.1.5 Laredo Sound

There are seven passively-managed sockeye streams in the Laredo Sound sub-area. The target escapement is 14,900. Escapements have been declining steadily. They have totaled only 5% of the target escapement in two out of the past four years.

Laredo Sound pink stocks (3 actively-managed, 17 passively-managed) seem to have suffered severe damage in the 1980 floods. In the three actively-managed stocks, escapements during 1980 met or exceeded targets, but the 1982 return from those escapements averaged just above 3% of the targets. Target escapements are 35,000 for Arnoup, 20,000 for Nias and 15,000 for Tyler. Odd-year escapements are severely depressed and declining. The passively-managed pink stocks, with a combined target escapement of 35,000, are in poor condition also.

Laredo Sound chum stocks are in good condition relative to other Area 6 chum stocks. Escapements have generally been about 50% of the target for Anoup (5,000). The target for Nias is 10,000 and recent escapements have achieved 70% of that goal. The target for Tyler is 8,000 and escapements have been 50-75%. Price Creek chums, which have a later run than the other chum stocks, have a target escapement of 10,000; recent escapements have ranged

from 20-70%. The other 16 passively-managed stocks have a collective escapement target of 9,000; recent escapements have averaged about 25% of the target.

There are no chinook stocks in the Laredo Sound sub-area.

The production of coho in the Laredo Sound sub-area is from 20 small stocks. Current escapement is around 20% of the target of 15,850. This sub-area target is only 6% of the Area 6 coho total.

2.6.1.6 Campania Sound

There are no actively-managed stocks of any species in the Campania Sound sub-area. There are six passively-managed sockeye stocks, with a combined target escapement of 2,500. Escapements are depressed and fluctuating. The passively-managed pink stocks have a combined escapement target of 112,000 with current escapements about 20% of target. In general, the even-year pink stocks have higher escapement than do the odd-year stocks. The passively-managed chums in 19 streams are depressed and fluctuating. The target escapement is 9,900, and recent escapements have ranged from 300 - 4,500. There are 24 small coho-producing streams in the sub-area; their escapement is 13% of the target of 18,200. The sub-area total is 7% of the Area 6 total.

2.6.1.7 West Side Aristazabal Island

There are no actively-managed stocks in this sub-area. A passively-managed group of 10 sockeye stocks is currently depressed and fluctuating near 20% of the target escapement of 5,100. There are 16 passively-managed pink stocks with a combined target escapement of 102,800. The even-year escapement is currently at about 4% of the target, and declining. The odd-year run has an escapement over 10% of the target, and it is increasing. There are 16 passively-managed chum stocks in the sub-area with a combined target of 24,000. Escapement (8,755 in 1983) has increased slightly in recent years. There are no chinook stocks in this sub-area. There are 16 small coho-producing streams in the sub-area; they are at 10% of the target escapement of 15,850. The sub-area target is 6% of the Area 6 total.

2.6.2 Fisheries

Area 6 is managed as a major mixed-stock fishery in the Gil Island Area. Some attempt is made to match weekly exploitation to individual stock surpluses, but this is difficult to achieve because of the complexity of the mixed-stock problem. The management of the commercial fishery is guided by apparent fish abundances in the Gil Island area (as indicated from commercial catches). Current catch data are interpreted by comparison to historical catch data for equivalent weeks. In-season escapement information is derived chiefly from a subset (key streams) of the 130 streams in Area 6. Key streams for Area 6 are Kitimat, Dala, Giltoyees, Quaal, Kitkiata, Kemano, Kitlope, Canoona, Green, Arnoup and Gil.

There is currently no directed fishery for Area 6 sockeye stocks. Catches of sockeye that do occur in Area 6 are incidental in pink and chum fisheries, and are composed largely of passing stocks.

The pink and chum fisheries in Area 6 are largely restricted to waters adjacent to Princess Royal Island, including Whale Channel, Squally Channel, Campania Sound, Laredo Sound, Princess Royal Channel, Fraser Reach and McKay Reach. This includes Management Units 6-5, 6-6, 6-7, 6-10, 6-11, 6-13, 6-14, 6-15, 6-16, 6-20, 6-26 and 6-27. Gill nets and seine nets are both permitted for all fisheries.

The following general description of commercial fishing areas is meant to outline those areas that would be opened if all stocks had harvestable surpluses. This does not reflect the current stock strength. The fishery would open in early July in Management Units 6-5, 6-6, 6-10, 6-11, 6-26 and 6-27 and for Kemano pink and chum, Kitimat pink and chum, Quaal pink and Douglas chum (Fig. 2.6-2). These stocks are present in the fishery until the end of July. In mid-July the fishery would be expanded to include Laredo Sound pink and chum stocks in M.U. 6-14, 6-15 and 6-16 and the Fraser-Graham pink and chum stocks in M.U. 6-7 and perhaps 6-20. Finally, in early August the fishery would begin for Aristazabal pink and chum in M.U. 6-13, and Campania pink and chum in M.U. 6-10. All commercial fishing activity would cease in early September.

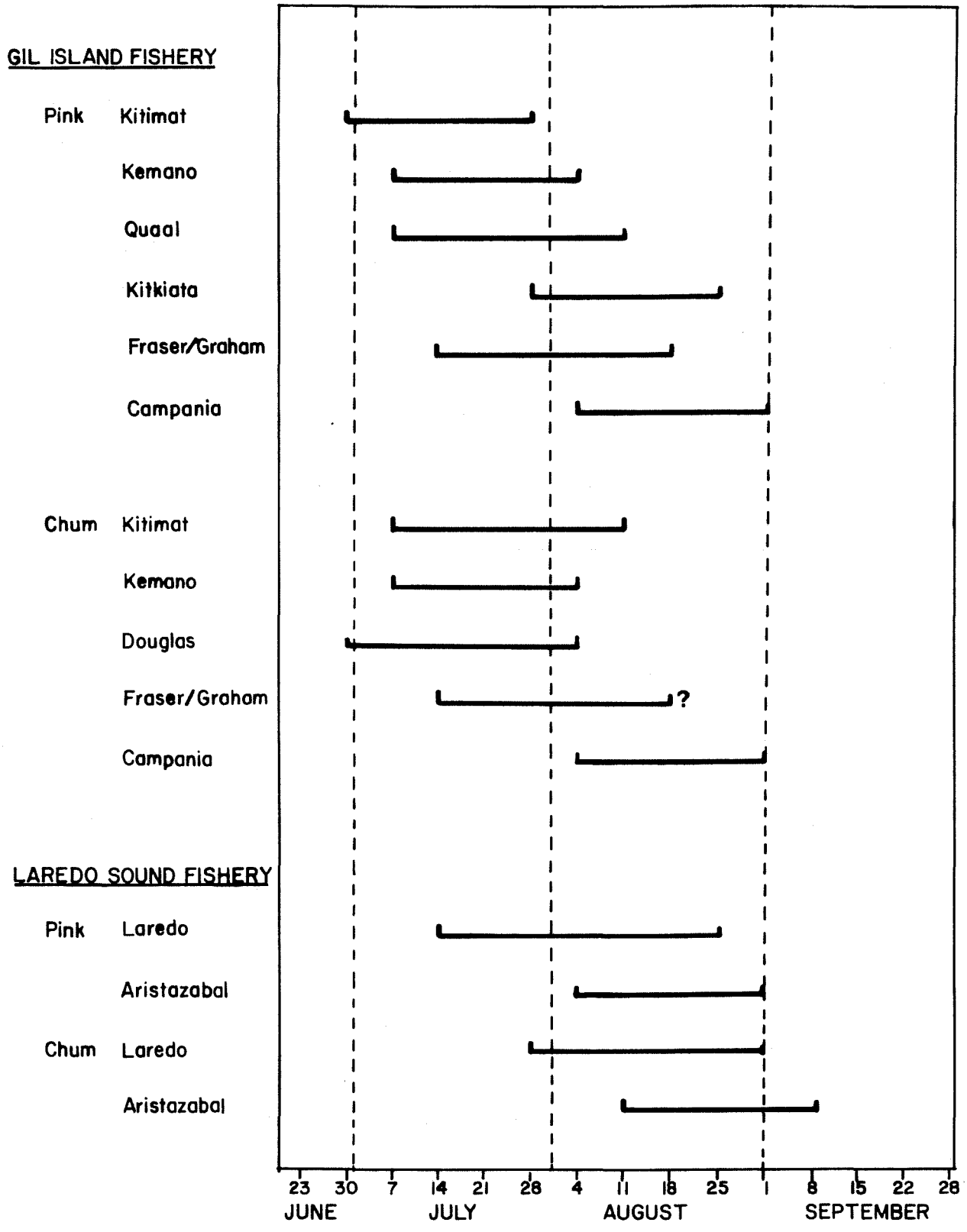


Figure 2.6-2. Stock migration timing through Gil Island and Laredo Sound fisheries.

2.6.3 Current Enhancement Activities

Currently, a major hatchery, a smaller CEDP facility, and a lake enrichment program are operating in Area 6. A pilot hatchery for chum and chinook on the Kitimat River was discontinued when the major hatchery began operating there in 1983. The lake enrichment project on Kitlope Lake is continuing, although there is some doubt about its effectiveness. The Kitimat Hatchery is located approximately 3 km south of Kitimat. The original plan was to enhance nine chum stocks and a variety of chinook and coho stocks in the Kitimat River and Kildala Arm. There are also plans for incubating and rearing small numbers of pink and sockeye salmon and steelhead trout.

The production goals for the Kitimat Hatchery at capacity are:

Species	Egg Take	Adult Production
Chum	11 million	158,400
Chinook	3 million	64,500
Coho	600,000	60,000
Steelhead	55,000	1,000

Egg collection targets for 1984 were 3,000,000 chum and 2,000,000 chinooks. The chinook target was met. However, because of the depressed state of chum stocks in the Kitimat area, only 30% of the chum egg target was realized, despite a low exploitation rate in 1983 and 1984. A smaller hatchery, run as a Community Economic Development Project by the Hartley Bay Band began operating in 1983. This facility is presently rearing 80,000 coho from Hartley Bay Creek.

2.6.4 Habitat Status

Habitat descriptions for Area 6 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.6-1 through 2.6-5, respectively. For a description of the tables, see Section 2.2.4.

2.6.5 Management Conflicts

The most important conflicts to be resolved by management for Area 6 include problems caused by mixed-stock fisheries and management uncertainties. These are discussed below.

Table 2.6-1. Statistical Area 6 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	283 ?	62	21

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 43

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow problems throughout area. No significant development impacts on sockeye streams.
Current Status	Largely unchanged from historic pattern.
Future Outlook	No significant change.
Natural Habitat Production Potential	Unchanged from historic status.
Improved Production Potential	Unknown - fertilization occurring.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Low - Medium	Unknown

CONCLUSION

Table 2.6-2. Statistical Area 6 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	150	680	550

MANAGEMENT STYLE Active 70%
Passive
Unknown

NUMBER OF STREAMS 108

HABITAT NOTES

Historic Status, Production Constraints and Development History	70% of production target from about 10 streams. Major stocks - Kitimat and Kemano. Historic natural flow problem throughout area. Logging on some streams since mid 1950's. Moderate/high impact on Kitimat River. Low elsewhere on stock-wide basis. Industrial development at Kitimat - moderate impact. Alcan flow control on Kemano stabilizes flows beneficially.
Current Status	Logging in Kitimat and some smaller streams moving to higher elevations - impacts uncertain. Flows in Kitimat will likely stabilize but nature of whole system may change.
Future Outlook	Stable for most of area with light impacts. Kitimat River uncertain.
Natural Habitat Production Potential	Good flows over most of area. Uncertain for Kitimat.
Improved Production Potential	Largely unknown. Stabilization on Kemano could lead to further improvements.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High*	Medium - High	High*	Unknown

CONCLUSION Problem with a few large stocks dominating area. Needs more sub-area specific refinement for understanding of habitat issues.

* Kitimat questionable.

Table 2.6-3. Statistical Area 6 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,265	508	57

MANAGEMENT STYLE: Active 50% ±; Passive ____; Unknown ____

NUMBER OF STREAMS: 101

HABITAT NOTES

Historic Status, Production Constraints and Development History	40% of stock target from Kitimat and Kemano. Very depressed escapements. Historic natural flow problem throughout area. Logging on some streams since mid 1950's. Moderate/high impact on Kitimat River. Low elsewhere on stock-wide basis. Industrial development at Kitimat - moderate impact. Alcan flow control on Kemano stabilizes flows beneficially.
Current Status	Logging in Kitimat and some smaller streams moving to higher elevations - impacts uncertain. Flows in Kitimat will likely stabilize but nature of whole system may change.
Future Outlook	Stable for most of area with light impacts. Kitimat River uncertain.
Natural Habitat Production Potential	Good flows over most of area. Uncertain for Kitimat.
Improved Production Potential	Largely unknown. Stabilization on Kemano could lead to further improvements.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	Medium - High	High	Unknown

CONCLUSION

Table 2.6-4. Statistical Area 6 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	68	70	7

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 31

HABITAT NOTES

Historic Status, Production Constraints and Development History	Major stocks - Kitimat and Kemano. Historic natural flow problem throughout area. Logging on some streams since mid 1950's. Moderate/high impact on Kitimat River. Low elsewhere on stock-wide basis. Industrial development at Kitimat - moderate impact. Alcan flow control on Kemano stabilizes flows beneficially.
Current Status	Logging on Kitimat and some smaller streams moving to higher elevations - impacts uncertain. Flows on Kitimat will likely stabilize but nature of whole system may change.
Future Outlook	Stable for most of area with light impacts. Kitimat River uncertain.
Natural Habitat Production Potential	Good flows over most of area. Uncertain for Kitimat.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High*	Medium - High	High	Unknown

CONCLUSION Habitat is not the reason for declines.

* Kitimat uncertain.

Table 2.6-5. Statistical Area 6 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	487	275	40

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 74

HABITAT NOTES

Historic Status, Production Constraints and Development History	Historic natural flow problem throughout area. Logging on some streams since mid 1950's. Moderate/high impact on Kitimat River. Low elsewhere on stock-wide basis. Industrial development at Kitimat - moderate impact. Alcan flow control on Kemano stabilizes flows beneficially.
Current Status	Probable loss of some small stream habitat especially in Kitimat drainage.
Future Outlook	Stable for most of area with light impacts. Kitimat River uncertain.
Natural Habitat Production Potential	Good flows over most of area. Uncertain for Kitimat.
Improved Production Potential	Probably potential for local restoration.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium - High	Medium - High	Medium - High	Medium - High	High

CONCLUSION Habitat is probably not the major problem.

2.6.5.1 Management Uncertainties

The primary management uncertainty in Area 6 is the assessment of run strength. Currently, the primary indicator of run strength is the seine catch. There are two problems with this indicator. First, weekly seine catches may not reflect the subsequent escapement to the spawning grounds (i.e., the indicator is poor). For example, in 1983 high catch rates were achieved, but the expected escapements were not realized. Second, the fishery can quickly take a large proportion of the run. In 1984, an overall exploitation rate of 50% was achieved in only four days fishing. In one day, 16% of all the pinks returning to Area 6 were caught by the Gil Island fishery. Run strength is also estimated from escapement counts made in-season. Counts are inexact, and projections of expected total escapement are often in error.

2.6.5.2 Mixed-Stock Harvests

The mixed-stock conflicts in Area 6 are enormous. Salmon from over 100 streams are fished in the Gil Island fishing area. The runs of most important stocks overlap in time (Fig. 2.6-2), and management by stock in this area is impossible. For example, in 1984 management was conservative; there were no openings until 12 August, i.e., 4 to 6 weeks later than five or six years ago, and only four days fishing were allowed. The result was a 50% exploitation rate and a total escapement of less than 50% of the target. The situation is actually worse than it appears; 40% of the escapement was to the Kemano River, which had 240,000 spawners (90,000 more than the target escapement). In addition, chum escapements were less than 25% of desired levels.

The underlying problem is the extreme difference in productivity between stocks. For example, the Quaal and Kemano pinks seem to be much more productive than other Area 6 stocks. Kitimat Hatchery chums, if produced by the hatchery at full capacity, will aggravate the situation. If the fishery were geared to take less productive stocks, catch must be forgone from the more productive stocks. Conversely, if the fishery were geared to take more productive stocks, the less productive stocks would be severely depleted.

2.6.6 Stock Rebuilding Potential

The potential for stock rebuilding is summarized by sub-area below; refer

also to Section 2.6.5.1 for specific suggestions for resolving management conflicts about rebuilding.

2.6.6.1 Gardner Canal

In the Gardner Canal sub-area, the potential for rebuilding sockeye is limited. The Lake Enrichment Program at Kitlope was not considered successful. Both cycles of Kemano pinks are approaching optimum. The passively-managed pink stocks are currently at less than 10% of the target and will be difficult to rebuild other than by enhancement. All Gardner Canal chum, actively-managed and passively-managed, are near or below 10% of the target escapement. The rebuilding potential is limited if the high exploitation on Kemano pink stocks is maintained.

2.6.6.2 Kitimat Arm

The passively-managed sockeye stocks in the Kitimat Arm sub-area are mostly creek sockeye, and are within 20% of the target. Rebuilding potential for sockeye is limited, although the stocks should benefit from the reduced exploitation required to rebuild Kitimat pink and chum stocks. Rebuilding potential for Kitimat Arm pink and chum stocks is high. Pinks and chums stocks are at less than 10% of the target escapements. Changes in the fishing pattern in Area 6 have reduced the harvest of these stocks significantly. In addition, operation of the Kitimat hatchery will eventually result in an increase in productivity of Kitimat system chum stocks.

2.6.6.3 Douglas, Ursula and Devastation Channel

Rebuilding potential for the passively-managed sockeye stocks in this sub-area is low. However, interceptions may decline if the exploitation of Kitimat and Gardner stocks is moved to a more terminal area than Gil Island. Rebuilding potential for pinks and chums is good. Pinks are at 50% of the target escapement, while chum are 10-20% of the target escapement. Harvest rates for these stocks could be decreased by changes in fishing patterns.

2.6.6.4 Fraser Reach and Graham Channel

Rebuilding potential for sockeye in this sub-area is low; however, sock-

eye interceptions will be reduced if directed fisheries for pink and chum stocks are moved to a more terminal area. Rebuilding potential for pink stocks is good, although odd-year pink escapements have recently been near the target level. The even-year fish will need special consideration to rebound from low escapements caused by floods in 1980. Changing the fishing patterns in Area 6 would provide some flexibility to protect these stocks. Rebuilding potential for chum salmon is only fair, despite the fact that they are currently at only 10% of the target escapement. A major conflict which will significantly affect rebuilding of chum stocks is the relative strength of the pink stocks.

2.6.6.5 Laredo Sound

Sockeye are not currently fished, so there is little that can be done with respect to rebuilding. The stocks are currently at only 5% of the target escapement. Even-year pink escapements were at optimum before 1982, and it is expected that the stocks will rebuild fairly quickly if they are not fished until target escapements are achieved. Odd-year pinks have never been strong, but the potential for rebuilding is still considered to be high. Changed fishing patterns in the Laredo Sound area have started the rebuilding process. Laredo chums also have a good potential for rebuilding, in that exploitation in the area has been greatly reduced.

2.6.6.6 Campania Sound

Sockeye have a fair potential for rebuilding in this sub-area. Most recently recorded escapements were 60% of the target. Changes in the Gil Island fishery would reduce the interception of sockeye. The stream-by-stream variability of Campania pinks is very high. As with sockeye, changes in the Gil Island fishery may also reduce the interception of both pink and chum. Rebuilding potential is not as good for chum stocks, given the relative strength of Campania pink stocks.

2.6.6.7 West Side Aristazabal Island

Sockeye escapements are currently 20% of optimum. They may benefit from changes in Laredo and Gil Island fisheries. Pink and chum stocks are current-

ly at extremely low levels with respect to the target escapements. However, the target escapements for pinks and chums may not be realistic. In any case, a reduction of the exploitation rate of the Laredo Sound fishery should benefit these stocks.

2.6.7 Management Strategies for Stock Rebuilding

Rebuilding options are discussed below; see also Section 2.6.5, Management Conflicts, for a review of problems treated in this section.

2.6.7.1 Management Uncertainties

Options for reducing management uncertainties are described first:

1. Continue and expand test fishing programs started in 1984: In 1984 a charter test seine was operated from July 9 to August 4 in the Gil Island area. Although it was difficult to provide reasonable coverage of the entire area with only one seine boat, the test fishery did support the expectations of weak stocks, without the cost to the stocks of a commercial test fishery. Based on the test fishing results, the commercial openings were delayed due to apparent poor run strength.

The fishery cannot be managed to produce optimum escapement unless timely and accurate information regarding escapement is available. Therefore, test fisheries in terminal areas should be initiated, since they could act as indicators of escapement past the fishing areas. For example, Gardner Canal and Kitimat Arm are two feasible test fishing areas which would provide early estimates of escapement to these sub-areas if properly calibrated with the true escapement values.

2. Install a fence on the Quaal and review the potential for counting facilities for other streams: Escapement to the Quaal River should be a good indicator of total escapement to the Douglas, Ursula and Devastation Channel sub-areas. Furthermore, the installation of a fence or counting tower is feasible on the Quaal River. The potential for counting facilities at other streams in Area 6 should also be reviewed.

2.6.7.2 Mixed-Stock Harvests

Options for resolving some of the conflicts resulting from mixed-stock harvest are described below:

1. Fish any Kitlope sockeye surplus in the outer portion of Gardner Canal: Kitlope sockeye are an early-running stock, and could be harvested without conflict in the outer portion of Gardner Canal, part of M.U. 6-4. The ability to control effort would be especially useful to manage the exploitation on this stock. Quality loss would be minimal.

2. Conduct fisheries for Kemano pink and chum stocks in outer Gardner Canal: Kemano pink and chum stocks could also be harvested selectively in the outer portion of Gardner Canal, part of M.U. 6-4. A major benefit is that the Kitimat, Douglas and Fraser/Graham sub-area stocks would no longer be harvested incidentally to the highly productive Kemano pinks. Unfortunately, the suggested fishing area is restrictive and there would be some quality loss.

The Kitlope stocks are believed to overlap with the Kemano stocks (i.e., the former would be caught incidentally in M.U. 6-4). There is a great deal of uncertainty associated with the target escapement and productivity of the Kitlope stocks, since the stream system is glacial (recent escapements have been listed as non-observed or a few thousand).

3. Move target fishery on Kitimat pink and chum stocks to M.U. 6-4 (inner Douglas and Devastation channels): This option could result in considerable quality loss and impose a new and restrictive area for the commercial fleet to fish. A compromise solution of moving the fishery a little further out into M.U. 6-2 or 6-3 would not suffice as there would be a direct conflict with Quaal - Douglas stocks or with Gardner Canal stocks (i.e., fishing in M.U. 6-2, 6-3 is no better than the Gil Island fishery).

Moving the fishery to M.U. 6-1 would not solve all the mixed-stock problems associated with the Kitimat stocks. The Kitimat Arm stock is from a combination of streams tributary to the Kitimat River and the Dala River. There will undoubtedly be harvest conflicts among these streams. Some mitigation may be possible by manipulating the operation of the Kitimat hatchery.

Further, the enhancement of Kitimat chums may eventually pose a threat, as the exploitation for Kitimat chum returns may be higher than that required for returning pinks. This problem could be reduced through selective harvesting of chums using gill nets; however, a gillnet-only fleet would be a radical departure from historical gear allocation in the area.

4. Maintain fishery at Gil Island: If the fishery is to be maintained in the Gil Island area, effort should be directed at determining what overall exploitation rate would yield the highest total production from the area. The present system of fishing at Gil Island for any suspected surplus from any stream does not yield the maximum long-term benefit to the fishermen. If we choose to fish this way then the overall exploitation rate must be reduced considerably.

5. Move target fisheries on Fraser/Graham stocks to M.U. 6-7 (McKay Reach) and to the top portion of M.U. 6-20: These stocks could be harvested in McKay Reach (M.U. 6-7) and in the northerly part of M.U. 6-20. There would be some interception of Kitimat, Douglas and Gardner stocks but it should be minimal. The fishing area would be restrictive, but the move should result in little quality loss.

6. Conduct future fisheries for Laredo Sound stocks in M.U. 6-16: Laredo Sound pink stocks will require complete protection for many cycles. Therefore, gillnet-only fisheries with large mesh nets should be used for any future chum surplus. A reasonably discrete fishery can be held in M.U. 6-16 on the chum stocks, since the timing is later than for the inside stocks. Interception of Campania chum stocks should be the only serious conflict.

2.6.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

2.6.8.1 Kemano Pilot Facility and Channel Improvements (Project No. 6 - 1A)

A pilot experimental facility is proposed, using as much as possible of the available Kemano infrastructure. This facility would be designed to develop techniques which could overcome the apparent impediments to a successful project, so that extremely large-scale chum, pink, and chinook enhancement could be undertaken, and the stocks thereby produced could be discretely harvestable in Gardner Canal. The techniques expected to be studied include:

1. Cold water fish culture techniques for chinook salmon, including the use of heat pumps to provide pulse heating to aid feeding;

2. Channel improvement technologies to improve egg-to-fry survivals of pinks and chums homing on the tail-race supply; and

3. Any feasible satellite possibilities to assist Kitlope stocks (and possibly others) which are being fished concurrently with Kemano stocks.

Saltwater pen rearing has been ruled out because surveys have shown a deep freshwater lens in the few potential sites with sufficient shelter. It is believed that warming of Kemano River by the tail-race supply has perhaps benefited Kemano stocks by allowing them to emerge earlier. This would permit them to take advantage of better rearing conditions in nearshore waters before the spring runoff increased turbidity.

The experimental project has tentative targets set at 500,000 chinook eggs yielding approximately 10,000 adults and 100,000 coho eggs yielding 1,500 adults. The channel improvements would yield approximately 30,000 returning chum adults, or perhaps a mix of pink and chum. The facility for coho and chinook would operate for approximately 5 years and then be closed or expanded to a permanent facility. The channel improvements should have a useful life of at least 10 years with minimum maintenance.

The project would contribute pinks and chums primarily to the Area 6 fisheries at Gil Island, and in Gardner Canal if a new fishery begins there as

proposed for 1985 or 1986. The chinooks and coho would contribute to local troll and sports fisheries, as well as to the northern British Columbia and Alaska troll fisheries. Some chinooks would be taken incidentally in the net fisheries. The CWT returns from Kitimat chinooks may provide an indication of the contributions to various fisheries that would be expected from Kemano enhancement.

There would be minimal impacts on other stocks caused by fishing for the relatively few fish produced by the experimental project. If major pink or chum enhancement followed from the pilot project, most of the surplus production would be cropped by terminal fisheries in Gardner Canal. This increased exploitation rate would adversely affect other stocks in Gardner Canal, if their run timing is similar. However, this is really no different from the current situation in the area, since Kemano stocks have a much higher rate of return than do other Gardner stocks.

2.6.8.2 McKay Creek Side Channel Construction (Project No. 6 - 8B)

A side channel on McKay Creek is proposed to enhance a local stock of stream sockeye. The channel would be 5,000 m^2 in size and would produce approximately 37,000 sockeye. The impacts from this small-scale production would be minimal. If production exceeded local food fishing requirements, there would be problems harvesting surpluses commercially.

2.6.8.3 Butedale Hatchery Project (Project No. 6 - 16B)

Butedale is the most attractive of a number of outstanding physical opportunities for large-scale fish culture facilities in Area 6. Along with the other sites (Whalen Lake, Yule Lake, Surf Inlet and Redbluff Lake), the Butedale site offers a large gravity-fed water supply. Water quality at Butedale should be good, since all of the stream systems have large lakes with outlets virtually at tidewater. In addition, the Butedale site has an unused cannery/cold storage facility, parts of which could be easily adapted to fish culture purposes. The present owner is interested in developing the site as both a lodge and as an aquaculture facility; a co-operative program therefore may be possible at relatively low cost.

The project could be undertaken in either of two ways: It could serve as a central facility to rehabilitate sub-area chum and pink stocks; or an entirely new fishery could be developed, using transplanted valuable species and stocks which are sufficiently different in run timing from local and passing stocks so as to minimize interception. With respect to the latter approach, chinooks which run in May (or possibly Kitimat chinook which run in June), or sockeye which run from April to June have been identified as desirable. Coho, chum and pink salmon are less desirable due to potential overlap with existing stocks. Sockeye would probably be incubated at Butedale and then out-planted into nearby hanging lakes in Surf Inlet (preferred) or possibly Whalen Lake. Chinooks would be incubated and reared on land (not in sea pens).

As a first stage, a facility producing all one species, and releasing about 4,000 kg of juveniles is proposed. If only 5-g chinooks were produced, total adult production would be 24,000 fish; if unfed sockeye fry were out-planted, total adult production could be 121,000 fish.

There is considerable uncertainty about the benefits and probability of relocating Area 6 fisheries to more terminal areas. Fishery contribution for a central facility is difficult to predict and would require further analysis. If this project were successful, it would create an entirely new commercial (and possibly sport) fishery, with negligible interception problems. In 1985/1986, two analyses should be undertaken: Analysis of the benefit of relocation of fisheries to more terminal locations; and development of a candidate list of potential donor stocks of chinooks and sockeye for the project. When these analyses are completed, meetings should be held to decide whether a central facility should be planned during the pilot operation. Additional biological and engineering feasibility studies are required at the site, and negotiations with the present owner of the Butedale facilities are needed.

2.6.8.4 Hartley Bay Hatchery (Project No. 6-24)

This is a relatively new pilot project, currently incubating 160,000 coho eggs. No new fisheries are expected to be required to harvest the returns. The opportunities for expansion of this facility have not been fully discussed, but a meeting is scheduled for May 1985. It is proposed this project be continued.

2.6.9 Predicted Results for Management Options

The following analyses were carried out using a preliminary model. The results are therefore preliminary. Re-analysis is in progress and the results will be presented in the next edition of this report.

The options for reducing management uncertainties have not been analysed; however, evidence from the 1984 fishing season indicates that it may be impossible to halt the decline of the stocks in Area 6 in the absence of a more finely tuned approach to management. Unless charter test fisheries are employed to give indications of run strength, it will be necessary to conduct a commercial test fishery. This could have potentially disastrous results, especially at current stock sizes, and, in turn, may preclude any other stock rebuilding options.

The options to reduce the mixed-stock catches while conducting target fisheries for Kitlope sockeye were also not analysed, due to the early and relatively discrete timing of runs of those stocks.

The balance of the options presented deal with reducing mixed harvests of pinks and chums.

Three analyses were carried out. The first analysis modelled the current mixed stock fishing patterns in Area 6. The second analysis modelled a series of discrete "pink-driven" fisheries, and the third modelled a series of discrete "chum-driven" fisheries. The results are tabulated in Table 2.6-6. Option 1, which represented the Gil Island and Laredo Sound mixed stock fisheries, had an NPV of $58,000,000. Option 2 represented a series of more discrete "pink-driven" fisheries in:

a) Gardner Canal;
b) Kitimat Arm;
c) McKay Reach;
d) Douglas Channel;
e) Laredo Inlet;
f) Campania Sound; and the
g) West side of Aristazabal Island

Table 2.6-6. Comparison of Kitimat pink and chum management options.

Option	Catch				Escapement				Net Present Value (Million $)
	Pink		Chum		Pink		Chum		
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend	
1(a)	1,213,075	up	88,364	down	638,888	stable	65,229	down	46.5
1(b)	331,764	up	39,760	up	216,912	stable	36,796	down	11.4
2(a)	353,040	up	33,927	stable	157,821	up	25,052	down	8.9
2(b)	469,595	up	27,457	up	250,481	up	25,215	down	9.8
2(c)	344,548	up	14,695	down	169,105	stable	11,854	down	11.0
2(d)	663,448	up	25,845	stable	313,938	stable	19,437	down	22.0
2(e)	121,384	up	23,950	up	68,148	up	25,513	down	4.8
2(f)	205,032	up	2,978	up	102,597	up	2,326	down	6.1
2(g)	160,043	up	7,730	up	80,724	up	7,426	down	4.6
3(a)	190,906	up	65,000	up	170,818	down	73,172	up	6.0
3(b)	233,432	up	39,613	up	246,545	up	62,069	up	5.5
3(c)	137,584	up	24,658	up	159,720	stable	33,338	up	5.5
3(d)	320,224	up	49,998	up	284,813	stable	51,626	up	13.0
3(e)	57,925	up	31,318	up	51,190	up	31,245	up	3.7
3(f)	91,677	up	4,860	up	97,123	up	6,076	up	2.8
3(g)	68,693	up	11,906	up	74,412	up	14,834	up	2.6

The NPV of Option 2 was $67,000,000. Option 3 represented the same basic fisheries as Option 2; however, in Option 3 they were "chum-driven". The NPV was $39,000,000.

Over the twenty-year simulation period, Option 1 resulted in continually increasing pink catches at the expense of chum escapement and catch.

Option 2 was "pink-driven", was run at exploitation rates appropriate for pink salmon, and resulted in steady increases of both pink catch and escapement. Chum stocks, however, exhibited steady declines in escapement mirrored by steady increases in catch. It is noteworthy that, although the overall trend in chum catch was up, in some cases the last three to five years of the simulation showed noticeable declines in chum catch.

Both of the preceding options implied that chum salmon simply could not withstand exploitation rates that were efficient for pink salmon. Option 3, therefore, simulated a series of discrete "chum-driven" fisheries. It was only under these conditions that the goal of rebuilding the natural stocks was achieved. Although the economic analysis indicated that the NPV of this option was lower than the others over the twenty years modelled, it is not difficult to envisage Option 3 as preferable. Over the longer term, it will most likely prove advantageous to have managed both species.

In attempting to relate modelling results to reality, it is apparent that, in addition to moving the fishery out of the major mixed-stock areas and into more discrete and controllable areas, some consideration must also be given to lowering the overall exploitation rate, in order to allow both chum and pink stocks to rebuild.

2.7 Statistical Area 7

Statistical Area 7 is located on the central coast of British Columbia, approximately midway between Vancouver Island and the Queen Charlotte Islands (Fig. 2.7-1). The area includes Queens Sound, Milbanke Sound, Spiller Channel, Seaforth Channel, Mathieson Channel and Finlayson Channel. The major salmon producing streams include Kainet Creek, Mussel (Bear) River, Neekas Creek, Salmon Bay Creek, Nameless Creek, James Bay Creek, Clatse Creek and Roscoe Creek. A detailed list of stock attributes and fishing patterns can be found in Appendix 1.

2.7.1 Stock Description

Approximately 21 chum and pink stocks are actively managed in Statistical Area 7. In addition, there are numerous small sockeye, pink and chum stocks which are passively managed.

Twenty-three sockeye streams are passively managed in the area, of which none are major producers. Only two systems, Kadjuadish and Tankeeah Creek, have had escapements in excess of 1,000 fish. Total Area 7 sockeye escapement has declined from an average of 12,000 in the early 1970's to approximately 3,000 more recently. The fish are not a primary target of any commercial fishery, but they are exploited by Indian food fisheries.

No chinooks have been reported in Area 7 since 1969. Sporadic reports during the 1950's and 1960's indicated very minor chinook stocks in Conter, Duthie, Kainet, Mussel and Poison Cove creeks.

Pink salmon occur in 55 streams in Area 7. The even/odd-year dominance pattern of Area 7 pinks has alternated several times over the last century; most recently, odd-year pinks have been dominant. Most Area 7 pinks appear to approach their natal streams from a westerly direction through Milbanke Sound, although some probably move south through Statistical Area 6 and north through Area 8. The 1983 escapement of approximately 325,000 fish was close to the escapement target of 350,000, and was greater than the brood year escapement and five-year cycle average from 1973-1981. The abundance of both even- and odd-year pink stocks in the Area 7 fisheries peaks in late July. Most spawning activity occurs in mid- to late August.

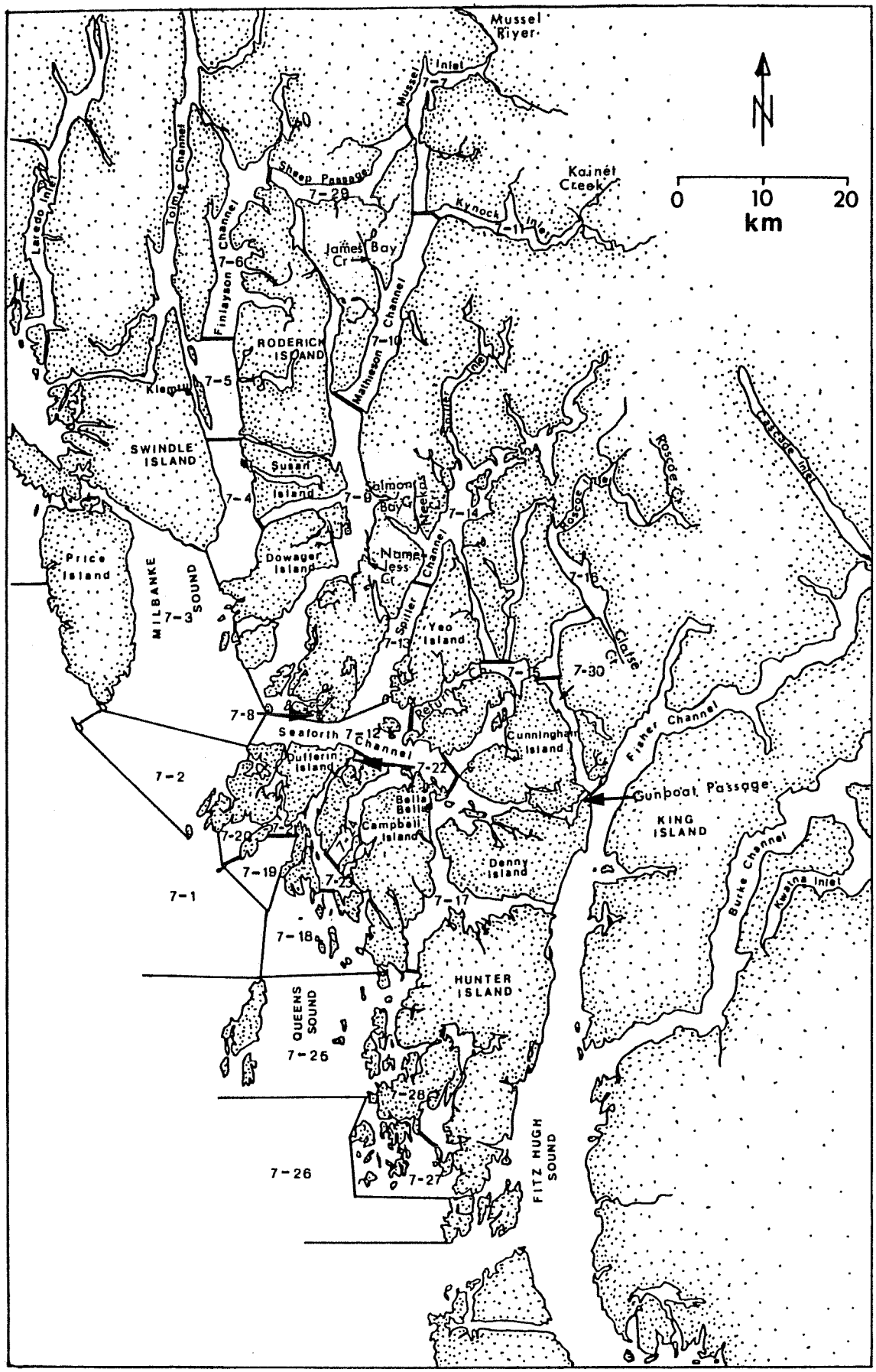


Figure 2.7-1. Statistical Area 7.

Chum salmon occur in over 50 streams in Area 7. It is generally believed that most chums approach from the west through Milbanke Sound, although some probably migrate from the north through Statistical Area 6. Some also migrate through Area 8 from the south. Area 7 chum escapements have varied dramatically over the last 30 years, and have been declining since 1975. The 1983 escapement of 124,000 fish was below the 1973-1982 ten-year average of 186,000, and well below the optimum escapement of 350,000 (under review). The abundance of chum in the vicinity of the fishery is greatest in late July and early August. Most spawning activity occurs in August and September.

For convenience, the 21 actively-managed stocks are divided among the seven following management sub-areas:

1. Finlayson Channel and Mussel Inlet;
2. Kynock Inlet;
3. Mathieson Channel;
4. Seaforth Channel, Gunboat Passage and Return Channel;
5. Spiller Channel;
6. Roscoe Inlet; and
7. Southern Area 7.

A stock description for each of these sub-areas is given separately below.

2.7.1.1 Finlayson Channel and Mussel Inlet

The only actively-managed pink stock in the Finlayson/Mussel sub-area originates in Mussel (Bear) River. Ten-year average escapement estimates have varied by a factor of two over the last 30 years. The current escapement target for both even and odd years is 50,000, which is 14% of the escapement goal for Area 7. In addition, 13 streams are managed passively, with a target escapement of 35,000 fish.

The actively-managed chum stock in the Finlayson/Mussel sub-area originates in Mussel (Bear) River. The ten-year average escapement estimates from 1950-1983 show little variation, and are generally close to 20,000 fish. The escapement target for the stock is set at 40,000, which is 11% of

the Area 7 target escapement. In addition, 13 chum streams are managed passively, with a combined target escapement of 10,200 fish.

Current stock levels in the 11 coho streams in the subarea are estimated at 3% of the target escapement of 3,070. This target is 13% of the Area 7 total.

2.7.1.2 Kynock Inlet

One pink stock in the Kynock sub-area is actively managed. The stock originates in Kainet Creek. Ten-year average escapement estimates for the stock have varied by a factor of about two over the last 30 years. The escapement target for both even and odd years is 75,000 fish, which is 21% of the escapement goal for Area 7. In addition, three streams in the Kynock sub-area (target escapement 16,000) are managed passively.

The chum stock originating in Kainet Creek is the only actively-managed chum stock in the Kynock sub-area. The ten-year average escapement estimate from 1950-1979 has declined continuously from 58,000 in the 1950's to 30,000 in the 1970's; it now appears to have stabilized. The escapement target for the stock is set at 75,000 chum, which is 21% of the target Area 7 escapement. In addition, three streams are managed passively with a combined target escapement of 5,000 chum.

Kainet Creek provides the majority of the coho production of the two streams in this sub-area. The stock is currently thought to be near 20% of the escapement target of 1,100. The sub-area potential production is only 5% of the Area 7 total.

2.7.1.3 Mathieson Channel

The actively-managed pink stock in the Mathieson sub-area originates in James Bay, Salmon Bay and Nameless Creek, and is referred to as the Mathieson pink stock. Ten-year average escapement estimates for the pink stock have shown little variation over the last 30 years, ranging from 55,000 - 65,000. The escapement target for both even and odd years is 55,000 which is 16% of the escapement goal for Area 7. In addition, six streams in the Mathieson sub-area are managed passively, with a target escapement of 7,800.

The Lower Mathieson chum stock, originating in Nameless and Salmon Bay Creek is actively managed. The stock is small compared to many other Area 7 chum stocks, with an escapement ranging from 10,000-15,000 fish. The target escapement for the chum stock is 15,000, less than 1% of the target Area 7 escapement. In addition, seven streams in the Mathieson sub-area are managed passively with a combined target escapement of 8,000 chums.

James Bay and Nameless Creek produce most of the coho salmon from the four streams in this sub-area. The coho stocks are currently believed to be at less than 10% of the target escapement of 1,110. This target represents 5% of the Area 7 total.

2.7.1.4 Seaforth Channel, Gunboat Passage and Return Channel

The only actively-managed pink stock in this sub-area originates in Gullchuck Head and Kwakusdis Creek. It is referred to as the Seaforth pink stock. Ten-year average escapement estimates have varied by a factor of two over the last 30 years. The current escapement target for both even and odd years is 30,000 which is 8.5% of the escapement goal for Area 7. In addition, eight streams are managed passively, with a target escapement of 6,900 fish.

The actively-managed chum stock originates in Gullchuck Head and Kwakusdis Creek, and is referred to as the Seaforth chum stock. Ten-year average escapement estimates for the stock have exhibited little variation from 1950 - 1979, ranging from 20,000 - 26,000 fish. However, escapement estimates declined rapidly in the 1980's to levels averaging only half that of the previous 30 years. The escapement target for the stock is 28,500 which is 8% of Area 7 target escapement. In addition, 13 streams are managed passively, with a combined escapement target of 11,000 fish.

Kadjuadish Creek is the major coho producer of the nine coho streams in this subarea. Current escapements are at less than 20% of the target (6,380). This sub-area represents 27% of the total Area 7 coho target escapement.

2.7.1.5 Spiller Channel

The actively-managed pink stock in this sub-area originates in Neekas

Creek. Ten-year average escapement estimates for stock from 1950-1979 have varied by a factor of 10. The escapement target for both even and odd years is 50,000, which is 14% of the escapement goal for Area 7. In addition, five streams with a target escapement goal of 9,000 fish are managed passively.

The actively-managed Spiller sub-area chum stock also originates in Neekas Creek. The ten-year average escapements from 1950-1979 showed little variation, ranging from 36,000 - 47,700. However, more recent escapements have averaged approximately 25,000. The escapement target for the stock is set at 30,000, which is 9% of the target Area 7 escapement. In addition, four streams are managed passively, with a combined target escapement of 4,000.

The current escapement of the three stream systems that produce coho is about 10% of the subarea target of 3,500, which in turn represents 15% of the Area 7 coho target escapements.

2.7.1.6 Roscoe Inlet

The actively-managed pink stock in the Roscoe Inlet sub-area originates in Clatse and Roscoe creeks, and is referred to as the Roscoe Inlet pink stock. The Clatse component of the run is dominant, and in most years accounts for over 70% of the total stock size. Ten-year average escapement estimates for the stock from 1950-1979 ranged from 31,000 - 49,000, although more recent estimates are approximately 50% lower. The escapement target for both even- and odd-year stocks is 60,000 which is 17% of the escapement goal for Area 7. In addition, three other streams in the Roscoe Inlet sub-area are managed passively, including Quartcha Creek, which is monitored in-season. The target escapement for the passively-managed streams is 9,000.

The chum stock originating from Roscoe, Clatse and Quartcha creeks is the only actively-managed chum stock in the Roscoe sub-area, and is referred to as the Roscoe chum stock. The Roscoe component of the stock is the largest, accounting for over half of the total run in most years. The ten-year average escapement from 1950-1979 shows little variation, although escapements decreased rapidly from 1980-1983. The escapement target for the stock is 65,000, which is 18% of the target Area 7 escapement. In addition, two other streams are managed passively with a combined escapement of 1,000.

Quartcha and Roscoe are by far the largest producers of the four sub-area streams. Current stocks are thought to be 15% of the target escapement of 6,250. This sub-area represents 26% of the Area 7 potential.

2.7.1.7 Southern Area 7

The actively-managed pink stock in the Southern sub-area originates in Howyete Creek (a tributary to Cooper Inlet), and is referred to as the Howyete pink stock. The ten-year average escapement estimates ranged from a low of 11,200 fish in the 1950's to approximately 20,000 fish from 1960-1979. Recent escapement estimates are approximately 11,000. The escapement target for both even- and odd-year stocks is 20,000, which is 6% of the Area 7 escapement. In addition, seven streams are managed passively, with a combined target escapement of 2,000 pink.

Howyete Creek, a tributary to Cooper Inlet, is the only chum system in the Southern sub-area of Statistical Area 7. The Howyete chum stock is the smallest of the actively-managed Area 7 chum stocks. The average 10-year escapement estimates decreased from approximately 17,000 from 1950-1959 to 9,000 in the 1970's. Escapement estimates continued to decrease, reaching approximately 4,000 in 1982 and 1983. The target escapement for the stock is 15,000 which is 4% of the target Area 7 escapement.

Coho production is balanced between the eight streams in this sub-area. Current production is believed to be 10% of the target escapement of 2,400. This target represents 10% of the area total.

2.7.2 Fisheries

Major Area 7 pink and chum salmon stocks are generally managed to produce specific escapement goals. There is no directed fishery for a stock when its run size is not near or above the optimum escapement. Catches by the commercial fishery provide the basis for in-season assessments of run size, particularly early in the fishing season. These catches are compared to catches and corresponding total run sizes from previous years to generate predictions of current run size. In addition, 12 key streams (Kunsoot, Kwakusdis, Neekas, James Bay, Nameless, Salmon Bay, Roscoe, Quartcha, Clatse, Mussel (Bear),

Kainet and Carter) are monitored in-season to provide information on timing and run size which can be used to assess the fishing plans.

There are no fisheries specifically for Area 7 sockeye stocks. Catches of sockeye are incidental during fisheries for Area 7 pink and chum stocks. It is believed that most of the sockeye catch is composed of fish that come from stocks destined for other Statistical Areas.

Current fishing areas are difficult to define because many stocks are low and have not been harvested recently. The simple overview of fishing areas that follows is meant to describe where and when fisheries would be held if a surplus stock were identified. There are basically two fisheries (Mathieson/Finlayson and Seaforth). The timing of migration of stocks through these fisheries is presented in Figure 2.7-2. A fishery for Kynock and Finlayson stocks would be conducted in Management Units 7-4, 7-5 and 7-9 beginning in early July and continuing to mid-August. The Mathieson stocks are approximately two weeks later and would be fished in Lower Mathieson (M.U. 7-9) only. A fishery for early Seaforth, Spiller, Roscoe and southern group stocks would begin in early August, and would continue for three or four weeks before switching emphasis to the chum stocks arriving later. The main fishing area would be Seaforth Channel (M.U. 7-12), with some movement towards more terminal areas to harvest identified local surpluses in Spiller Channel (M.U. 7-13), Roscoe-Return Channel (M.U. 7-15) or Hunter-Lama Pass (M.U. 7-17).

2.7.3 Current Enhancement Activities

The Klemtu CEDP hatchery located on Klemtu Creek is a small chum and coho facility with a capacity of 1,000,000 chum eggs and 100,000 - 250,000 coho eggs. The eggs are collected from streams in the vicinity of the hatchery; fry are placed in sea pens and are later back-planted to the streams of origin. Eggs collected in 1983 produced approximately 90,000 and 800 chum and coho fry, respectively. In 1984, 500,000 chum eggs were collected.

The Bella Bella CEDP hatchery is located on Campbell Island on McLoughlin Bay Creek. The primary goal of the hatchery is to increase the availability of chum salmon to Central Coast commercial and Indian food fisheries. The

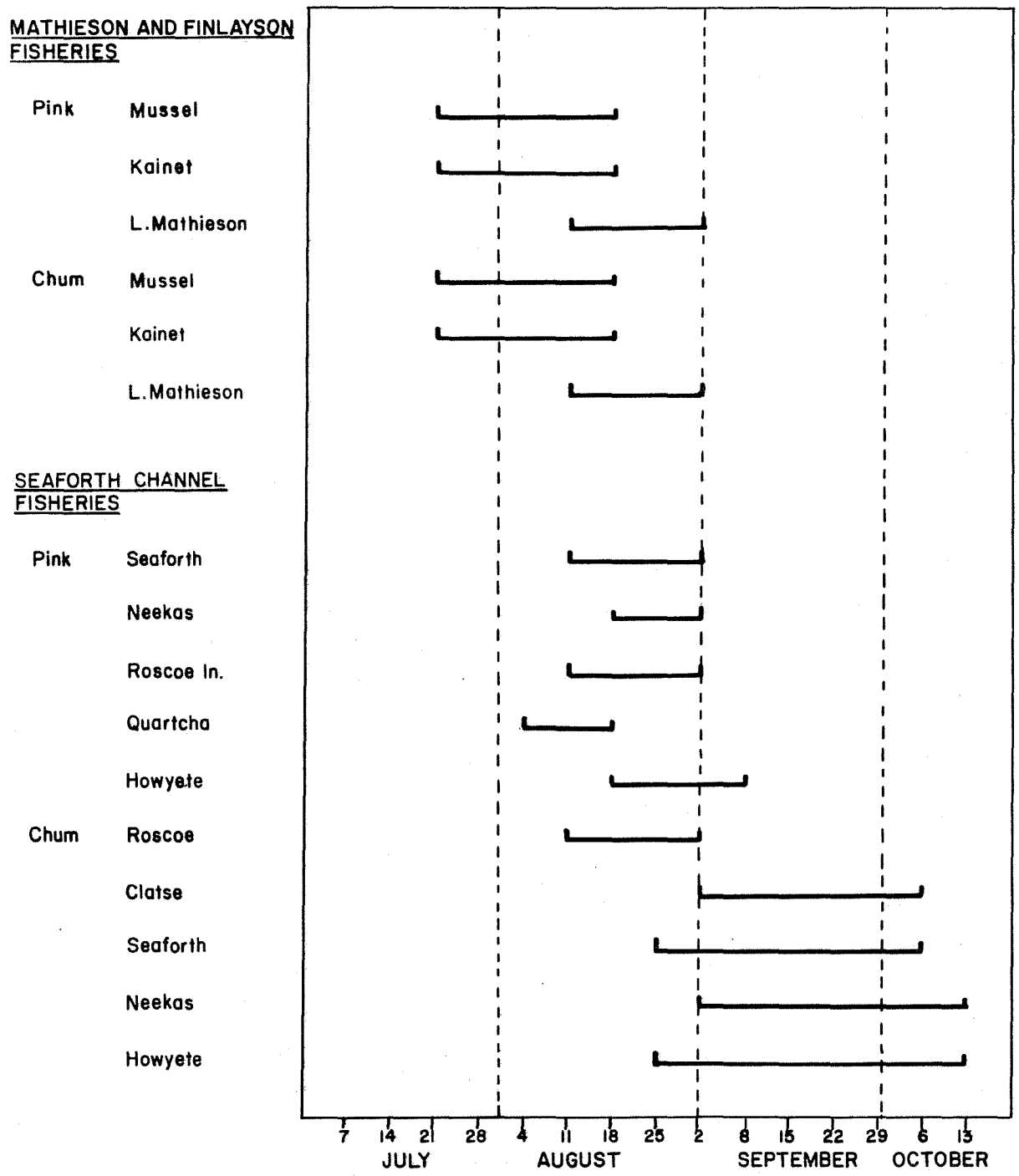


Figure 2.7-2. Stock migration timing through the Mathieson-Finlayson and Seaforth fishing areas.

capacity of the hatchery has been set at 2,000,000 chum eggs and 100,000 coho eggs. The eggs are collected from streams in the vicinity of the hatchery. Management problems associated with the harvest of these fish have yet to be resolved.

2.7.4 Habitat Status

Habitat summaries for Area 7 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.7-1 through 2.7-5, respectively. For a description of the habitat tables, see Section 2.2.4.

2.7.5 Conflicts in Current Management Approach

Conflicts discussed below include the problems of uncertainties in data and mixed-stock fisheries.

2.7.5.1 Management Uncertainties

The management of Area 7 has changed radically in recent years from a mixed-stock fishery for passing stocks in Milbanke Sound to a series of relatively discrete fisheries for stock surpluses. The move to new fishing areas that have limited historical catch data increases the uncertainty (in the short term) of in-season management. Part of the commitment to local stock management requires that assurances are made to industry that harvestable surpluses will be identified and caught in an orderly manner, with a minimum of quality loss. There is a strong conflict between permitting fish to escape to the spawning ground, and the need to fish to avoid an unexpected surplus. Until appropriate historical data are available and predictive capabilities are developed, this will remain a difficult task.

2.7.5.2 Mixed-Stock Harvests

The revision of the Area 7 fishery has greatly reduced the mixed-stock harvest problem. For example, chinook interceptions have been greatly reduced. The early Area 6 and 8 runs essentially pass unhindered through Area 7, and the interception of the later runs to these areas no longer occurs in Milbanke Sound. However, mixed-stock problems have not been completely eliminated.

Table 2.7-1. Statistical Area 7 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	60	23	3

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 14

HABITAT NOTES

Historic Status, Production Constraints and Development History	Only a minor stock. Low summer flows. Very low level/low impact logging activity.
Current Status	Virtually pristine.
Future Outlook	Logging proposed on some major systems.
Natural Habitat Production Potential	No change from historic high.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Low	Unknown

CONCLUSION No apparent habitat reason for depressed stocks.

Table 2.7-2. Statistical Area 7 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	491	426	165 Even 294 Odd

MANAGEMENT STYLE Active 80%
Passive
Unknown

NUMBER OF STREAMS 56

HABITAT NOTES

Historic Status, Production Constraints and Development History	80% of target from 10 - 15 streams. Low summer flows. Very low level/low impact logging activity.
Current Status	Virtually pristine.
Future Outlook	Logging proposed on some major systems.
Natural Habitat Production Potential	No change from historic high.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Medium - High	Unknown

CONCLUSION Habitat does not appear to be a constraint.

Table 2.7-3. Statistical Area 7 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	797	608	122

MANAGEMENT STYLE: Active 60%; Passive; Unknown

NUMBER OF STREAMS: 58

HABITAT NOTES

Historic Status, Production Constraints and Development History	Low summer flows. Very low level/low impact logging activity.
Current Status	Virtually pristine.
Future Outlook	Logging proposed on some major systems.
Natural Habitat Production Potential	No change from historic high.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	Medium - High	Unknown

CONCLUSION

Table 2.7-5. Statistical Area 7 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	60?	23	3?

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 14

HABITAT NOTES

Historic Status, Production Constraints and Development History	Low summer flows. Very low level/low impact logging activity.
Current Status	Virtually pristine.
Future Outlook	Logging proposed on some major systems.
Natural Habitat Production Potential	No change from historic highs.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	Unknown

CONCLUSION Habitat is clearly not the reason for declines.

The Mussel and Kainet pink and chum stocks migrate through both Finlayson and Mathieson channels. There is also an overlap of Mussel and Kainet stocks in Mathieson with the local pink and chum stocks during the second or third weeks of August. The Mathieson and Finlayson stocks are not thought to be intercepted by Seaforth Channel fisheries for other Area 7 stocks.

The stocks returning to Spiller, Roscoe, Seaforth and Southern Area 7 also pose a mixed-stock harvest problem, as they can be exploited in the Seaforth fishery. With few exceptions (Neekas, Clatse, some Seaforth Area chums and Quartcha pinks) at least part of these stocks return through Milbanke Sound in August. Area 8 stocks also pass through during this period, but the proportion of the Area 8 stock that uses this route is unknown.

2.7.6 Stock Rebuilding Potential

The rebuilding potential for sockeye in Area 7 is limited. The local stocks will benefit incidentally from the conservation actions taken to protect pink and chum stocks. Further benefits could be obtained from reducing the local Indian food fisheries. For pink and chum stocks, the rebuilding potential is discussed by the management sub-areas previously defined. In addition, because of the recent conservation measures adopted, the potential conflicts which are anticipated to occur in the near future (i.e., interfering with optimum production for each of the stocks) are also discussed.

2.7.6.1 Finlayson Channel and Mussel Inlet

Present management actions should be sufficient to rebuild the Mussel (Bear) River stocks quickly. A management conflict between pink and chum harvests could occur in future years if only one of the stocks has a harvestable surplus.

2.7.6.2 Kynock Inlet

The Kainet is the dominant producer of pink and chum salmon in the upper Mathieson Channel. Stocks should rebuild under present management actions. The anticipated harvest of the 1985 pink stock surplus may conflict with the conservation of Kainet chums and Mussel pink and chum stocks. Selective

harvest of pink salmon exclusively by gillnetters (if technically feasible) would be a drastic departure from current catch allocation. A selective fishery for chums may be more practical, but this action would also disturb the historical catch allocation.

2.7.6.3 Mathieson Channel

Mathieson pink and chum stocks will benefit greatly from the Milbanke Sound closures. The stocks are expected to rebuild quickly. Because they are partially separable from Kainet and Mussel stocks by their run timing, they are not expected to be adversely affected by exploitation of Kainet or Bear River surpluses. Pink and chum harvest conflicts may disturb the historical allocation if selective species harvest is employed.

2.7.6.4 Seaforth Channel, Gunboat Passage and Return Channel

The Seaforth pink and chum stocks should increase in response to recent management changes; however, the increase may be limited. The chum stock is vulnerable to the Seaforth Channel fishery for an extended period of time (Fig. 2.7-2) while the pink stock may be concentrated in the Seaforth fishery area, and may thus experience a higher exploitation rate than other stocks. The extent to which rebuilding will be limited depends largely upon the proportion of Seaforth stocks migrating through Hunter Channel, the southerly approach route.

2.7.6.5 Spiller Channel

The Neekas pink stock is severely depressed. Present management actions will be of some benefit but more action may be required if the stock proves to be less productive than the other stocks harvested in the Seaforth fishery. The Neekas chum stock is a late run, and is harvested in Seaforth Channel with the smaller Seaforth, Clatse and Howyete late chum runs. In 1984 the harvest of the smaller stocks was reduced by moving the fishery for the Neekas chum stock toward terminal areas in Spiller Inlet.

2.7.6.6 Roscoe Inlet

The Roscoe Inlet pink stock will benefit from the new management actions. However, a major Seaforth fishery would conflict with conservation measures for the pink stocks. The Quartcha pink stock (monitored in-season but considered a passively managed stock) should display a good response, since only the latter portion of this early run overlaps the current fishing season. Nevertheless, the Quartcha run is small and could not support a separate fishery. The Roscoe Creek chum stock dominates the early portion of the chum run through Seaforth Channel. Returns will improve, even with a large mixed stock fishery in Seaforth Channel.

2.7.6.7 Southern Area 7

The Howyete pink and chum stocks are expected to rebuild, since a sufficient proportion of the stocks is believed to migrate through Hunter Channel (i.e., avoids the Seaforth Channel fishery). In addition, the chum stock has few interactions with other stocks because of the lateness of the run.

2.7.7 Management Strategies for Stock Rebuilding

Rebuilding strategies include reducing management uncertainties, controlling fishing effort, and limiting mixed-stock harvests. Each is discussed below.

2.7.7.1 Management Uncertainties

The current stocks in Area 7 are generally very depressed. However, drastic management changes have been recently implemented (closing Milbanke Sound, and harvesting only identifiable surpluses) which will quickly rebuild Area 7 stocks. Numerous management conflicts still exist, and will continue to exist when the stocks are rebuilt. There are a number of options for reducing management uncertainties. These include:

1. Review historical catch database: The recent changes to Area 7 fisheries have increased the complexity of management and information requirements. Unlike Area 8, where there is a large historical data base derived from relatively constant fishing areas, the changes in Area 7 require a

fresh start to compile a catch data base. While a major analysis of historical catch data is not appropriate, an effort should be made to compile, where feasible, the historical catch data in a form compatible with current fishing patterns. The fishing areas are not necessarily stable. Further changes or adjustments can be expected.

2. Begin an interim test fishing program: In 1984, some local impromptu test fisheries were conducted. In addition, the monitoring of local Indian food fishery catches was an important management tool. The information from these two sources, although helpful, does not meet basic management requirements. The most important requirements at present are for test fisheries in Seaforth, Mathieson and Finlayson channels. Spiller and Roscoe inlets are important terminal areas which should also be monitored. Since the fishing areas are likely to change in the near future, interim test fisheries are recommended until the fishing patterns in the area become more stable.

3. Initiate tagging studies: The lack of information on the timing and migration routes of Area 7 stocks is a serious hindrance to current management. Central Coast tagging programs conducted in 1976, 1978 and 1979 have been extremely valuable in the restructuring of the Area 7 fishery. However, the fisheries have been moved from the areas where previous tagging programs were conducted and the information from these studies is generally no longer applicable. Unfortunately, stock separation techniques such as electrophoresis, parasite incidence or morphometric analysis are not likely to be useful in Area 7. While tagging studies are expensive, they are the only available method to obtain the information.

4. Install counting fences: The move to more terminal fisheries increases the importance of escapement data for in-season management. The streams in Area 7 are good candidates for the use of counting fences, because a number of the fisheries are close enough to the spawning areas such that the escapement data can be obtained quickly, thereby influencing in-season management of the fishery.

2.7.7.2 Effort Control

An ability to control effort by limiting the fleet size would greatly simplify the management conflicts in Area 7. The fishery is based on relatively small surpluses from a number of stocks rather than a major fishery on one large producer. There is a large effort over capacity during almost all fisheries in Area 7, which restricts management opportunities.

2.7.7.3 Mixed-Stock Harvests

The management of Area 7 has changed radically in recent years from a mixed-stock fishery for passing stocks to a series of relatively discrete fisheries. No drastic changes from present management are proposed. The response of the stocks and catch levels to these management changes must be monitored before further changes are made.

2.7.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

2.7.8.1 Klemtu (Kitasu) CEDP Continuation (Project No. 7 - 9)

The existing project should be continued, and limited to the production targets of 12,000 chums and 3,000 coho.

2.7.8.2 Bella Bella CEDP (Project No. 7 - 15A)

A second facility at Bella Bella is proposed. Production targets are 37,000 chums and 3,000 coho.

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

2.7.9 Predicted Results for Management Options

The following analyses were conducted using a preliminary computer model. The results are therefore preliminary. Further analyses are underway, and the results will be included in the next edition of this report.

As noted earlier, the fishing patterns and management philosophy in Area 7 have recently undergone radical changes. As a result of these changes, the principal options for any additional stock rebuilding activity lie in improving the accuracy of fisheries management in the Area. These options are detailed above. While they have not been analysed in detail, failure to carry out some or all of the management options may well subvert any further stock rebuilding activity.

Action has been taken to reduce the costs to escapement of fishing mixed stock (e.g., the Milbanke Sound fishery has been closed), but there are still some costs associated with fishing mixed stocks (e.g., Seaforth Channel). Because of the absence of a relevant historical data base, however, it is impractical to analyse any further reductions in mixed stock fishing.

Despite the uncertainty remaining, the stock rebuilding actions that were initiated with the closing of the Milbanke Sound fishery are examples of what must occur in other areas, and therefore they have been modelled in a similar fashion. In this model, Option 1 simulated the historic Milbanke Sound fishery, Option 2 simulated "pink-driven" fisheries in Finlayson Channel, Mathieson Channel/Kynock Inlet and Seaforth Channel, and Option 3 simulates the same fishing areas at lower overall exploitation rates (i.e., "chum-driven"). The results are summarized in Table 2.7-5.

In Option 1, the NPV over the 20-year simulation period was $32,400,000. Catches and escapements of both pinks and chums were decreasing. Even this model is probably an over-optimistic representation of the Milbanke Sound fishery, since passing stocks, which played a major role in the past, were not included in the model.

Option 2 had the greatest NPV at $40,500,000. However, chum stocks were not rebuilt with this management regime. Pink catches and escapements in-

Table 2.7-5. Comparison of pink and chum management options in Area 7.

	Catch				Escapement				Net Present Value (Million $)
	Pink		Chum		Pink		Chum		
Option*	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend	
1	685,345	down	160,921	down	325,484	down	103,867	down	32.4
2	820,512	up	154,101	down	392,595	up	111,966	down	40.5
3	432,040	up	265,324	up	336,690	stable	234,552	up	35.4

* see text for description of Options 1-3.

creased very rapidly over the twenty-year simulation period to a total stock of $1,400,000. While it is doubtful that a total stock of that magnitude can be maintained, there was no indication in the model whether the stock would decline, begin to cycle, or merely stabilize at some slightly lower level.

Option 3 was the only true stock rebuilding option. Despite a slightly lower NPV of $35,200,000, both pink and chum stocks showed increases over a twenty-year period.

The implications of this exercise are that chum salmon are not productive enough in general to withstand efficient exploitation rates for pink salmon. Therefore, additional effort to separate chum from pink stocks by timing or geography are required in order to rebuild both species. This reinforces the need to improve the accuracy of fishery management, as discussed earlier.

2.8 Statistical Area 8

Statistical Area 8 is located on the central coast of British Columbia north of Vancouver Island (Fig. 2.8-1). For fisheries management purposes, Area 8 has been subdivided into the following six sub-areas:

1. North Bentinck Arm;
2. South Bentinck Arm;
3. Upper Dean Channel;
4. Dean Channel Closed;
5. Burke Channel; and
6. Fisher Channel and Fitz Hugh Sound (Fisher/Fitz Hugh).

Detailed information with respect to stock attributes and current fishing patterns in Area 8 can be found in Appendix 1. The Fisher Channel and Fitz Hugh Sound sub-area will be divided into Fisher Channel sub-area and Fitz Hugh Sound sub-area beginning in the 1985 season. However, since the data have been compiled for six sub-areas, the discussion below treats them together.

There are few data regarding migration to the sub-areas; however, the available data suggest that the stocks destined for North and South Bentinck Arm and Upper Dean Channel sub-areas use both Burke and Dean Channels as migration routes, crossing through Labouchere Channel. For the purposes of this discussion, we have assumed that an equal proportion of all stocks destined for the above noted sub-areas migrate through both Burke and Dean Channels. Despite this assumption, the true proportions migrating through either route are unknown.

2.8.1 Stock Description

An overview of the stocks found in each of the sub-areas is given below.

2.8.1.1 North Bentinck Arm

The only actively-managed sockeye stock in North Bentinck Arm originates in Atnarko River. There are no passively-managed sockeye stocks. The Atnarko sockeye stock is depressed, but rebuilding with a target escapement of

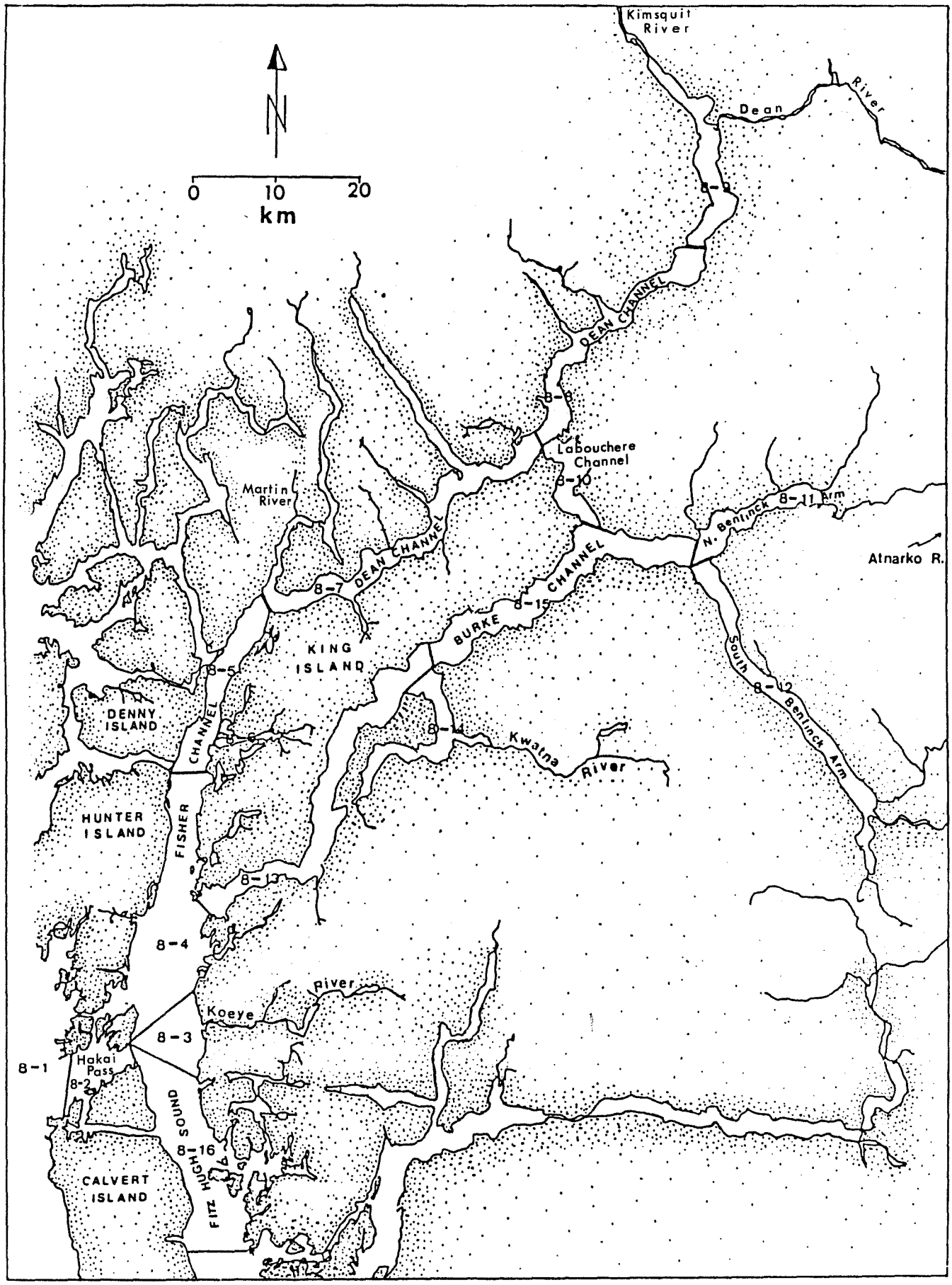


Figure 2.8-1. Statistical Area 8.

75,000. Atnarko River pinks are actively managed, and are the dominant stock in Area 8. The target escapement is 1,000,000. The even-year escapement was reduced to 100,000 following floods in 1980 but has increased to 650,000 in 1984. The odd-year stock is at optimum escapement levels. Atnarko pinks are fished by seiners and gillnetters in the Fisher/Fitz Hugh fishery and by gillnetters in the Bella Coola gillnet area (Management Units 8-10, 8-15). There are three passively-managed pink stocks in North Bentinck Arm. Both odd- and even-year stocks are depressed, and fluctuate considerably below the combined target of 36,000. Timing of runs and other characteristics are assumed to be similar to those of Atnarko pinks.

There are one actively-managed and three passively-managed chum stocks in the North Bentinck Arm sub-area. There are two components of the actively-managed stock: the Bella Coola summer chums with an escapement target of 60,000, and the Bella Coola fall chums with a target of 20,000. Summer and fall chum are differentiated not only by run timing but by size. Summer fish are larger, with an average weight of about 7 kg, while fall fish have an average weight of 4.5 kg. The summer chum stock in the Bella Coola system is enhanced at the Snootli Creek facility. Collectively, the three passively-managed chum stocks are depressed, but stable at about 30% of the escapement target of 15,500. Timing of runs of the passively-managed stocks is similar to that of Bella Coola summer chums.

The Bella Coola system is the only chinook producer in the sub-area, as well as the dominant producer in Area 8 and the Central Coast. The chinook stock appears to be responding to recent conservation measures, and is expected to rebound to the target escapement of 25,000 within one cycle with the aid of hatchery production. The target represents 59% of the Area 8 total.

The Bella Coola system is by far the largest coho producer of the three streams in this sub-area, and also represents more than a third of the Area 8 production potential. Current escapements to the sub-area fluctuate from 10 - 50% of the target of 83,000.

2.8.1.2 South Bentinck Arm

There are no actively-managed stocks in the South Bentinck Arm sub-area. In general, this is a very isolated area with highly turbid glacial streams, which makes any reasonable assessment of stock strength very difficult. South Bentinck stocks are thought to have migration timing similar to North Bentinck Arm actively-managed stocks. There are two passively-managed sockeye stocks, with a combined target escapement of 50. There are four passively-managed pink stocks, of which the even-year cycle is severely depressed, while the odd-year cycle is depressed but stable. Both cycles are far below a combined target escapement of 45,500. Finally, there are four passively-managed chum stocks. They are depressed but stable at less than 10% of the combined target escapement of 21,250.

The Noeick and Taleomey are the only chinook producing stream systems in South Bentinck Arm, and stocks are thought to be depressed to about 10% of the target escapement of 1,000. This target is only 2% of the Area 8 total.

The Noeick and Taleomey systems produce most of the coho. Current stock levels for the three coho streams in the area are thought to be 5% of the target escapement of 6,750. The sub-area production potential is minor, about 3% of the area total.

2.8.1.3 Upper Dean Channel

There are two sockeye stocks in Upper Dean Channel. The actively-managed Kimsquit sockeye are increasing and approaching the target escapement of 30,000. The passively-managed Dean sockeye is a very minor stock and is severely depressed.

There are four passively-managed pink stocks in the Upper Dean Channel sub-area. Escapement is depressed and fluctuating far below a collective target of 71,500.

The actively-managed Kimsquit chum stock is depressed, but seems to be rebuilding towards a target escapement of 60,000. The four passively-managed chum stocks in this sub-area are very depressed and declining. The target is 25,100; however, recent escapements have been below 1,000 for the group.

The Dean is the major chinook producer in the sub-area, with the Kimsquit a distant second. Recent stock levels have fluctuated from 5-25% of the target escapement of 16,000. This target is 38% of the Area 8 total.

The Dean and Kimsquit are the major producers of the four coho streams in the area. Current coho escapements are estimated at 8% of the area target of 51,100, which represents 24% of the area total.

2.8.1.4 Dean Channel Closed

There are only two very small passively-managed stocks of sockeye in this sub-area. Escapements are low but the target for the sub-area is only 200.

As with sockeye, there are no actively-managed pink stocks in this sub-area. The seven passively-managed stocks have a total target escapement of 76,500. The even-year pink stock is depressed and declining, while the odd-year pink stock is slightly depressed and fluctuating. These stocks are present in the Fisher/Fitz Hugh fishing area during the latter half of July.

The six early-spawning chum stocks in the Dean Channel Closed sub-area are collectively managed actively as one group. There are no passively-managed chum stocks. The Martin chum stock is the only late-running or fall chum stock in this sub-area. It is also actively managed. The early-running group is moderately depressed but stable. The Martin stock is building, and a fishable surplus is expected in 1985.

Elcho Creek had four chinooks recorded as the escapement in 1980; this is the only recorded escapement.

Coho are produced from six streams in the Dean Channel Closed sub-area. Coho escapements are currently 10% of the target of 24,000. This target represents 11% of the Area 8 potential.

2.8.1.5 Burke Channel

The only sockeye stock in the sub-area is the passively-managed Kwatna River sockeye, with an escapement of less than 100.

While there are no actively-managed pink stocks in the sub-area, there are three passively-managed pink stocks. They have a relatively large combined escapement target of 115,000 of which the Kwatna accounts for 100,000. The even-year stocks are depressed as a result of severe flooding in 1980, but the odd cycle exceeded the target in 1983. The timing of these stocks through the Fisher/Fitz Hugh fishing area is coincident with Atnarko River pinks (see Section 2.8.1.1).

As with sockeye and pink, there are no actively-managed chum stocks in the Burke Channel sub-area. The three passively-managed stocks have a combined escapement target of 35,000, but they are depressed and declining. The timing of runs through the Fisher/Fitz Hugh fishery is as noted above for Burke Channel sub-area pink stocks.

The Kwatna is a minor chinook producer; current chinook stocks are thought to be 10% of the target level.

The Kwatna is the major producer of the three sub-area streams. Current coho escapements are about 15% of the sub-area target of 17,600, which in turn represents about 8% of the potential for Area 8.

2.8.1.6 Fisher Channel and Fitz Hugh Sound

The sub-area contains one actively-managed and four passively-managed sockeye stocks. Koeye River, the actively-managed stock, is depressed but stable, and supports only local Indian food fisheries. Koeye sockeye are present in the Fisher/Fitz Hugh fishing area in June, prior to the commencement of commercial fisheries. The only fishery specifically for Koeye sockeye is a local Indian food fishery. The four passively-managed stocks are also depressed but stable.

As with sockeye, there is only one actively-managed pink stock, Koeye River. Koeye pink escapements are fluctuating near optimum in both cycles. There are six passively-managed pink stocks in the sub-area. The passively-managed stock's even cycle is declining, while the odd-year cycle has been building strongly. Fisher/Fitz Hugh pinks run comparatively later than do other Area 8 pink stocks.

There are no actively-managed chum stocks in Fisher Channel and Fitz Hugh Sound. Escapements in the seven passively-managed chum stocks in the sub-area are depressed and fluctuating between 10% and 30% of optimum.

The only recorded chinook escapement is ten fish in the Koeye River in 1983.

The Koeye is the dominant coho producer of the eight streams in this sub-area. Current coho escapements represent about 5% of the identified target of 32,400, which in turn is 15% of the Area 8 potential.

2.8.2 Fisheries

There are three principal commercial fishing areas in Area 8. These are the Fisher Channel/Fitz Hugh Sound seine and gillnet fisheries (M.U. 8-2, 8-3, 8-4 and 8-5), the Dean Channel gillnet area (M.U. 8-8) and the Bella Coola gillnet area (M.U. 8-10, 8-11, 8-12, 8-15). The stock migration timing through the three fishing areas is illustrated in Figure 2.8-2.

The earliest fishery typically begins in mid-May for chinook stocks. The fishery uses large-mesh gill nets in Fisher/Fitz Hugh, Dean Channel and Burke Channel. The chinook fishery in Area 8 has not operated in recent years due to low stock levels; however, a surplus is possible in 1986 and a commercial test fishery is planned.

Fishing for sockeye does not begin until the first week of July, when the area is opened to small-mesh gill nets. This fishery is spread over the Bella Coola, Dean Channel and Fisher Channel/Fitz Hugh Sound areas. Kimsquit sockeye runs are usually a week or more behind Atnarko sockeye runs, which normally peak in the second week of July in Bella Coola gillnet area, with Kimsquit sockeye runs peaking a week later.

Atnarko sockeye are managed principally using catch data that include mean catch per drift in the Bella Coola Indian food fishery, and catch data from the Bella Coola and Fitz Hugh Sound fisheries. Kimsquit sockeye are managed in a similar fashion; however, there are two notable differences. There is no directed Indian food fishery for Kimsquit sockeye. In addition, in 1984

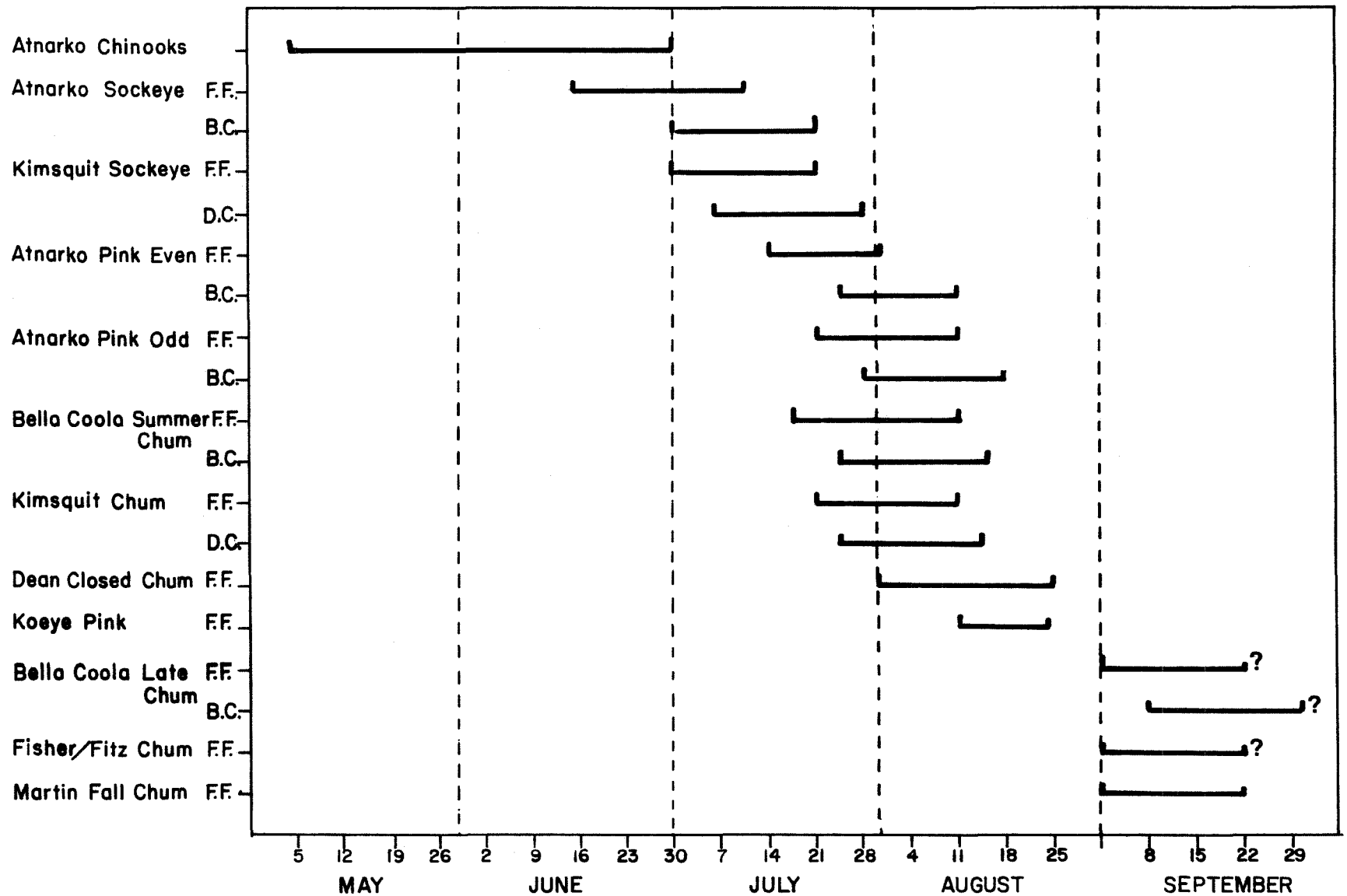


Figure 2.8-2. Stock migration timing through the Area 8 fisheries. (F.F. = Fisher/Fitz; D.C. = Dean Channel Gillnet; B.C. = Bella Coola gillnet).

a charter test fishery was instituted. In time this test fishery should become useful to measure in-season escapement.

Atnarko pinks and Bella Coola and Kimsquit chums begin to be taken as incidental catches in the sockeye fishery during the second week of July, but the third week of July is generally the first week that pink and chum are targeted, and the first week that seiners are permitted to fish in Fisher Channel/Fitz Hugh Sound. Management is initially based on expectations, but as the season progresses, emphasis is shifted to catch and escapement data. Quality also becomes important in late July for chums, and in early August for pinks. The Dean Channel charter test fishery will serve as an escapement test fishery once it is calibrated. 29 July - 4 August is the peak week for even-year Atnarko pinks, as well as for both Kimsquit and Bella Coola chums. The second week of August is the peak week for fishing odd-year Atnarko pinks. Dean Channel Closed chums begin to appear during the week of 5-11 August. During the following week (12-18 August), the inside pink and chum stocks decrease in abundance, and the fishery shifts to outer Area 8 stocks. This is the peak week for Koeye pinks and for Dean Closed chums, both of which are managed first on the basis of expectations, and later on the basis of catch and escapement data. By the last week in August, the fishery for pinks and summer chums is over, unless the late summer or early fall chum run is very strong. If so, there would be a fishery during the week of 25 August - 1 September. By 25 August, the seiners are finished in Area 8 for the season.

If a surplus of fall chums is available, the Bella Coola gillnet area could be opened the first week of September. Fisher Channel, or possibly Cousins Inlet, could also open for Martin River fall chums in mid-September. The peak week for runs of both fall chum stocks is believed to be 16-22 September. The only time there would be a fishery during the week of 23-30 September would be if escapements for fall chums were met, otherwise Area 8 is closed for the balance of the season.

2.8.3 Current Enhancement Activities

Enhancement activities in Area 8 have a relatively long history. A pilot hatchery was built and operated in 1975 to revitalize the declining odd-year Atnarko pink stock. The objective of this project was to increase the

escapement of odd-year pinks to over 100,000. The Atnarko pink stock recovered quickly, and since the facility was in Tweedsmuir Park and the Park Use Permit was due to expire, the hatchery was closed and removed in 1979.

The only notable current enhancement activity in Area 8 is the Snootli hatchery, on the Bella Coola system. The Snootli hatchery is a Japanese-style chum hatchery. The original intent of the hatchery was to produce enough summer chum to allow the pink fishery to continue at an efficient exploitation rate without adversely affecting the summer chum population. In addition to chum, the hatchery also produces chinooks, coho and steelhead.

The summer chum are taken from all of the major stocks in the Bella Coola area, including Salloompt, Snootli, Necleetsconnay, Thorsen, Nuhalk, Fish, Klonnick and Airport Slough. In 1983, 35-50% of the returns to some spawning areas were attributable to hatchery production. The hatchery capacity is a total of 10,000,000 chum eggs. Actual collection of eggs ranged from 2,000,000 - 3,000,000 from 1979-1981 period; the 1982-1984 collection of eggs are tabulated in Table 2.8-1.

Table 2.8-1. Eggs taken for chum production at Snootli hatchery, 1982-1984.

Year	Summer Chum Egg Take Totals
1982	4,300,000
1983	7,900,000
1984	9,500,000

2.8.4 Habitat Status

Habitat descriptions for Area 8 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.8-2 through 2.8-6, respectively. For a description of the habitat tables, see Section 2.2.4.

2.8.5 Management Conflicts

Conflicts discussed below include the problems of uncertainties in data and of mixed-stock fisheries.

Table 2.8-2. Statistical Area 8 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	193	139	58

MANAGEMENT STYLE Active 75%±
Passive
Unknown

NUMBER OF STREAMS 15

HABITAT NOTES

Historic Status, Production Constraints and Development History	Atnarko and Kimsquit - dominant target stocks. Natural flow fluctuations. Periodic flooding. Extensive logging has had a moderate impact on a number of major systems (Atnarko/ Bella Coola, Kimsquit, Dean, Kwatna). Moderate impacts for flood control in Bella Coola area.
Current Status	Lower level of logging partly due to depressed forest economy.
Future Outlook	Unlikely to return to former level of forestry activity. Most economic timber is gone. Good prospects for recovery.
Natural Habitat Production Potential	Should return close to historic highs over time. May be some long-term impacts - gravel loss.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	Medium - High	High	Medium	Low

CONCLUSION Habitat is probably not a constraint. Major mixed stock management problem.

Table 2.8-3. Statistical Area 8 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	2,477	1,475	1,420 Odd 205 Even

MANAGEMENT STYLE: Active 45%±; Passive ____; Unknown ____

NUMBER OF STREAMS: 33

HABITAT NOTES

Historic Status, Production Constraints and Development History	Dominated by Atnarko stock - Rejuvenated by temporary hatchery. Natural flow fluctuations. Periodic flooding. Extensive logging has had a moderate impact on a number of major systems: Atnarko/Bella Coola, Kimsquit, Dean, Kwatna. Moderate impacts for flood control in Bella Coola area.
Current Status	Lower level of logging partly due to depressed forestry economy.
Future Outlook	Unlikely to return to former level of forestry activity. Most economic timber is gone. Good prospects for recovery.
Natural Habitat Production Potential	Should return close to historic highs over time. May be some long-term impacts - gravel loss.
Improved Production Potential	Possible flow control. Possible gravel replacement.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	Medium - High	High	High	Medium

CONCLUSION Area has probably seen the peak of development activity during present forestry cycle.

Table 2.8-4. Statistical Area 8 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	566	325	94

MANAGEMENT STYLE: Active X; Passive ____; Unknown ____

NUMBER OF STREAMS: 31

HABITAT NOTES

Historic Status, Production Constraints and Development History	Two stocks - summer and fall. Enhancement hatchery on Bella Coola (Snootli Creek). Natural flow fluctuations. Periodic flooding. Extensive logging has had a moderate impact on a number of major systems (Atnarko/ Bella Coola, Kimsquit, Dean, Kwatna). Moderate impacts for flood control in Bella Coola area. Probably some habitat loss from flow fluctuations caused by logging.
Current Status	Lower level of logging partly due to depressed forestry economy.
Future Outlook	Unlikely to return to former level of forestry activity. Most economic timber is gone. Good prospects for recovery.
Natural Habitat Production Potential	Should return close to historic highs over time. May be some long-term impacts - gravel loss.
Improved Production Potential	Possible flow control. Possible gravel replacement.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium - High	Medium - High	High	Medium - High	Medium

CONCLUSION Area has probably seen the peak of development activity during present forestry cycle.

Table 2.8-5. Statistical Area 8 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	48	42	9

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 8

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow fluctuations. Periodic flooding. Extensive logging has had a moderate impact on a number of major systems: Atnarko/Bella Coola, Kimsquit, Dean, Kwatna. Moderate impacts for flood control in Bella Coola area.
Current Status	Lower level of logging partly due to depressed forestry economy.
Future Outlook	Unlikely to return to former level of forestry activity. Most economic timber is gone. Good prospects for recovery.
Natural Habitat Production Potential	Should return close to historic highs over time. May be some long-term impacts - gravel loss.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High - Medium	High - Medium	High	Unknown

CONCLUSION Habitat is not the problem.

Table 2.8-6. Statistical Area 8 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	156	215	24

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 36

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow fluctuations. Periodic flooding. Extensive logging has had a moderate impact on a number of major systems: Atnarko/Bella Coola, Kimsquit, Dean, Kwatna. Moderate impacts for flood control in Bella Coola area. Probably some habitat loss from flow fluctuations caused by logging. Some loss of small stream habitat.
Current Status	Lower level of logging partly due to depressed forestry economy.
Future Outlook	Unlikely to return to former level of forestry activity. Most economic timber is gone. Good prospects for recovery.
Natural Habitat Production Potential	Should return close to historic highs over time. May be some long-term impacts - gravel loss.
Improved Production Potential	Probably plenty of scope for restoration.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Low - Medium	Medium - High	Medium - High	Medium - High	High

CONCLUSION Target seems high in relation to M.R.E.

2.8.5.1 Management Uncertainties

The complexity of alternative migration routes compounds the problems of interpreting in-season catch data for all the basic fishing areas. Salmon return to the Dean and Bella Coola area streams by two routes, either through Dean or Burke Channel. The Atnarko pink and sockeye, Bella Coola chum and Kimsquit sockeye and chum all migrate in unknown proportions through these two routes. This is further confounded by uncertainties about the migration routes of these stocks in the outside areas. The entry into Fisher Channel can be made either through a variety of routes in Area 7, or through Fitz Hugh Sound. Entry into Fitz Hugh Sound can be made through Hakai Pass through Area 9 or from the North through Fisher Channel.

2.8.5.2 Mixed-Stock Harvests

Proceeding chronologically, the Bella Coola River chinooks are taken first, with incidental catches of Dean River chinooks. The present enhancement of Bella Coola chinooks increases the problem. There is a minor overlap between Bella Coola chinooks and Bella Coola sockeye, but because of the obvious differences in gillnet mesh size in the fisheries for the two stocks, the only problem is a minor interception of chinooks by the early July sockeye fishery.

There is a slight overlap in the timing of Bella Coola and Kimsquit sockeye runs in mid-July; however, little difficulty is experienced in maintaining a separate harvest of the two stocks. The Kimsquit sockeye, Atnarko even-year pinks, Dean chums and Bella Coola chums are in the Fisher Channel/Fitz Hugh Sound area in mid- to late July. The targeting of any of these stocks by the Fisher Channel/Fitz Hugh Sound seine fishery could have a serious impact on the Kimsquit sockeye stock.

The mixed-stock problem is more severe from late July to the third week of August. The mixed-stock conflicts are between Atnarko pinks, Bella Coola chums, Kimsquit chums and (to a lesser degree) the Dean Closed Area chums. The Atnarko pinks are a productive stock, and the exploitation rate of stocks in Fisher Channel/Fitz Hugh Sound has (in the past) been dictated by the harvest of Atnarko pinks. The major conflict in the past was with Bella Coola

chums; however, these stocks are now enhanced and the stocks should be able to sustain the high exploitation directed at Atnarko pinks. Unfortunately, the remaining two stocks (Kimsquit and Dean Closed chums) cannot sustain high exploitation rates.

The interception of Area 8 stocks in Area 7 was formerly a major problem. It has been resolved largely by altering the fishing areas and by delaying the opening date of the Area 7 fishery. Interceptions still occur in the Seaforth fishery.

2.8.6. Stock Rebuilding Potential

The potential for stock rebuilding is summarized by sub-area below.

2.8.6.1 North Bentinck Arm

Atnarko sockeye are responding slowly to current management. Rebuilding has been slowed by the escapement losses to commercial test fisheries that assessed stock abundance.

The even-year Atnarko pink stocks were devastated by flooding in 1980, having a return of 100,000 from brood year escapement of 1,000,000. Fortunately, the stock rebounded to 650,000 in 1984. The odd-year stock escapement is optimum. No further actions are necessary to maintain or rebuild Atnarko pinks. There is no potential to actively manage the pinks that are presently passively managed in this sub-area.

The Bella Coola stock of summer chums is enhanced, with escapements from 1985 onwards expected to be at target levels. The passively-managed stocks are very minor, and will continue to be passively managed.

2.8.6.2 South Bentinck Arm

There are only two minor passively-managed sockeye stocks in the sub-area; they will continue to be passively managed. The four minor pink stocks are passively managed, with no potential options for rebuilding. Enhancement of these stocks is not considered a viable option at present. The chum stocks

in South Bentinck are harvested with the North Bentinck chums. Enhancement of these stocks has been recommended to prevent their over-exploitation by Bella Coola chum fisheries.

2.8.6.3 Upper Dean Channel

Kimsquit sockeye stocks are slightly affected by the Atnarko pink fisheries. The potential to rebuild is limited by the present management scheme. The Upper Dean pinks will probably not rebuild unless the exploitation rate in the Atnarko pink fishery in the Fisher/Fitz Hugh area is reduced.

The Kimsquit chum escapements have benefited from the relatively low exploitation of Atnarko pinks and Bella Coola chums in recent years. However, the anticipated high harvest rates of these stocks in future years may reduce the production from Kimsquit chums. The passively-managed chum stocks in the area will remain passively-managed stocks and probably will not rebuild.

2.8.6.4 Dean Channel Closed

The two small, passively-managed sockeye stocks will continue to be passively managed. The passively-managed pink stocks may benefit from Area 7 closures. The Dean Channel Closed chum group is actively managed at present, and should slowly increase under current management practices. The achievable production is limited by the problems associated with harvesting the six stocks together. No spatial or temporal separation appears possible.

2.8.6.5 Burke Channel

The Kwatna sockeye stock is essentially extinct. The Kwatna pink stocks are listed as passively managed, but, since the Kwatna escapement trends tend to mirror those of Atnarko pinks, conflicts are unusual. No active management appears to be required. The odd-year stock is at optimum and the even-year stock is recovering from a 1980 flood. The Burke chums will probably decline from the increased exploitation required to harvest Atnarko pinks and Bella Coola chums.

2.8.6.6 Fisher Channel and Fitz Hugh Sound

Koeye sockeye and the other passively-managed sockeye stocks in the subarea remain severely depressed. The stocks could be rebuilt if the Indian food fishery were reduced. Target escapements for Koeye pinks could be achieved if escapement losses to commercial test fisheries could be reduced. The passively-managed pink stocks are severely depressed, and will probably remain so.

The passively-managed chum stocks are at low levels despite the absence of terminal area exploitation. The run timing of these stocks is sufficiently late that few mixed-stock problems with local stocks should exist, with the exception of Martin fall chums or Bella Coola late chums.

2.8.7 Management Strategies for Stock Rebuilding

Rebuilding options are discussed below and include mitigating environmental impacts, reducing management uncertainties, controlling fishing effort, and reducing mixed-stock harvests.

2.8.7.1 Environmental Impact Mitigation

Options may exist to stabilize inconsistent production resulting from environmental factors. For example, Atnarko pinks are subjected to a severe flood an average of once every ten years. The average time required to rebuild after each flood is six cycles. If this rebuilding time could be shortened, the stock would be more productive. To this end, small stabilization spawning channels have been proposed for the Atnarko pink stock and for the passively-managed Kwatna pink stock. These will be discussed in greater detail in Section 2.8.8.

2.8.7.2 Management Uncertainties

Several options have been identified to reduce management uncertainties by improving or building on existing information. In general, improved accuracy in fishery management data will result in improved catches and escapements. Some of these options include the following:

1. Analyse in-Season catch data: An analysis of the in-season use of catch data as an indicator of abundance would be useful for a number of fisheries. In order of priority, the catch data analysis of the following fishery/stock combinations would be desirable:

1. Fisher Channel/Fitz Hugh Sound seine nets for pinks;
2. Fisher Channel/Fitz Hugh Sound gill nets for chums;
3. Bella Coola gill nets for chums;
4. Dean Channel gill nets for chums;
5. Bella Coola gill nets for sockeye;
6. Dean Channel gill nets for sockeye;
7. Fisher Channel/Fitz Hugh Sound seine nets for chums;
8. Bella Coola gill nets for pinks; and
9. Bella Coola gill nets for chinooks.

2. Conduct test fisheries: In 1984 a charter test fishery was initiated for Kimsquit sockeye and chum salmon. The program was a success and should be continued. Moreover, the usefulness of the information will increase as more data are added each season. In a similar vein, charter test fisheries would be particularly valuable in the Bella Coola gillnet area for chum, as would a charter test seine operation in Fitz Hugh Sound for Atnarko pink salmon.

3. Obtain migration and timing data for Kimsquit sockeye and chum: Although improved information on migration routes and timing is a universal requirement, the situation in Area 8 deserves special attention, since the proportion of Kimsquit sockeye and chum migrating through Burke Channel is of particular interest. In order to reduce the exploitation of Kimsquit sockeye and chum by the fisheries for North Bentinck stocks (Bella Coola chums and Atnarko pinks) in the Fisher/Fitz Hugh area, the fishery could be moved into Burke Channel. To evaluate the potential effectiveness of this action, data must be obtained on run timing, speed of movement and the proportion of Kimsquit sockeye and chums using the Burke Channel - Labouchere Channel route. Therefore, a tagging study in Burke Channel and the Bella Coola gillnet area is recommended.

4. Monitor in-Season Bella Coola hatchery chum marks: Some of the chums released from Snootli hatchery on the Bella Coola River are fin-clipped as

part of hatchery experiments. The proportion of tags in the commercial fisheries can indicate the relative abundance of hatchery fish in the catch, as well as the timing and pattern of migration of the Bella Coola chums. This information is also pertinent for an evaluation of moving the Fisher/Fitz fishery into Burke Channel (see above). The data must be recovered in a timely fashion (i.e., in-season); therefore, the ability to initiate a sampling program for marks in the commercial catch and summarize the results in-season should be investigated.

2.8.7.3 Effort Control

Limiting the number of vessels allowed to fish during commercial openings would permit more controlled commercial test fisheries. This is a particular problem for potential late chum fisheries, specifically Martin River and Bella Coola fall chums. Discussions with industry should be initiated which explore options to limit effort in fisheries where only a small harvestable surplus is available.

2.8.7.4 Mixed-Stock Harvest

A number of options have been identified to improve escapements of minor stocks by reducing the need for mixed-stock fisheries. In most cases, actively-managed stocks should be harvested in areas where less mixing occurs. Often this implies terminal fisheries, and will improve escapement and subsequent production of minor stocks. Some of these options for mixed-stock fisheries are listed below.

1. Protection of Kimsquit sockeye and Dean steelhead: There are no serious mixed-stock problems with Atnarko sockeye. They are presently fished in both the Bella Coola gillnet area (M.U. 8-10, 8-15) and Fitz Hugh Sound (M.U. 8-3, 8-4). The exploitation could be restricted to the Bella Coola gillnet area with no significant loss of quality if the interception of Kimsquit sockeye on Dean steelhead in Fitz Hugh Sound were identified as a problem. A more severe restriction would be to move the fishery to the inside portion of M.U. 8-15 and the outer portion of M.U. 8-11. This measure would be considered only if significant interceptions of Kimsquit sockeye or Dean steelhead occurred in Burke or Labouchere Channel. The measure is considered

extreme, because the fleet would be cramped into a very small area, and there would be a significant loss in fish quality, particularly in the latter part of the run. The latter portion of the Bella Coola chinook run overlaps the timing of the fishery for Atnarko sockeye, but because of the small mesh used for sockeye, the incidental catch of chinooks is considered to be very small.

2. Move Fisher Channel/Fitz Hugh Sound fishery closer to terminal areas: The harvest of Atnarko pink stock dominates the Area 8 fisheries. The Atnarko pink stock is highly productive (mean return rate since 1950: 3.9 even-year; 2.5 odd-year), and the exploitation rate in Fisher Channel/Fitz Hugh Sound area is generally dictated by the harvest of the stock. One commonly suggested solution to improve the mixed-stock situation is to move the fishery into Burke Channel or the Bella Coola gillnet area. This option, if proposed, would be controversial because of the problems to industry that would result. These problems include the following:

1. Constraining the fleet into a much smaller fishing area;
2. Moving seiners into a non-traditional area;
3. Loss of traditional fishing areas;
4. Loss of associated local expertise; and
5. Loss of fish quality.

Obviously, to justify such a move would require a well documented rationale, with the benefits of the change clearly defined. Studies of stock timing and migration patterns are required prior to any drastic changes in the exploitation pattern for Atnarko pink stocks.

3. Harvest increased production of Bella Coola chums in the Bella Coola gillnet area: Bella Coola chum stocks are enhanced in the Snootli hatchery. The basic enhancement strategy is to take brood stock from seven discrete areas in the Bella Coola system, and release the fry from the hatchery back into the area from which the brood stock is taken. This strategy assures the optimum spawning population in the Bella Coola system, and increases overall productivity by adding enhanced production to the natural escapements. The enhancement of any of the seven stocks within the Bella Coola system could be adjusted in response to changes in the abundance of these sub-stocks. Straying studies are being conducted by the Snootli hatchery staff, and

adjustments will be made if the information indicates that some of the presently defined sub-stocks are, in fact, not separate. The Bella Coola chum stock is considered ideal for this exercise, as no conflicts are expected between stocks in the Bella Coola system.

The harvest of these enhanced Bella Coola chums will require a higher exploitation rate, which will conflict with the South Bentinck Arm chums in particular. Any required increase in the rate of exploitation on Bella Coola chum should take place in the Bella Coola gillnet area (M.U. 8-10, 8-15) rather than in the Fisher Channel/Fitz Hugh Sound area (M.U. 8-3, 8-4, 8-5). The best solution is to enhance the South Bentinck chum stocks, perhaps through the Snootli hatchery.

4. Protect upper Dean Channel stocks: The option of moving the Atnarko pink and Bella Coola chum fisheries out of the Fisher Channel/Fitz Hugh Sound sub-area would benefit all Upper Dean Channel stocks (see above for a full discussion).

5. Protect Dean Channel Closed pink stocks: While there are no actively-managed pink stocks in the sub-area, the strategies employed for chum salmon will affect the passively-managed pink stocks. One such option is to restrict the Dean Closed fishery (i.e., Management Unit 8-5) to gillnetters. Seiner operations harvest the pink and chum stocks at the same exploitation rate. It should be noted that this option would require a change in the traditional catch allocation by gear. A similar argument can be made for the Fisher Channel fishery, which intercepts Dean Channel Closed stocks.

While conflicts arising from the harvest of the six actively-managed Dean Closed chum stocks cannot be resolved, a reduction in the exploitation rate of Atnarko pinks or Bella Coola chums in the Fisher Channel/Fitz Hugh Sound area would benefit the Dean Channel Closed chum stocks (see above).

The Area 7 Seaforth fishery in late July and early to mid-August is believed to intercept Dean Closed chum stocks. The movement of this fishery would benefit the sub-area's chum stocks.

6. Protection of Burke Channel stocks: Since the passively-managed Kwatna sockeye stock is essentially extinct, there are no rebuilding plans. On the other hand, the passively-managed pink stocks seem to be productive, and no further action is required to assure their recovery. The Burke chum stocks will probably decline as a result of the anticipated high exploitation rates for Bella Coola chum and Atnarko pink stocks. The option of moving the Atnarko pink and Bella Coola chum fisheries out of the Fisher/Fitz Hugh sub-area would benefit the Burke Channel chum stocks (see above).

7. Protection of Fisher Channel/Fitz Hugh Sound stocks: The only option in the Fisher Channel/Fitz Hugh Sound sub-area is to rebuild Koeye River sockeye through limiting the Indian food fishery. A mixed-stock problem does not exist for pinks. For chums, the currently minimal terminal harvest will be maintained.

2.8.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

All of the projects are tentatively proposed for Phase II of SEP, and have been categorized as either approved (Category 1) or of high priority, but further stocks required (Category 2) by fisheries management. All of the projects described below for Area 8 fall into Category 1 or 2. The Category 1 projects include:

1. Atnarko Channel (2.8.7.2);
2. Atnarko Fence (2.8.7.3);
3. Bella Coola Hatchery Expansion (2.8.7.1);
4. Kwatna Channel (2.8.7.7); and
5. Stream Counting Fence - Dean Channel Closed Sub-area (2.8.8.6).

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

The remaining projects all require further study before development.

2.8.8.1 Bella Coola Hatchery Expansion (Project No. 8 - 9A)

This project involves expansion and modification of the existing Snootli Creek Hatchery to function as a central incubation and early rearing station for Atnarko chinooks. Chinook fry would be out-planted or transported back to a channel on the Atnarko River for rearing to release size. This channel could be constructed in conjunction with a spawning channel for Atnarko pinks. This project could contribute to a terminal net fishery in May and June in the Bella Coola gillnet area, and is a high-priority project for the North Coast in general.

The project could start with 2,000,000 eggs in 1986/87 (40,000 total adult production) with only slight modifications to the existing facility. No upper limit to production is defined at present, and must be reviewed once the physical constraints of the site are known.

The project would aid in re-establishing the chinook gillnet fishery in the Bella Coola gillnet area, and would benefit both tidal and river sport fisheries, and possibly the Indian food fishery. No significant interception problems are foreseen.

2.8.8.2 Atnarko Channel (Project No. 8 - 8)

A small, flood-proof spawning channel for Atnarko pink salmon would assist in stabilizing returns of this stock, which is the third most important pink stock in British Columbia. A smaller chinook-rearing channel may be associated with this project (see previous project). The total adult production has been tentatively set at 270,000. This should be reviewed once the physical constraints of the site are better defined. The project is meant to assist in stabilizing the average annual return of Atnarko pink salmon, as described earlier, rather than to boost production *per se*.

2.8.8.3 Atnarko Fence

A permanent fence on the Atnarko River to provide accurate counts of

chinook and pink salmon is proposed. This project will contribute to improving the management data base.

2.8.8.4 South Bentinck Pilot (Project No's. 8 - 12, 8 - 13A)

It is desirable to increase production of chum in South Bentinck Arm, both to offset additional fishing pressure exerted due to Snootli Hatchery summer chum returns, and to expand the South Bentinck Arm fishery. This is a difficult area in which to work: access is tenuous at best, the Noeick River is subject to disastrous flooding and stock abundances are difficult to estimate. Therefore, stock separation is not requested. Biological reconnaissance to date would suggest that eggs could be taken from Noeick and Taleomey tributary chum stocks, although access is likely to be a problem. Eggs could be incubated at a small station located at either Tarrant Creek or at Larso Bay Creek. The Tarrant Creek and Larso Bay Creek sites present some logistic problems; access is difficult especially in winter. An alternative which is more attractive from the perspective of logistics is to incubate eggs at Snootli hatchery, and return the fry to sea pens for rearing. Larso Bay is a possibility for a seapen site. A further proposal would be to transfer the Bella Coola chum stock to these sea pens in order to divert a directed fishery for summer chum directed fishery into an area less likely to result in incidental catches of Dean Channel chum and steelhead. Further local involvement with the subdistrict staff, fishermen and the Bella Coola Band is required to more clearly define the requirements of the area.

This project could expand the Area 8 terminal fishery for summer chums, and may assist in reducing interception of Kimsquit chums and Dean steelhead. It will, however, increase pressure on the South Bentinck Arm stocks, particularly if the seapen-return or Bella Coola donor stock concepts are implemented.

2.8.8.5 Ocean Falls Facility (Project 8 - 3A)

This site has excellent physical potential for development of a large production facility, drawing on the infrastructure of the closed pulp mill and a small remnant community. Link Lake provides a water supply via an existing pipeline. This site is similar in potential and objectives to the Butedale Project, and a pilot operation of a similar size and nature is considered.

Donor species for this facility would be sockeye or chinooks. Run timing would not be critical, especially if harvests were conducted in Cousins Inlet. Martin River fall chums could be a potential stock for the facility, but manageability studies are required first.

Proposed production levels would be the same as for Butedale sockeye and chinooks. Chum production levels could not be set until the results of the manageability studies are known. A new sockeye or chinook terminal fishery could be developed in Cousins Inlet and possibly expanded outside into Fisher/Dean Channels. If the facility produces chinooks that are fished outside of Cousins Inlet, interception of Dean River chinooks could be a problem. Use of Martin River fall chums may result in mixed-fishery problems in Fisher Channel and Fitz Hugh Sound.

2.8.8.6 Stream Counting Fence - Dean Channel Closed Sub-area

The establishment of a counting fence or tower on one of the summer chum spawning streams in this sub-area would be desirable. This project would provide accurate counts needed to improve the in-season management and data base. Reconnaissance and discussions with subdistrict staff are needed to establish the best site.

2.8.8.7 Kwatna Channel (Project 8 - 7)

In order to increase stock levels to offset the effects of a directed fishery for the stabilized Atnarko pink and enhanced Bella Coola chum stocks, a small-scale unmanned spawning channel for Kwatna River chum and pink stocks is proposed. A 7,500-m^2 side channel could produce 75,000-132,000 pinks (total adult production), depending on the type of construction. Better definition of production levels must await engineering surveys and discussions with subdistrict staff. Annual variation in utilization may occur if the channel site is located too far up river. Fish from the channel would be caught by the Atnarko pink fisheries.

2.8.8.8 Koeye River Hatchery (Project No. 8 - 6A)

The Koeye River supports the only actively-managed sockeye stock in the Fisher Channel/Fitz Hugh Sound sub-area, as well as the only actively-managed

stock of pinks. The run timing of both these stocks is discrete from those of other Area 8 fisheries. This river also supports chums and coho. The Koeye is seen as a good enhancement opportunity, and there appears to be physical potential for a facility on the system. However, there may be logistical advantages to locating a facility at Namu instead (Project No. 8 - 4). Namu appears to have outstanding physical potential, comparable to that seen at Butedale or Ocean Falls. Hooknose Creek (Project No. 8 - 5) may also have potential for a facility in this sub-area. Although Namu appears to be the most attractive site, additional reconnaissance is required to determine which of these sites is most suitable.

2.8.9 Predicted Results for Management and Enhancement Options

In order to predict the potential outcomes of the various scenarios and options described in the preceding sections, a model was used to project catches and escapements for forty years. Because of time constraints, only the major fisheries in Area 8 have been modelled to date. The major fishery is the mixed pink and summer chum fishery that occurs throughout the months of July and August in the three main fishing areas. Since pink and summer chum stocks are jointly fished, it is appropriate to discuss them as a group.

The Area 8 pink and chum fishery is dominated by the Atnarko pink stock. Other actively-managed stocks are Bella Coola chums, Kimsquit chums and Dean Channel Closed sub-area aggregate chum stocks. The remainder of the summer chums and early pinks are grouped as passively-managed chums and pinks. To predict the outcomes of various management and enhancement options on this group of stocks, the simulation model was run with the above six stock groups in three fisheries. The fisheries modelled were the Fisher Channel/Fitz Hugh Sound mixed fishery, the Bella Coola gillnet fishery, and the Upper Dean gillnet fishery.

Three basic fisheries management options were modelled (Table 2.8-7). Additional scenarios that were modelled attempted to simulate the effects of an Atnarko stabilization channel, and the combined effects of an Atnarko stabilization channel and a Kuratna stabilization channel on the three basic fisheries management options.

The Base Case (Option 1) fisheries management scenario has four main fisheries. These are, in order: Fisher Channel managed to produce an escapement target for Dean Channel Closed chums; Fitz Hugh Sound managed to produce an escapement target for Atnarko pinks; Bella Coola gillnet area managed to produce an escapement of Bella Coola chum; and Dean Channel gillnet area managed to produce an escapement of Kimsquit chum. Option 2 involved altering the model to harvest any available surpluses. Option 3 was identical to the Base Case, with the exception that the Bella Coola chum fishery was conducted with no catch of Kimsquit chums and simulating a terminal chum fishery inside North Bentinck Arm.

Table 2.8-7. Escapement trends under management options in Area 8.

Option	Atnarko Pink	Bella Coola Chum	Kimsquit Chum	Dean Closed Chum	Passive Pink	Passive Chum
1. Base Case	Increasing to target	Increasing to target	Declining	Stable	Increasing	Declining
2. Surplus Harvested	Increasing to target	Stable near target	Declining	Stable	Over Target	Declining
3. Option 3 (see text)	Increasing to target	Stable near target	Declining	Stable	Stable	Declining

The best option was the Base Case, which approximated current management (Fig. 2.8-3). This scenario represented the best value and management flexibility. Option 3, which is an attempt to reverse the escapement trends in Kimsquit and passively-managed (mainly South Bentinck Arm) chum stocks, only slowed the decline (Fig. 2.8-4), and resulted in lower values, due to reduced catches of other stocks and reduced quality in the terminal area.

Figures 2.8-5 and 2.8-6 illustrate total pink catch and total chum catch under the Base Case and Option 3 fisheries management regimes. NPV's were $163,000,000 and $157,000,000, respectively, at 10% discount rates.

The second series of simulations includes an additional stock which represented the Atnarko stabilization channel products. The management scenarios were unchanged from the previous series, except to accommodate the additional 40,000 spawners required for the channel (Table 2.8-8).

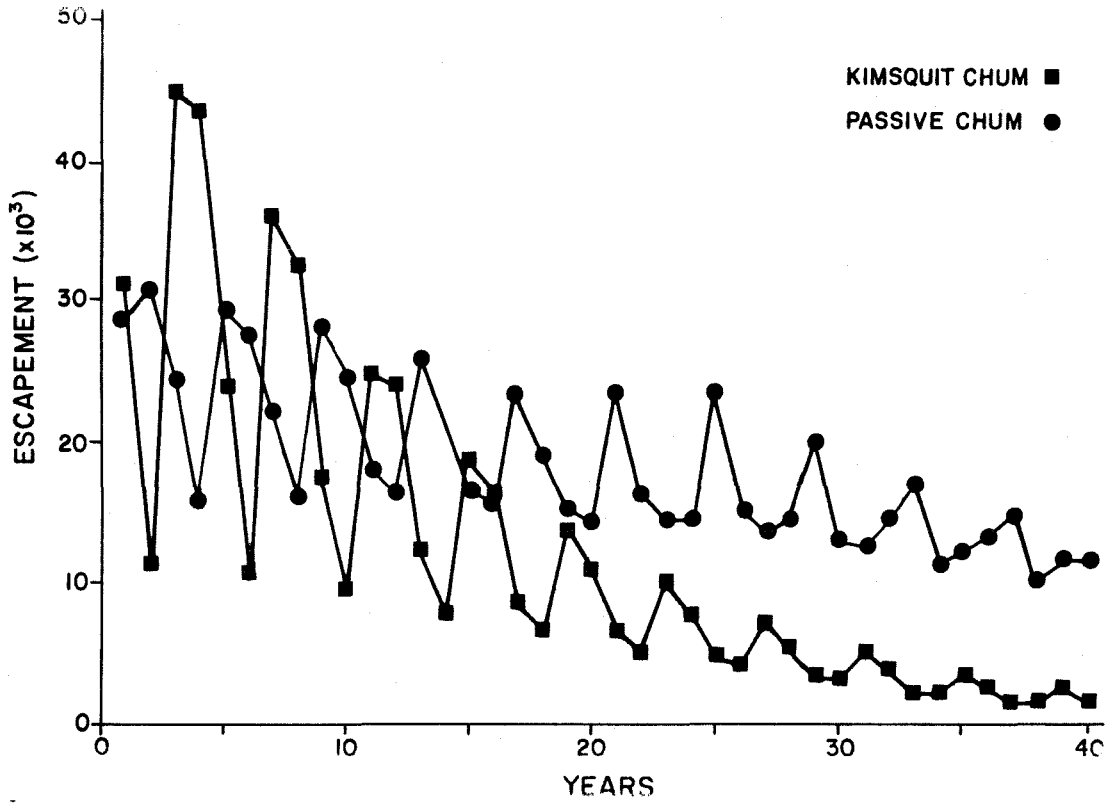


Figure 2.8-3. Base Case (Option 1) escapement trends for Kimsquit and passively-managed chum stocks in Area 8.

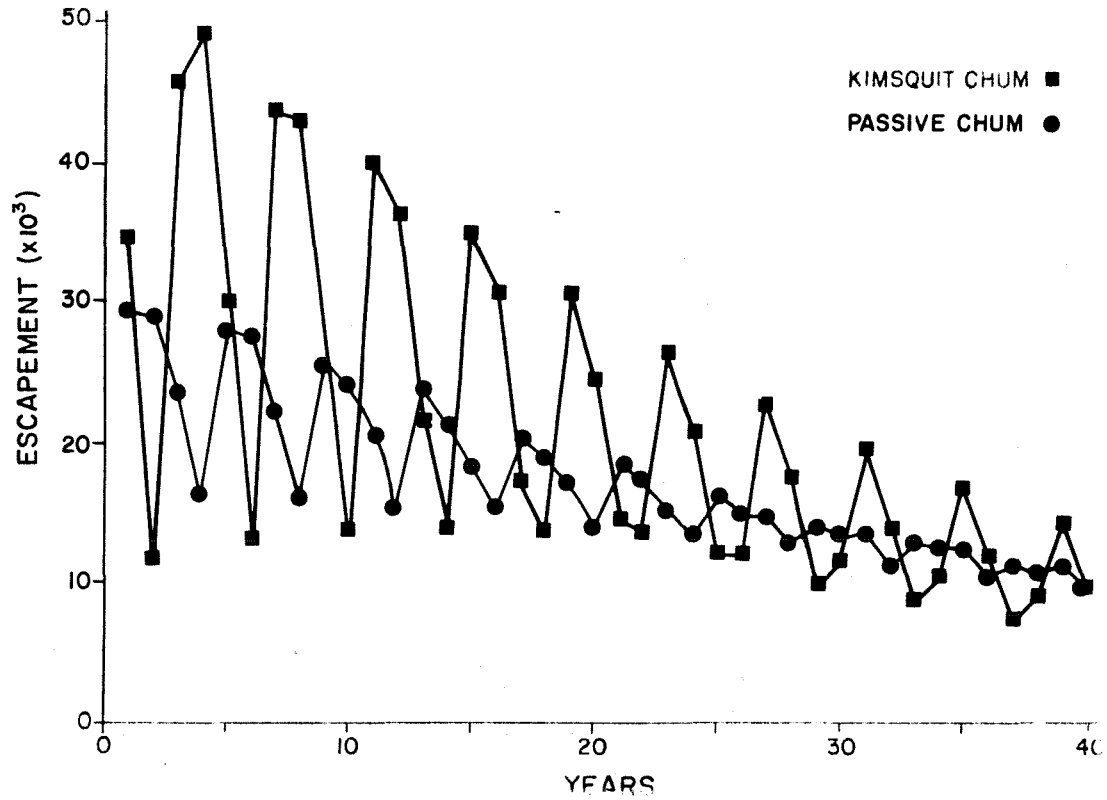


Figure 2.8-4. Escapement trends under Option 3 for Kimsquit and passively-managed chum stocks in Area 8.

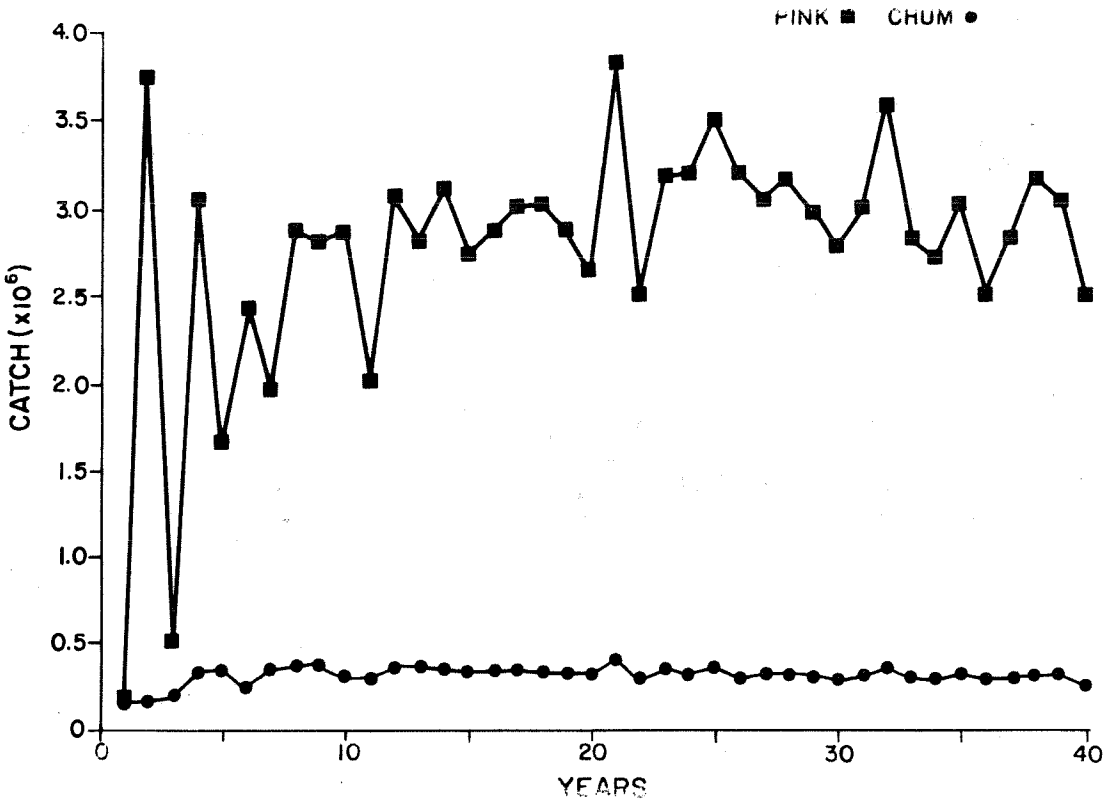


Figure 2.8-5. Base Case (Option 1) catch trends for Area 8 pink and chum salmon.

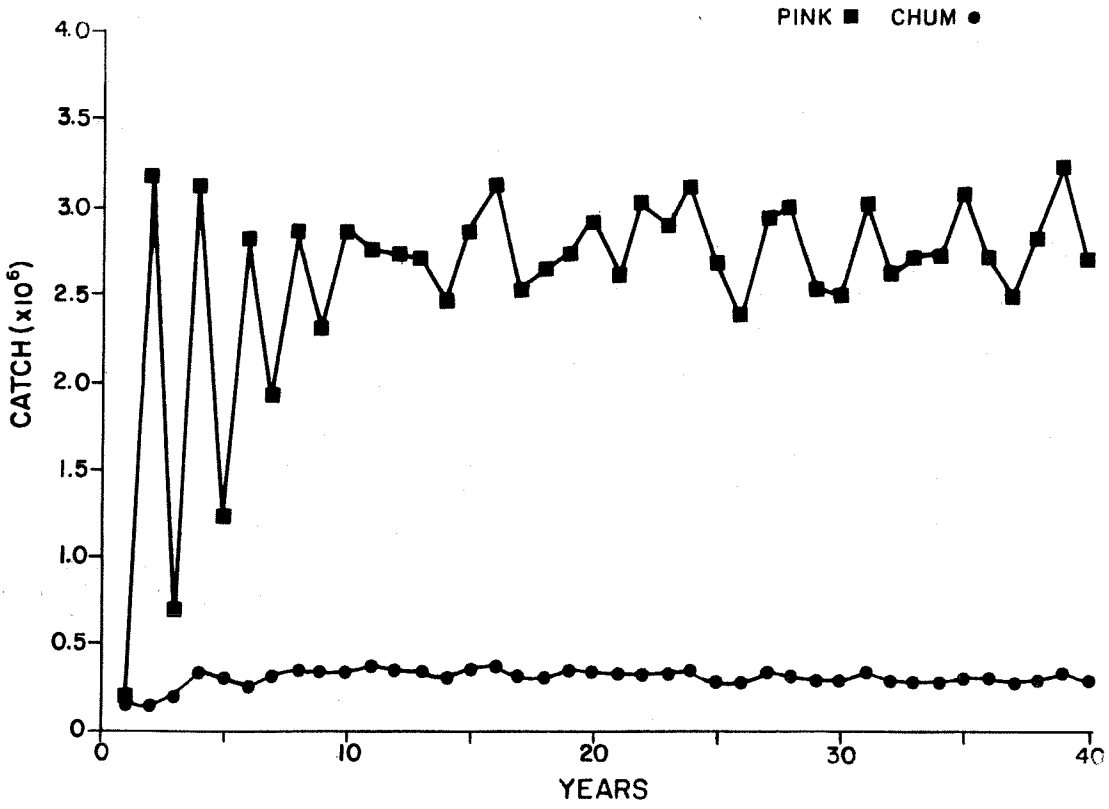


Figure 2.8-6. Catch trends under Option 3 for Area 8 pink and chum salmon.

Table 2.8-8. Escapement trends in Area 8 with addition of the Atnarko stablization channel.

	Option	Atnarko Pink	Bella Coola Chum	Kimsquit Chum	Dean Closed Chum	Passive Pink	Passive Chum	Atnarko Channel
1.	Base Case Plus Channel	Stable at target	Stable at target	Declining	Stable	Near target	Declining	At target
2.	Option 2 Plus Channel	Stable near target	Declining	Declining rapidly	Declining	Declining	Declining rapidly	At target
3.	Option 3 Plus Channel	Near target	Near target	Declining	Near target	At target	Declining	At target

The catch trends are illustrated in Figures 2.8-7 and 2.8-8. Note that, compared to Figures 2.8-5 and 2.8-6 there did appear to be a slight stabilizing effect on pink catches at a slightly higher level, as a result of the increased production from the channel. Figure 2.8-7 represents Base Case fisheries management with the addition of an Atnarko pink stabilization channel (Option 1), while Figure 2.8-8 represents changes in the Bella Coola fishery to protect Kimsquit and passive chum stocks with the addition of an Atnarko pink stabilization channel. Overall catch between the two options appeared to be little different, and this was confirmed by the NPV (at 10% discount rates) of the two scenarios; they are identical at $168,000,000.

To summarize, fishing to take all surpluses when the channel is operating would appear to be disastrous. All stocks would decline except for Atnarko pinks, due to the channel. Both other options appear to have similar results. The steady catch from the stabilized Atnarko stock would raise the pink catch average without any adverse effects on other stocks.

The final series of simulations included an elevated target escapement for the passive pinks. This increased target represented the small stabilization channel proposed for the Kwatna. Results for this scenario were identical to those for the previous one, except the NPV's were higher due to increased catch of passive pinks in the mixed fishery. The NPV's, at 10% discount rate were: Option 1 (Base Case), $169,000,000; Option 2, $102,000,000 and, Option 3, $170,000,000.

In conclusion, the results of this modelling exercise suggest that:

1. Spawning channels are confirmed to have a stabilizing effect on pink stocks;

2. Kimsquit chum and passive chum (particularly South Bentinck Arm stocks) require immediate action to avoid serious declines; and

3. It is unlikely that any major departures from current management are necessary, although minor adjustments to accommodate the weaker chum stocks will be necessary.

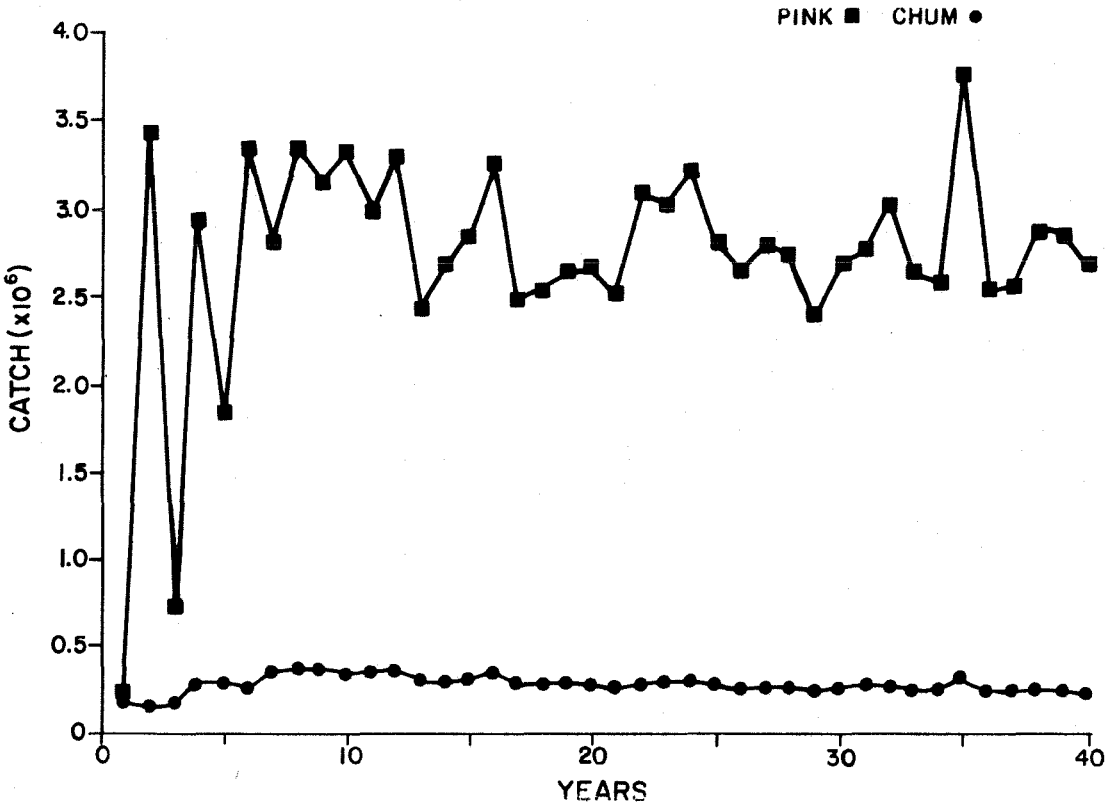


Figure 2.8-7. Catch trends of Area 8 pink and chum salmon under the Base Case with the addition of Atnarko stabilization channel.

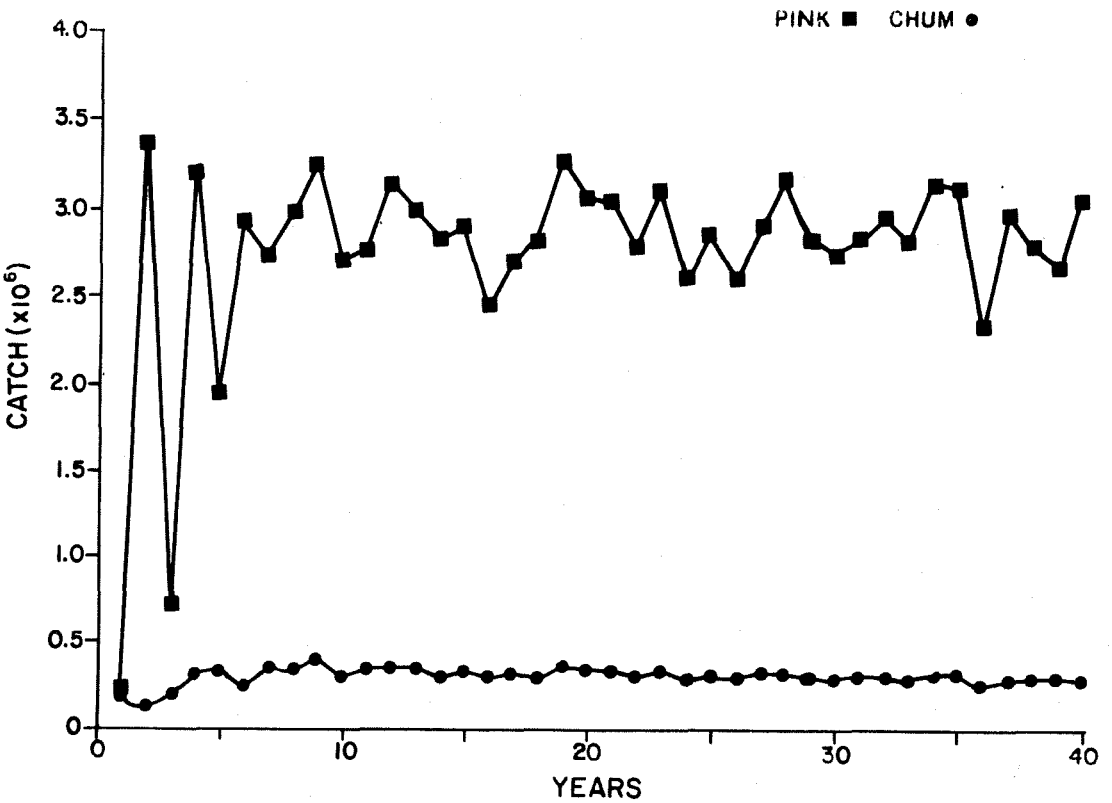


Figure 2.8-8. Catch trends of Area 8 pink and chum salmon under Option 2 with the addition of Atnarko stabilization channel.

2.9 Statistical Area 9

The major geographical components of Statistical Area 9 are Fitz Hugh Sound, Rivers Inlet and Owikeno Lake (Figure 2.9-1). Detailed stock attributes and current fishing patterns in Area 9 can be found in Appendix 1.

2.9.1 Stock Description

The Owikeno sockeye stocks are considered as one actively-managed group with one small passively-managed stock. There are four actively-managed pink stocks in both even and odd years, as well as 15 passively-managed pink stocks in both cycles. Finally, there are five actively- and ten passively-managed chum stocks.

The Owikeno Lake sockeye stock is made up of those sockeye that spawn in the ten spawning areas in tributaries to Owikeno Lake. Owikeno sockeye are in the Rivers Inlet area from late June until early August. The second and third weeks of July are peak weeks for the commercial fishery. The Owikeno sockeye target escapement was increased in 1980 from 500,000 to 1,000,000, which has reduced the surplus available for harvest. The five-year average catch for 1971-1975 was 450,000, compared to only 40,000 for 1979-1983. Escapements in the 1970's averaged 380,000, while the average escapement for 1980-1983 inclusive was 610,000. Beaver Creek in outer Rivers Inlet supports the only other sockeye stock in Area 9. This is a small, passively-managed stock of only 100 fish.

The four actively-managed pink stocks in Area 9 originate in Clyak River, Chuckwalla River, Kilbella River and Johnston Creek. For the purposes of this discussion, Chuckwalla and Kilbella stocks have been combined, since their timing through the fishery is similar and the rivers have a common estuary.

The timing of pink migration through the fisheries in Area 9 is presented in Figure 2.9-2. Pink catches have been poor in recent years (1979-1983) after a period (1960's and 1970's) of relative stability. The recent poor catches reflect the stricter management of the resource coupled with extreme environmental problems (floods) in 1980 and 1982. Clyak pinks were strong on the even-year cycle until 1980 and 1982. With a target escapement of 50,000

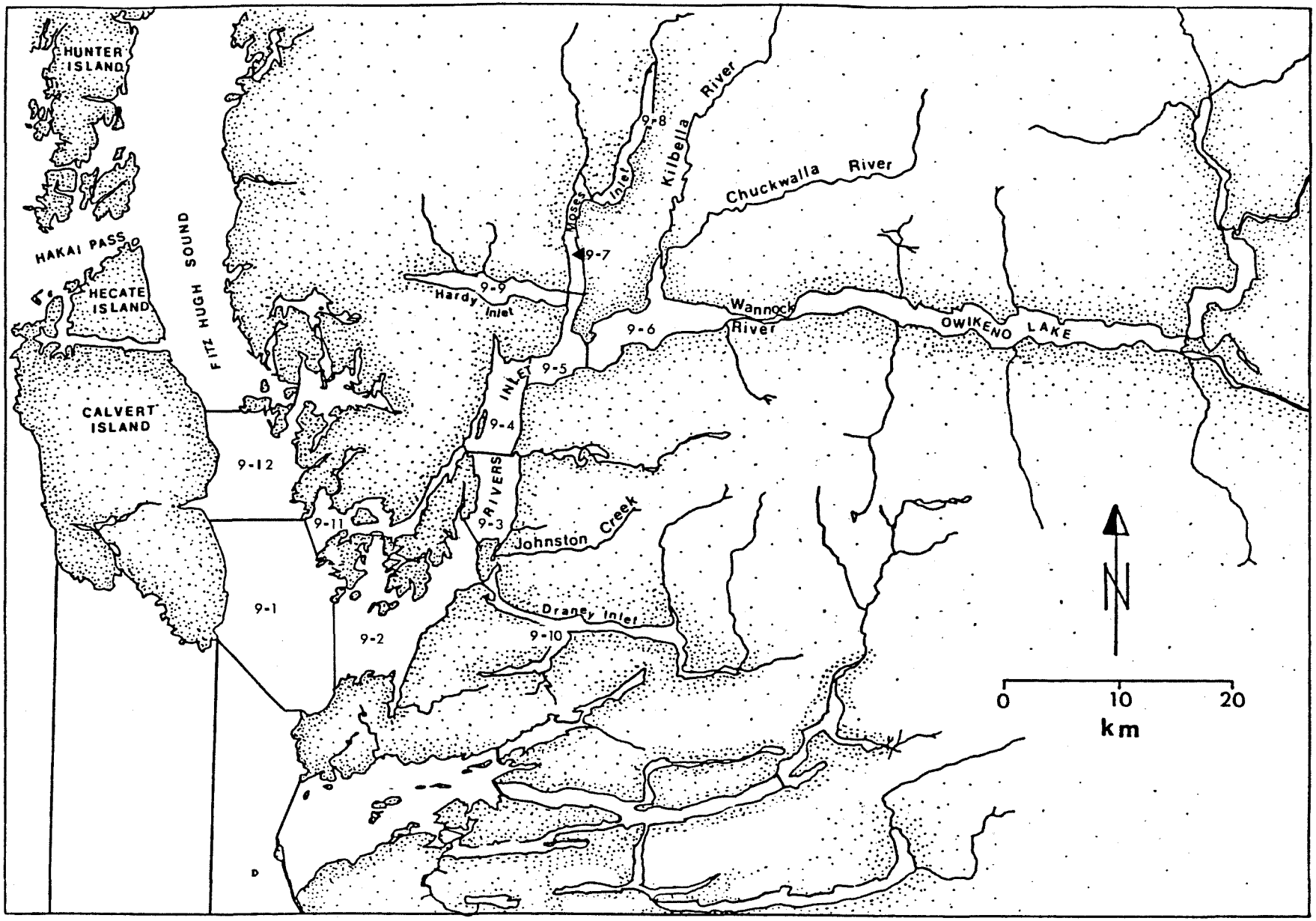


Figure 2.9-1. Statistical Area 9.

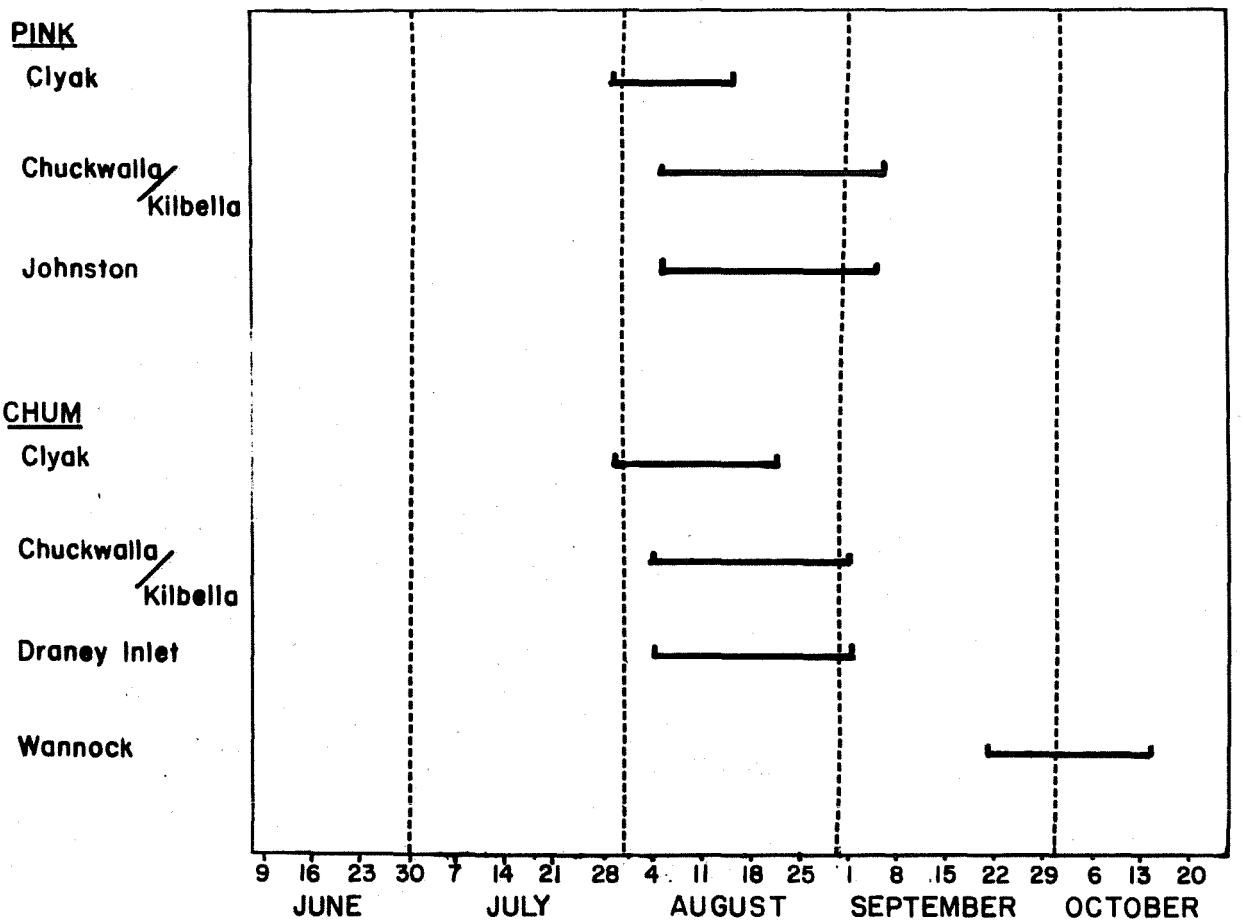


Figure 2.9-2. Stock migration timing through the fisheries in Area 9.

and no further environmental problems, there should be a surplus available to fisheries by 1986. The odd-year cycle, however, is depressed but stable near 1,000. Chuckwalla pink stocks are depressed and both cycles appear to be declining. The even-year stock is currently at about 10% of the target escapement of 100,000, while the odd-year stock is near 20% of the target. Kilbella pinks have also been at very low levels in both cycles. Although the 1983 escapement was 20,000, escapements have been less than 5,000 in recent years, far below the target of 50,000. Johnston Creek pink stocks are slightly depressed but seem to be rebuilding toward the target of 90,000. Escapements in 1982 and 1983 were 70,000. Historically, the odd cycle seems to have been weaker, but this is no longer the case. The 15 passively-managed pink stocks have a collective target escapement of 57,000. There were fairly good escapements in 1980 (41,000 total) but, in general, escapements have been depressed and fluctuating below 10,000.

The five actively-managed chum stocks in Area 9 are from Clyak River, Draney Inlet, Chuckwalla River, Kilbella River and Wannock River. As with pinks, the Chuckwalla and Kilbella stocks are combined because of coincidental timing and proximity of the river systems. Timing of chum migrations through the fisheries is presented in Figure 2.9-2. Timing of runs of the passively-managed group coincides with runs of the Draney Inlet and Chuckwalla/Kilbella stocks. Clyak chum stocks are depressed and fluctuating. The target escapement of 40,000 was achieved in 1982, but escapements before and since have been poor. Draney Inlet chum stocks are also depressed and fluctuating. The target escapement of 20,000 was exceeded in 1982; however, escapements have generally been between 25% and 50% of the target escapement. Chuckwalla and Kilbella chum stocks are also depressed and fluctuating below 20% of the target escapements of 25,000 and 5,000, respectively. Wannock chum stocks are depressed but appear to be rebuilding slightly. Recent escapements have been less than half of the target of 40,000. The ten passively-managed chum stocks are depressed and fluctuating around 10% of the combined target of 51,000 for the area.

The Wannock and Chuckwalla-Kilbella rivers are currently the largest chinook producers in the area. The Owikeno Lake streams had major runs in the

1930's, but recent escapements are extremely low. Wannock chinook stocks have been enhanced by Snootli Hatchery in Bella Coola since 1983, and the CEDP facility in Owikeno Lake will be enhancing the Wannock chinook stocks in future years. The effects of the current chinook conservation measures on Wannock chinooks is not clear. The 1984 escapement was extremely poor, but this was expected because of a severe flood in 1980.

Coho production in Area 9 is spread among 24 streams in the area, with no dominant stock. Current stocks are fluctuating around 15% of the area target escapement of 49,800.

2.9.2 Fisheries

Fisheries management for salmon in Area 9 normally commences during the last week of June. The target stock is Owikeno sockeye. Sockeye continues as the only target stock until the week of 29 July to 4 August when Clyak pinks and chums begin to appear in the fishery. There are few mixed-stock problems in the sockeye fishery in Rivers Inlet; the only incidental catches of note are Chuckwalla/Kilbella chinooks in the first two weeks, and Clyak pinks and chums in the final week. The fishery is managed to produce a target escapement using an echo-sounding program to estimate escapement past the fishery. The only boats operating in Area 9 are gillnetters.

During August the Rivers Inlet fishery is managed as a mixed pink and chum fishery. This is considerably more complex than the sockeye fishery because there are eight actively-managed stocks involved (for pink: Clyak, Chuckwalla, Kilbella and Johnston; for chum: Clyak, Chuckwalla, Kilbella and Draney Inlet). In addition, the incidental catch includes Owikeno sockeye, all of the passively-managed pink and chum stocks, and Wannock chinooks. The pink/chum fishery is managed to produce target escapements using catch data and then escapement data as the season progresses.

After the mixed pink/chum fishery, there is no commercial fishing activity in Rivers Inlet until the last week in September, when there may be a fishery for late-running chums heading to the Wannock River. As with the previously described fisheries, this fishery is also managed by assessing escapement. Wannock chums may contribute to a commercial fishery up to the second

week of October. The only incidental catches may be some local coho. After 13 October the Rivers Inlet commercial salmon fishery is closed for the balance of the season.

2.9.3 Current Enhancement Activities

During the first phase of the SEP, enhancement activities in Area 9 were extremely limited, and included no large-scale projects. Some small projects were undertaken by the Owikeno Band under a Job Creation Project in 1982, but none of these projects will affect the stocks of fisheries management to any noticeable extent. For the past two years (1983, 1984), staff from the Snootli hatchery have worked with the local band to take eggs from Wannock chinooks for incubation at Snootli. This is part of a concerted effort to halt the decline of a unique chinook stock.

2.9.4 Habitat Status

Habitat descriptions for Area 9 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.9-1 through 2.9-5, respectively. For a description of the habitat tables, see Section 2.2.4.

2.9.5 Management Conflicts

Conflicts discussed below include the problems of mixed-stock fisheries, and uncertainty in data.

2.9.5.1 Management Uncertainties

In Area 9, the buildup of sockeye at the head of Rivers Inlet is estimated by echo-sounding, which thus provides an estimate of the sockeye escapement through the fishing area. The program is most appropriate and useful for small run sizes in which catch information is not available to confirm stock abundance. Without the echo-sounding program, more commercial test fisheries would have to be operated. Predicting stock abundance in-season in Area 9 is a problem for all species, especially for sockeye because of its prominence.

Table 2.9-1. Statistical Area 9 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	845	1,000	640

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 21

HABITAT NOTES

Historic Status, Production Constraints and Development History	Dominated by Owikeno Lake stocks. Natural flow instability. Extensive logging with overall low - mod. impacts. High impacts in some instances have compounded natural flow problems. Peak of logging on Owikeno system has probably passed, but some lower reaches of streams have long-term impacts.
Current Status	Logging continuing - probably with improved habitat protection control. Logged watersheds recovering - possible some long-term watercourse changes.
Future Outlook	Stabilizing to a "recovery" watershed status.
Natural Habitat Production Potential	Recovery to historic capacity.
Improved Production Potential	Unknown but probably low.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High - Medium	High	High	Low

CONCLUSION Manageability of a complex stock mix is major issue.

Table 2.9-2. Statistical Area 9 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	587	347	115

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 18

HABITAT NOTES

Historic Status, Production Constraints and Development History	Species most likely to have been impacted by logging development. Natural flow instability, compounded by logging activity. Overall logging impacts low - moderate but may have long-term impact on some key pink streams. Logging impacts have probably peaked, but some long-term residual impacts.
Current Status	Logging continuing with better control over impacts. Watersheds recovering but may not include "pink" habitat.
Future Outlook	Stabilizing to "recovering" watersheds.
Natural Habitat Production Potential	Careful evaluation of natural recovery potential needed.
Improved Production Potential	Possible gravel replacement - depending on natural recovery potential.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium - High	Medium	Medium	Medium	Medium

CONCLUSION Flow instability may be a continuing problem.

Table 2.9-3. Statistical Area 9 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	184	141	36

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 17

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability, compounded by logging activity. Overall logging impacts low - moderate but may have long-term impacted, on some key streams. Logging impacts have probably peaked, but some long-term residual impacts.
Current Status	Logging continuing with better control over impacts. Watersheds recovering.
Future Outlook	Stabilizing to "recovering" watersheds.
Natural Habitat Production Potential	Careful evaluation of natural recovery potential needed.
Improved Production Potential	Possible gravel replacement - depending on natural recovery potential.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium - High	Medium	Medium	Medium	Medium

CONCLUSION Flow instability may be a continuing problem.

Table 2.9-4. Statistical Area 9 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	11	22	3

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 9

HABITAT NOTES

Historic Status, Production Constraints and Development History	Whonnock River is major stock. Natural flow instability, compounded by logging activity. Overall logging impacts low - moderate but may have long-term impact on some key streams. Logging impacts have probably peaked, but some long-term residual impacts.
Current Status	Logging continuing with better control over impacts. Watersheds recovering.
Future Outlook	Stabilizing to "recovering" watersheds.
Natural Habitat Production Potential	Careful evaluation of natural potential needed.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium	Medium - High	Medium - High	Medium - High	Unknown

CONCLUSION Target seems optimistic based on natural historic stock. Assume that augmentation is part of the plan.

Table 2.9-5. Statistical Area 9 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	54	49	8

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 22

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability. Extensive logging with overall low - moderate impacts. High impacts in some instances have compounded natural flow problems. Peak of logging in Owikeno system has probably passed, but some lower reaches of streams have long-term impacts. Probable loss of small streams spawning and rearing habitat.
Current Status	Logging continuing - probably with improved habitat protection control. Logged watersheds recovering - possibly some long-term watercourse changes.
Future Outlook	Stabilizing to a "recovery" watershed status.
Natural Habitat Production Potential	Likely recovery over 20+ years.
Improved Production Potential	Plenty of scope for local restoration projects.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium	Medium	Medium - High	Medium - High	High

CONCLUSION Habitat is almost certainly a factor in stock decline.

2.9.5.2 Mixed-Stock Harvests

There is no significant mixed-stock problem for Rivers Inlet sockeye. There are only minor interceptions of southerly migrating stocks to Smith Inlet, and also of sockeye coming through Hakai-Fitz Hugh Sound from the north. A mixed-stock problem occurs in one common area (Management Units 9-2, 9-3, 9-4 and 9-11). The current management plan is to exploit any pink or chum surplus while attempting to minimize the effect on other stocks. This tactic will create problems in the future, since catch reductions in recent years have resulted in a rebuilding of these stocks, and some major surpluses are expected. The Wannock chum stock returns much later than the other stocks in Area 9, and interacts only with Area 9 coho.

2.9.6 Stock Rebuilding Potential

Since 1979, when the target escapement for sockeye was increased to 1,000,000, there has been essentially no harvest of Rivers Inlet sockeye. Escapements in 1981, 1982 and 1983 were high (600,000 - 800,000) and are expected to reach the target escapement in the near future, thus yielding a large harvestable surplus. The present policy of fishing only if a surplus is available has rebuilt the sockeye stocks.

For pinks, fisheries are held only for stocks that exceed estimated escapements. Stocks are responding, but severe floods in 1980 and 1982, management uncertainties, and the mixed-stock problem have slowed the potential rebuilding rate. The stocks that are passively managed have little potential to be actively managed.

Chums stocks are responding to current management practices which have reduced exploitation. All of the chum stocks had one strong cycle year (1982), with all other cycles severely depressed. The harvest of surplus pinks from presumably more productive stocks is a major deterrent to rebuilding chum stocks. If separation of stocks cannot be achieved through time, area or gear manipulation, forgoing some pink surpluses may have to be considered. The present passively-managed stocks have no potential to be actively managed, with the exception of MacNair Creek, which has potential although it has not yet responded to presently low exploitation rates.

2.9.7 Management Strategies for Stock Rebuilding

Rebuilding options discussed below include reducing management uncertainties and reducing mixed-stock harvest.

2.9.7.1 Management Uncertainties

Some options that will reduce management uncertainty by improving or building on existing information include:

1. Conduct a charter gillnet sockeye test fishery in the outer portion of Rivers Inlet: A pilot gillnet sockeye test fishery was attempted in 1981 in the outside area of Rivers Inlet. The initial results indicated that the test fishery would be a useful indicator of the abundance of the incoming run. However, the most appropriate test fishing sites are within the commercial fishing boundaries, and the program is disrupted by commercial fisheries. Since the returning sockeye stocks are anticipated to be very strong in the foreseeable future, a large number of fishing days are expected. Although charter test fisheries can produce better data, they may be unnecessary if a large regular commercial fishery is conducted. Charter test fisheries for pink or chum stocks have a much lower priority, but would be an asset. The migration patterns and timing for pinks and chums are more variable and overlap, which makes the information from a charter test fishery difficult to interpret. A commercial test fishery may be more appropriate, as it provides information over a wider geographical area, and may enable biologists to perform catch analysis for individual stocks.

2. Limit effort during commercial test fisheries: An ability to limit the number of vessels during commercial test fisheries would reduce escapement losses. This is more pertinent to the smaller pink and chum stocks than to sockeye.

3. Analyse Area 9 sockeye catch data fully for in-season management (Special Project): An analysis of in-season use of sockeye catch data as an indicator of abundance must be done prior to the large returns expected in 1985 and 1986.

4. Review Wannock chum catch data: The mixed-stock problem for pinks and chums is related more to stock separation than to interpretation of catch data. The Wannock chum stock is an exception, and the meagre historical data will have to be reviewed prior to the proposed 1986 fishery.

5. Install fence on the Quap River: The Owikeno sockeye escapements are presently estimated from stream surveys. A fence on the Quap River would be useful as a standard index to compare with the estimate made by stream-walking. The Quap is a large salmon producer and is an appropriate site for a fence.

2.9.7.2 Mixed-Stock Harvest

A number of options have been identified to reduce incidental catches in mixed-stock harvests. These are treated below by species. The discussion centers on actively-managed stocks. It is assumed that all the passively-managed stocks in Area 9 will decline if they cannot withstand the exploitation rates required to harvest the actively-managed stocks.

Sockeye There are only very minor mixed-stock harvests of Owikeno sockeye within Rivers Inlet. Only the early pink or chum fisheries could intercept sockeye, which can be a problem if sockeye stocks are low. Given the high value of sockeye, fishermen tend to ignore pinks or chums in favour of sockeye. If chums are the target, a mesh restriction (requiring a larger mesh) could be used to protect sockeye and pinks; however, sockeye and pinks are too similar and variable in size to be separated from each other by a mesh restriction. Interceptions in Area 8 are limited by shifting management control of the pertinent areas (M.U.'s 8-2, 8-3) to Area 9 during the sockeye migration period through these areas. Interception in the Smith Inlet fishery is discussed in the following section on Smith Inlet. There are no other confirmed sockeye interceptions, although more information is required on troll catch of sockeye.

Pink and Chum Of the nine actively-managed pink and chum stocks, only Wannock chums can be harvested separately at present. The other 8 stocks are subject to a mixed-stock harvest. Options for these eight pink and chum stocks are presented individually. It is assumed that there is a surplus to

harvest. The intent of each option is to maximize the exploitation of the target stock while minimizing the interception of others. An exhaustive discussion of all permutations of weak stock/strong stock possibilities is not attempted because of the complexity; there are 28 possible combinations. The size of the target escapements is also not considered. The stocks and locations (Figure 2.9-1) considered are:

Species	Stock	Location
Pink	Clyak River	Head of Moses Inlet
	Chuckwalla River	North side - Head of Rivers Inlet
	Kilbella River	North side - Head of Rivers Inlet
	Johnston Creek	Mid Inlet - East side - In M.U. 9-3
Chum	Clyak River	Head of Moses Inlet
	Chuckwalla River	North side - Head of Rivers Inlet
	Kilbella River	North side - Head of Rivers Inlet
	Draney Inlet	Head of Draney Inlet
	Wannock River	Head of Rivers Inlet

1. Move Clyak pink harvest to more terminal areas: Several options are available for geographical separation of Clyak pinks. The most severe move would be to limit the fishery to Management Unit 9-7, the middle portion of Moses Inlet. This would eliminate all interceptions except of Clyak chums. If required, a mesh restriction (to smaller mesh) would reduce the exploitation rate of chums. This option presents two problems. First, M.U. 9-7 is small and would crowd the fleet; second, fish quality would be poor in this more terminal area. The quality problem can be reduced by fishing earlier, but this increases in-season management uncertainty about run size. Management Units 9-5 and 9-4 could be added, which would improve quality, and the enlarged fishing area would accommodate more gear. On the other hand, Kilbella-Chuckwalla pinks and chums and Wannock chinooks would be intercepted in these management units. Management Units 9-3, 9-2 and 9-11 could also be opened; however, Johnston Creek pinks and Draney Inlet chums would be added to the interception lists. In summary, although the Clyak stocks return earlier, the overlap with other stocks is too great to permit separate management.

2. Move Clyak chum harvests to more terminal areas: The same arguments apply as for Clyak pinks except that, with a mesh restriction, pink stocks would not be intercepted. Quality problems would likely be more severe for chums.

3. Move Chuckwalla-Kilbella harvest to more terminal areas: The Chuckwalla and Kilbella rivers share the same estuary, and timing of the pink and chum stocks is similar. Since separation of these two stocks is not possible, they are considered as one. Although the Chuckwalla stock is larger, the escapements tend to fluctuate together; thus, conflicts may be minimal.

A terminal fishery in M.U. 9-6 with added boundaries which exclude Kilbella Bay would be the most extreme harvest strategy. Reduced quality would be expected in this area, especially for chums, although exploitation in the early portion of the run would improve this situation. Management Units 9-5 and 9-4 could be added, but then Clyak pink and chum would be intercepted. Fisheries further out in the inlet would take Johnston pinks and Draney Inlet chums.

4. Restrict Johnston pink harvest to more terminal areas: Johnston pinks could be exploited by opening M.U. 9-3 alone. This action would, however, permit fishermen to intercept all the other stocks except perhaps Draney Inlet chums. Management Units 9-2 and 9-11 could be added to expand the fishing area and exploitation. A lack of information on timing or migration patterns does not permit intelligent redesigning of the present M.U. boundaries; however, more restrictive boundaries which would limit the fishery to areas closer to Johnston Creek could reduce the interception of other species. Obviously, the quality of fish caught would be reduced.

5. Restrict Draney Inlet chum to more terminal areas: At present, if a surplus of Draney Inlet chum were available, the fishery would be directed to M.U. 9-2. However, Clyak and Chuckwalla-Kilbella chums would also be intercepted in this area. An alternative would be to move the fishery to a portion of Draney Inlet (M.U. 9-10) with the major advantage that there would be no interceptions of other stocks. On the negative side, this area is highly tidal and uncharted; moreover, the quality of the fish would be poor. A com-

promise may be to create a new more restrictive Management Unit adjacent to the entrance of Draney Inlet, thus reducing the incidental catch of non-target stocks and minimizing the loss in quality. However, the relatively small area would crowd the fleet and restrict fishery operations.

2.9.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

2.9.8.1 Fertilization of Owikeno Lake (Project No. 9 - 1A)

Owikeno Lake has been suggested as a candidate for lake fertilization. However, the high turbidity of this glacial lake lowers the probability that primary production would increase through enrichment. As a consequence, lake fertilization has not been recommended at present. However, a study on the fertilization of Alaska glacial lakes is in progress; the results from this program will be used to re-assess the decision not to fertilize Owikeno Lake.

2.9.8.2 Owikeno Lake Spawning Area Improvements

Several opportunities to improve the quality of spawning areas in Owikeno Lake were deferred, pending further assessment, and awaiting road development in the area. Projects included:

1) Wash-wash-Tzeo breakthrough channel stabilization side channel development (Project No. 9 - 2);

2) Inziana channel control (Project No. 9 - 3); and

3) Owikeno second narrows spawning area improvements (Project No. 9 - 1B).

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[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

The Wash-wash River has changed channels as a result of a log jam. Corrective measures are recommended. Any major developments in Owikeno Lake are deferred at this time, because all systems appear to have a relatively similar productivity; all spawning areas are still producing well after 100 years of intensive fishing.

2.9.8.3 Adult Counting Fence on Coop River

Construction of an adult counting fence on the Coop River using an existing cement pad as a base for the fence was suggested. The fence could be operated by the Owikeno Lake Band in conjunction with its other CEDP activities in the Rivers Inlet. Although the fence would not be used for in-season management, it would be highly desirable for partial calibration of the escapement estimates of all the Owikeno systems.

2.9.8.4 Neechanz Chinook

Chinook escapements to the Neechanz River are very low. Rebuilding of these stocks through transplants of eggs or fry has been suggested; no potential stock or action has been identified. There are remnant chinook stocks in all of the stream spawning areas of Owikeno Lake, and chinook production in all these systems should be encouraged.

2.9.8.5 Good Hope Cannery (Project No. 9 - 16)

This project would use the existing infrastructure at the Good Hope Cannery to develop facilities to incubate coho and chinook eggs. Fish would be out-planted in nearby Sandell Lake and seapens in Rivers Inlet. The Chuckwalla-Kilbella chinooks were identified as a brood source; however, it was recommended that Wannock River chinooks not be used. No production levels were established; presumably these would be proposed following additional study. Fish from this project are expected to primarily benefit sports fishermen in Rivers Inlet. Management of present commercial fisheries in the Inlet would not be altered because of this project.

2.9.8.6 Chuckwalla River (Project No. 9 - 10)

This project includes the development of a central facility and channel

on the Chuckwalla River, with satelliting capability to the Kilbella, Clyak, Milton and Wannock rivers. The major species would be pink with an adult production goal of 250,000. Also included are chinook (50,000), coho (95,000) and chum (25,000). Overlaps in run timing with unenhanced pink and chum stocks reduce the attractiveness of this project and, consequently, it is not recommended for development as a whole. Chinooks and coho are still highly desirable to enhance in this area because of their non-overlapping run timing.

2.9.8.7 Wannock River Chinook and Chum (Project No. 9 - 9)

In 1983 and 1984, Wannock chinook eggs were taken to Snootli Hatchery for incubation. Of the 90,000 eggs taken in 1983, 53,000 were reared, coded wire tagged and released into the Wannock as smolts. An additional 28,000 fry were transported to saltwater net pens operated by the Owikeno Salmon Enhancement Program (the local community development project) and reared for a short period. 170,000 eggs were taken in 1984, and are currently being incubated at Snootli hatchery. The present goal for numbers of chinook eggs is 250,000, and it will be reviewed in 1985. A proposal to increase the project capacity to 1,000,000 eggs is being considered. However, because of the very large size of Wannock chinooks, their high sport and commercial value, and the uncertain genetic impacts of the project, further review is required before changes are made to the present number of eggs being incubated.

The OSEP group are also incubating 100,000 Wannock chum eggs in an experimental floating incubator in the Wannock River. Depending on the success of this project, the chum program will be expanded, with a very small chinook pilot program also possible.

2.9.9 Predicted Results for Management Options

The following predictions are based upon simulation models of sockeye, pink and chum salmon exposed to various management regimes.

The sockeye rebuilding plan described earlier will be successful in rebuilding sockeye stocks for Owikeno Lake. Based on management to produce the new escapement target of 1,000,000, sockeye long-term mean catch projection is 1,240,000 annually (Table 2.9-6).

Table 2.9-6. Catch projections for sockeye stocks in Area 9.

Year	Total Catch
1	387,545
2	989,023
3	910,079
4	911,828
5	1,188,673
6	1,408,120
7	1,095,724
8	1,238,124
9	1,602,827
10	1,338,270
11	1,191,225
12	1,119,274
13	1,488,760
14	1,393,976
15	1,501,637
16	1,430,356
17	1,301,426
18	1,456,942
19	1,373,725
20	1,462,887

Considerable conflict exists with regard to management of mixed stocks of pink and chum salmon. There are conflicts in management of individual stocks of one species, and between stocks of pink and chum. Many options were described above for management of pink and chum stocks. A complete analysis of all options has not been attempted. The present management approach involves harvesting all the stocks in a mixed stock fishery. The result is less than optimum production potential. Catch projections for the current management approach yield long-term averages for pink salmon of 508,000, and for chum salmon 72,000 (Tables 2.9-7 and 2.9-8).

Options to reduce the impact of the mixed fishery on incidental and depressed stocks involve moving fisheries to more terminal areas. In order to demonstrate the possible yield from such actions, the analysis has concentrated on the Clyak, Chuckwalla and Kilbella River stocks. It was assumed that the Clyak and the Chuckwalla/Kilbella fisheries harvest both pinks and chums. One option explored involved managing the fisheries by controlling pink escapement only ("pink driven"), while the other manages the fishery by controlling chum escapement only ("chum driven"). The results for Clyak pink and chum and Chuckwalla/Kilbella pink and chum salmon are presented in Tables 2.9-9 to 2.9-12.

If one were to manage Clyak pink and chum stocks in terminal fisheries for pinks ("pink driven"), the long-term catch average for pinks would be 76,000 and for chums would be 20,000 (Table 2.9-9). Similarly, Chuckwalla/Kilbella stocks managed in the same way for pinks would have long-term average catch projections of 275,000 for pinks and 8,000 for chums Table 2.9-10). On the other hand, the fishery could be managed for chum stocks ("chum driven") and forgo some pink salmon catch in the terminal fishery. Catch projections for such an option for Clyak pinks and chums would be 31,000 chums and 34,000 pinks (Table 2.9-11). This would reduce the pink catch by 42,000, and would increase the chum catch by 11,000 relative to the pink-driven scenario (Table 2.9-9). Similarly, for Chuckwalla/Kilbella combined stocks, the chum management system would result in a long-term catch of 20,000 chums and 84,000 pinks (Table 2.9-12). This would reduce the pink catch by 191,000, while chums would increase by 11,000 relative to the pink-driven scenario (Table 2.9-10).

Late-running Wannock chum stocks can be rebuilt and will provide a long-term catch projection of 27,000 (Table 2.9-8).

Table 2.9-7. Catch projections for pink stocks in Area 9.

Year	Johnston	Clyak	Chuckwalla	Kilbella	Passive
1	141,185	11,606	9,462	3,145	11,430
2	136,586	1,225	19,084	28,902	20
3	161,564	33,399	22,138	5,706	26,812
4	179,451	2,736	63,225	54,254	43
5	197,330	75,672	66,351	12,546	57,499
6	182,823	7,883	117,168	92,533	82
7	210,978	80,604	131,586	27,526	73,052
8	181,571	16,992	136,540	92,209	143
9	186,449	95,069	148,253	56,423	101,131
10	191,554	25,848	184,110	115,199	295
11	193,462	96,491	192,724	63,473	98,836
12	203,143	47,483	195,642	87,675	555
13	190,355	96,545	221,664	103,741	102,605
14	203,202	45,734	191,198	95,922	1,199
15	207,004	80,600	176,443	94,190	100,285
16	192,583	66,383	207,782	104,314	2,772
17	189,902	119,767	196,386	100,586	119,158
18	215,975	69,809	215,037	118,737	7,579
19	193,864	109,383	228,565	95,824	112,680
20	193,558	91,028	209,042	107,182	20,782

Table 2.9-8. Catch projections for chum stocks in Area 9.

Year	Clyak	Draney	Chuck-walla	Kil-bella	Pas-sive	Wannock
1	3,221	14,916	2,634	520	6,581	872
2	5,958	7,463	6,687	476	3,864	2,769
3	54,868	37,421	5,164	1,239	8,637	24,102
4	13,284	7,610	1,211	564	2,213	9,631
5	4,179	16,111	3,468	595	5,937	2,265
6	10,620	11,309	7,761	570	4,337	10,293
7	36,946	20,382	5,328	1,439	7,208	40,518
8	14,400	8,662	1,615	624	2,525	22,066
9	6,691	14,941	4,614	648	6,448	8,049
10	14,696	13,376	10,292	743	4,647	19,785
11	31,353	19,218	5,514	1,619	5,978	48,423
12	13,172	12,209	2,011	722	2,550	35,313
13	8,141	13,414	7,049	794	6,986	17,010
14	18,118	13,030	10,111	872	4,502	36,556
15	30,044	18,996	6,082	2,000	5,340	52,632
16	16,424	12,667	2,968	829	3,133	38,958
17	9,699	12,866	8,378	1,019	5,224	28,522
18	21,308	14,767	11,967	1,149	3,874	45,096
19	28,017	16,056	6,665	2,053	4,403	58,785
20	15,790	12,598	3,917	1,005	3,201	48,335

Table 2.9-9. Catch projections for terminally-managed Clyak pink and chum stocks (pink driven).

Year	Catch	
	Pink	Chum
1	7,478	1,141
2	430	1,226
3	40,096	34,428
4	1,049	2,715
5	98,002	7,476
6	11,974	4,286
7	118,460	46,479
8	38,081	18,006
9	121,169	12,404
10	72,889	19,493
11	91,375	33,331
12	90,372	33,111
13	133,271	13,034
14	75,232	21,203
15	113,530	29,270
16	107,219	33,273
17	97,547	14,967
18	104,513	28,729
19	111,871	23,665
20	94,780	22,866

Table 2.9-10. Catch projections for terminally-managed Chuckwalla/Kilbella stocks (pink driven).

Year	Catch	
	Pink	Chum
1	24,039	1,757
2	28,001	1,546
3	144,456	1,777
4	153,981	5,043
5	214,287	10,047
6	276,536	8,742
7	326,675	4,848
8	259,079	12,352
9	284,351	13,043
10	317,372	9,723
11	377,353	5,938
12	391,610	15,816
13	337,943	19,070
14	302,645	9,367
15	349,651	5,857
16	245,118	12,366
17	338,585	14,891
18	331,044	11,616
19	344,548	5,437
20	405,797	14,395

Table 2.9-11. Catch projections for terminally-managed Clyak pink and chum stocks (chum driven).

Year	Catch	
	Pink	Chum
1	3,346	725
2	413	1,218
3	34,041	46,085
4	1,417	4,393
5	12,179	1,978
6	4,233	6,186
7	59,389	51,089
8	23,176	28,177
9	20,408	6,959
10	25,876	16,745
11	65,968	43,083
12	40,901	43,221
13	45,701	23,297
14	48,123	50,358
15	51,172	48,862
16	44,614	41,840
17	43,311	31,626
18	57,150	60,595
19	54,693	62,476
20	49,204	53,354

Table 2.9-12. Catch projections for Chuckwalla/Kilbella pink and chum stocks (chum driven).

Year	Catch	
	Pink	Chum
1	3,949	802
2	10,724	1,565
3	13,718	1,449
4	35,680	528
5	32,491	2,400
6	65,067	9,293
7	46,963	4,443
8	57,094	1,482
9	73,399	10,986
10	142,868	31,482
11	70,295	11,433
12	59,805	5,051
13	122,838	30,320
14	138,727	40,413
15	133,664	25,244
16	87,415	28,745
17	158,366	55,737
18	183,409	64,004
19	129,856	37,591
20	115,270	34,350

2.10 Statistical Area 10

Statistical Area 10 is located on the central coast of British Columbia north of Vancouver Island (Fig. 2.10-1). The area includes Smith Sound, Boswell Inlet, Naysash Inlet, Smith Inlet and Wyclees Lagoon. The major salmon-producing streams are Canoe Creek, Docee River, Nekite River, Smokehouse Creek, Takush River and Walkum Creek.

Detailed information of stock attributes and current fishing patterns in Area 10 can be found in Appendix 1.

2.10.1 Stock Description

Six stocks (of one sockeye, two pink and three chum) are actively managed in Statistical Area 10. In addition, there are several small pink and chum stocks which are passively managed. The largest and most important stock in Area 10 is the sockeye stock.

The Area 10 sockeye stock originates in Canoe and Smokehouse creeks; the latter, which is the larger of the two systems, supports 75% of the spawning sockeye. The largest component of the stock appears to approach Smith Sound from a westerly direction. Smaller components, however, are thought to migrate south through Statistical Areas 7 and 8 as well as north from Statistical Area 27. Normally, sockeye enter Smith Inlet in late June, and the run continues through July until early August. The fish appear on the spawning grounds in early September and spawn through October.

Escapement of Area 10 sockeye has increased from an average of approximately 71,000 from 1950-1959 to 90,000 from 1970-1977. In 1980, the escapement target was increased from 120,000 to 200,000. Recent escapements have reflected this increase, averaging near 200,000 from 1980-1983.

The two actively-managed pink stocks in Statistical Area 10 are the Nekite even-year stock and the Nekite odd-year stock. They account for approximately 95% of the total pink escapement. In addition, there are several smaller passively-managed pink stocks originating in Walkum, Boswell and Takush creeks. Little is known about their migration pattern prior to

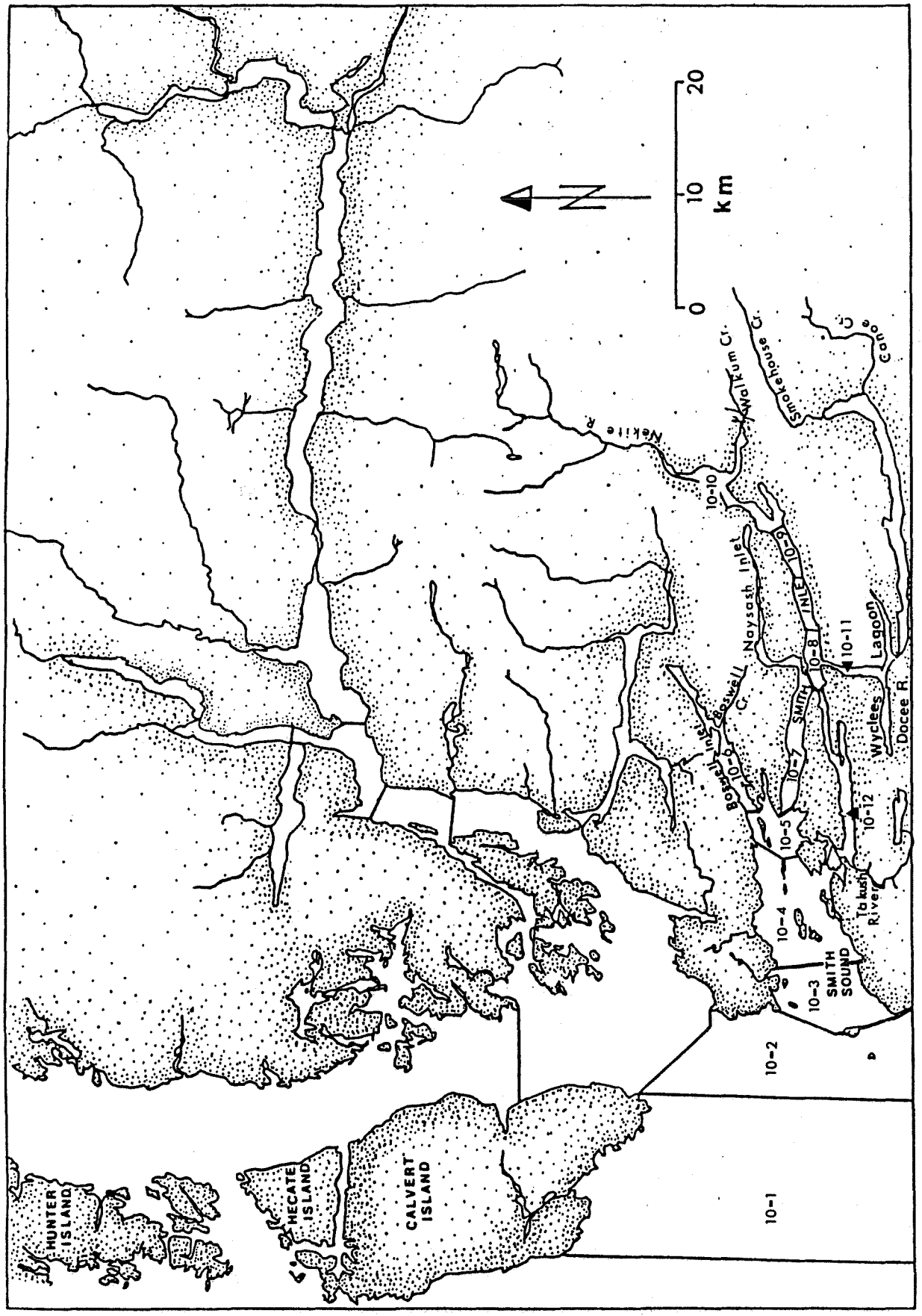


Figure 2.10-1. Statistical Area 10.

their presence in the Area 10 terminal fishery from mid-July to early September. Both Nekite stocks enter the Nekite River in August and complete spawning by late September. Spawning in Walkum Creek occurs somewhat later; fish enter the stream in September and spawn until late October. Escapements for the even- and odd-year Nekite stocks averaged approximately 16,000 and 10,000, respectively, from 1950-1979. More recently, escapement of the even-year stock has declined to approximately 5,000, while odd-year escapement has increased dramatically to approximately 55,000. The escapement target for both odd- and even-year stocks is 60,000.

Statistical Area 10 chums are concentrated in the Nekite and Takush rivers and Walkum Creek. Nekite chums (currently the largest chum stock in Area 10) and Takush chums are actively managed. Walkum chums are subject to a passive management regime. Little is known about the migration pattern of Area 10 chums. Chums are present in the Area 10 fishery between late July and early November. Nekite chums are found in the fishery during August and early September, followed by the Takush chums during the remainder of September. These two actively-managed stocks do not overlap in timing during the fishery.

Chum escapements to Area 10 ranged from 15,000 - 30,000 from 1950-1979. However, beginning in 1980, escapement to the Nekite system increased rapidly, resulting in an average escapement of 60,000 from 1980-1983. Escapement targets to the Nekite, Takush and Walkum systems are 60,000, 15,000 and 7,500, respectively.

The Docee and Nekite rivers are the only chinook streams in Area 10; the Docee is the larger producer of the two. Escapements of chinooks to the area are currently 20% of the target (6,500).

The Nekite is the largest of the seven coho producers in the Area. The current coho escapements for the area are about 15% of the target of 10,700.

2.10.2 Fisheries

Area 10 salmon stocks are generally managed to produce optimum escapements. There is no fishery opening when run size is expected to be below optimum escapement. In addition, the early part of each fishery is monitored

carefully to establish quickly any deviation from the pre-season forecasts of run size. The run timing of stocks found in the fishery is presented in Figure 2.10-2.

Gill nets are the only gear employed in the Area 10 fishery, which opens for sockeye as early as the last week of June and may continue as late as early August. The emphasis of the fishery shifts in late July from one dominated by sockeye to pinks and chums. The majority of the pink catch is taken by mid-August. Nekite and Walkum chums are normally through the fishery by early September, while the Takush chum run does not usually peak in the fishery until the third week of September. Mesh size restrictions (to larger mesh) are used to protect pinks during those periods when both pinks and chums are in the vicinity of the fishery.

2.10.3 Current Enhancement Activities

The fertilization of Long Lake (Fig. 2.10-1) is the only salmon enhancement activity in Statistical Area 10. The lake was initially fertilized in 1976, 1977 and 1978 in an attempt to increase the production of Area 10 sockeye. The program was interrupted for two years in 1979 and 1980 because of an increase in stickleback populations which adversely affected salmon production. Fertilization began again in 1981 and has continued to date, apparently without a similar increase in the stickleback population. The returns from recent years have been good, with an average return rate of 3.9 fish per spawner.

There is some doubt as to whether this increase can be attributed to the enrichment program, because unfertilized Owikeno sockeye stocks in Area 9 also returned at an exceptionally high rate during the same period. The smolt abundance surveys taken by the Lake Enrichment Group (Table 2.10-1) indicate that the broods from 1981 to the present were very productive.

2.10.4 Habitat Status

Habitat descriptions for Area 10 sockeye, pink, chum, chinook and coho salmon are presented in Tables 2.10-2 through 2.10-6, respectively. For a description of the habitat tables, see Section 2.2.4.

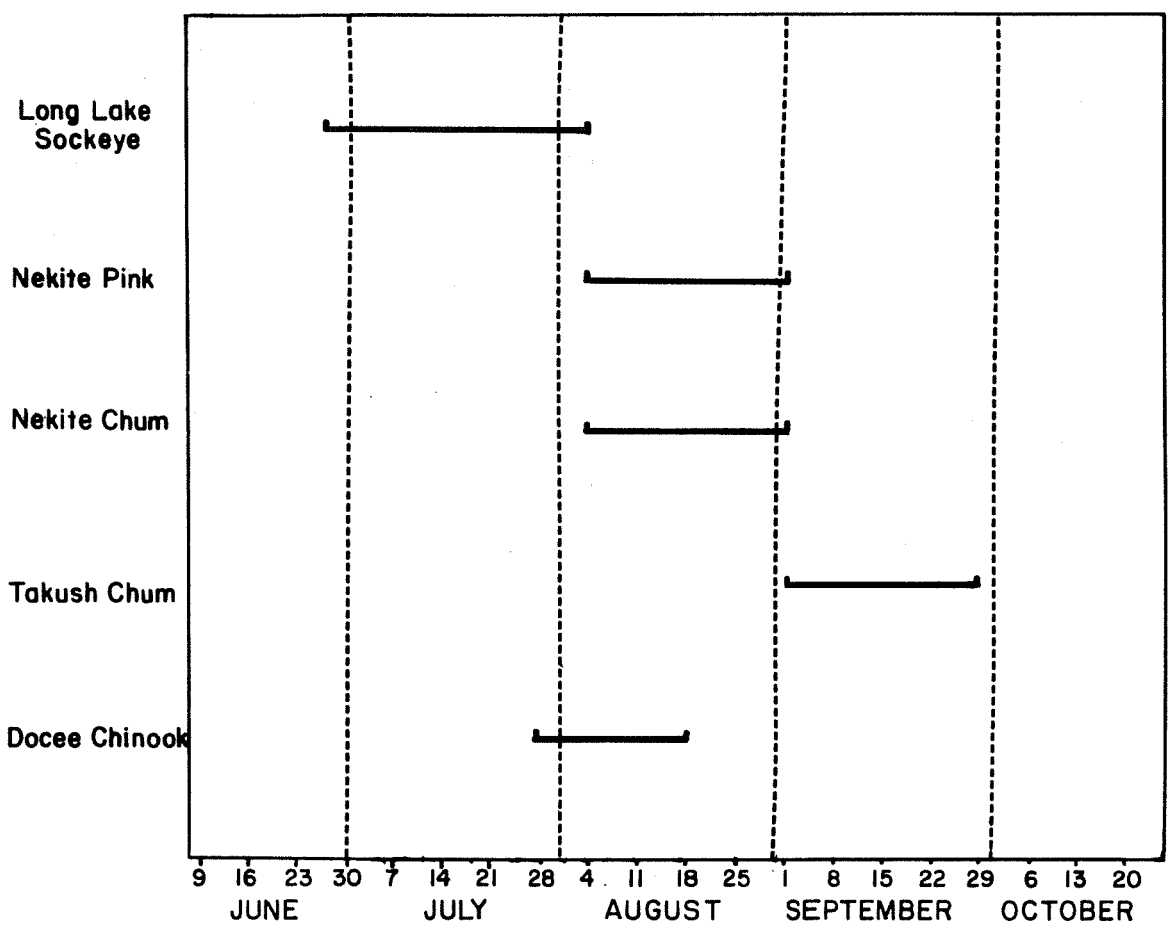


Figure 2.10-2. Stock migration timing through the fisheries in Area 10.

Table 2.10-1. Effect of the fertilization of Long Lake on the weight and density of sockeye salmon smolts.

Brood Year	Sample Year	Wt(g) Smolts	Treatment	Density Index #/ha	Escapement
1972	1973	2.2	Unfertilized		76,000
1975	1976	2.4	Unfertilized		63,000
1976	1977	4.9	Fertilized	790	61,000
1977	1978	2.3	Fertilized	1,166	129,000
1978	1979	1.2	Fertilized	1,683	84,000
1979	1980	1.9	Unfertilized	378	21,000
1980	1981	3.0	Unfertilized	860	128,500
1981	1982	2.5	Fertilized	2,800	215,000
1982	1983	2.2*	Fertilized	2,900	215,000
1983	1984	1.18*	Fertilized	1,485	200,000

* Computation method was altered.

Table 2.10-2. Statistical Area 10 sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	200	200	200

MANAGEMENT STYLE: Active X; Passive ____; Unknown ____

NUMBER OF STREAMS: 2

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability. Logging - low impacts during past decade.
Current Status	Current logging - low impacts.
Future Outlook	Logging likely to continue with improved concern for habitat management.
Natural Habitat Production Potential	Probably unchanged from historic status.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Medium	Unknown

CONCLUSION Seems to be a very stable stock.

Table 2.10-3. Statistical Area 10 pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	Unknown	60	5 Odd 55 Even

MANAGEMENT STYLE: Active 95%; Passive ____; Unknown ____

NUMBER OF STREAMS: 3

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability. Logging - low impacts during past decade.
Current Status	Current logging - low impacts.
Future Outlook	Logging likely to continue with improved concern for habitat management.
Natural Habitat Production Potential	Probably unchanged from historic status.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	Low	Unknown

CONCLUSION Target seems close to even-year current escapement - habitat does not appear to be a constraint.

Table 2.10-4. Statistical Area 10 chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	44	83	44

MANAGEMENT STYLE Active 90%
Passive
Unknown

NUMBER OF STREAMS 3

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability. Logging - low impacts during past decade.
Current Status	Current logging - low impacts.
Future Outlook	Logging likely to continue with improved concern for habitat management.
Natural Habitat Production Potential	Probably unchanged from historic status.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Low - Medium	Unknown

CONCLUSION Stock managers must have reason to assume target of double historic high can be reached. No habitat data to suggest otherwise.

Table 2.10-5. Statistical Area 10 chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
	3,500	6,500	1,200

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 2

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability. Logging: low impacts during past decade.
Current Status	Current logging - low impacts.
Future Outlook	Logging likely to continue with improved concern for habitat management.
Natural Habitat Production Potential	Probably unchanged from historic status.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium	High	High	High	Unknown

CONCLUSION Assume that augmentation is being considered, and that M.R.E. is considered low.

Table 2.10-6. Statistical Area 10 coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	34	11	2

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 7

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability. Logging: low impacts during past decade.
Current Status	Current logging - low impacts.
Future Outlook	Logging likely to continue with improved concern for habitat management.
Natural Habitat Production Potential	Probably unchanged from historic status.
Improved Production Potential	Restoration possibilities likely.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium	High	High	Medium - High	High

CONCLUSION

2.10.5 Management Conflicts

Conflicts discussed below include uncertainties in data, and the problems of mixed-stock harvests.

2.10.5.1 Management Uncertainties

In Area 10, the average migration timing of Long Lake sockeye through the Docee Fence has been compiled into a model that predicts total returning stock from escapement totals through the fence. The accuracy of the prediction increases as the season progresses, but there is still enough uncertainty to require that commercial test fisheries measure stock abundance. There is also uncertainty about the level of the Long Lake sockeye target escapement; however, this is a problem common to all stocks in all areas. Smith Inlet is unique in that productivities at various escapement levels can be evaluated.

2.10.5.2 Mixed-Stock Harvests

The mixed-stock harvest problems in Smith Inlet are relatively minor. Sockeye fishing in the outermost portion of Smith Inlet (M.U. 10-3) intercepts Rivers Inlet sockeye and may bias stock size projections for Smith Inlet sockeye. This increases the uncertainty in projections of total returning stock, and may result in fishery openings that are not warranted.

The Nekite chum and Nekite pink fisheries may conflict, but since the fishery uses only gill nets, restricting the nets to larger mesh sizes will protect pinks when fishermen are seeking chums; however, the converse is not necessarily true. A fishery on Nekite chum may intercept Docee River chinooks, and the later Takush chum fishery may intercept Area 10 coho.

2.10.6 Stock Rebuilding Potential

Area 10 sockeye stocks have essentially been "rebuilt". The Long Lake sockeye stock offers an almost unique opportunity to assess optimum escapement requirements because the catch and escapement data can be measured accurately. Long-term production may be increased by changing the present target escapements. This option may be raised with industry with the basic understanding that both higher and lower escapement levels would be examined.

Fisheries for managed pink stocks in Area 10 are not initiated unless a surplus is anticipated. Since there are essentially no losses attributed to mixed stock fishing, increases in production can be achieved only by reducing management uncertainty and by increasing the in-season response to environmentally-caused variability. A special opportunity may exist to re-establish pinks in the Takush River, as there is currently no exploitation of these stocks. Since the causal factor for the reduced even-year Nekite pink run was flooding during 1980 and 1982, pinks should increase quickly from the present depressed levels with no changes in current management, while odd-year Nekite pinks should maintain their present high production.

Current management policies have rebuilt Nekite chum stocks, and Takush chums are expected to respond in the next cycle. Future problems may result if Nekite pink stocks are rebuilt, as pink target fisheries would capture Nekite chums incidentally.

The exploitation rate for Nekite pinks may exceed that required for chums. Restricting nets to small mesh will help to decrease chum catches, but there will still be cases where chum escapements will suffer. Time and area closures may be of some benefit, but this information will have to be acquired during future fisheries. Further analysis of the relative merits of harvesting pinks at the expense of chums is required before the option of forgoing pink production to increase chum stocks can be properly considered.

Furthermore, if both pink and chum surpluses are available, methods would have to be devised to harvest pinks when the primary target is chums. Two possible solutions are as follows:

1. Allow only small mesh nets to ensure pink harvests, and increase mesh size if chum exploitation is insufficient; or

2. Allow some chum fishing days with large mesh nets before switching to pink harvest days with small mesh nets.

To achieve further chum production increases, we would have to reduce losses from environmental variability or management uncertainty.

2.10.7 Management Strategies for Stock Rebuilding

Rebuilding strategies are discussed below by species.

2.10.7.1 Sockeye, Pink and Chum Salmon

The only recommended change in management is to attempt to reduce management uncertainty for in-season management. At present, full fleet test fisheries are used to assess total run size. In years of poor returns, such test fisheries can take up to 50% of the total stocks, resulting in target escapement being missed. Development of test fishery charters or restricted entry vessel openings would reduce this potential impact, and allow target escapements to be met on a more consistent basis. A similar situation occurs with sockeye due to the mixed stock interception of Rivers and Smith Inlet stocks in Management Unit 10-3. The catch may bias the stock size projections for Smith Inlet. However, in some years, it may be difficult to catch sufficient Long Lake sockeye without fishing in this area (presuming a fishery is not opened in Wyclees Lagoon). Further study to evaluate the extent of this problem may confirm or reject the need for such a change.

2.10.7.2 Chinook and Coho Salmon

As a result of the Canada/U.S. agreement, large returns to the terminal areas are anticipated. Chinook catches will be monitored during future fisheries and time or area closures may be instituted to reduce the incidental catch. The extent of coho interception is not known. If a problem is identified, attempts will be made to reduce conflicts by time or area closures.

2.10.8 Future Enhancement Activities

Following is a description of a future enhancement project that is compatible with management practices. Accompanying the project title is the project number from Lill *et al.* (1983)[1].

---

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

2.10.8.1 Nekite Spawning Channel (Project No. 10 - 2A)

The Nekite chums provide an exceptional opportunity for spawning channel chum production. The stock is currently near the target escapement of 60,000 for the system. The objective is to increase the chum production to levels well in excess of the natural potential. The spawning channel production would also provide benefits by contributing to and stabilizing the natural spawning population in the river. A channel with a capacity of 135,000 is recommended. The Nekite chums will be harvested by gillnetters in Area 10. The primary fishing area would be Management Unit 10-4 and 10-5, with the potential to add M.U. 10-3, 10-7, 10-8, 10-9 and even 10-10, depending on returning stock strength and quality and the fleet size.

2.10.9 Predicted Results of Enhancement Options

No management options were modelled for this area. An analysis of the effects of reducing management uncertainty will be added in the next edition of this report. The enhancement option proposed involves building a spawning channel to increase the natural potential and stabilize the existing production. This option was evaluated with a simulation model. Three scenarios were proposed:

Base Case (Option 1)
- manage general fishery to any surplus of pink or chum stocks.
- no enhancement

Option 2 - Nekite enhancement - with management of a general fishery to Nekite chum target of 120,000 (60,000 river, 60,000 channel).

Option 3 - Nekite enhancement - with management of a general fishery to pink escapement and a target terminal fishery with chum nets on Nekite aggregate escapement of 120,000.

The results of this analysis are summarized in Table 2.10-7.

Table 2.10-7. Catch projections for Area 10 pink and chum salmon under the Base Case and two management options.

Option	Pink	Chum	Nekite Pink	Nekite Chum	Walkum Chum	NPV* at 10% (millions of $)
1. Base Case	121,537	44,107	58,700	79,000	9,050	10.6
2. Option 2**	27,046	268,948	157,970	117,065	1,498	24.1
3. Option 3**	109,766	263,227	51,475	116,540	1,408	28.1

* NPV = net present value
** See text for explanation

Note that under the Base Case (Option 1) all stocks are near or above target levels. However, in both Option 2 and 3 (with enhancement) Walkum chum stocks decline significantly. The difference between Option 1 and 2 lies in being able to "fine-tune" the management of pink salmon to avoid over-escapement. Catch of chums, on the other hand, climbs dramatically in Options 2 and 3 from 44,000 to over 260,000. Pink salmon, however, decline under both enhancement options from the Base Case but Option 3 shows a significant improvement over Option 2. Figures 2.10-3 to Figure 2.10-4 illustrate the trends in catch of pink and chum stock in the Base Case and Option 3.

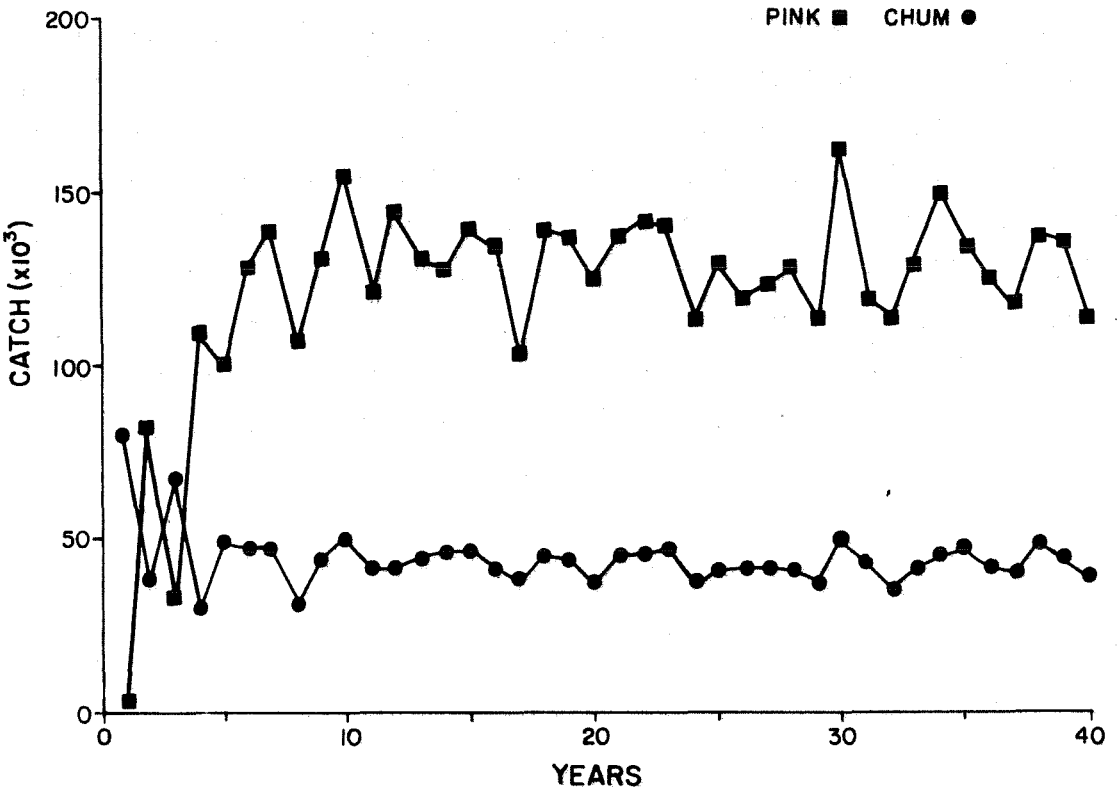


Figure 2.10-3. Catch trends of Area 10 pink and chum salmon under the Base Case.

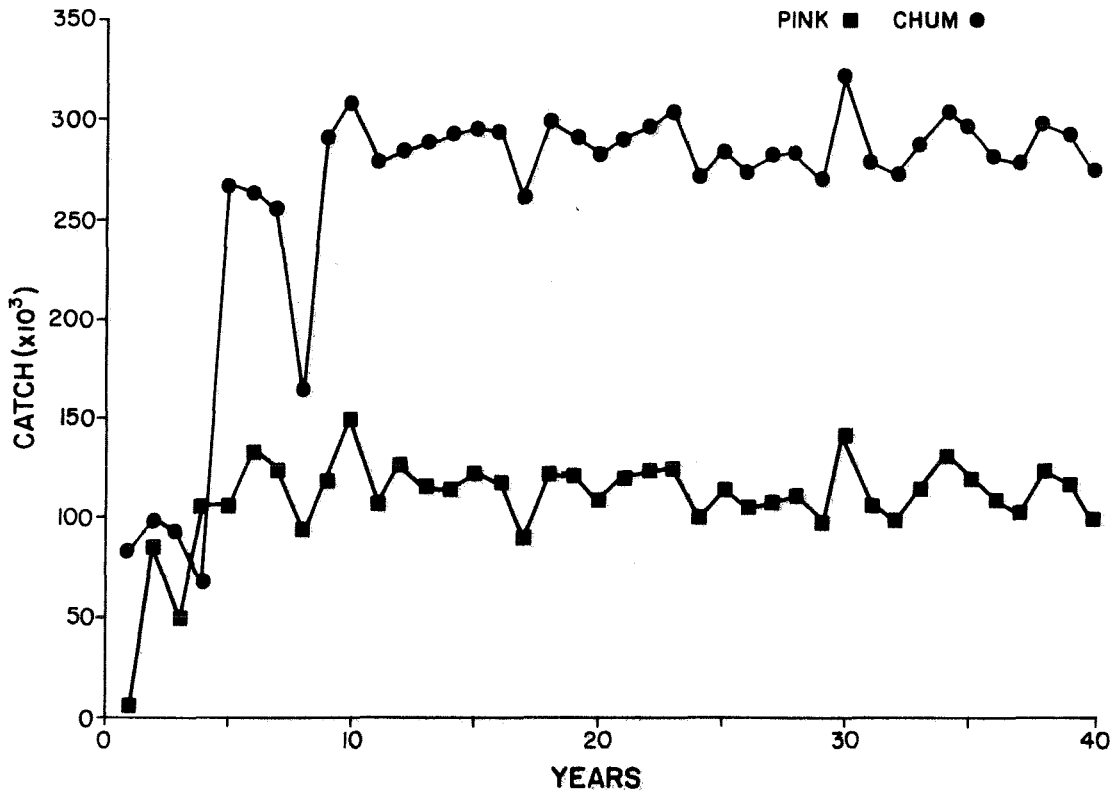


Figure 2.10-4. Catch trends of Area 10 pink and chum salmon under Option 3.

3.0 SOUTH COAST - FRASER SALMON RESOURCE MANAGEMENT PLAN

3.1 Overview

3.1.1 Introduction

This section of the report has undergone extensive revision since earlier drafts. The revision has been more than cosmetic; the organization has been changed from 22 sections describing specific stocks or groups of stocks, to seven sections covering discrete areas. The only stock-specific section remaining is section 3.10 (Inside Chums). A new area has been added, the Northern Transboundary Rivers (Section 3.9). There has been little opportunity for fishery managers to review the South Coast-Fraser section. Readers should consider all parts of it preliminary pending their review.

The South Coast region, for the purposes of this document, encompasses all of the salmon fisheries and stocks from Cape Caution to the Canada/U.S. border. The fisheries in the South Coast take twelve major stocks:

Sockeye
- Fraser River
- Barkley Sound
- Nimpkish River

Even-Year Pinks
- Johnstone Strait

Odd-Year Pinks
- Johnstone Strait
- Georgia Strait
- Fraser River

Chums
- Johnstone Strait
- Georgia Strait

- Fraser River
- West Coast of Vancouver Island

Chinooks

- Barkley Sound

The Fraser River pink and sockeye stocks are the largest on the coast of British Columbia and consequently dominate many of the South Coast fisheries.

The major net fisheries are in Johnstone Strait, the Strait of Juan de Fuca, and within the six sounds on the west coast of Vancouver Island. In all of these fisheries, the seine fleet takes the largest portion of the catch because of its efficiency. There are also gillnet fisheries in the Fraser River and in Barkley Sound. In addition, there are major troll fisheries, which harvest a significant portion of Fraser pink and sockeye, particularly along the west coast of Vancouver Island.

Three main issues involved in managing the south coast fisheries are:

1. Fleet Size: Usually the surplus available for harvest is moderate at best, and due to the large fleet size the fishery must be severely restricted (e.g., one day/week for 7-10 weeks) to prevent overharvesting.

2. Location of Fishery: Traditionally the south coast fisheries have focused their efforts on the approach routes of migrating stocks (i.e., Johnstone Strait and Strait of Juan de Fuca), where they intercept the most abundant stocks. Fishing for a number of stocks simultaneously causes the decline of less productive stocks.

3. Cyclic Dominance: Fraser River sockeye have quadrennial dominance cycles (see Section 3.8). This phenomenon greatly increases the complexity of harvesting the surplus production in the mixed-stock situations common to a number of south coast fisheries. In any given year some stocks are in their dominant year, others in their subdominant year, and still others in their lower abundance years.

3.1.2 Major Stocks and Fisheries

It is convenient to think of the salmon stocks of the south coast as belonging to two distinct groups depending on whether they are from streams on the inside (east) or outside (west) of Vancouver Island (Figure 3.1-1). Each is discussed separately below.

3.1.2.1 Inside Stocks

For the inside stocks, there are two routes by which the fish return to their natal streams; a southern approach route through Juan de Fuca Strait and a northern routes through Johnstone Strait (Figure 3.1-1). The proportion of each stock returning via each of these routes is fairly consistent from year to year. The major exception is the Fraser River sockeye with diversion rates (% of fish taking the northern route) that appear related to cycle characteristics and annual climatic conditions (Figure 3.1-2). The major stocks and their associated catch, escapement and total numbers are summarized in Table 3.1-1. Their migration routes are shown in Figures 3.1-3 to 3.1-8, and the timing of these migrations is summarized in Table 3.1-2.

Three major and three minor commercial fisheries are conducted in the inside south coast area from early June until the end of November (Table 3.1-3). The first major inside fishery is in Johnstone Strait, and concentrates mainly on Fraser-bound sockeye, pinks and chums. All gear types are used, with seiners harvesting the bulk of the available catch. This fishery continues to focus on the Fraser River stocks. It is managed by controlling harvests of Fraser River stocks. Harvests depend both on stock strengths and on the rates of diversion of pink and sockeye down the inside of Vancouver Island. This fishery is an intensive gauntlet which catches a multitude of stocks. A one-day fishery can result in a weekly exploitation rate of 60-70% of some of these stocks.

The second major inside fishery is in Statistical Area 29 between late July and early September. This is a gillnet and troll fishery formerly managed by the IPSFC for the Fraser River-bound sockeye and pink stocks. Fall chums may also be harvested in years of high abundance from October to November.

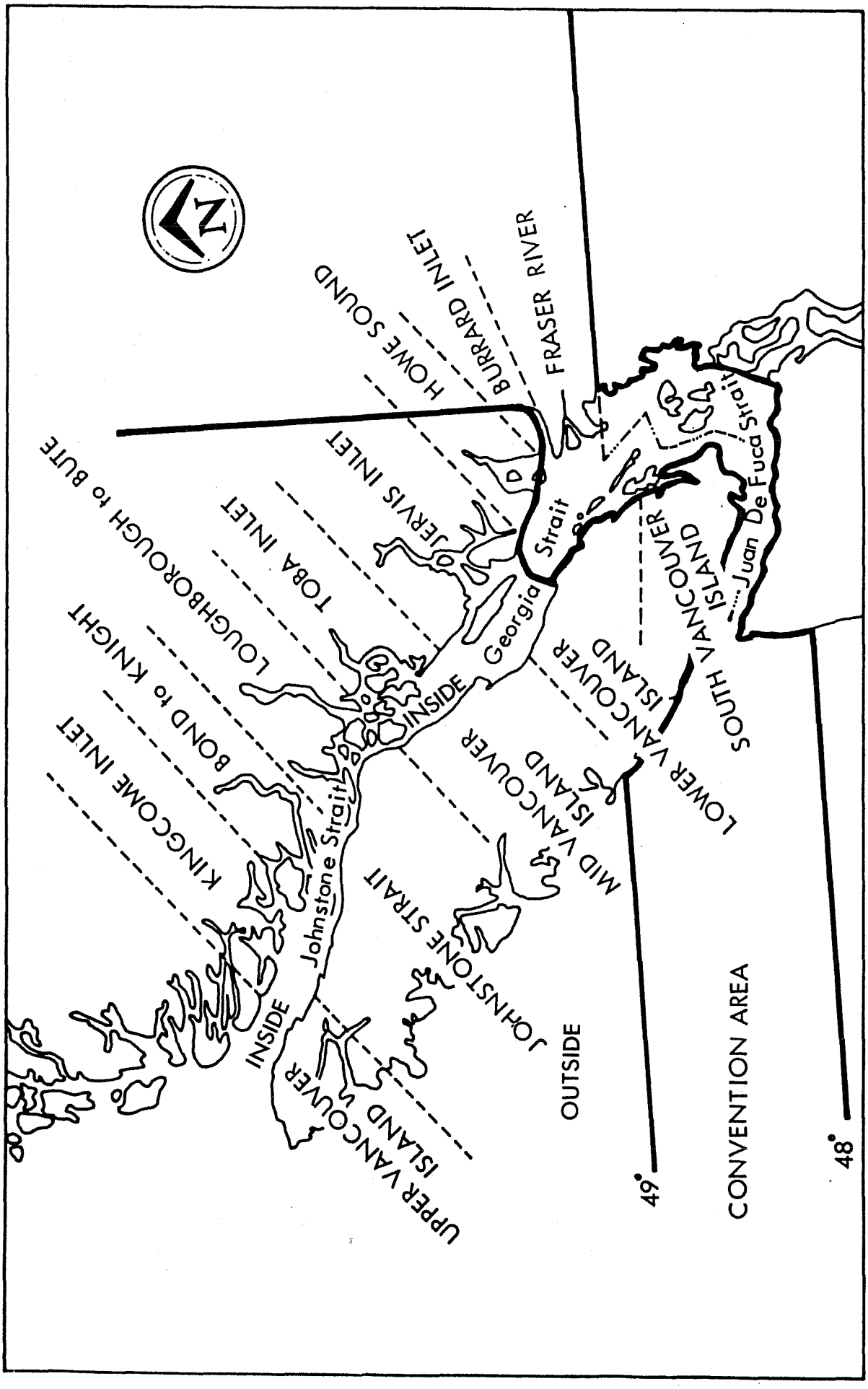


Figure 3.1-1. The inside South Coast, showing the major inlets and areas which have salmon stocks associated with them.

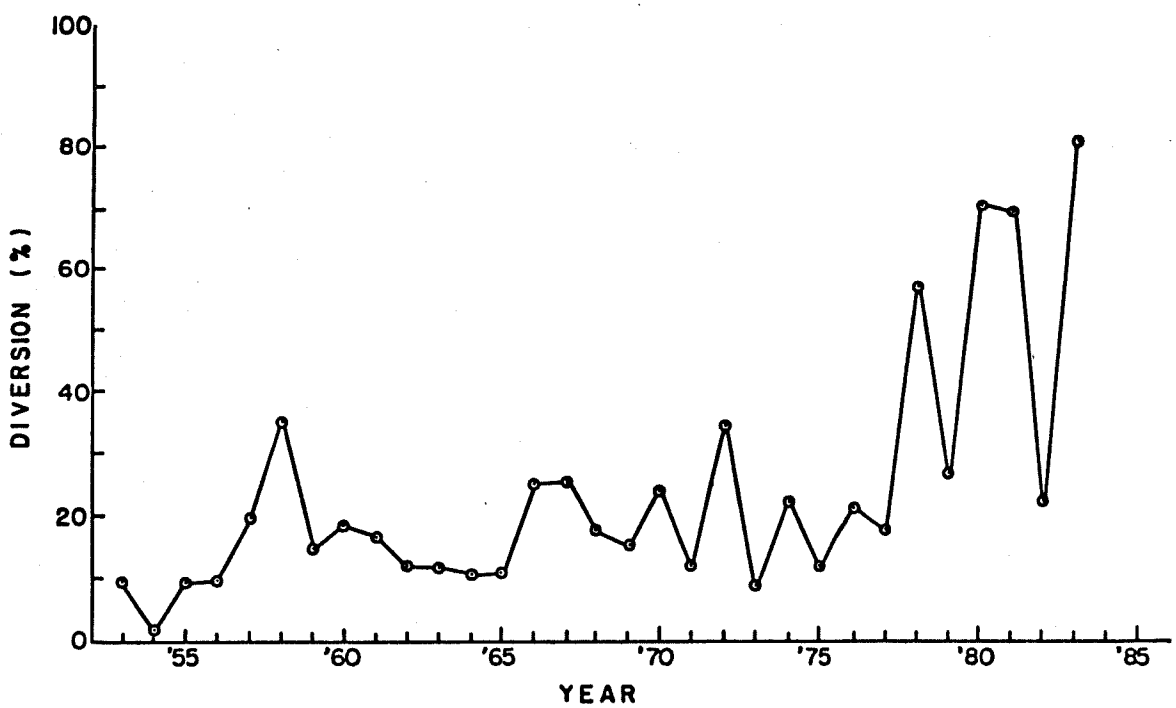


Figure 3.1-2. The percentage of Fraser River sockeye migrating via Johnstone Strait.

Table 3.1-1. Catch, escapement and total numbers of major stocks in the inside South Coast area.

Stock	Catch	Escapement	Total Stock
1. Sockeye			
Fraser River			
- 1978/82 Adams	6,290,000	2,430,000	8,720,000
- 1979/83 Chilko/Sub-Adams	4,780,000	1,095,000	5,875,000
- 1980/84 Chilko	2,446,000	711,000	3,157,000
- 1981/85 Early Stuart/Quesnel	4,554,000	1,118,000	5,672,000
Nimpkish	20,000	60,000	80,000
2. Pink (Odd)			
Fraser River	8,800,000	3,300,000	12,100,000
Johnstone Strait/ Georgia Strait	797,000	948,000	1,745,000
3. Pink (Even)			
Johnstone Strait	1,770,000	1,190,000	2,960,000
4. Chum			
Fraser River	1,770,000	440,000	2,210,000
Johnstone Strait/ Georgia Strait	929,000	906,000	1,835,000

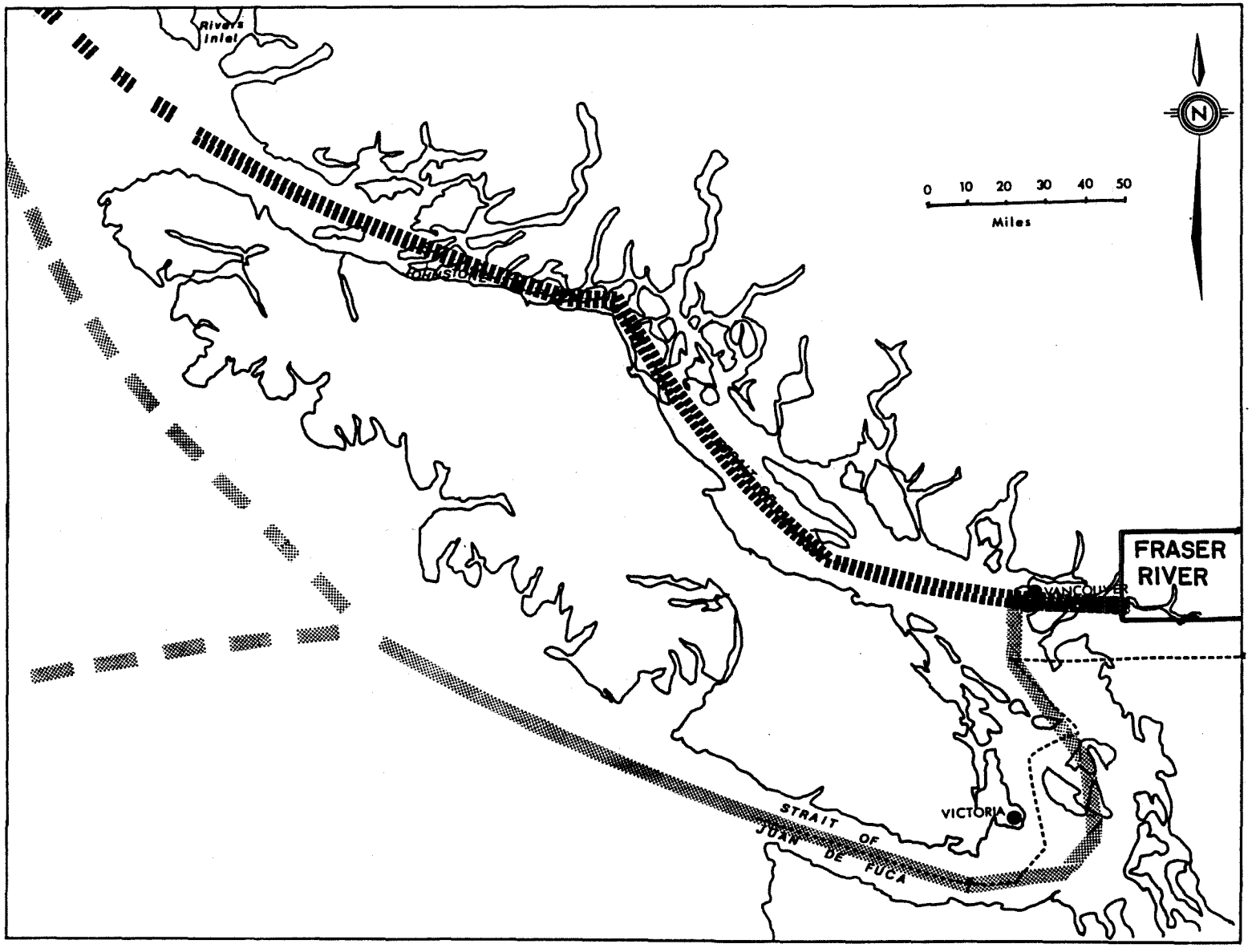


Figure 3.1-3. Major approach routes for Fraser sockeye.

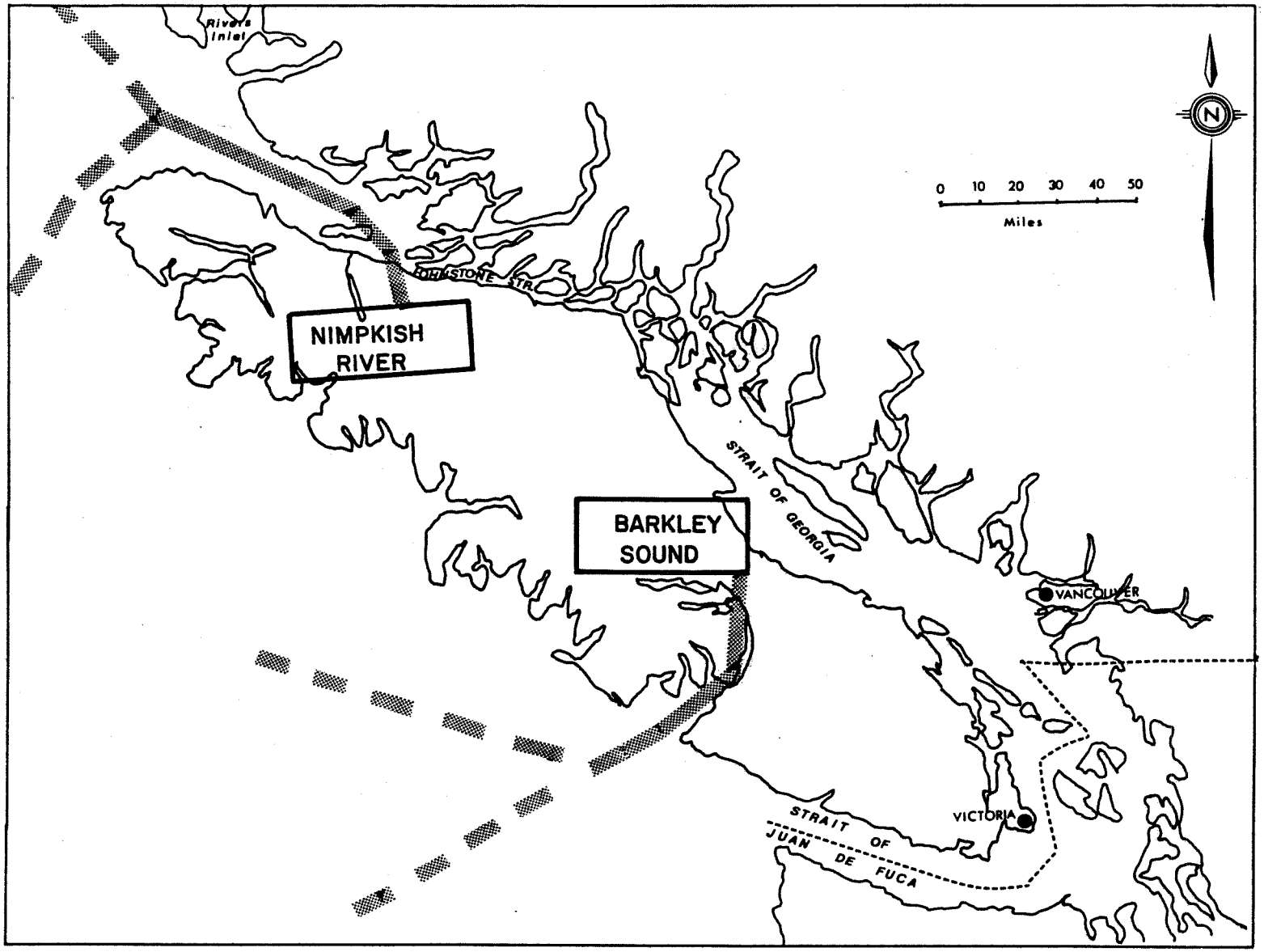


Figure 3.1-4. Major approach routes for Barkley Sound and Nimpkish River sockeye.

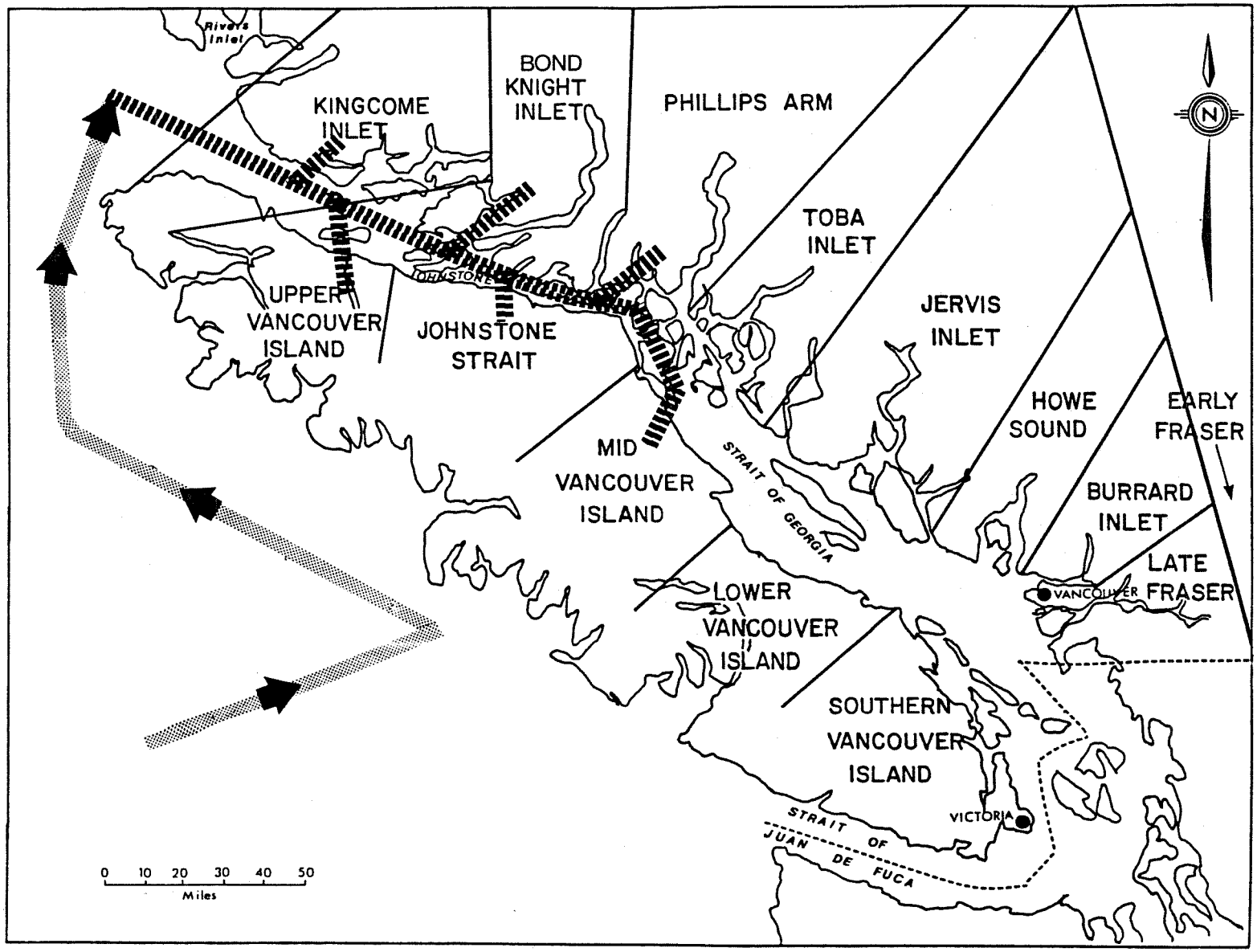


Figure 3.1-5. Major approach routes for Johnstone Strait even-year pinks.

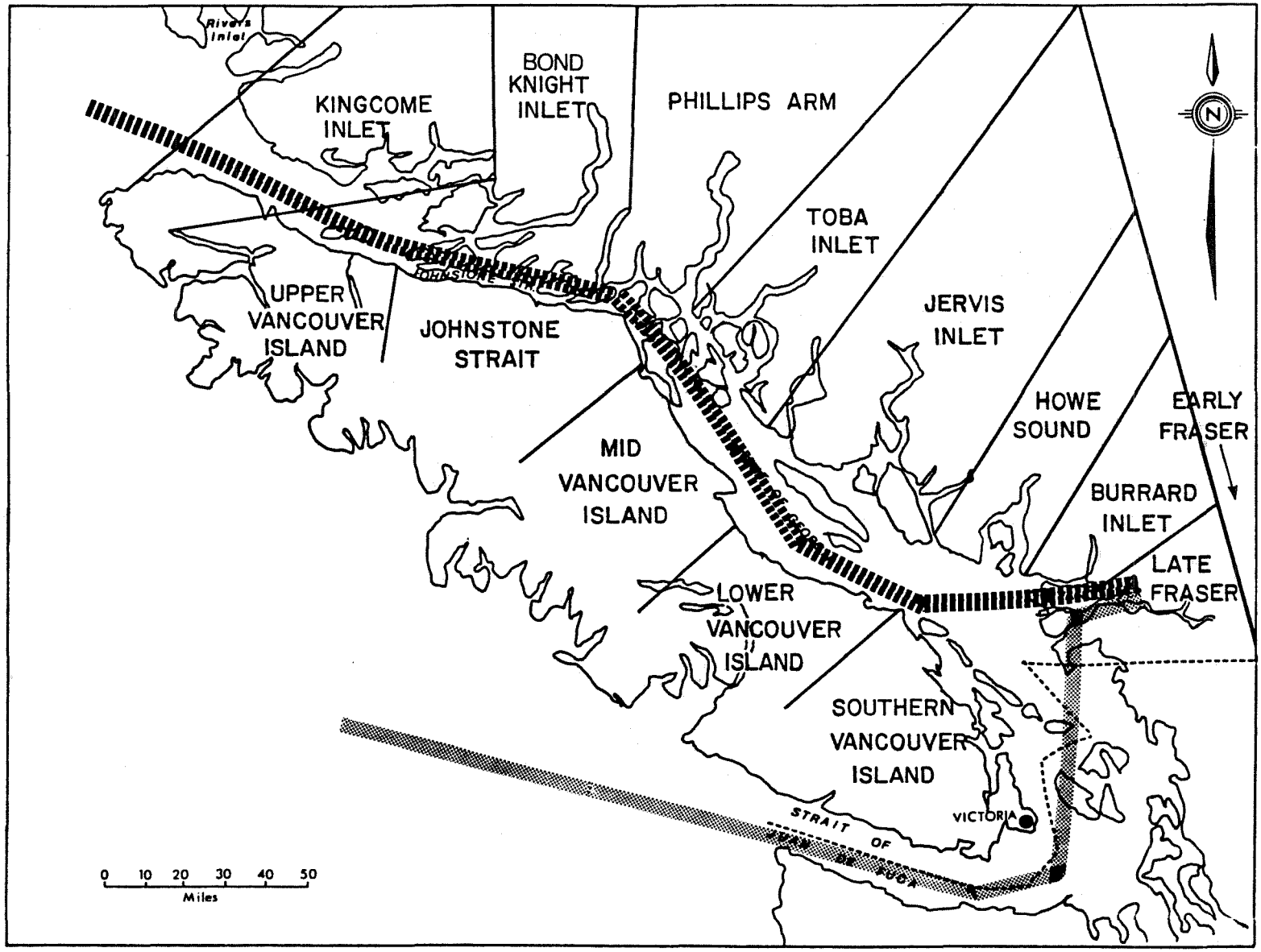


Figure 3.1-6. Major approach routes for Fraser River odd-year pinks.

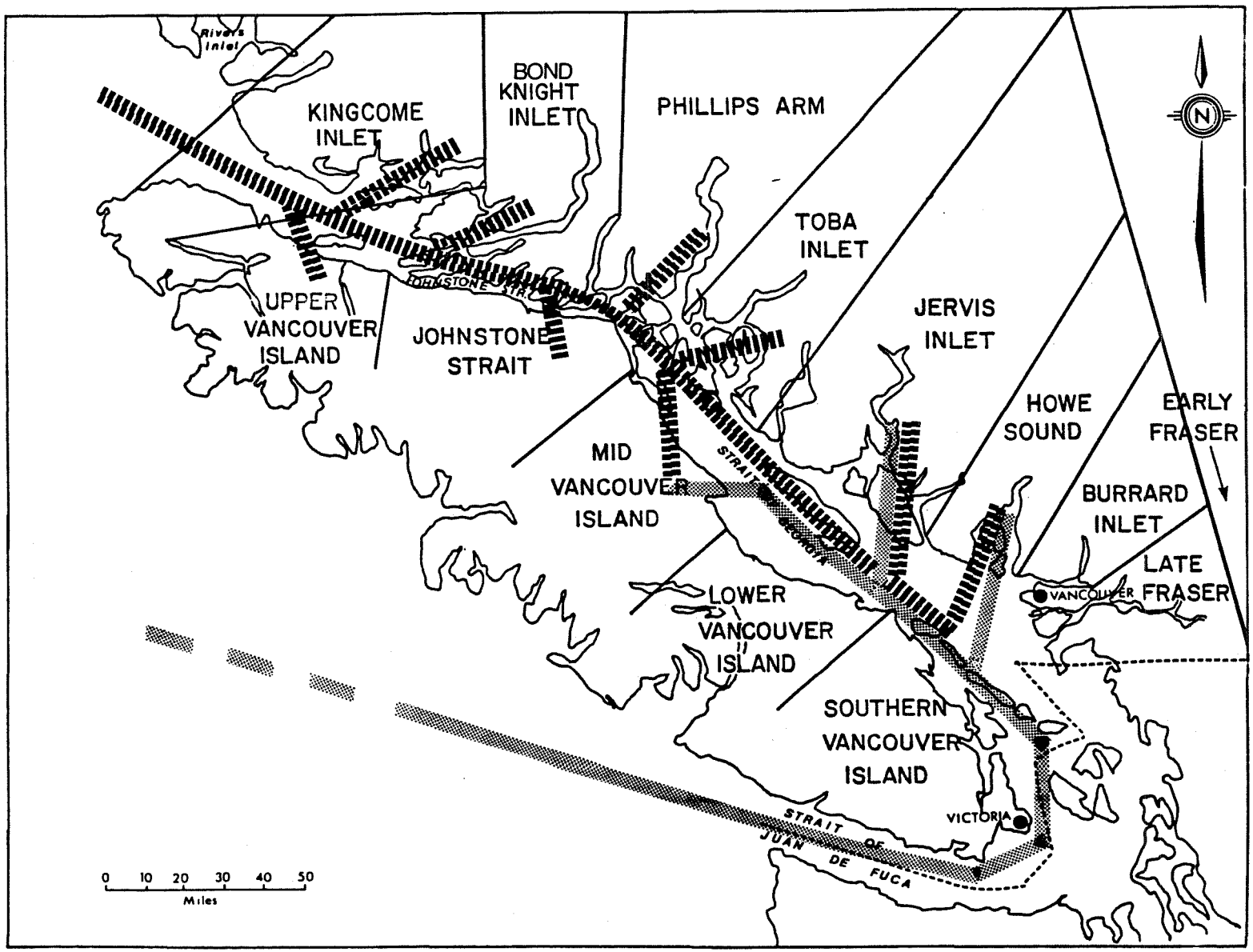


Figure 3.1-7. Major approach routes for Johnstone Strait - Georgia Strait odd-year pinks.

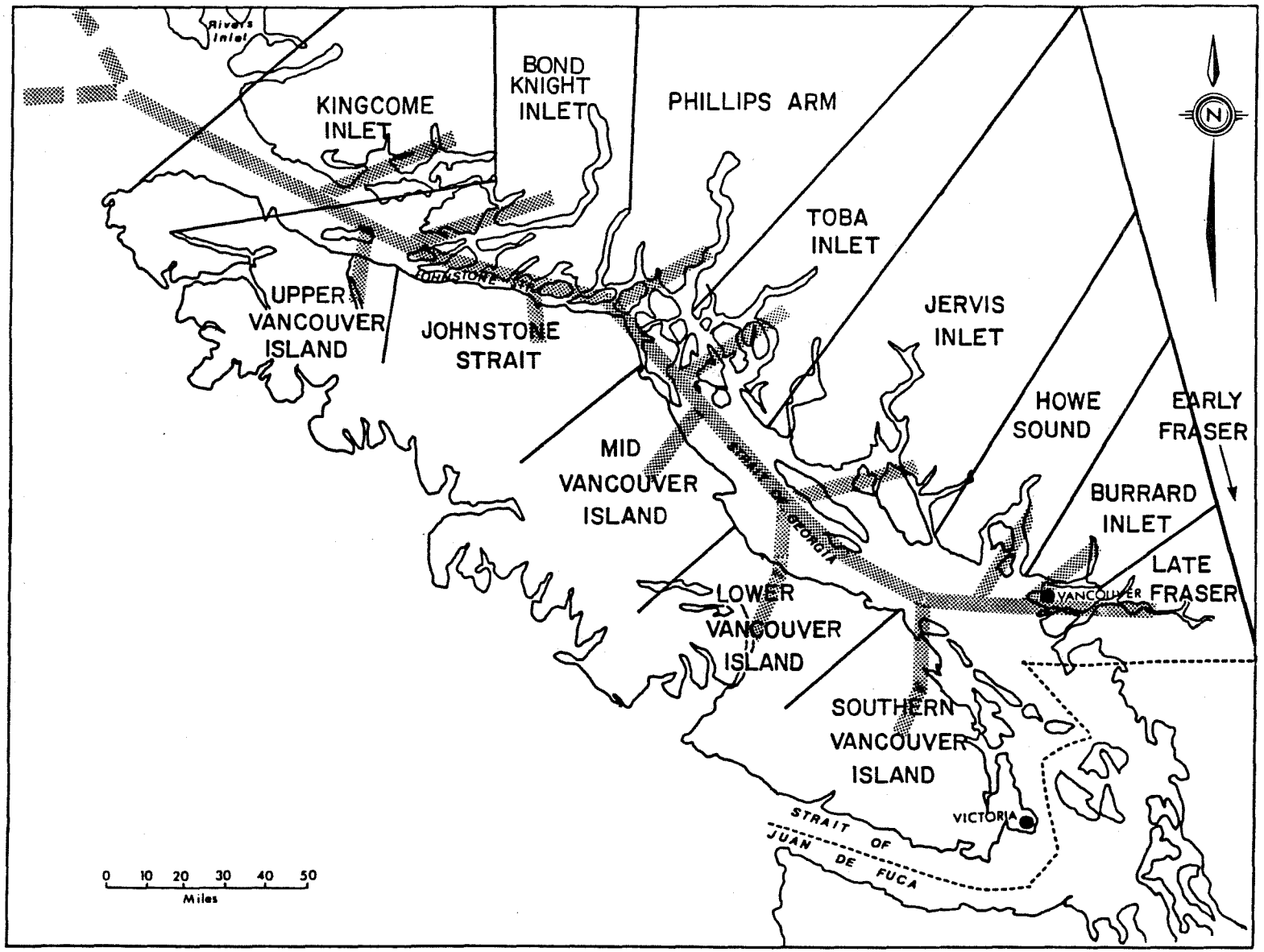


Figure 3.1-8. Major approach routes for Johnstone Strait - Fraser River chums.

Table 3.1-2. Dominant route and timing of major stocks in the inside South Coast area.

Stock	Approach Route	Run Timing
Sockeye		
Fraser		
1978/82 Adams	north and south	late August
1979/83 Chilko/Sub Adam	north and south	late July - August
1980/84 Chilko	north and south	late July - early August
1981/85 Early Stuart/Quesnel	north and south	July - early August
Nimpkish	north	mid-June - July
Pink (odd year)		
Fraser River	north and south	mid-August - early Sept.
Johnstone Strait/ Georgia Strait	north/south, respectively	July - August
Pink (even year)		
Johnstone Strait	north	July - early September
Chum		
Fraser River	north	September-November
Johnstone Strait/ Georgia Strait	north/south, respectively	mid-September - November

Table 3.1-3. Major stocks, run timing and gear type for the major and minor South Coast inside fisheries.

Fisheries	Major Stocks	Timing	Gear Type
Major			
Johnstone Strait	Fraser sockeye, pink and chum; even-year JS pink, odd-year GS/JS pink, and JS/GS chum	mid-July - - November	seine, gill net and troll
Fraser River	Fraser sockeye and chum	late July - early November	gill net and troll
Juan de Fuca Strait	Fraser sockeye and pink	mid-July to mid-September	seine, gill net and troll
Minor			
Sabine Channel	Fraser River sockeye	late July to early September	seine, gill net and troll
Mainland Area 12	Mainland Area 12 pink	late July-August	seine and gill net
Qualicum	Enhanced Mid-Vanc. Island chum	early October - end of November	seine and gill net

The third major inside fishery is in Statistical Area 20 in late summer. This is a seine and gillnet fishery for Fraser-bound sockeye and pinks using the southern approach. As with the Area 29 fishery, it has been managed by the IPSFC.

In regard to the inside "minor" fisheries, the first is conducted in Sabine Channel in Statistical Area 16 for passing Fraser River sockeye salmon. This fishery uses all gear types and extends from late July until the end of August. The 10-year average catch has been 65,000 sockeye, with the bulk of the catch being harvested by seiners. This fishery has been designed to maximize harvest of Fraser River-bound sockeye salmon which cannot be done in Johnstone Strait because of adverse impacts on other local stocks.

The Area 12 mainland pink salmon fishery occurs from the end of July to early September. It is a seine and gillnet fishery.

There is a chum fishery using gill nets and seines in the Qualicum area for enhanced stocks from the Puntledge and Big and Little Qualicum facilities. This fishery occurs from early October to the end of November. The 10-year average catch has been 69,000. Total escapement is 150,000 into the three production areas. This fishery is characterized by moderate to large numbers of boats (up to 800 gillnetters and 300 seiners) in a small area. Fish quality is a big concern in this fishery, and catch is generally somewhat low in quality. In recent years, the management approach (based on assumed stable production) has been modified to increase the quality of the catch.

3.1.2.2 Outside Stocks

There are two principal groups of stocks on the outside of Vancouver Island (Table 3.1-4). The migration routes for these stocks are well established (Figures 3.1-3 and 3.1-9) and are not subject to as many complicating factors as are the inside stocks.

At the present time one major and two minor fisheries are conducted in the outside south coast area between early June and the end of November (Table 3.1-5). The major outside commercial fishery occurs in Barkley Sound (Area 23) for enhanced sockeye stocks bound for Great Central and Sproat

Table 3.1-4. Catch, escapement and total numbers of major stocks in the outside South Coast area.

	Catch	Escapement	Total	Timing
Sockeye				
Barkley	610,000	270,000	880,000	June - July
Chum				
West Coast Vancouver Island	210,000	470,000	680,000	mid September - late October

Table 3.1-5. Major stocks, timing and gear types for the major and minor ouside South Coast fisheries.

Fisheries	Major Stocks	Timing	Gear Types
Major			
Barkley Sound	enhanced sockeye	early June - mid July	seine and gill net
Minor			
Barkley Sound	enhance chinook	mid August - early September	gill net
West Coast Vancouver Island	wild and enhanced chum	mid September - mid October	seine and gill net

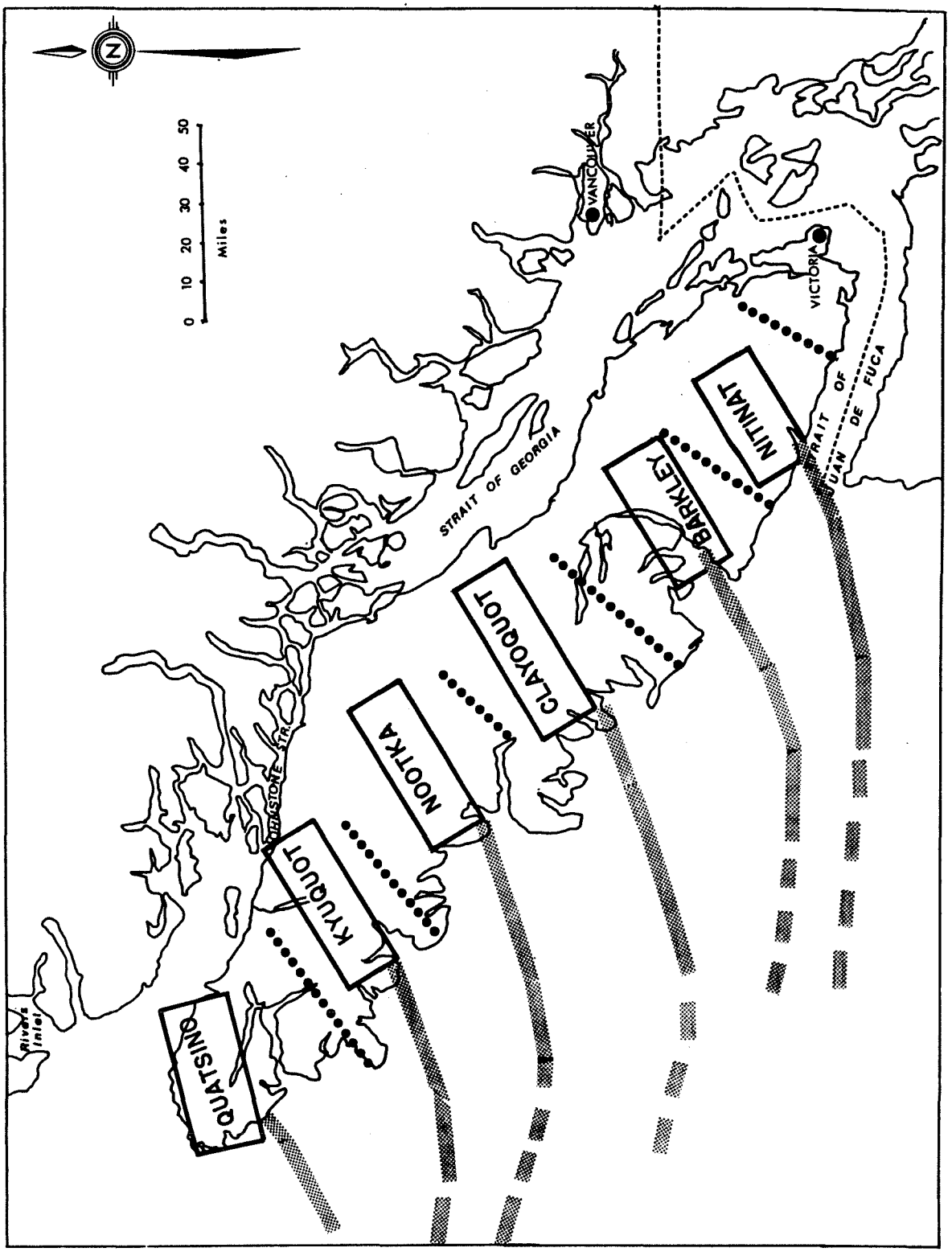


Figure 3.1-9. Major approach routes for West Coast Vancouver Island chums.

lakes. This is a seine and gillnet fishery which commences in early June and usually lasts until mid-July. The Barkley Sound sockeye fishery is conducted for two to four days per week, for about seven weeks. The catch in this fishery over the past 10 years averaged 600,000, and the escapement averaged 300,000. In recent years catches up to 1,400,000 have occurred.

As this is the first major net fishery conducted each year in the Pacfic Region, large fleet sizes are the general rule and conflicts often result. The fleet generally includes 200-300 seiners and 600-700 gillnetters. Gillnetters are permitted in the outside Barkley Sound area, and seiners are restricted to the inside canal area. The separation by gear type has served a major conservation need. By restricting the seiners to the inside canal, the catch of small chinooks has been reduced from previously high numbers (20,000-30,000) to less than 2,000.

One of the two minor fisheries is for wild and enhanced chum stocks on the west coast of Vancouver Island. This fishery has tended to be somewhat sporadic and only recently, with enhanced returns from Nootka Sound and Nitinat, does it appear that there will be some consistent fishing opportunities. This is a seine and gillnet fishery and, as with all chum fisheries, quality is a major concern. The 10-year average catch in this area has been 241,000 but, due to enhancement, catches should improve.

One of the few fisheries specifically for chinooks on the British Columbia Coast is in Barkley Sound. This minor fishery is for returning Robertson Creek surplus hatchery production. Total available harvests have been 50,000-70,000 in recent years. Gill nets are used exclusively in upper Barkley Sound to harvest the surplus, although a sport fishing catch in the outer sound is growing.

3.2 Upper East Coast Vancouver Island

This area includes the portions of Statistical Area 12 on Vancouver Island (Figure 3.2-1).

3.2.1 Stock Descriptions

Sockeye in the Upper East Coast Vancouver Island (UECVI) area are found in the Nimpkish river and lake system, located south of Port Hardy on northern Vancouver Island. Stocks return to an estuary emptying into Broughton Strait, between Malcolm Island and the northern portion of Vancouver Island. Nimpkish sockeye approach through Gordon and Goletas channels, enter the lower part of Queen Charlotte Strait and from there move through Broughton Strait and into the estuary. There are two distinct runs of Nimpkish sockeye. The first is an early run, mostly of 5-year old lake spawners, returning predominantly in June. The run ends in the first or second week of July. This stock is depressed to approximately 5,000-10,000, and is primarily harvested by the Indian food fishery. The second run, the main Nimpkish sockeye stock, returns later, migrating from the late part of June through the end of July or early August. The peak of this run is primarily in the second or third week of July in the Broughton Strait - Malcolm Island fishing area. Figure 3.2-2 shows the timing of runs entering the fishing area. This stock is primarily 4- and 5-year old fish. They are thought to be exclusively river spawners returning primarily to the outlet of Woss and Nimpkish lakes. Since the Nimpkish system is very large, there may be undiscovered lake spawners within both Woss and Nimpkish lakes.

Escapements of sockeye to the Nimpkish system averaged 90,000 from 1950-1959; 80,000 from 1960-1969; and 55,000 from 1970-1979. The 1980-1983 period had an average escapement of 46,000 (Figure 3.2-3). It should be noted, however, that as in other coastal sockeye systems, there may be an error (perhaps as large as 100%) in the estimation of total escapement. The target escapement for the Nimpkish River system is 150,000. However, with the anticipated returns of fertilization from the 1981 brood year it is possible that the 150,000 target should be increased to 250,000 sockeye.

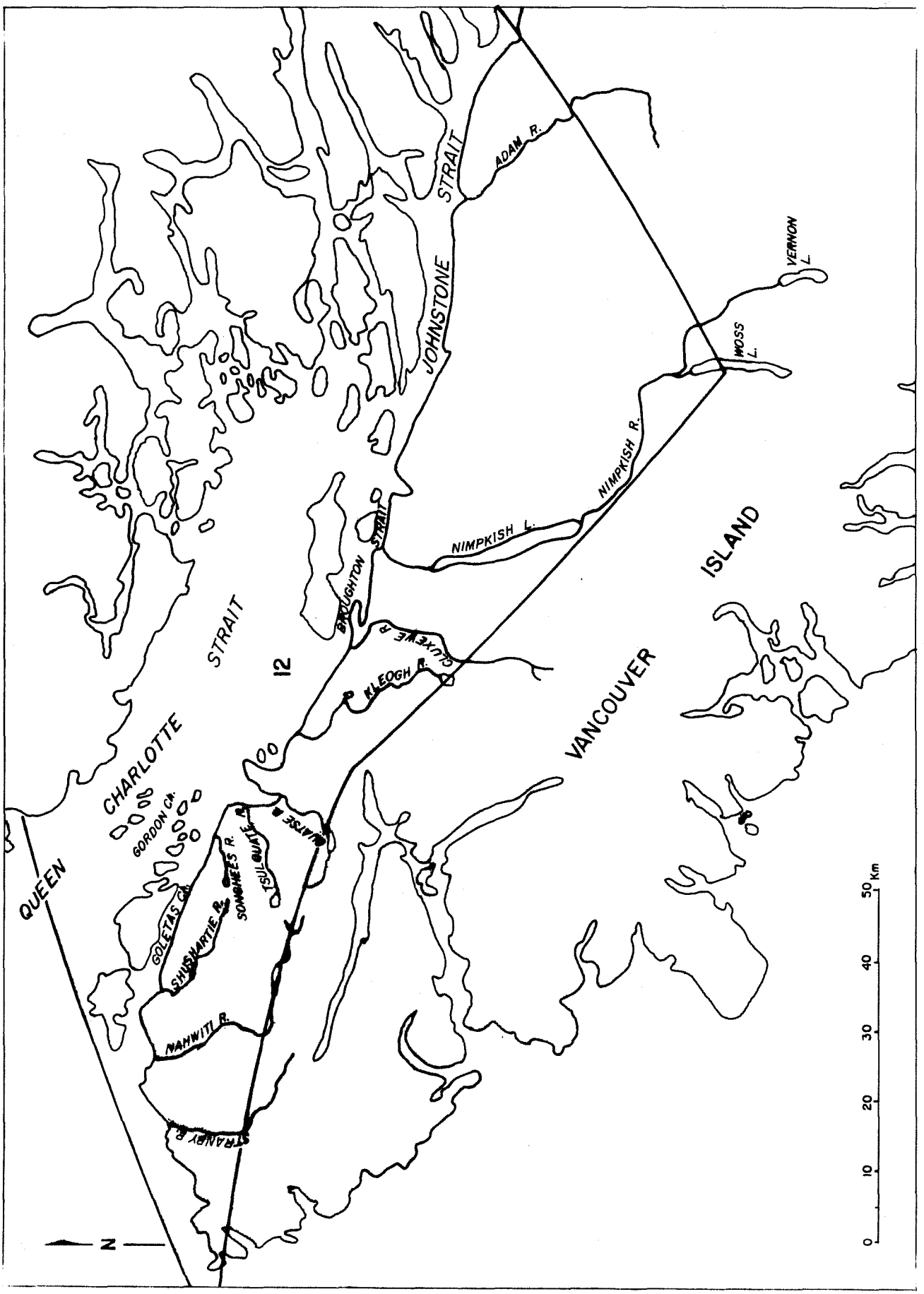


Figure 3.2-1. Upper East Coast Vancouver Island portion of Statistical Area 12.

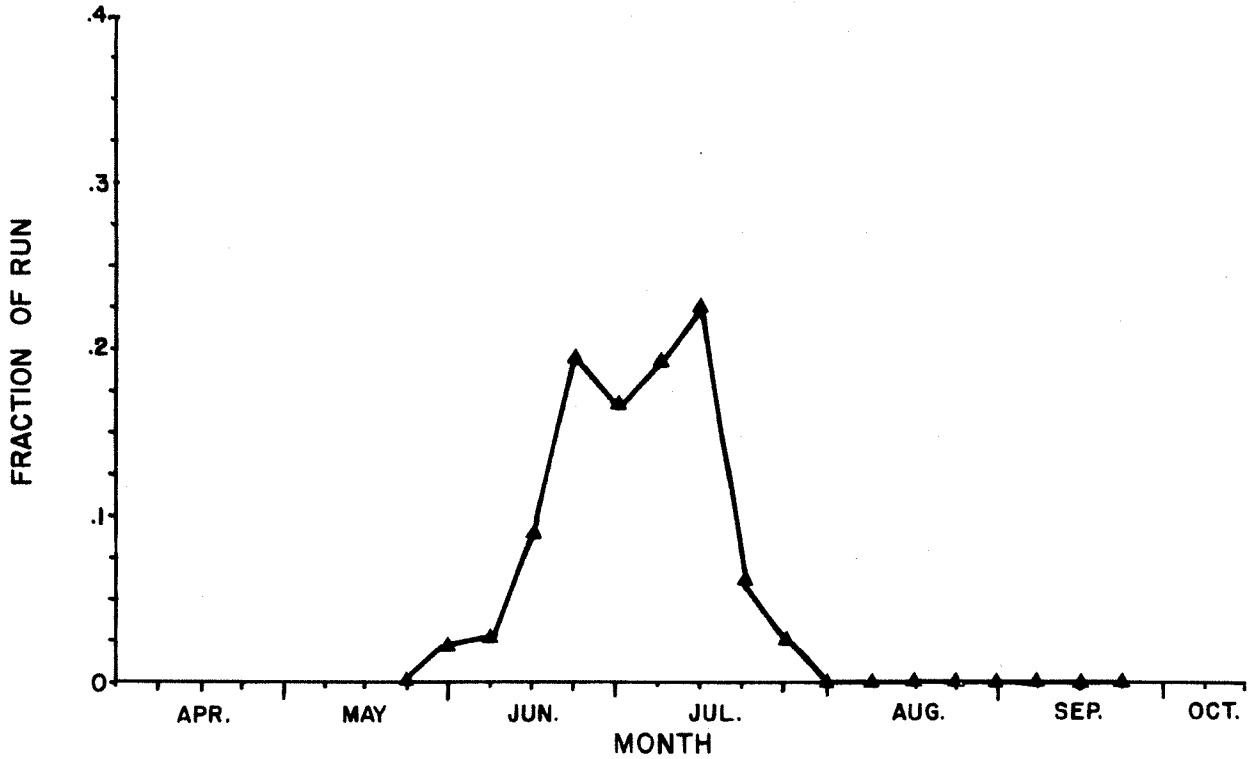


Figure 3.2-2. Timing of Nimpkish sockeye run.

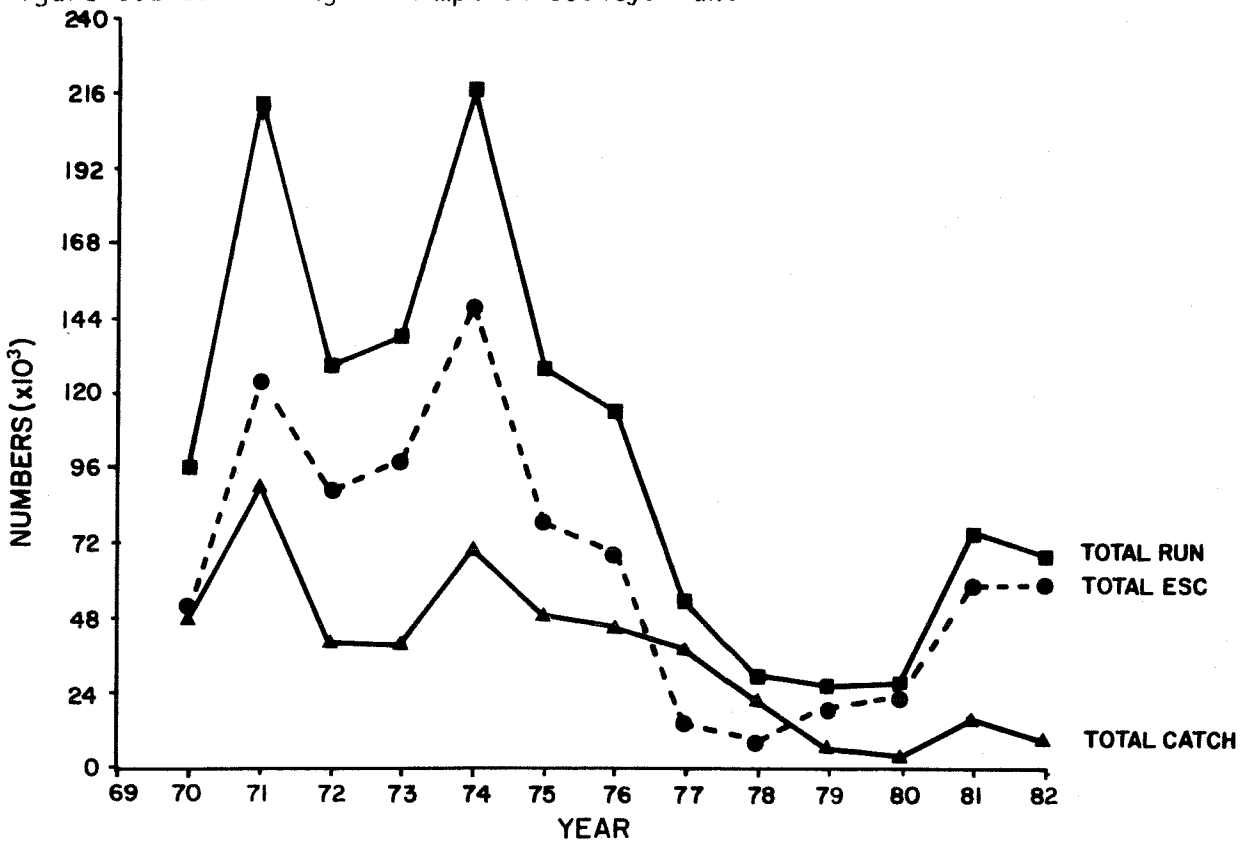


Figure 3.2-3. Total run size, escapement and catch of Nimpkish sockeye from 1969-1982.

UECVI pink stocks first enter upper Johnstone Strait in the second week of July, and are present in the area until the second week of August, peaking during the last week of July. The more northern stocks, which include the Shushartie, Nahwitti, Tsulquate, Stranby, and Songhees, no longer have any commercial value because their numbers have been so far reduced by intensive harvesting. These stocks approach the rivers primarily through Goletas Channel. The southern stocks (Quatse, Keogh and Cluxewe), which migrate through both Gordon and Goletas channels, are depressed but relatively stable. Currently there are no habitat problems or issues of concern that may affect their productivity. Pink escapement levels are severely depressed, particularly for stocks from streams north of Port Hardy. The current escapement target is 438,500. There is little information currently available on their productivity; however, it appears to be less than 1.5.

The two chum stocks in this area are in the Quatse and Cluxewe rivers. In 1984, the Quatse stock represented 88% of the total escapement. Escapement averaged 8,600 during the 1960's, and declined to 1,400 during the 1970's and 330 during the 1980's. Currently, this stock is depressed and shows little sign of recovery. The target escapement for the area is 33,000.

There are two chinook stocks in Area 12, in the Nimpkish and Quatse rivers. The Nimpkish is the largest and most important stock, representing 99.9% of the total chinook escapement in 1983. Escapement from 1961-1970 averaged approximately 11,000, and declined to an average of 3,000 from 1971-1980. Recent escapements averaged 1,000 from 1981-1983.

There are four coho stocks in Area 12. The primary producer is the Nimpkish River, followed by the Cluxewe and Quatse rivers. These three stocks accounted for 99% of the total coho escapement in 1983. From 1961-1970, escapements averaged approximately 42,000; 11,000 from 1971-1980; and 1,500 from 1981-1983.

3.2.2 Current Enhancement Activities

Enhancement facilities in operation in the UECVI area are presented in Table 3.2-1. They are described below by species.

Table 3.2-1. Enhancement facilities in the Upper East Coast Vancouver Island area (production capacity estimated from SEP biostandards).

Facility	Production Capacity		Target Stock, 1984
	Releases	Returns	
Sockeye			
Nimpkish	3,500,000	31,500	Willow
Pink			
Port Hardy (Quatse)	1,250,000	31,000	Quatse, Cluxewe
Chum			
Nimpkish	1,000,000	20,000	Willow
Port Hardy (Quatse)	1,000,000	20,000	Cluxewe
Total chum	2,000,000	40,000	
Chinook			
Nimpkish	150,000	4,500	Nimpkish
Coho			
Port Hardy (Quatse)	250,000	7,500	Quatse, Cluxewe
Nimpkish	150,000	4,500	Nimpkish
Total coho	400,000	12,000	

3.2.2.1 Sockeye Salmon

The Nimpkish sockeye stock is the only sockeye stock in British Columbia that SEP is enhancing using hatchery technology (other than minor work at Skidegate). The Nimpkish hatchery plans to release fry into Nimpkish Lake; coupled with lake fertilization. This will accelerate rebuilding. While many DFO staff feel hatchery production should shift from sockeye to other species (leaving lake fertilization to enhance sockeye), there is a strong desire in the community to continue sockeye work.

While sockeye hatcheries were very popular in British Columbia during the early 1900's, their overall success is questionable. More recent experiences in Alaskan hatcheries and in British Columbia spawning channels suggest that some past failures were very likely due to IHN virus, which normally causes mortality during the late alevin and early fry stages. IHN virus is found in virtually every sockeye stock examined. The potential for outbreak of disease appears to increase if fish are stressed during critical stages of their development. All enhancement facilities in British Columbia release sockeye as emergent fry, although hatchery rearing on pilot-scale levels has demonstrated that high quality smolts can be produced. Mixing sockeye with other species is avoided in British Columbia hatcheries because of the potential for transfer of IHN virus to chinook and steelhead in particular. Both these species suffer heavy losses on the Columbia River due to this virus.

3.2.2.2 Pink Salmon

There is one enhancement facility for pink salmon in the UECVI area. Pink salmon enhancement usually involves improving egg-to-fry survival either in a spawning channel or an incubation box, followed by release of emergent fry. Post-release survival rates for pink fry are high compared to other salmon species, especially considering that they are relatively small at emergence. This survival advantage is correlated with their early age of maturation. The Quatse facility incubates pink salmon eggs in gravel boxes. The Port Hardy facility deals with two stocks, Quatse and Cluxewe.

3.2.2.3 Chum Salmon

UECVI chum enhancement facilities all incubate eggs in artificial containers; fish at Nimpkish and Quatse are reared to a weight of approximately one gram before release.

3.2.2.4 Chinook Salmon

Nimpkish chinooks are released as 90-day smolts. Marking of the Nimpkish stocks will provide ocean catch distribution data for stocks in areas where such data are not currently available.

3.2.2.5 Coho Salmon

The facilities in the UECVI area plant coho fry or fingerlings. There are many depressed coho stocks in the area. This has resulted in considerable discussion about the benefits and advisability of colonization and transplant work.

3.2.3 Fisheries

The current management approach for Nimpkish sockeye is to control escapement, with a target of 150,000 (total of both early and late stocks). However, there is currently no way of determining stock abundance in the Upper Johnstone Strait and Queen Charlotte Sound areas during the season. As a result, since stock expectations are well below the required 150,000 sockeye, all fisheries along the migration route are kept closed until the end of July. Interception Areas 27 and 11 are also closed during this period. Past studies have indicated that 85-90% of the stock has entered the river (or at least the estuary area) by this time.

UECVI pink stocks migrate to the spawning areas by two approaches, Goletas and Gordon channels. As individual river systems are managed to produce their target escapements, and all stocks are depressed with no allowable surpluses, the Goletas Channel fishery has been closed. UECVI stocks returning through Gordon Channel are protected by the Nimpkish closures until late July. In general, management regulations have been developed to limit the

harvesting of UECVI pinks throughout their migration. Nonetheless, UECVI pink stocks are subject to differential harvest rates which depend on approach route and timing. The more northern stocks which migrate through Gordon Channel are harvested only by a northern troll fishery which takes 3-5% of them . Those stocks returning south of Hardy Bay and approaching through Goletas Channel likewise have only a 3-5% harvest rate. However, the southern stocks migrating after mid-July through Gordon Channel pass through an intensive net fishery which has a 60% harvest rate (30% for combined approaches).

3.2.4 Habitat Status

Habitat summaries for UECVI sockeye and pink salmon and Johnstone Strait coho salmon are presented in Tables 3.2-2 through 3.2-4, respectively. For a description of the habitat tables, see Section 2.2.4.

3.2.5 Management Conflicts

Despite a low harvest rate, Nimpkish sockeye stocks have not rebuilt naturally. This is thought to be related to environmental conditions and/or interactions within the lake and marine environment. For example, one hypothesis is that parasites reduced the stock to such low levels during the mid-1970's as to preclude the rebuilding of this stock. In addition, Indian food harvests of approximately 5,000 per year (primarily early Nimpkish sockeye) have also contributed to a decrease in the overall production of the system. Of particular concern is the effect of harvesting Nimpkish sockeye on even- and odd-year Keogh and Cluxewe River pink stocks. These two stocks border on the Nimpkish estuary, and taking Nimpkish sockeye most certainly will harvest these stocks. Enhancement must increase the productivity of both of these stocks if they are to co-exist.

UECVI pink stocks north of Hardy Bay are harvested at a rate of 3-5% by the northern troll fishery. It is suspected that some may also be harvested by the WCVI troll or central coast net fisheries, but there are no existing data to support this assumption. Despite these low levels of harvest, these stocks are too depressed to rebuild by management action alone. The stocks south of Hardy Bay are also harvested at a rate of 3-5% by the northern troll fishery, followed by a 30% harvest rate by the Gordon Channel fishery.

Table 3.2-2. Upper East Coast Vancouver Island sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	150	225	10

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 1

HABITAT NOTES

Historic Status, Production Constraints and Development History	Nimpkish River naturally stable - no flash floods. History of logging since turn of century with moderate impacts. Forest spraying; moderate - heavy impacts.
Current Status	Much of watershed in second growth. Logging continuing with better environmental control.
Future Outlook	Continued forestry with improved concern for fish habitat.
Natural Habitat Production Potential	Could return to historic levels.
Improved Production Potential	Lake fertilization.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	Unknown*

CONCLUSION

* It is assumed that lake fertilization accounts for target in excess of historic high.

Table 3.2-3. Upper East Coast Vancouver Island pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	460 ?	500	80

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 14

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow instability. Logging has had low - moderate impacts. Some spawning gravel may have been lost.
Current Status	Logging to continue at lower level than in past with better habitat concern. Watersheds in recovery phase.
Future Outlook	Recovery of watersheds. Much lower forestry impacts.
Natural Habitat Production Potential	Should return to natural levels.
Improved Production Potential	Headwater flow control.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	Medium - High	High	High	Unknown

CONCLUSION Habitat is probably not a constraint.

Table 3.2-4. Johnstone Strait coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	280		15

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: *

HABITAT NOTES

Historic Status, Production Constraints and Development History	Coho likely to be species most affected by development. Logging and limited settlement has had a low - moderate impact. Historic high falls in the middle of the logging activity that could have impacted habitat. Localized natural summer low flow and winter flooding problems probably compounded by development.
Current Status	Probably improving as forest regeneration occurs, coupled with improving habitat protection.
Future Outlook	Medium-range recovery to historic levels in 10 - 15 years.
Natural Habitat Production Potential	Recovery to near historic levels.
Improved Production Potential	Localized opportunities for restoration and flow control.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium - High	Medium - High	High	Medium - High

CONCLUSION Spread between current and high esapements cannot be accounted for through habitat changes.

* General habitat notes.

3.2.6 Stock Rebuilding Potential

It is anticipated that the potential sockeye production from the Nimpkish system, including Woss, Vernon and Nimpkish lakes, is from 700,000-1,300,000 adults per year. The SEP assessment of the Nimpkish Lake system states that Nimpkish Lake stocks can be enhanced by fertilization.

There are no management options available for rebuilding pink stocks north of Hardy Bay. As a result, they can be rebuilt only through transplants from the Quatse or Cluxewe rivers, together with maintenance of the Goletas Channel closure. Should the transplants be successful, it is anticipated that it will take from three to five cycles to reach optimum escapement. The pink stocks south of Hardy Bay can be rebuilt with the current management practice of using large stream box boundaries, and the continued and lengthened closure of the Gordon Channel fishery. There may also be some opportunities for habitat enhancement for these systems, which could boost or stabilize current rates of production. It is anticipated that by using management practices only, it will take from five to ten cycles to reach optimum escapement.

3.2.7 Management Strategies for Stock Rebuilding

Strategies are described below for rebuilding stocks of Nimpkish sockeye and of UECVI pinks.

3.2.7.1 Nimpkish Sockeye

Management to rebuild Nimpkish sockeye stocks began in the mid-1970's. No immediate stock increases occurred, and more stringent area closures were implemented in 1979. At that time the upper portion of Area 12 (Queen Charlotte Strait) northwest of the Nimpkish estuary was closed to all commercial fishing. Review of Nimpkish sockeye harvests (through scale analysis and stock reconstruction) indicates that harvests are generally not substantially greater than 10% per year (1982-1983). There are currently no further major rebuilding options strictly by means of management that can reduce the harvest rates significantly.

The Nimpkish system is currently being enhanced by lake fertilization. It is important to note that there are three separate lake drainages (Nimpkish, Woss and Vernon) within the overall Nimpkish watershed. If all three systems have discrete stocks with different productivities, and if harvest rates are keyed to the most productive, enhancement of one system will eventually reduce the stocks in the other systems. If future studies indicate that either the Woss or Vernon Lake stocks are being over-harvested as a result of Nimpkish production, it is recommended that the other two stocks be enhanced to increase their productivity.

In order to manage Nimpkish sockeye stocks (once rebuilding has taken place), it will be necessary to:

1. Obtain test fishery indices or enumeration methods for estimating the total stock abundance, run timing (Nimpkish plus other stocks) prior to entering the fishery area, and accurate catch information from the fishery;

2. Develop stock identification methods in the fisheries to separate Nimpkish sockeye from UECVI and Fraser River sockeye. This information is required while fisheries are in progress, to allocate catch by stock;

3. Make daily escapement counts in the Nimpkish River. This will require a fence to be constructed on the Nimpkish River;

4. Continue monitoring smolt outputs from Nimpkish, Woss and Vernon lakes. This means a continuation of the current SEP lake monitoring program. This program is required to estimate survival of freshwater and marine stages;

5. Increase enforcement of both harvest and habitat legislation throughout the watershed; and

6. Obtain basic biological data required for management, e.g.:

a) Identification of spawning areas and segments of the run utilizing each area (radio tagging program required);

b) Escapement information by spawning area;

c) Egg deposition and retention (required to understand long-term optimum escapement parameters);

d) Proportion of jacks on spawning grounds as well as in catch; and

e) Age class of fish on spawning grounds and in the fishery.

Predicted results of altering or maintaining harvest rates with and without lake fertilization are described in Section 3.2.9.

3.2.7.2 Pink Salmon

There are a number of management options that could be considered viable means to rebuild UECVI pink stocks, including:

1. Reduce or eliminate the northern troll catch (Area 11) and the WCVI troll catch. Elimination could reduce the catch by 5% for Area 11 and 10-15% for the WCVI troll fishery;

2. Eliminate the Gordon Channel pink catch, which would potentially reduce the harvest rate of the catch of UECVI stocks migrating to the Keogh, Quatse and Cluxewe by 30%. This may only result in limited overall reductions in the harvest rates, since a portion of southern stocks are through the upper Gordon Channel fishery prior to mid-July;

3. Prevent seiners from fishing above Lewis Point; and

4. Restrict the intensity of net fishery above Lewis Point until the end of the first week in August. This requires more detailed information about migration timing.

In summary, management options are limited and current fisheries management practices have largely eliminated most fisheries for UECVI pink stocks.

To achieve rebuilding and stock stability in the long term, additional management requirements are obligatory. These are:

1. A better understanding of migratory pathways and timing of UECVI pinks. Recent research on stock separation techniques employing electrophoretic analysis should be continued;

2. A large tagging program for pinks should be considered if electrophoresis will not discriminate between stocks;

3. Enforcement and protection especially for the area north of Port Hardy must be expanded;

4. Enumeration fences will be required as the stock sizes increase and terminal harvesting initiated; and

5. Basic biological data regarding spawning locations, escapement information, egg retention, egg deposition information, over-winter survivals and fry output information etc. will be required to manage these stocks for optimal production.

In order to select the best rebuilding option, and to manage after rebuilding, additional information is required on migration routes and timing.

3.2.8 Future Stock Enhancement Activities

Enhancement opportunities to be considered for the northern group of pinks include:

1. Transplanting using the Quatse, Keogh and Cluxewe group as the donor stock after those stocks have been rebuilt;

2. Setting up small portable hatcheries on-site and using sea pens for rearing in the estuary starting with the northern barren streams with

the first returns from transplanted pinks; and

3. Developing a number of flow-controlled spawning channels. This could be particularly important if the potential production levels of Nimpkish sockeye are achieved and the proposed fishing area is expanded into Goletas Channel. This option would exist only if transplant have been proved successful.

For the southern group of pink stocks a small enhancement project is being conducted through the local Community Economic Development Project. This project should be expanded to accommodate expected increased harvest rates in the terminal areas of the Keogh and Cluxewe rivers (possibly the Quatse as well) and to provide a brood stock sufficient for transplanting the northern barren streams.

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

3.2.8.1 Woss/Vernon Lakes Fertilization (Project No. 12-11)

Fertilization of Nimpkish Lake has adequately increased smolt output and survival to provide a small harvestable surplus of sockeye adults in 1985. Increased harvest rates of returning Nimpkish stocks are expected to over harvest earlier running stocks returning to the Woss and Vernon lakes. Fertilization of Woss and Vernon lakes is required to increase production of sockeye in order to mitigate increased harvests of adjacent stocks and to equalize harvest rates for all stocks within the Nimpkish River watershed. The potential increase in production from Woss/Vernon fertilization is expected to be 100,000-200,000 adult sockeye.

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[1] Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

3.2.8.2 Nimpkish (Cheslakee) CEDP Expansion (Project No. 12-12B)

The Nimpkish Band has a CEDP project on the Nimpkish River system. Two facilities are currently being operated. The Willow Creek facility currently produces sockeye (25,200), chinook (12,500) and coho (14,000). The other facility, the Cheslakee site is a pilot facility primarily devoted to chum incubation. Current production is 12,500 adults. The proposal is to expand the Cheslakee facility and move all production onto this site. Willow Creek's main design was for sockeye production, which will be taken care of by the lake fertilization program instead. Existing sockeye production would be retooled into increased chinook, coho and chum production. The Cheslakee expansion will produce 10,000 chum adults, 10,000 coho and 17,000 chinook adults, in addition to current production. An adult counting fence will be required on the Nimpkish River for management purposes.

3.2.8.3 Quatse River CEDP Expansion (Project No. 12-5B); Nahwitti, Stranby, Shushartie Rivers Recolonization (Project No. 12-1A); Recolonization, Cluxewe and Keogh Transplants (Project Nos. 12-7, 12-8)

Pink salmon in both odd and even years have been almost eliminated from the stream systems north of Port Hardy, and Nahwitti, Stranby, Songhees and Shushartie. Escapement of pinks to these streams at one time was 500,000. The Cluxewe, Keogh and Quatse have also seen declines, and are going to be adversely affected by an expected substantial increase in Nimpkish sockeye and the resultant harvesting of all stocks in the UECVI area. In order to recolonize these barren rivers it is proposed to expand the Quatse River CEDP project. Currently, this project incubates chums, pinks and coho from the Quatse and Cluxewe rivers. The production levels are: 5,250 adult coho for both Cluxewe and Quatse; 7,200 adult chums for both rivers; and 18,000 and 14,000 adult pinks for the Quatse and Cluxewe, respectively.

The first phase of the expansion would be production to mitigate the losses to the Quatse, Cluxewe and Keogh from expanded Nimpkish harvesting. This would be accomplished by expanding production to 20,000 pink adults for the Quatse, 30,000 pink adults for Cluxewe and 30,000 for the Keogh. This would be sustained odd- and even-year production. The second phase of the

expansion is the recolonization of barren streams. It is proposed that 3,000,000 eggs be taken as a mixture from the Keogh, Cluxewe and Quatse wild stocks. The fry could be fed and then released into the barren streams. Future eggs would be taken from brood stock from the Nahwitti, Stranby, Songhees or Shushartie as production permitted. It should be noted that, in any year, eggs would be used to supply first the needs of the Quatse, Keogh and Cluxewe and then the requirements for recolonizing stocks.

3.2.8.4 Nahwitti River (Project No. 12-C1)

The Nahwitti River is the most northerly large river and lake system on Vancouver Island. This system, which drains into Goletas Channel, produced over 100,000 pinks as recently as 1970. Current production for all species is almost negligible, probably as a result of illegal harvest practices. Low flows during the summer period may now be a limiting factor preventing any re-building. A small storage dam at the outlet of Nahwitti Lake would improve the flow during the late summer and early fall. The proposed earthfill dam would have good access and would be gated to allow releases by a patrolman. It has been estimated that the production of the Nahwitti River would be increased by 2,200 coho and 20,000 pink salmon in both odd and even years.

3.2.8.5 Adam River (Project No. 12-19)

This project is located in upper Johnstone Strait and involves addition of gravel to side channels of the Adam River. The total spawning area created will be about 5,000 m^2 of protected gravel habitat. Estimated production is 35,000 pink salmon and 1,000 coho.

3.2.9 Predicted Results of Management and Enhancement Options

The following sections discuss both management and enhancement options and their likely consequences.

3.2.9.1 Sockeye Salmon

Projections using models indicated that maintenance of present low harvest rates (10%) would eventually rebuild Nimpkish sockeye (Fig. 3.2-4).

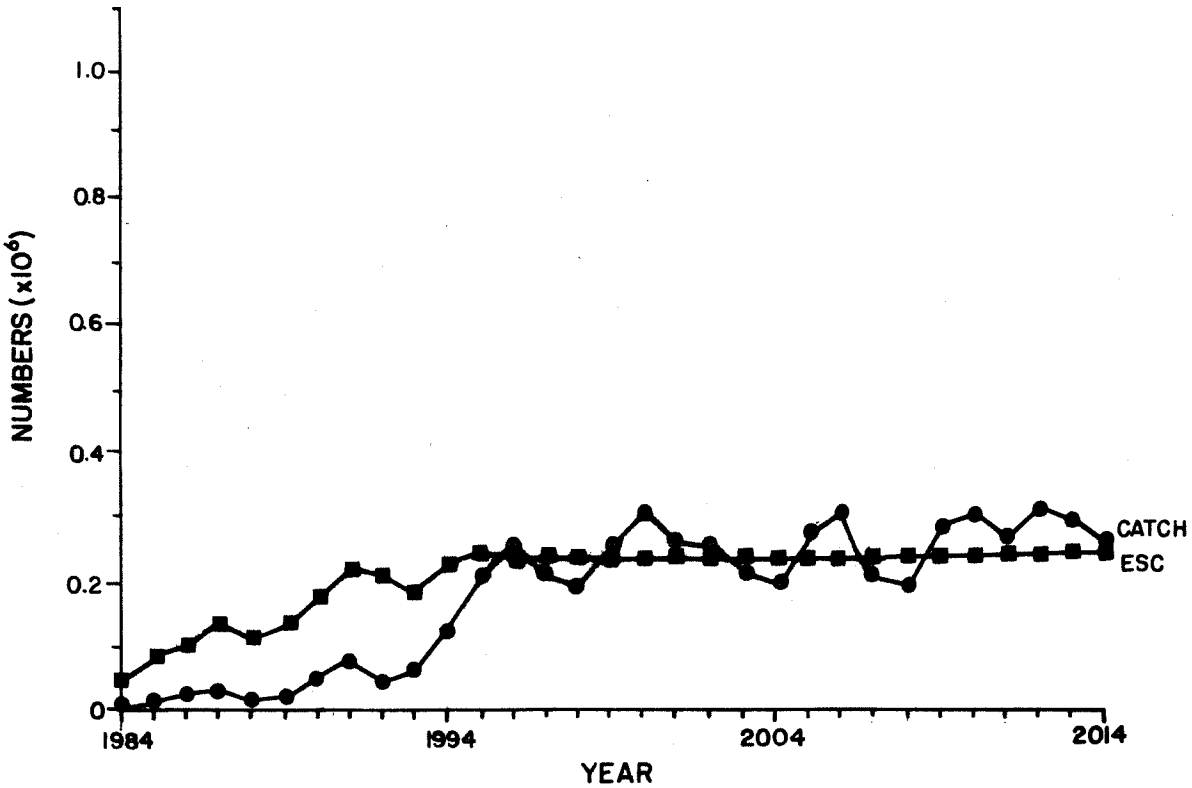


Figure 3.2-4. Catch and escapement projections for a 10% harvest rate of Nimpkish sockeye with no lake fertilization.

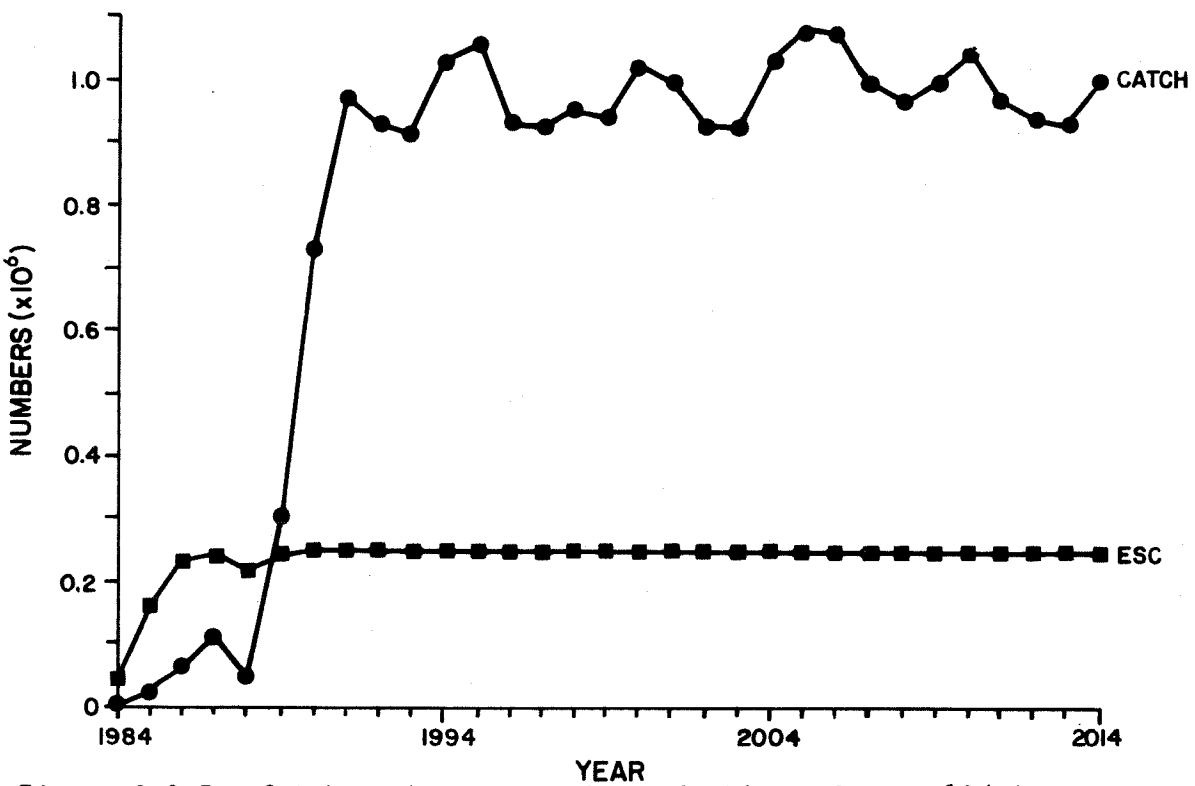


Figure 3.2-5. Catch and escapement projections for a 10% harvest rate of Nimpkish sockeye with lake fertilization.

Note that the stocks would not rebuild to the required escapement (250,000) until 1995. After 10 years, catches would increase dramatically and maintain themselves between 200,000 and 300,000. The 10-year catch average would be 39,400. Only minor decreases in the harvest rate might be required for the offshore troll fisheries and possibly minor changes to the Johnstone Strait net fisheries.

The Nimpkish sockeye system has been enhanced starting in 1981 through lake fertilization. If the fertilization program in the Nimpkish system is successful, and the fisheries are maintained at the current 10% harvest level, it is expected the Nimpkish sockeye should be rebuilt within two years (Fig. 3.2-5). The model indicated a small decline in the expected escapement in 1988 due to poor recruitment in one year. However, it is anticipated that the escapement requirement (250,000) would be fairly stable after 1986. The model predicted a 10-year average catch of 410,000.

The model projections indicated that rapid rebuilding of the stocks is possible, assuming that lake fertilization would increase productivity as expected. However, there are other options which would rebuild Nimpkish sockeye and provide a harvest each year. The current approach of maintaining a total closure until the stock has reached its target escapement has the disadvantage of not providing information for management of fisheries, and precluding the harvest of the large expected returns of Nimpkish sockeye. This necessary information can only be obtained through operation of fisheries.

To evaluate the potential for increased fisheries on the Nimpkish sockeye, a series of fixed harvest rates (i.e., 25%, 40% and 60%) were explored (Table 3.2-5). Although a fixed-catch approach may be more reasonable over the longer term, until the fertilization program has demonstrated low variability in total returns, a fixed harvest rate is likely the best strategy. In evaluating these different scenarios, it will be necessary to compromise rebuilding stocks as rapidly as possible vs. marginally increasing the time required to rebuild stocks (with a lower average catch), but increasing the capability to manage future fisheries. If this management capability is not developed, the predicted catches by future fisheries may not be accurate.

Table 3.2-5. Summary of model projections for increased harvest rates of Nimpkish sockeye with lake fertilization.

	Harvest Rates			
	10%	25%	40%	60%
Year Rebuilt	1986	1987	1990	1994
No. Of Years Required	2	3	7	11
10-Year Average Catch	410,000	392,000	335,000	240,000

In terms of the 10-year average catch, there appears to be little difference between the current management approach and one with a harvest rate of 25% (Figures 3.2-4 and 3.2-6). The harvest rates of 40% (Figure 3.2-7) and 60% (Figure 3.2-8) offer immediate benefits for fishermen; however, rebuilding is slower and the average catch is considerably lower.

Figure 3.2-9 shows expected returns if the production rate remained similar and the escapement requirement were raised to 500,000. This approach of increasing the optimum escapement is being used successfully in Barkley Sound. The model showed that escapement built to 500,000 in 7 years (1990) with a 10-year average catch of 333,000 sockeye. Potential production after that time was large, with average catches of about 100,000.

To achieve the goals outlined above requires accurate estimation of the stock size entering the fishery, and the escapement. Obtaining this information is not possible now, but methods can be developed over time. It is expected that at least five years are required to develop an indexing system which allows accurate determination of total stock size in the fishing area. The primary requirement is a means of estimating the total stock size by counting sockeye entering the river, either through a side-scanning sonar system or a fish-counting fence. Other more traditional methods are not

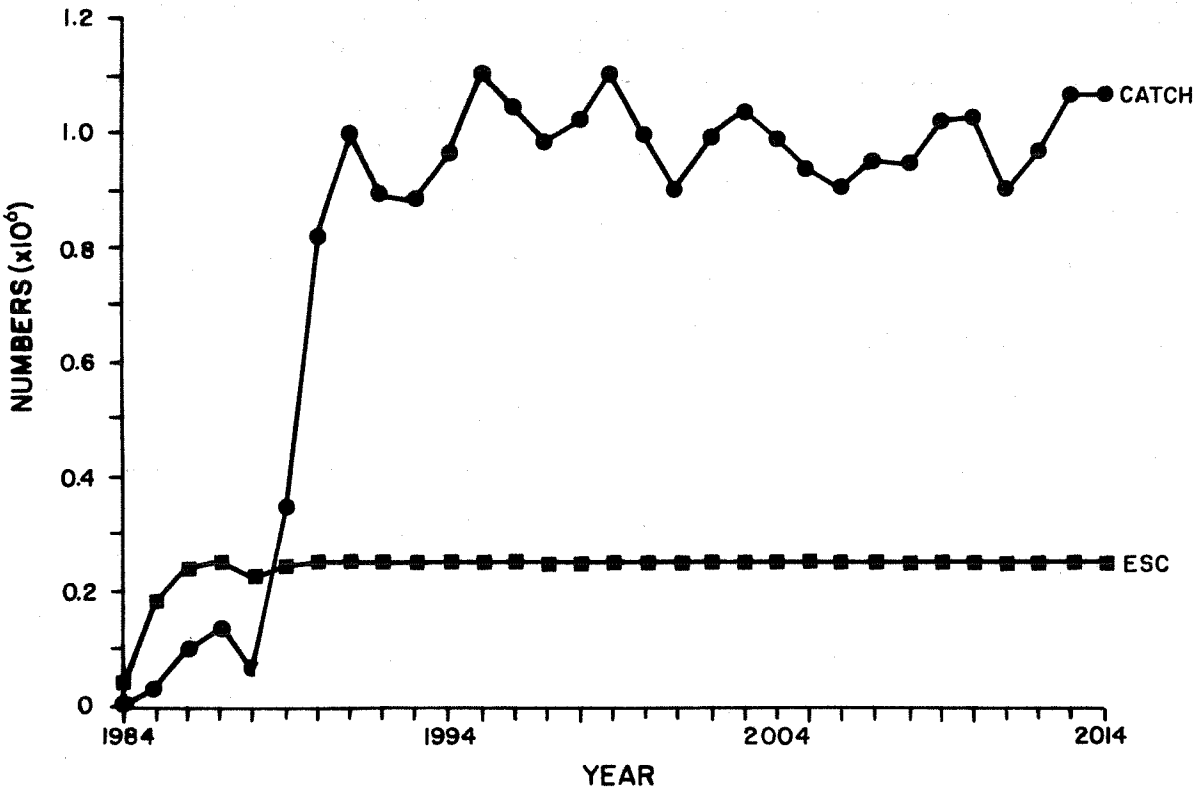


Figure 3.2-6. Catch and escapement projections for a 25% harvest rate of Nimpkish sockeye, with lake fertilization.

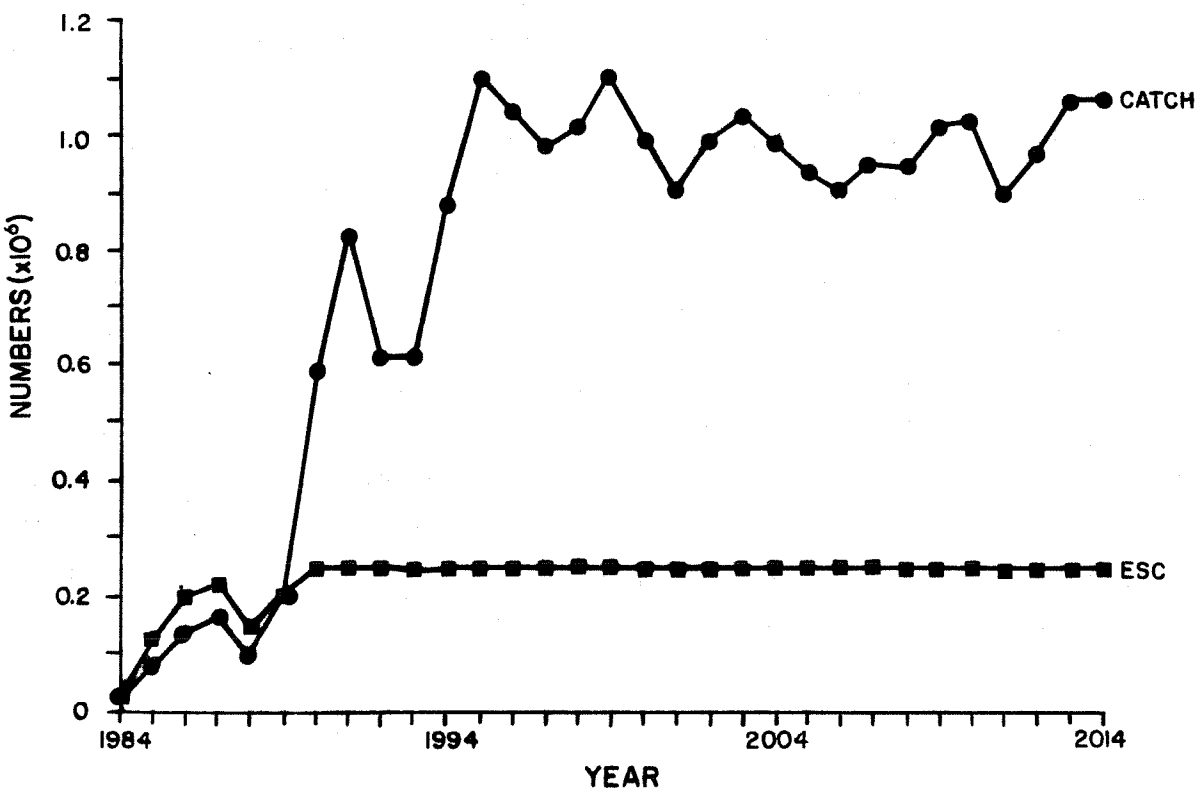


Figure 3.2-7. Catch and escapement projections for a 40% harvest rate of Nimpkish sockeye, with lake fertilization.

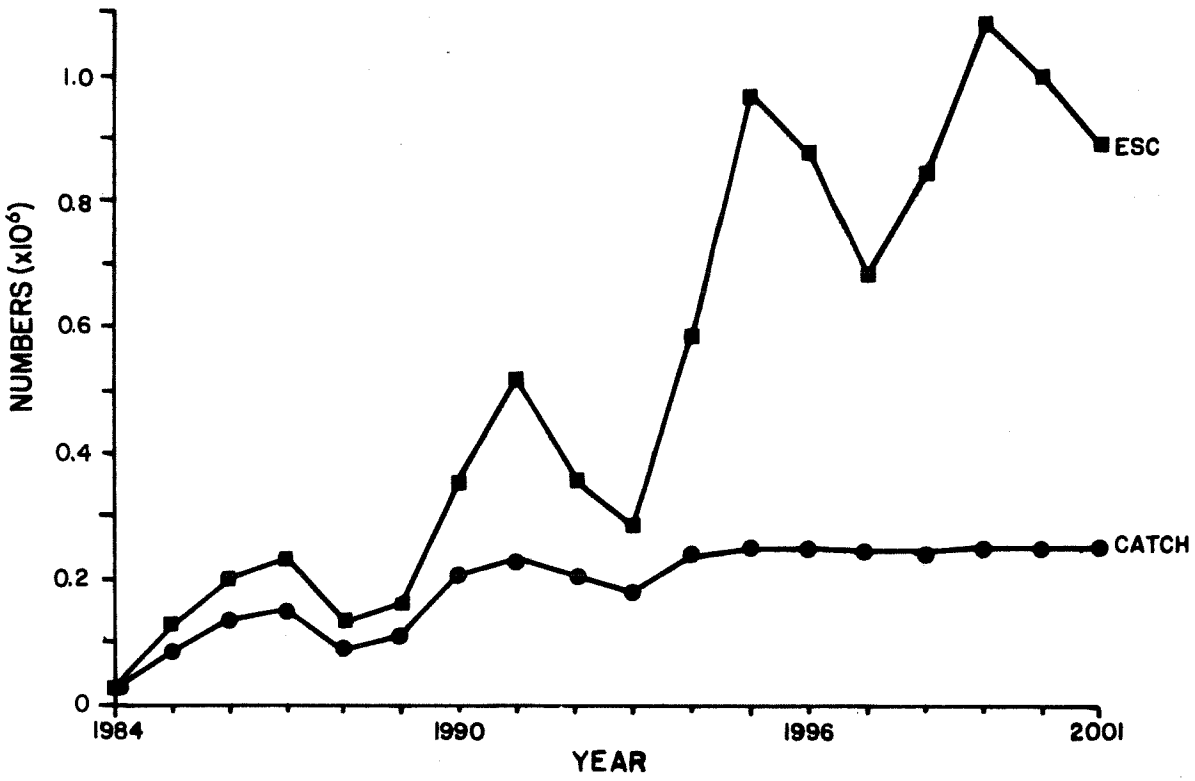


Figure 3.2-8. Catch and escapement projections for 60% harvest rate of Nimpkish sockeye, with lake fertilization.

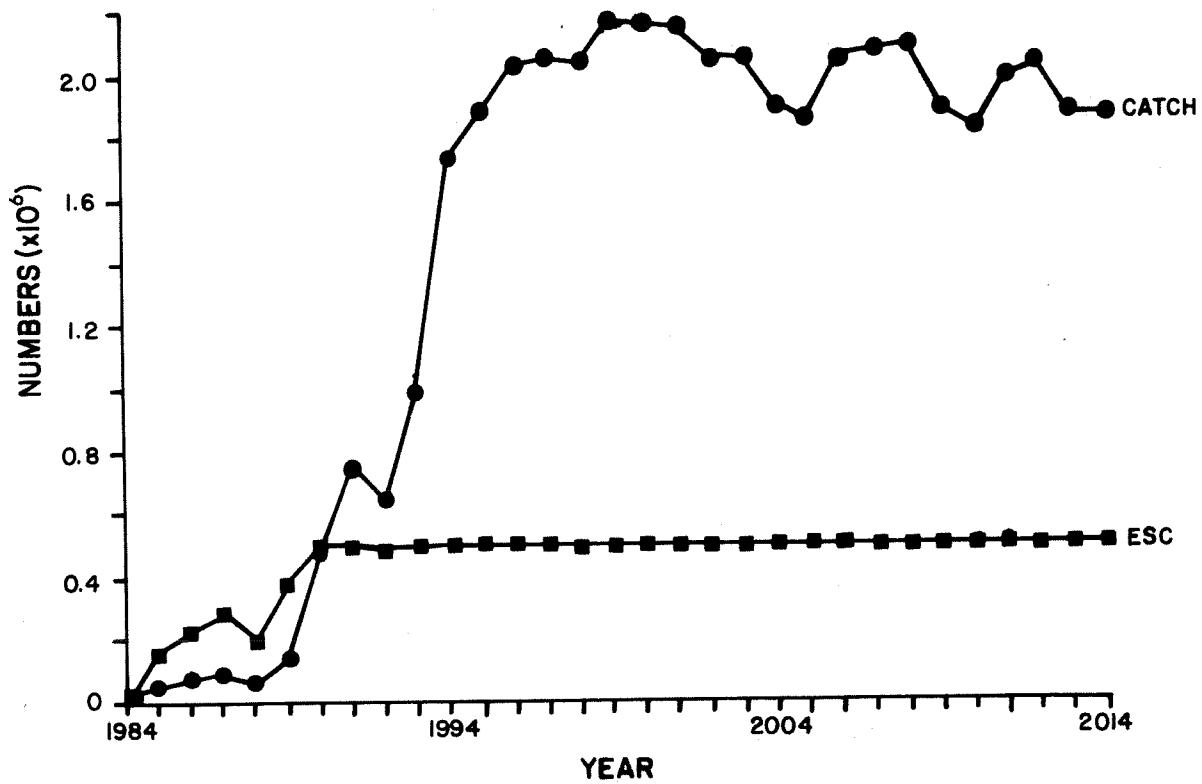


Figure 3.2-9. Catch and escapement projections for 25% harvest rate of Nimpkish sockeye and target escapement of 500,000 with lake fertilization.

adequate. For example, spawning ground enumeration gives a conservative estimate of the total population size, but this is 2-3 months after the fish have left the fishing area. Also, spawning ground enumerations cannot be used to manage the fishery in-season and at best may be useful for summarizing the total annual production. Stock identification methods such as scale analysis or parasites may be useful, but cost and analysis time make this an expensive approach.

While developing methods to estimate harvest rates accurately in-season, several options exist for harvesting surpluses. Nimpkish sockeye enter upper Queen Charlotte Strait through Gordon Channel (M.U. 12-12 and 12-11) and through Goletas Channel (M.U. 12-15 and 12-16). The majority of Nimpkish sockeye then pass through Broughton Strait to the Nimpkish River estuary. It has been estimated that the proportion passing through Broughton Strait is approximately 80-90% of the total returning stock. The remaining 10-20% move east along the north shore of Malcolm Island, through Blackfish Sound and the Double Bay area and then west to the Nimpkish estuary. In past years, the primary areas for harvesting Nimpkish sockeye have been in the upper portions of Area 12 in Queen Charlotte Strait. To rebuild Nimpkish sockeye under the current management scheme, the approach areas of Gordon and Goletas Channel, Port Hardy Bay, and the north shore of Malcolm Island have been kept closed to fishing. In anticipation of substantial surplus sockeye being available, several options for harvesting Nimpkish sockeye in various areas are outlined below.

1. Open the areas north of Lewis Point to the Area 11 and 12 boundary: The advantage of opening the upper portion of Area 12 is that it will provide a large area in which the gillnet and seine fleet can fish for more than one day's migration of Nimpkish sockeye. It is estimated that 200-300 seiners and approximately the same number of gillnetters could operate in this area. The disadvantages of the option will be that the increased harvest rate for Nimpkish sockeye will affect other stocks, e.g., the UECVI pink stocks, which return to the same geographic areas, and the passing Bond/Knight and Kingcome/Wakeman pink stocks in both odd and even years. It is anticipated that current pink harvests would increase by 200-400% if full Nimpkish sockeye harvests were initiated. There would also be a

substantial harvest of chinooks as they migrate through this area. In addition, increasing harvest rates for Nimpkish sockeye in upper Queen Charlotte Strait would have the same result for other area and early Fraser sockeye stocks.

2. Restrict the harvesting to M.U. 12-9 and 12.8 (for gillnetters only): Although M.U. 12-9 and 12.8 are common migration areas for both pinks and sockeye, by utilizing gillnetters only the harvest rate for pinks could be substantially reduced. Under this option, seiners would be limited to fishing in the terminal areas of M.U. 12-17, 12-18 and 12-19. The advantage of this option would be that it would eliminate pink interceptions in all areas, and therefore maintain the current rebuilding schedule for pinks. It would also provide a means of separating fishermen by gear to avoid gear conflict, and would restrict (if not eliminate) the harvesting type of other area and Fraser River sockeye stocks. One disadvantage of this option is it will limit the working area of seiners. The total number of seine boats able to fish in the prescribed area would be limited to 50-150. Another disadvantage is that the fleet would be limited to an area in which there will be returning pink stocks (Keogh and Cluxewe). A modified version of this option would provide for a greater area for seine harvesting by changing the current M.U. 12-8 boundary to run from Boyles Point across to the north shore of Malcolm Island (likely Lizard Point). Seiners could then fish a potentially greater proportion of the migration route, while avoiding a separate area for gillnetters. It is anticipated that utilizing the terminal area and revising the M.U. 12-8 boundary to Boyles Point would provide a fishery for up to 250 seine vessels. However, the rest of the disadvantages described above apply to this modified option.

3. Restrict harvesting to M.U. 12-17 and 12-19 with seiners and gillnetters: Additional harvesting to achieve the total allowable catch would be conducted by gillnetters in Nimpkish Lake. The approach of harvesting the lake after the marine fishery has taken its catch has the advantage of maximizing any potential returns above the target

escapement of Nimpkish sockeye. It also reduces the need for management precision in estimating the total stock size in the outside marine fisheries. Theoretically, this is the best option, since it maintains the current harvest rate for all other species and stocks that pass through the upper portion of Johnstone Strait. The obvious disadvantage is that the area in which the fleet can operate is limited. However, more days of fishing could be provided and the catch total would be similar. Gillnetters would be required to retool to harvest sockeye in the lake, and trailers and launching sites would have to be constructed.

3.2.9.2 Pink Salmon

The enhancement opportunities proposed for UECVI pink salmon stocks were compared to the Base Case (best management option) by modelling. Each of the options takes into account the interaction of the UECVI pink salmon stocks with the Nimpkish sockeye salmon stock. Fertilization of Nimpkish Lake is anticipated to continue, and the enhanced sockeye production is expected to be most important to the local fisheries, which will also intercept the pink salmon stocks. The Base Case, or best management scenario, included the outside troll fishery which intercepts 5% of the pink salmon stocks, since it is unlikely that this fishery will be altered. This scenario differed from existing management plans since it involved moving the Gordon Channel fishery for Nimpkish sockeye salmon south into Queen Charlotte Strait, where the actively-managed pink stocks are only partially (50%) vulnerable. This fishery would be managed to produce 25% exploitation rate for Nimpkish sockeye. The additional surplus of sockeye salmon would be captured in a terminal fishery in Broughton Strait, which also intercepts actively-managed pink salmon stocks. Actively-managed pink salmon stocks would be controlled by escapement goals in terminal fisheries near the river mouths, and passively-managed pink stocks would be fished to produce target escapements in Goletas Channel. Additional production of 20,000 pink salmon from the CEDP enhancement project in the Quatse River was accounted for in this scenario.

Escapements of actively-managed pink salmon stocks were anticipated to increase rapidly to within 60% of target escapement, and then stabilize at

about 50% of target (Fig. 3.2-10). The rise and fall in the escapements of actively-managed pink salmon stocks was attributed to their interaction with sockeye salmon. The Nimpkish sockeye salmon stocks did not achieve target escapement for about 8 years; therefore, the terminal fishery for these stocks would be closed for this period and the pink stocks could begin to rebuild. However, once sockeye salmon achieved target escapement, the terminal fishery was opened to capture the surplus and more pink salmon were intercepted, resulting in fewer escaping to their spawning streams. The effect of this interaction was also evident in the following enhancement options, since the pink stocks did not achieve target escapement before the sockeye salmon fishery was open. Escapements of passively-managed pink salmon stocks remained well below target levels, gradually increasing from less than 1% to 13% in 40 years (Fig. 3.2-11). Catch of UECVI pink salmon stocks increased in the first 10 years and then fluctuated between 100,000 and 140,000 pieces (Fig. 3.2-12). The NPV of this option was estimated at $79,500,000, which included the value of the Nimpkish sockeye salmon catch.

The enhancement proposal to expand the Quatse facility (Option 2) and increase production to the Quatse River by 60,000 pink salmon was evaluated under the same management regime as in the Base Case. Escapement of the actively-managed pink salmon stocks was predicted to rapidly increase to 95% of target, and then decline slightly and stabilize at about 80% of target (Fig. 3.2-10). This enhancement proposal is not anticipated to change passively-managed pink salmon escapements from those observed in the Base Case (Fig. 3.2-11). Catches of UECVI pink salmon were predicted to increase quickly and fluctuate between 200,000 and 280,000. The NPV of this enhancement option was estimated at $82,600,000.

Another enhancement option (Option 3) proposed that the Quatse facility should be expanded to accommodate eggs from the actively-managed pink stocks, which could then be transplanted into streams supporting the passively-managed pink salmon stocks. Additional production of 60,000 pink salmon was estimated from this option. Surplus returns were assumed to spawn in the streams to which they were transplanted, and to have a productivity that is slightly lower than the natural stocks. The lower productivity of the transplanted stocks accounted for possible straying. Under this option, the escapement of actively-managed pink salmon stocks was predicted to increase rapidly as in

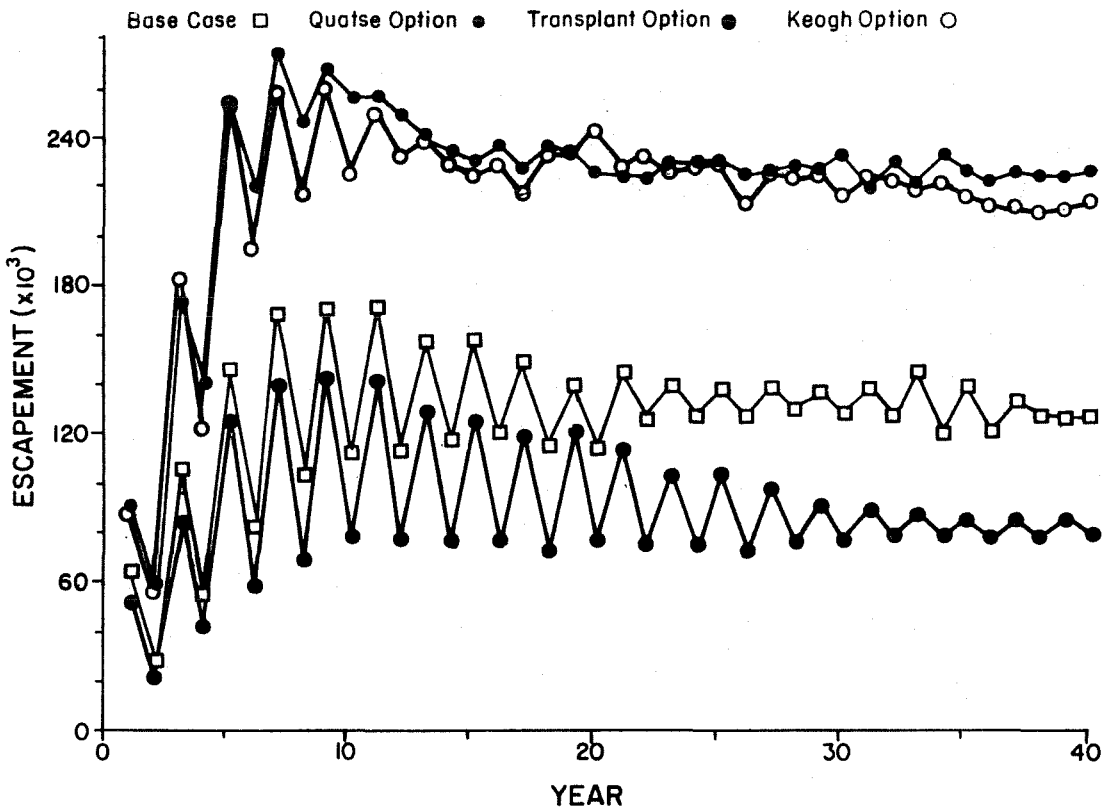


Figure 3.2-10. Predicted results of enhancement options for actively-managed UECVI pink escapements.

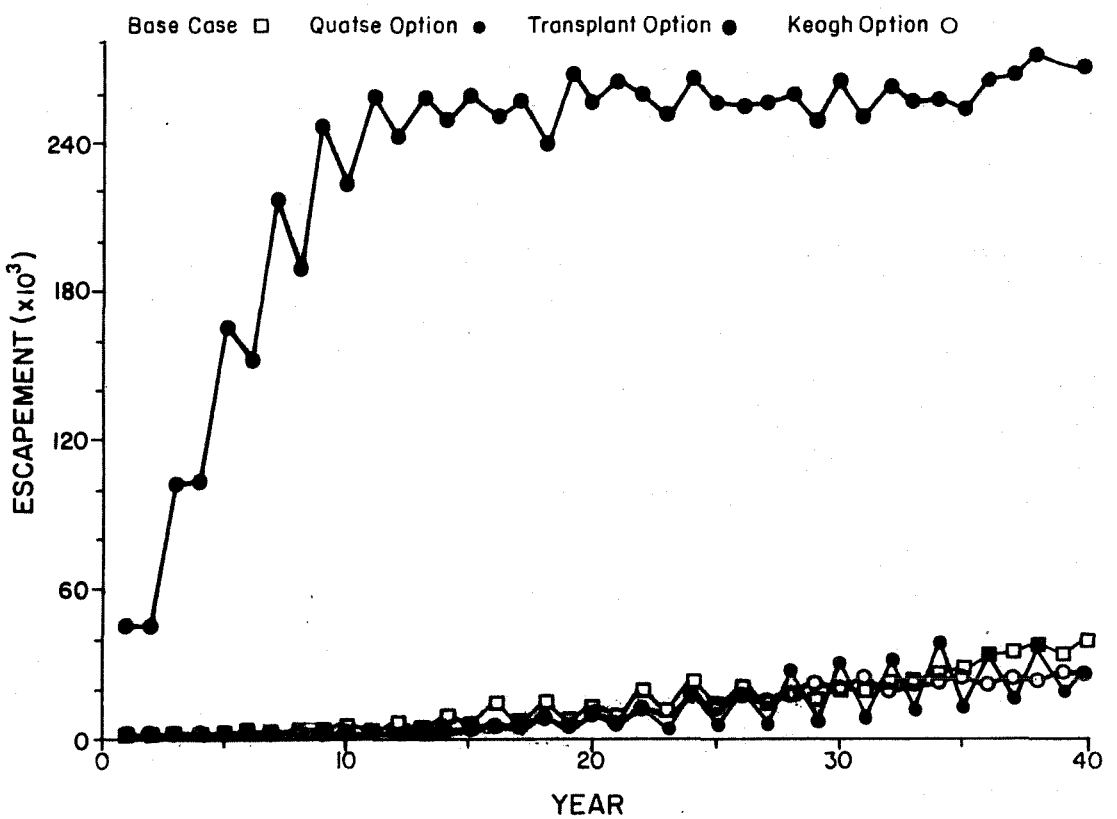


Figure 3.2-11. Predicted results of enhancement options for passively-managed UECVI pink escapements.

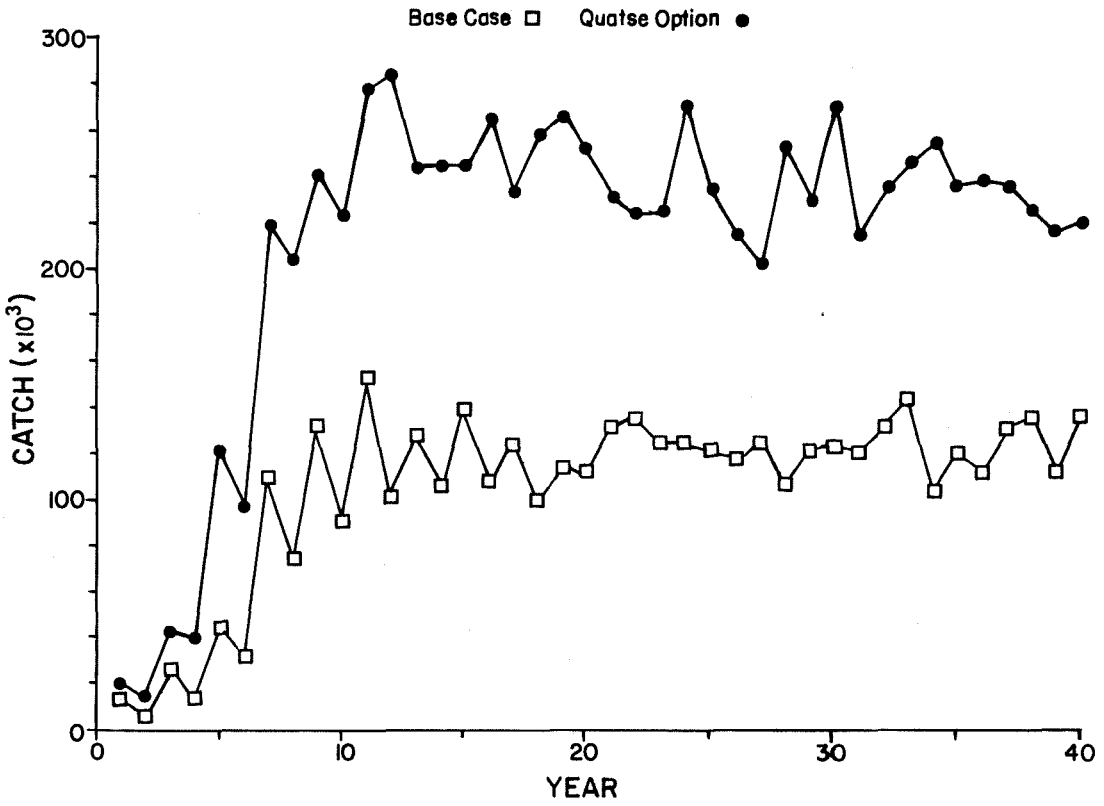


Figure 3.2-12. Predicted results for catch of UECVI pink salmon under the Base Case (Option 1) and Quatse enhancement option (Option 2).

the Base Case, but then began to decline to a level of 20% (Fig. 3.2-10). This decline in the escapement of actively-managed pink stocks can be attributed to interceptions of enhanced, passively-managed pink stocks in the Goletas Channel fishery, and in the Nimpkish terminal fishery for sockeye salmon. Escapements of passively-managed pink salmon escapements were projected to increase rapidly to between 80-90% of target escapement (Fig. 3.2-11). Total catch of UECVI pink salmon was expected to increase in the first ten years and then fluctuate between 150,000 and 300,000 (Fig. 3.2-13). The NPV of the transplant option was estimated at $81,700,000.

Option 4 involved expansion of the Quatse facility to incubate eggs from Keogh River pink salmon stocks and transplant unfed fry back into the Keogh River. The anticipated production from this option was 50,000 pink salmon. Escapement of actively-managed pink salmon stocks was predicted to increase rapidly to within 90% of target in the first 10 years, and then to stabilize at about 75% of target (Fig. 3.2-10). Escapements of passively-managed pink salmon stocks gradually increased at the same rate as predicted in the Base Case (Fig. 3.2-11). Catch of UECVI pink salmon was expected to increase in the first 10 years and then fluctuate between 200,000 and 300,000 (Fig. 3.2-13). The NPV of this option was $85,500,000.

Each of the proposed enhancement options rebuilds either the passively-managed or actively-managed pink salmon stocks. Two enhancement options (transplanting to the passively-managed pink salmon systems and enhancing the Keogh system) were combined in an effort to rebuild both actively-managed and passively-managed stocks. However, since brood stock from the odd years was limited, only half the capacity of the facility could be achieved in the first odd year. The available brood stock was divided equally between the passively-managed streams and the Keogh River. The model predicted that full capacity of the facility could be achieved within one odd-year cycle. Escapements of both passively-managed and actively-managed pink salmon stocks were predicted to increase significantly over those observed in the Base Case (Fig. 3.2-14). The actively-managed stocks were expected to stabilize at about 70% of target, and passively-managed stocks at about 85% of target. Catch was projected to fluctuate between 300,000-450,000, an increase over that observed in the individual options (Fig. 3.2-13). This option was predicted to have an NPV of $89,200,000.

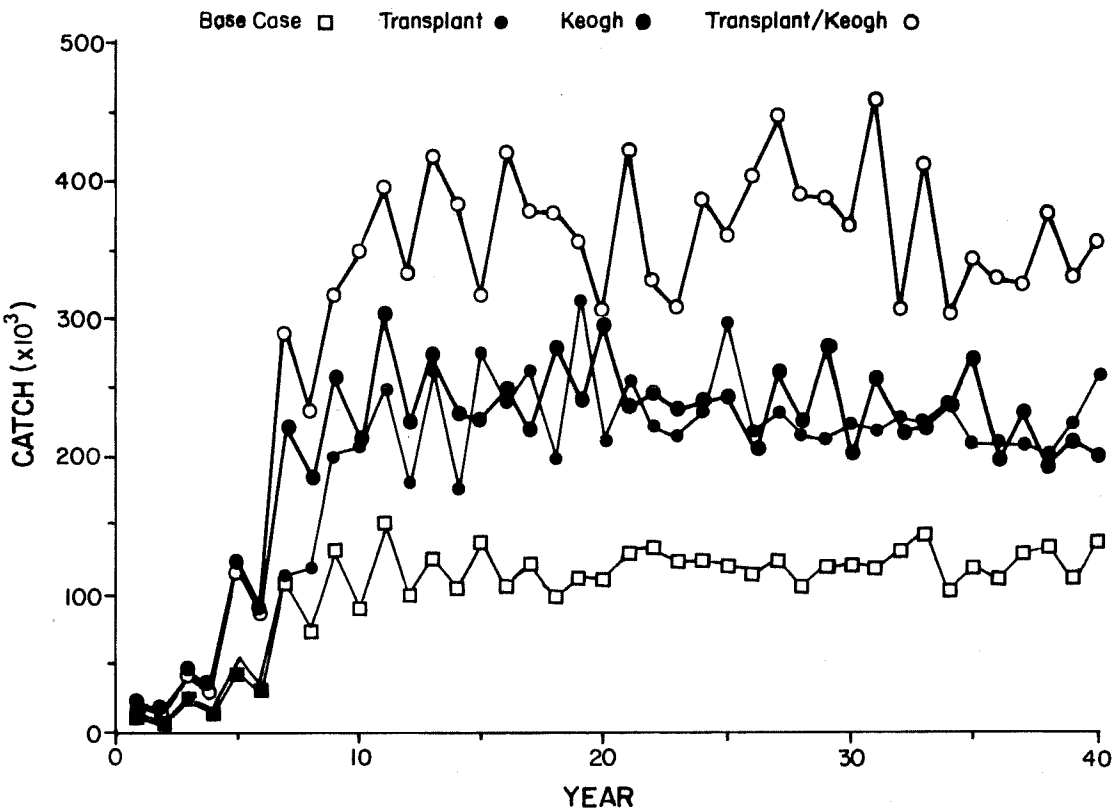


Figure 3.2.13. Predicted results for catch of UECVI pink salmon under the Base Case (Option 1) and Keogh and/or transplant option (Options 2, 3 and 4).

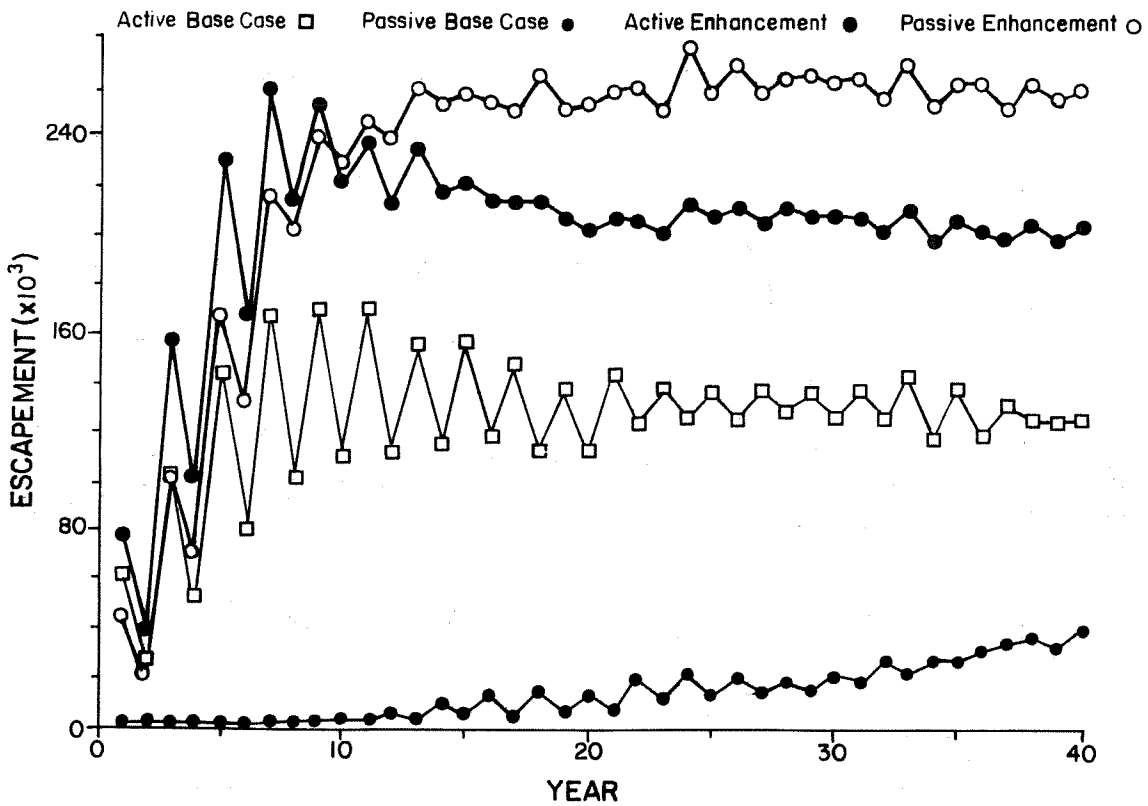


Figure 3.2-14. Predicted results for escapement of UECVI Island pink salmon under the Base Case (Option 1) and combined Keogh/Transplant Option (Option 4).

Based on this analysis, the highest benefits in terms of catch and escapements would be achieved by enhancing both the actively-managed and passively-managed pink salmon stocks simultaneously. If only one group is enhanced, the total catch is less than in the combined option and escapement of the other stock group is kept at low levels. Therefore, a combined project which enhances both passively-managed and actively-managed stocks is recommended.

3.3 Mid-East Coast Vancouver Island

This area includes Statistical Areas 13, 14 and 17 (Fig. 3.3-1). In addition, Johnstone Strait pink salmon stock management is described in this section, which includes an Upper Vancouver Island stock (Adam River) and Loughborough/Bute stocks (Area 13 - mainland).

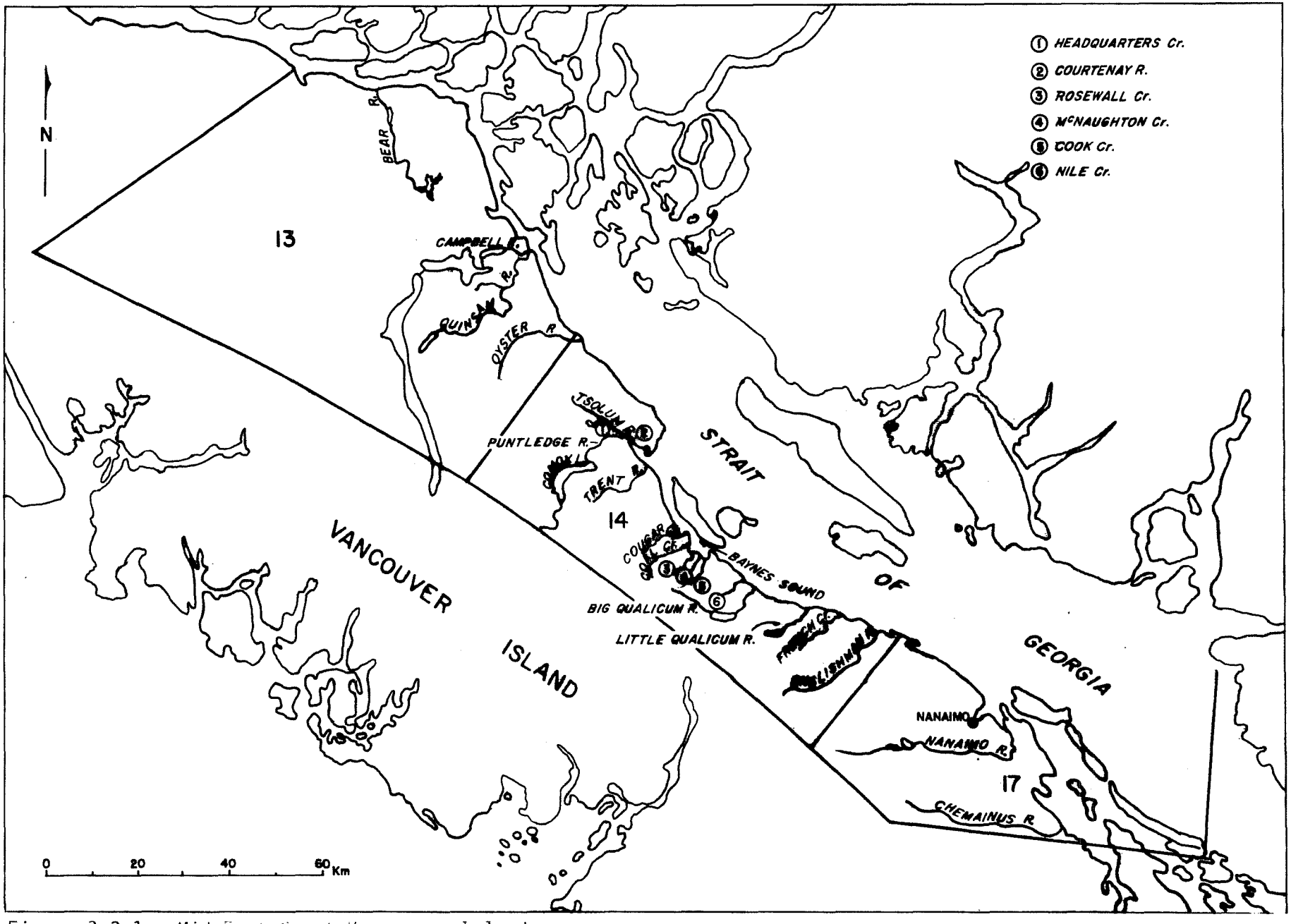
3.3.1 Stock Descriptions

Major Mid-East Coast Vancouver Island (MECVI) salmon stocks include Johnstone Strait pinks; fall chums; Little Qualicum and Big Qualicum River chinooks; and coho from the Big Qualicum, Quinsam, and Puntledge rivers. This section provides a brief description of each group of stocks.

Johnstone Strait pinks consist of an aggregation of stocks returning to Johnstone Strait (Statistical Areas 12 and 13 on Vancouver Island); Loughborough/Bute (mainland Statistical Area 13); and mid-Vancouver Island (lower Statistical Areas 13 and 14 on Vancouver Island). They enter Johnstone Strait from the north via Queen Charlotte Strait, and are present from mid-July to early September; their run peaks in early August. They are all actively managed, but escapements are severely depressed due to their incidental capture by intense fisheries for sockeye bound for the Fraser River. The overall target escapements are 458,250 (even years) and 290,700 (odd years).

There are 22 chum stocks in the MECVI area; most are hatchery-enhanced stocks. They run in the fall, and most fish are from enhanced stocks in the Big Qualicum, Little Qualicum and Puntledge rivers, which accounted for approximately 62% of the total escapement in 1984. SEP facilities were developed for chums at Big Qualicum River in 1965. Puntledge and Little Qualicum hatcheries began producing chums in the early 1980's. These are highly productive stocks, even in years of low overall abundance. In general, interception fisheries in Johnstone Strait do not take all surplus production; rather, the surplus fish are caught in terminal areas. MECVI chum stocks are actively managed in the interception fishery in Johnstone Strait.

MECVI chums migrate through Johnstone Strait from the first of October to the end of the first week in November. Date of peak passage varies but is


N
13
14
17
BEAR R.
CAMPBELL R.
QUINSAM R.
OYSTER R.
PUNTLEDGE R.
TSOLUM R.
COMOX L.
TRENT R.
COURTENAY R.
COMOX
COURTENAY
COURTENAY R.
COURTENAY R.
COURTENAY R.

usually during the third week of October. Generally, arrival in the terminal area peaks in the first to second week of November for the stocks returning to Big Qualicum River. Little Qualicum River and Puntledge stocks generally appear ten days to two weeks prior to the Big Qualicum arrival. The target escapement for enhanced stocks is approximately 150,000 and 300,000 for the entire area. Total escapement has increased from 194,000 in the late 1960's to 229,000 in the 1970's, and to 329,000 in the 1980's.

There are eight MECVI chinook stocks. The Little Qualicum and Qualicum rivers in Area 14 produce most of the MECVI chinooks, accounting for 47% of the total MECVI chinook escapement in 1983. Escapement increased from an average of 9,000 during the 1960's to 11,000 from 1971-1983.

There are 48 coho stocks in the MECVI area. The major producers are the Qualicum, Quinsam and Puntledge rivers, accounting for 80% of the total MECVI coho escapement in 1983. Escapement from 1961-1970 averaged approximately 63,000, increasing to 73,000 from 1971-1980 and to 115,000 from 1981-1983.

3.3.2 Current Enhancement Activities

Enhancement facilities in the MECVI area for pink, chum, chinook and coho salmon are presented in Table 3.3-1. Activities are described by species below.

3.3.2.1 Pink Salmon

Pink stocks are enhanced in the Puntledge and Quinsam river systems and the Bear (Amor de Cosmos) River. There is the capacity for incubation of pink eggs at the main lower site of the Puntledge Hatchery complex. In addition, a facility for rearing pink salmon was constructed on Headquarters Creek, a tributary of the Tsolum which flows into the Puntledge. Eggs from Puntledge pinks are incubated at Puntledge Hatchery and usually released as emergent fry. Eggs from Tsolum pinks were to be incubated at Puntledge and transported to the Tsolum rearing ponds, where they were to be reared and released. In fact, freshwater rearing has been abandoned because of poor fish quality and high mortality during rearing. Also, Puntledge and Tsolum pinks have not been treated as separate stocks because of the extremely poor escapement levels

Table 3.3-1. Enhancement facilities in the Mid-East Coast Vancouver Island area (production capacity estimated from SEP biostandards).

Facility	Production Capacity		Target Stock 1984
	Releases	Returns	
Pink			
Puntledge	400,000	10,000	Puntledge
Tsolum	3,200,000	80,000	Tsolum
Quinsam	6,000,000	150,000	Quinsam
Bear	3,200,000	80,000	Bear
Total Pink	12,800,000	320,000	
Chum			
L. Qualicum	49,100,000	311,000	Little Qualicum
B. Qualicum	56,800,000	386,000	Big Qualicum
Puntledge	6,000,000	120,000	Puntledge
Nanaimo	1,000,000	8,000	Nanaimo
Westholme Ch.	1,872,000	26,200	Chemainus
Total Chum	114,772,000	851,200	
Chinook			
L. Qualicum	1,500,000	45,000	Big Qualicum
B. Qualicum	6,750,000	203,000	Big Qualicum
Puntledge	3,600,000	108,000	Puntledge summer, fall
Quinsam	3,000,000	90,000	Campbell/Quinsam
Nanaimo	500,000	15,000	Nanaimo summer, fall
Chemainus	144,000	4,000	Chemainus
Total Chinook	15,494,000	465,000	
Coho			
B. Qualicum	2,250,000	337,000	Big Qualicum
Puntledge	3,900,000	149,000	Puntledge, Tsolum
Courtenay	400,000	6,000	Trent
Quinsam	1,600,000	160,000	Quinsam
Chemainus	50,000	1,000	Chemainus
Nanaimo	500,000	15,000	Nanaimo
Total Coho	8,700,000	668,000	

during the 1980's. Escapement was so low that no eggs were taken in 1984 and the Tsolum facility has not been in operation for the past several years.

Puntledge and Tsolum pinks have been released as fry either after fresh-water rearing or after sea-pen rearing in Comox Harbour. Fish were marked differentially to assess the different strategies, but too few marked fish have returned to permit evaluation of the results. At Quinsam and Puntledge, fry have been reared in fresh water prior to release, but this has proven unsuccessful. On the other hand, more recent studies rearing pink fry in sea-pens prior to release at Quinsam and Puntledge have been successful, and the Quinsam data indicate that sea-pen rearing may double ocean survival rates. This is a major production technique in Alaska. While the benefits of sea-pen rearing of pink salmon to increase their chances of survival to adulthood may not justify the costs for major production, it is worth considering when trying to rehabilitate threatened stocks.

Pink incubation boxes were added to Quinsam Hatchery when it became obvious that the Quinsam pink stock was declining rapidly. Hatchery returns now make up a major portion of the Quinsam run.

The prognosis for Puntledge pinks and other mid-Island stocks is poor; DFO may transplant fish from Quinsam pinks or another healthy stock, perhaps using wild milt to fertilize transplanted eggs during the next year or two. If the wild stocks are at extremely low levels, an alternative would be to cross hatchery females with wild males. The least desirable alternative would be to transplant pure hatchery stock.

The Bear River facility was a research hatchery taken over by SEP Facility Operations in 1980. While there are both odd- and even-year runs of Quinsam pinks, Bear River pinks have an even-year run only. Efforts to establish an even-year run have failed in the past, but 1981 brood year pinks transplanted from Quinsam to Bear did produce a spawning escapement in 1983 greater than the even-year runs in 1982 and 1984 and fry were observed migrating to sea in 1984.

3.3.2.2 Chum Salmon

Most MECVI chum stocks are enhanced by five major facilities on the

Puntledge, Big and Little Qualicum, Westholme Channel, and Nanaimo River systems.

Puntledge is operated as a Japanese-style hatchery, with typical incubation containers and rearing of fry prior to release, but is atypical in that surface water (rather than groundwater) is used. While this facility made significant contributions to the Area 14 terminal chum fishery in 1984, it is too early to assess its overall success.

The Little Qualicum facility is primarily a spawning channel operation based on the Big Qualicum model (see below). The channel has never been filled to capacity, as a result of relatively low escapement levels and because the channel is located upstream from most of the natural spawning grounds. To increase the rate of stock rebuilding, adults captured in the lower river have been transported to the spawning channel, and some of the early-migrating fry have been captured and reared to increase their post-release survival rate. The Little Qualicum stock contributes heavily to the Area 14 terminal fishery, and enhancement was designed to mitigate losses of Little Qualicum stocks while permitting a higher exploitation rate for Big Qualicum chums, as well as development of a terminal fishery for Big Qualicum coho.

Big Qualicum chum enhancement activities include controlling the total river flow, and maintenance of a spawning channel. Some fry have been reared prior to release on an experimental basis. Unlike other facilities, the production capacity listed for the Big Qualicum facility includes the total system (i.e., river and channel) because of the hatchery's capacity for controlling river flow. Egg-to-fry survival in the river is twice what it was before 1963 when flows were uncontrolled; survival in the channel is five times the natural survival rate. Returns to Big Qualicum were relatively good during the late 1960's and early 1970's, were poor during the mid- and late 1970's, and have recovered during the early 1980's.

At the Westholme Channel and Nanaimo River hatcheries, chum are released as emergent fry. The Area 14 terminal chum fishery is primarily for Big Qualicum enhanced stocks, although this situation will change as Little Qualicum and Puntledge production becomes more important. There is some

opportunity for enhancing specific runs of MECVI chum stocks as discussed for Lower Fraser chum hatcheries.

3.3.2.3 Chinook Salmon

Chinook production capacity from MECVI hatcheries is 465,000 fish (all ages), which exceeds by far the combined capacity of all the Fraser River hatcheries. Further expansion in this area would be logical if a strategy of enhancing chinook stocks and fixing catch ceilings to protect wild stocks were selected. MECVI chinook stocks are enhanced by several large facilities, Puntledge, Big and Little Qualicum, Quinsam, Chemainus and the Nanaimo River.

Puntledge Hatchery produces summer-run chinooks with releases from channels upstream near Comox Lake. The larger, fall-run chinooks are produced at lower river facilities. Location of the facilities on the Puntledge reflects the natural distribution of the two stocks. The summer-running fish spend more time in Georgia Strait compared to the fall-run stock. The summer run is at a relatively stable population size; the fall-run stock appears to be heading to extinction, with less than 100 fish estimated in the 1984 escapement. The prognosis for the next four years is bad. For this reason, Quinsam chinooks were transplanted to Puntledge in 1984, and DFO have proposed a multi-stock transplant in 1985.

Big Qualicum was the site of the first hatchery releases of chinook in British Columbia, and the hatchery was very successful through the 1970's. Production levels have been low since 1982 due to decreased survival of smolts after release. This trend has been apparent in all hatcheries for which a long time series of survival data exists. Big Qualicum chinook capacity was doubled in 1984; some ponds constructed for EXPO '86 coho production have since been allocated for chinook production.

Big Qualicum is the most widely transplanted chinook stock in British Columbia, and has proven very adaptable to new hatchery environments. In addition to Little Qualicum, the Capilano chinook run was established using Big Qualicum stock, since there was no native Capilano stock. Subsequent transplants from Capilano include Sechelt Inlet, Indian River and Vancouver river facilities, with smaller numbers going to a variety of Burrard Inlet

streams. Along with Robertson Creek, Big Qualicum is the major source of the chinook salmon raised in the commercial fish farming industry in British Columbia.

Little Qualicum has only rearing ponds for chinooks, which are incubated at Big Qualicum. The Little Qualicum run was established using transplanted Big Qualicum stock, and has had escapements of up to several thousand fish. Eggs are now taken from Little Qualicum, incubated at Big Qualicum, and then returned to Little Qualicum for rearing and release.

In 1984, rearing capacity for chinooks at the Quinsam hatchery was tripled to 300,000 smolts. Quinsam chinooks are released as 90-day smolts. The Quinsam run was established using Campbell River stock, and a significant portion of the hatchery returns spawn naturally in both the Campbell and Quinsam rivers. The Campbell River estuary is being studied intensively by DFO scientists, and marked releases of Quinsam chinook juveniles into the river, estuary and ocean are expected to provide data on the importance of rearing this species in estuaries.

Chemainus is a privately-owned fish farm producing smolts for release. Many of the stream systems south of Courtenay have both early-running spring (and/or summer) stocks, and a later, fall-running stock. These stocks have different life histories, with the early-running stocks producing predominantly stream-type smolts, and the fall-running stocks producing predominantly ocean-type smolts (see Section 4.0). While most hatchery production has been fall-running stocks, some work on early-running stocks has been done at the Nanaimo and Chemainus hatcheries. Early-running fish are generally difficult to capture due to their low numbers and because they migrate further upstream in the river systems. Consequently, it is harder to collect eggs from early-running stocks. Chemainus chinook rebuilding was accelerated by crossing Cowichan eggs with Chemainus milt; this was necessary due to very low escapements of Chemainus chinooks when the project was started. Recovery data for both Nanaimo and Chemainus indicate both facilities have been extremely successful.

3.3.2.4 Coho Salmon

There are many severely depressed coho stocks in the MECVI area. This

has resulted in considerable discussion about the benefits and advisability of colonization and transplant work. There are major hatcheries for coho on the Big Qualicum, Quinsam and Puntledge rivers. They mainly release yearling smolts, but Big Qualicum fry are distributed to local small streams that are underutilized, and fry are also planted in rivers and lakes of the upper Puntledge that are otherwise inaccessible to fish, and in Tsolum River. The public project at Courtenay produces fry for release in the Trent River. Quinsam fingerlings are planted directly in the river system above the hatchery.

The data from the Quinsam colonization program are the best evaluated of this type in British Columbia. Several broods of released fingerlings were marked so that their ultimate contribution to catch and escapement could be estimated. In addition, there is a fence on the Quinsam River at the hatchery site, so it has been possible to estimate planted fingerling-to-smolt survival. More data of this type will be available in the next few years, as colonization assessment programs are scheduled to start in 1985 on the east coast of Vancouver island and in tributaries of the upper Fraser and Thompson rivers.

Puntledge Hatchery has successfully rebuilt the Puntledge coho run to current escapements of 20,000 or more starting with a remnant population in the mid-1970's. Colonization of the upper Puntledge is expected to be less productive than the Quinsam colonization program because some downstream migrating smolts are lost in the hydroelectric generating systems of the Puntledge.

Big Qualicum has twice the coho production capacity of any other British Columbia hatchery except Chilliwack. Both these facilities were expanded in 1984 in an effort to double the number of Canadian hatchery coho available to fishermen in Georgia Strait during EXPO '86. Big Qualicum has been the most consistent and successful coho hatchery during the past 15 years.

The Chemainus and Nanaimo projects release pre-migrant coho fry. Chemainus coho fry are released in the spring after reaching weights of 2-3 g; Nanaimo fry are released at a larger size in late summer. Late release is expected to double fry-to-smolt survival.

3.3.3 Fisheries

Fisheries management for Johnstone Strait pinks and for chums is described below. Johnstone Strait pink stocks are not managed to control escapement, since they are taken incidentally by interception fisheries for Fraser River sockeye. The timing of their migration is concurrent with fishing for Fraser River sockeye stocks in Johnstone Strait. This fishery exerts unacceptably high harvest rates for Johnstone Strait pinks, and has severely hampered management efforts to rebuild stocks. An exception is the Loughborough/Bute stocks, which appear to be harvested at a lower rate than the others.

Terminal area fisheries for MECVI chum stocks are managed differently from the Johnstone Strait fishery, which is a "skim" fishery, removing a certain percentage of the total MECVI stocks before they reach the terminal areas. In general, the terminal fishery is managed on the basis of a fixed required escapement, blended with quota management. The expected total returning stock is determined from pre-season estimates using age-class data and fry outputs in the various brood years. To establish the actual fishing pattern, two fishing strategies are examined: (a) a Johnstone Strait fishery after 1 October, or (b) no Johnstone Strait commercial harvest.

When fishing is permitted in Johnstone Strait, MECVI chum catch is determined by using mark-recovery data. A known portion of the enhanced stock produced in the MECVI facilities is CWT-marked. An estimate of each stock's strength within the fishery is calculated, given the release-to-adult survival rate, the total enhanced output, the number of CWT's recovered in the fishery, and the total catch. Under strategy (a) it is anticipated that the difference between the pre-season estimate of total stock and the catch in Johnstone Strait will then arrive in the terminal area. Strategy (b) assumes there is no Johnstone Strait harvest, and all the fish arrive in the terminal area.

The terminal fishing strategy attempts to achieve maximum quality, generate the greatest revenue, and minimize the risk that escapement requirements will not be achieved. Due to the variability in stock size and the potential for error in calculating the total allowable catch (TAC) each year, only 60%

of the TAC is harvested in terminal areas before the fishery is closed. The harvest of high-quality "bright" chums is therefore reduced to minimize the risk of not reaching the target escapement. The remaining TAC, after escapement, is harvested in a clean-up fishery, which usually takes place mid- to late November.

3.3.4 Habitat Status

Habitat summaries for MECVI pink and chum salmon and Georgia Strait chinook and coho salmon are presented in Tables 3.3-2 through 3.3-5, respectively. For a description of the habitat tables, see Section 2.2.4.

3.3.5 Stock Rebuilding Potential

The Johnstone Strait aggregate of pink stocks could be rebuilt if the current harvest levels for Fraser River sockeye and pink stocks are maintained in the Johnstone Strait. As the current harvest rate for these stocks is 80%, (with the exception of Loughborough/Bute stocks), the only way to rebuild them is to increase their productivity through enhancement.

The chum stocks in the MECVI area are dominated by three large runs returning to the Puntledge, Big Qualicum and Little Qualicum rivers. There are approximately 15 other wild stocks which were minor prior to enhancement, and remain minor. Their production is decreasing due to the large returns to the three enhancement facilities. To maintain the production from these wild stocks, further enhancement will be required from the three existing facilities currently in operation. The time required to rebuild these smaller stocks by outplanting would be very short: between one and two cycles to increase their productivity to match the required harvest rates off the MECVI terminal area.

3.3.6 Management Conflicts

It is likely that few changes will occur in Johnstone Strait harvest rates due to the Canada/U.S. Treaty, at least initially. This will mean that intense fishing will continue in an area of mixed stocks, with disastrous effects on Johnstone Strait pink stocks. Presently there is no accurate

Table 3.3-2. Mid-East Coast Vancouver Island pink (odd and even year) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	700	500+ Even 290 Odd	169 Even 194 Odd

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 112

HABITAT NOTES

Historic Status, Production Constraints and Development History	Heavy past logging; low - moderate impacts. Some natural flow instability.
Current Status	Logging continues at much lower scale. Watersheds returning to second growth.
Future Outlook	Long-term watershed stability for 5 - 70 years.
Natural Habitat Production Potential	At historic high.
Improved Production Potential	Headwater flow control.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	Unknown

CONCLUSION Habitat is not a major constraint.

Table 3.3-3. Mid-East Coast Vancouver Island chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,008	584	329

MANAGEMENT STYLE Active 60%
Passive
Unknown

NUMBER OF STREAMS 54

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging has produced low impacts. Channeling and diking on some streams; low - moderate impacts.
Current Status	Generally good. Logging has tapered off. Will continue at low level with better controls.
Future Outlook	Good. Most watersheds well into second growth.
Natural Habitat Production Potential	Should be close to historic high.
Improved Production Potential	Because of good access there are probably plenty of opportunities for channel improvement.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	Medium - High	High	High	High

CONCLUSION Habitat is not a constraint.

Table 3.3-4. Georgia Strait chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	104		27

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS ____

HABITAT NOTES

Historic Status, Production Constraints and Development History	Development activity has had low - moderate effect with more significant effects on several major producers (e.g., Campbell, Puntledge, Nanaimo, Cowichan, Nimpkish). Unlikely that these impacts on a few systems reflect anywhere near overall stock decline.
Current Status	Probably stable, with development having peaked.
Future Outlook	Improving with less development activity on major systems.
Natural Habitat Production Potential	Return to historic high for most systems.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium - High	High	Medium - High	Unknown

CONCLUSION The decline in stocks is not matched by anywhere near a comparable decline in habitat conditions.

Table 3.3-5. Georgia Strait coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	298		160

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: *

HABITAT NOTES

Historic Status, Production Constraints and Development History	Coho likely to be species most affected by development. Historic logging and urban settlement development has had low - moderate impact. However, historic high escapement follows many years of development activity. Some natural low-flow problems, and problems in areas of competing water use.
Current Status	Almost certainly improving with much of the logging development over and better regulation of new development.
Future Outlook	Return to historic levels 10 - 15 years.
Natural Habitat Production Potential	Probably early return to historic levels.
Improved Production Potential	Localized opportunities for restoration, flow augmentation and re-colonization.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium - High	High	High	High

CONCLUSION Manageability of natural stocks with heavy SEP augmentation and conflicting mixed stock fisheries is likely a more important factor than habitat.

* General habitat notes.

method to assess the abundance of returning pink salmon. However, even if there were a system to assess stock size, it is unlikely that the management strategy could be altered significantly.

There are also conflicts which pertain primarily to the chum stocks that are not being enhanced, and problems related to over-harvesting Puntledge and Little Qualicum River stocks, which have not yet reached the target levels. It is likely that there will be few conflicts when the small stocks throughout the MECVI area are rebuilt. Because of their consistently lower level of productivity, it is anticipated that out-planting from the large facilities into the smaller stocks (e.g., through Baines Sound, and the French Creek area), will have to be continued annually. This will certainly be the case if French Creek stocks are caught by the fisheries off Big and Little Qualicum rivers. It is also anticipated that once the Puntledge River Hatchery is in full production, the fisheries will move closer to stream mouths, and there will be further harvesting of Baines Sound stocks unless substantial stream mouth boundaries are put into place.

When all MECVI stocks reach full production, the greatest problem will probably be dealing with the pressure to harvest the TAC. The number of returning fish each year will exceed 1,000,000. Historically, fisheries have responded to total abundance, and have over-harvested stocks with lower productivity. This must be avoided, and surpluses must be harvested in terminal areas.

3.3.7 Management Strategies for Stock Rebuilding

Management strategies for stock rebuilding are described below for Johnstone Strait pinks and for chums.

3.3.7.1 Johnstone Strait Pink Salmon

There are a number of management options available to assist in stock rebuilding, including:

1. Eliminating the net fisheries in the Gordon Channel and on the north shore of Malcolm Island;

2. Allowing only a gillnet fishery in the approach areas to Johnstone Strait, thereby not catching pinks until they got into Johnstone Strait;

3. Precluding any seining in the Johnstone Strait area except during time of peak sockeye migration (i.e., no early fishing in July, set openings based on tides, no standard Sunday opening, removal of the corridor); and

4. Eliminating seiners from upper and lower Johnstone Strait where most of the pinks are harvested.

The following enhancement opportunities should be considered:

1. Developing more hatcheries or expanding existing hatchery capability, and establishing sea-pen rearing areas for Johnstone Strait pinks; and

2. Developing spawning channels in those areas where high flows are a problem (e.g., Oyster River).

Enhancement development should occur first in Johnstone Strait, then Loughborough/Bute and finally on the mid-east coast of Vancouver Island. Before the best option or combination of options is selected for these stocks, an evaluation of the pink corridor in Statistical Areas 12 and 13 and identification of those stocks which use it should be done. It is suspected that the corridor may only benefit Loughborough/Bute stocks.

3.3.7.2 Chum Salmon

Increasing the harvests of chum salmon by high quality fisheries is highly desirable economically. This can only be accomplished by allowing a greater proportion of the TAC (currently 60%) to be harvested before escapement requirements are met. This approach would result in an unacceptable risk that target escapement would not be reached, and is therefore not recommended at this time. Minor increases in harvest rates (perhaps to 75%), may be practical when all three hatchery facilities (Puntledge and Big and Little Qualicum) have reached full production.

Rebuilding the passively-managed stocks cannot be achieved through management means alone without forgoing much of the terminal harvest of enhanced stocks. These minor stocks must therefore be enhanced. The rivers considered for further enhancement activities would be Cook Creek, Cougar Creek, Englishman River, French Creek, McNaughton Creek, Nile River, Rosewall Creek, Tsolum River, and Winifred or Cole Creek. These stocks are currently being overharvested, and escapement returns are dropping dramatically in all these rivers. The best approach would be to bring the productivity of these smaller streams up to the same level of productivity as larger stocks. This could be achieved by transplanting fed fry directly from hatcheries, or by gathering eggs in the fall from each of these creeks, bringing the eggs back to the facilities, and transplanting fed fry back to their streams of origin.

In the long run, the best management strategy for the MECVI area may be to reduce the overall production of chums and use the facilities for other species. Currently, chum production is creating difficulties in the management of Johnstone Strait fisheries, where increases in abundance of enhanced stocks are reducing wild stocks. Management plans being developed through the Johnstone Strait - Fraser River Chum Advisory Board are providing a rational approach for managing chums, but increases in all enhanced stocks may prohibit continuation of this strategy.

3.3.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

3.3.8.1 Bear River Pink Rehabilitation (Project No. 13-2)

The historically strong even-year Bear River pink run is on the verge of extinction (less than 1,000 fish). It is proposed to enhance this run by expanding the existing facility for incubation of pink eggs. The existing

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

hatchery can incubate 4,000,000 eggs. With expansion, capacity would be 5,000,000 eggs. Expansion should be delayed, however, until adequate numbers of eggs are available to utilize the additional capacity. Attempts will be made to rehabilitate the Bear run using native stock, but if returns continue to be poor, rebuilding will be accelerated by transplanting Quinsam/Campbell stock, ideally by crossing transplanted eggs with milt from wild stock. The proposed expansion includes incubation and short-term rearing of coho fry for release to the upper watershed. Production will be 10,000 even-year pinks. DFO recommend that this work be delayed until current studies on the feasibility and success of coho colonization on MECVI streams are completed.

3.3.8.2 Campbell River Side Channel (Project No. 13-6B)

The Campbell River is one of the best and most famous chinook-producing rivers in British Columbia. It has an intensive sport fishery. This proposal is to augment the natural spawning area in Campbell River. Potential exists for a 500-m channel on the left bank of the Campbell River, downstream of the pulp mill intake. The channel would be similar to one to be constructed during 1985. It would have screened spawning gravel, cobble bank protection, and be a more natural extension of the river. It is estimated there will be an additional 10,000 adult chinooks produced from this channel. It should be noted that this was first proposed as a chum production channel, with a total production of 35,000 returns. This channel should not be built until there is a demonstrated lack of chinook spawning area. The channel must not be occupied by chum salmon, as no further production is required from the Campbell River.

3.3.8.3 Little Qualicum Facility (Project No. 14-24A)

The rejuvenated chinook run to Little Qualicum River was developed by transplant of Big Qualicum chinooks. There is now a good escapement exceeding 2,000 fish. DFO has plans to capture that portion of the run entering the chum spawning channel and take its eggs, which would be used to continue Little Qualicum production and for aquaculture and research. Existing facilities are for chinook rearing only; there is nothing for incubation or adult holding, since incubation is at Big Qualicum. Expansion would provide an

adult holding raceway which could be used for juvenile rearing in the spring. Production capacity would increase from 45,000 to 60,000.

3.3.8.4 Nanaimo River CEDP Expansion (Project No. 17-7A)

The Nanaimo River is a river and lake system draining into Nanaimo Harbour. The system had substantial populations of all species of salmon (including steelhead) except sockeye. A CEDP project has been active on the Nanaimo River since the late 1970's. Existing production from the facility is 111,000 summer chinook eggs; 295,000 fall chinook; 250,000 coho eggs; and 1,100,000 chum eggs. Adult chinook production is currently around 7,000 (3:1 ratio of fall/summer-running chinooks). The proposed expansion would increase chinook production by 7,500 adults, mainly the summer run. This would be achieved by incubating and rearing an additional 250,000 eggs from summer-running chinooks, and 250,000 eggs from fall-running chinooks.

3.3.9 Predicted Results of Enhancement Options

Results of modeling some of the enhancement options listed above are described in the following sections.

3.3.9.1 Johnstone Strait Pink Salmon

The Base Case management scenario for Johnstone Strait pinks was compared to proposed enhancement options for pink salmon from Bear, Adam and Read Rivers. These fish are intercepted in outside troll fisheries at a fixed exploitation rate of 5%, and in Area 12 and 13 fisheries for passing Fraser River sockeye salmon. The exploitation rate of the Johnstone Strait pink salmon stocks in Area 12 fluctuates annually in a four-year cycle depending on the abundance of sockeye. The exploitation rate for pinks in Area 12 is 40% in the two consecutive years when Chilko and Horsefly sockeye stocks dominate, 60% when the large Adams sockeye cycle occurs, and 50% when the combined Adams, Stellako and Chilko sockeye stocks drive the fishery. The interception rate in Area 13 is about 20% for the Bear and 15% for the Read pink stocks. The Adam River is located in Area 12; consequently, the Adam stock is not intercepted by Area 13 fisheries. Terminal fisheries for these stocks have not generally been open because of low escapements. If a terminal fishery for

the Adam stock were open, it would intercept 10% of the earlier part of the Bear River stock. Given the current management scenario, the stocks were not anticipated to reach target escapements. Over 40 years, Bear River pink salmon escapements gradually increased from 1% to 4% of target, Adam River stocks gradually declined from 8% to 6% of target in even years and 30% to 20% in odd years, while Read stocks gradually increased from 30% to 60% in even years and 1% to 25% in odd years (Table 3.3-6). Even-year catch of these stocks was projected to remain relatively stable at about 20,000, while odd-year catches fluctuated from 10,000-20,000 (Fig. 3.3-2 and 3.3-3).

The enhancement proposal for the Bear River system involves expansion of the Quinsam hatchery. Eggs from Bear River would be incubated at Quinsam, and the fry out-planted in Bear River. This project is anticipated to produce 100,000 adults in even years. The feasibility of satelliting Bear River stocks from Quinsam was tested in 1984, when 70,000 eggs were taken. In the simulation modelling, the projected returns from this brood were assumed to provide brood stock for the future enhancement facility. The capacity of the expanded facility was predicted to be achieved within three cycles. The Bear River even-year pink salmon stock increased to within 90% of target within 5 cycles. Total even-year catches increased substantially within the first 10 years and then fluctuated between 270,000-300,000 (Fig. 3.3-2). This increase in catch was attributable to increased terminal catch of the Bear River stock. This proposal would not affect odd-year stocks, since the Bear has only even-year stocks.

The proposed enhancement for the Adam River involves side channel development with addition of 5,000 m^2 of spawning gravel. It was assumed that the productivity of fish using this channel would be similar to that in an unmanned spawning channel. Sufficient brood stock is available to immediately achieve the channel capacity of 5,200 in odd years. In the first even year of operation, brood stock would be limited to about half the channel capacity. The Adam odd- and even-year stocks were predicted to rapidly increase to within 75%-80% of target escapement. Escapement to the other systems remained similar to that observed in the Base Case, with gradual increases in both Bear and Read stocks. Catches increased in the first 10 years, and then fluctuated from 70,000-100,000 (Fig. 3.3-2 and 3.3-3). The increase in catch is largely attributable to increases in the Adam terminal catch.

Table 3.3-6. Johnstone Strait pink salmon comparison of Base Case and enhancement options.

Option	Escapement Trends (% of Target)			NPV (thousand $)
	Bear	Adam	Read	
Base Case	gradual increase (1%-4%) E	gradual decline (8%-6%) E (30%-20%) 0	gradual increase (30%-60%) E (1%-25%) 0	2,042
Bear Enhanced	rapid increase stable (90-100%) E	gradual decline (10%-7%) E (26%-13%) 0	gradual increase (30%-60%) E (1%-25%) 0	5,427
Adam Enhanced	gradual increase (1%-3%) E	stable (75%-85%) 0, E	gradual increase (30%-55%) E (1%-25%) 0	3,811
Read Enhanced	gradual increase (1%-3%)	gradual decline (10%-4%) E (26%-15%) 0	stable (100%) E (increases to 100%) 0	2,042
Bear/Adam/Read Enhanced	rapid increase stable (90%-100%) E	stable (85%) 0 (60%-70%) E	stable (100%) E (increases to 100%) 0	9,416

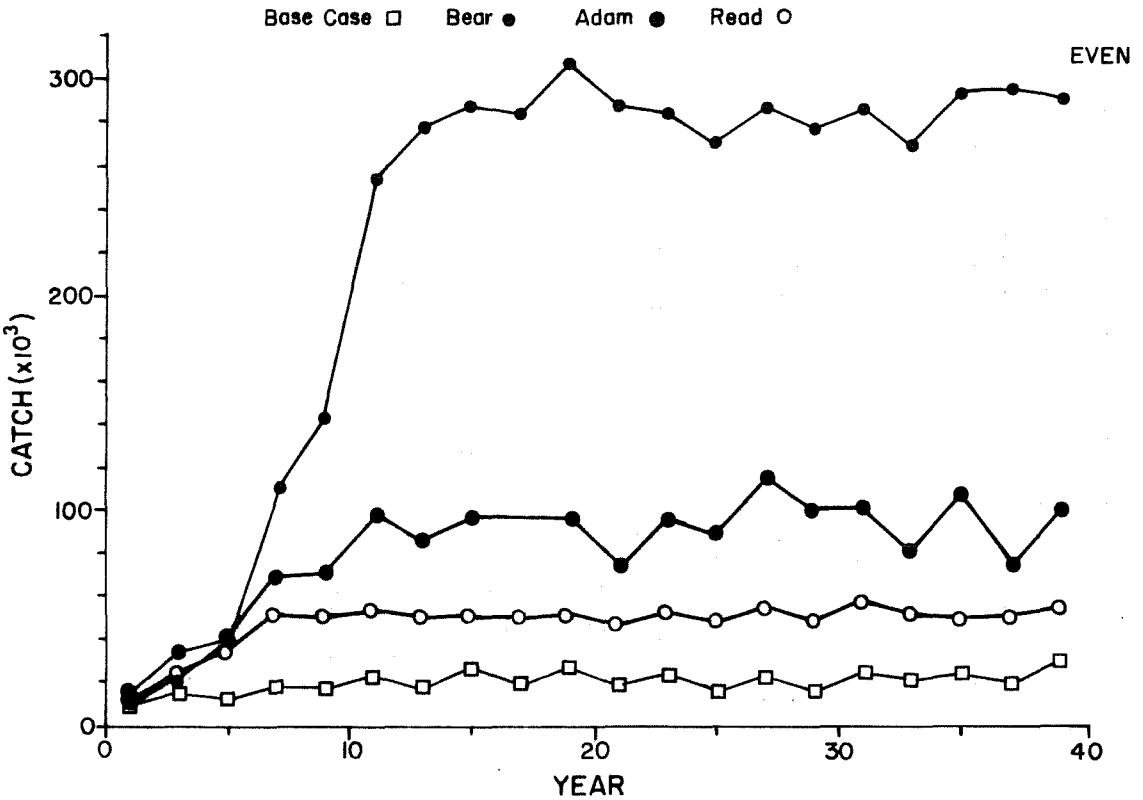


Figure 3.3-2. Catch trends of Johnstone Strait even-year pink salmon under the Base Case and the Bear, Adam and Read options.

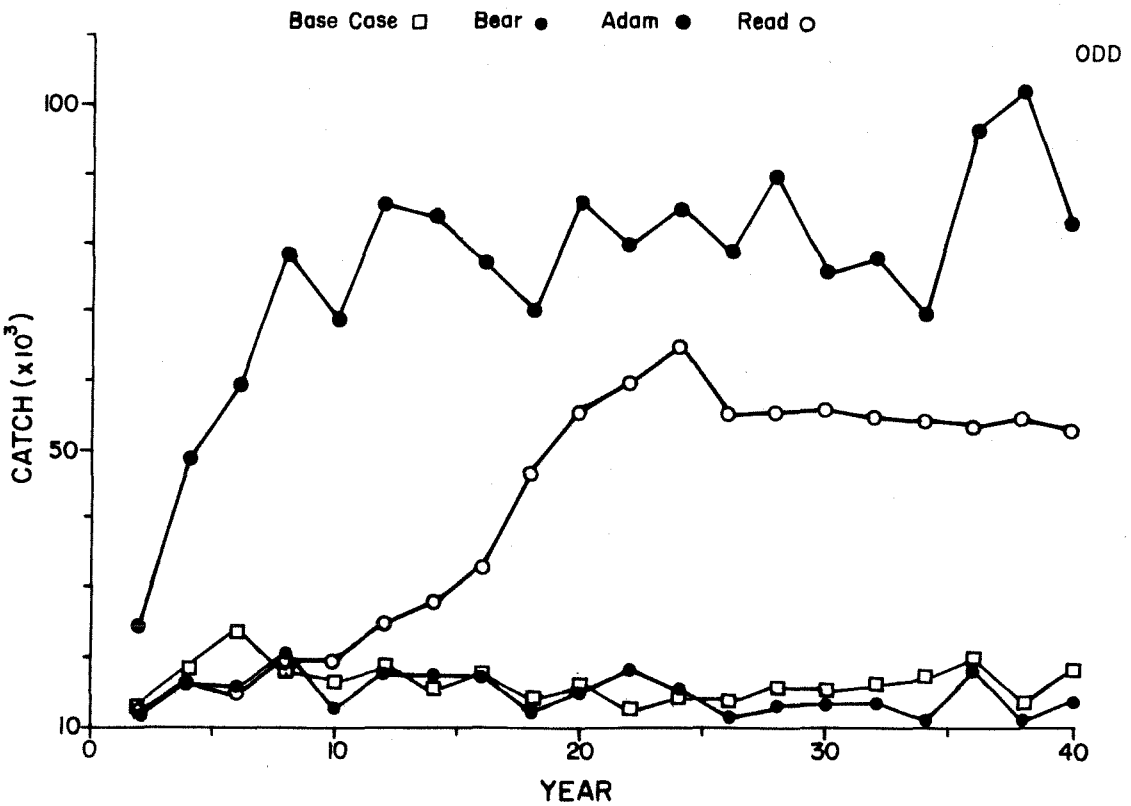


Figure 3.3.3 Catch trends of Johnstone Strait odd-year pink salmon under the Base Case and the Bear, Adam and Read options.

The enhancement proposal for Read Creek involves a flow control structure to stabilize the flows and improve the productivity of the stocks. It was assumed that this structure would increase productivity of the stocks by 50%, and that fluctuations would be reduced. The incremental production from this project was estimated at 21,000 pink salmon. The even-year stock was predicted to approach target escapement quickly within 3 cycles, while the smaller odd-year stock required 10 cycles to achieve target escapement. Predictions for the other systems were similar to the Base Case, with escapements increasing gradually in Bear and slowly declining in Adam. Total catch of even-year pink salmon increased in the first six years, and then stabilized at about 50,000 (Figure 3.3-2). Total catch of Johnstone Strait pink salmon in odd years increased over 20 years and stabilized at about 55,000. These increased catches would primarily occur in the Read Creek terminal fishery.

The major fisheries for Johnstone Strait pink salmon stocks are driven by Fraser River sockeye salmon and, therefore, changes in production from these three proposed enhancement facilities are not anticipated to alter fishing patterns in Johnstone Strait. Most of the additional production from these enhancement options would be caught in terminal fisheries. Since there is limited interaction between stocks in the terminal fisheries, with the exception of Bear River stocks in the Adam terminal fishery, the enhancement proposals are relatively independent, and the benefits for the combined project are just slightly less than additive benefits from the individual projects. If all three enhancement options were implemented, escapements of pink salmon stocks in the Bear, Read and Adam would generally increase to achieve target escapements. However, Adam even-year stocks would only achieve 60%-70% of target because of the interception of Bear River stocks in the terminal fishery. Even-year escapement to the Adam may be increased by fishing the Adam terminal fishery until its escapement target is reached. Further evaluation of this management option is contingent upon improved estimates of interception rates in the Adam terminal fishery, and upon the decision to enhance the Adam and Bear stocks simultaneously.

3.4 Lower East Coast Vancouver Island

This area consists of Statistical Areas 18 and 19 (Fig. 3.4-1).

3.4.1 Stock Descriptions

There are three chum stocks in Areas 18 and 19. The major producer is the Goldstream River, accounting for 59% of the total escapement in 1984. Escapement from 1960-1969 averaged approximately 68,000, increasing to 75,000 from 1970-1979 and 97,000 from 1980-1984. The escapement target for this area is 386,000. Chum stocks are relatively stable with recent escapements near 23-37% of the target.

There are six chinook stocks in Areas 18 and 19; the largest producer is the Cowichan River, which accounted for 75% of the total chinook escapement in 1983. Smaller stocks are the Koksilah and Goldstream River. From 1961-1970, chinook escapements averaged 5,000; increased to 7,300 from 1971-1980, and from 1981-1983 averaged 6,000.

The Cowichan River is the major coho producer in Areas 18 and 19, accounting for 98% of the total coho escapement in 1983. There are six coho stocks on Lower Vancouver island. Escapement averaged approximately 55,700 from 1961-1970; averages declined to 49,300 from 1971-1980, and 16,800 from 1981-1983.

3.4.2 Current Enhancement Activities

Enhancement facilities in the Lower East Coast Vancouver Island (LECVI) area and their production capacities are presented in Table 3.4-1.

Chum enhancement in the LECVI area consists of one hatchery on the Cowichan River. Cowichan chums are fed prior to release.

Like most coastal chinook hatcheries, Cowichan, the major producer in the lower Vancouver Island area releases 90-day smolts. Goldstream releases premigrant chinooks.

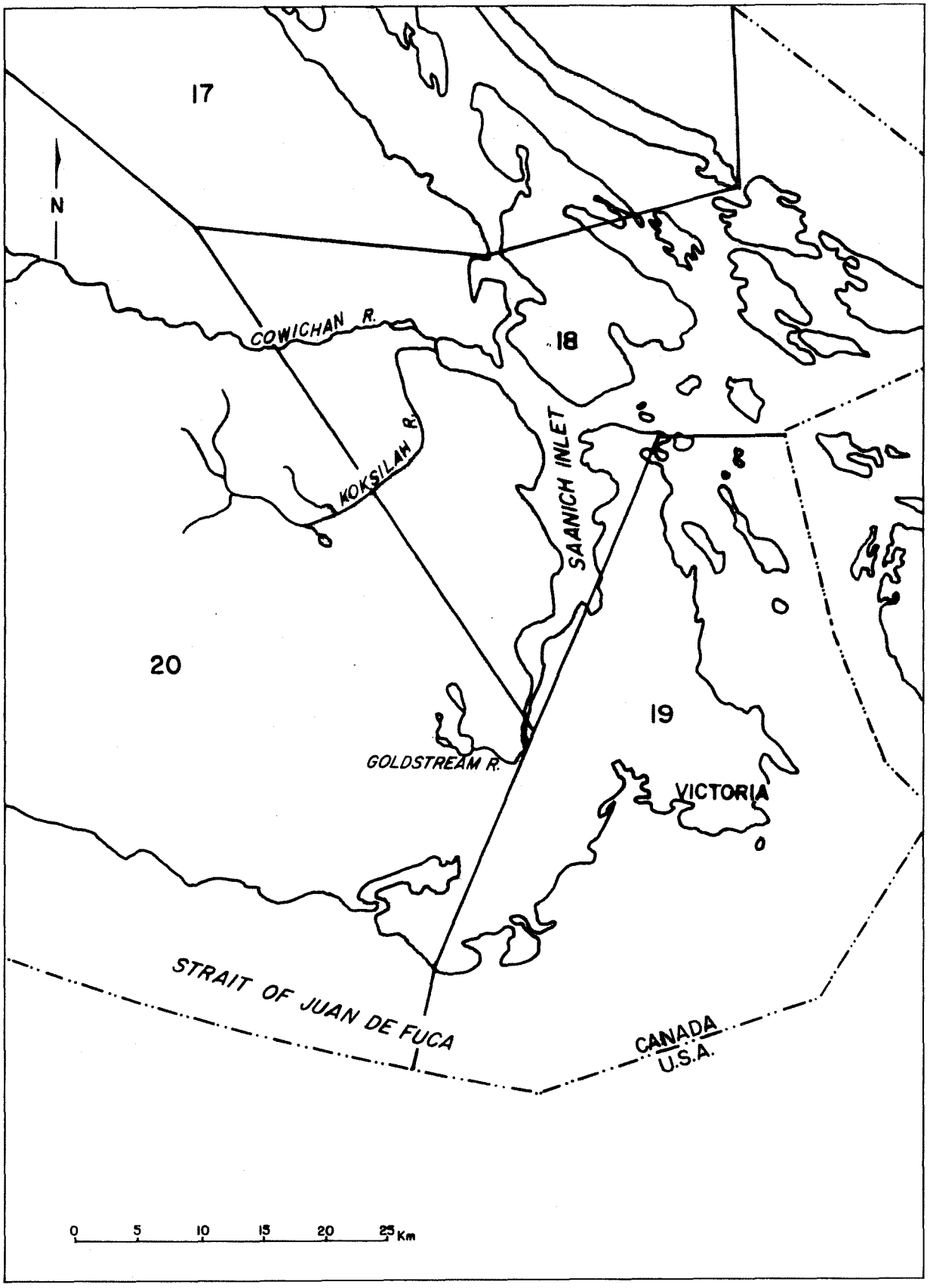


Figure 3.4-1. The lower East Coast Vancouver Island area.

Table 3.4-1. Enhancement facilities for chum, chinook and coho salmon in the LECVI area (production capacities estimated from SEP bio-standards).

Facility	Production Capacity		Target Stock 1984
	Releases	Returns	
Chum			
Cowichan	1,000,000	20,000	Cowichan
Total Chum	3,872,000	54,200	
Chinook			
Cowichan	500,000	15,000	Cowichan
Goldstream	36,000	170	Goldstream
Total Chinook	536,000	15,170	
Coho			
Cowichan	500,000	7,500	Cowichan
Goldstream	180,000	2,700	Goldstream
Total Coho	680,000	10,200	

The Cowichan community-operated hatchery is the largest coho enhancement facility on lower Vancouver Island. It releases pre-migrant fry. Cowichan coho fry are released weighing 2 or 3 g in spring.

3.4.3 Habitat Status

A habitat summary for lower Vancouver Island chum is presented in Table 3.4-2. Summaries for chinooks and coho can be found in Section 3.3.4. For a description of the habitat tables, see Section 2.2.4.

Table 3.4-2. Lower East Vancouver Island chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	251	238	138

MANAGEMENT STYLE: Active X; Passive ____; Unknown ____

NUMBER OF STREAMS: 2*

HABITAT NOTES

Historic Status, Production Constraints and Development History	Long history of logging - low impacts. Logging probably compounded natural flooding problems. Natural flooding and flood control limits chum potential.
Current Status	Stable - low-level logging. Continued diking and flood control.
Future Outlook	No change from current.
Natural Habitat Production Potential	Unlikely to achieve historic highs without careful habitat control through co-operative management.
Improved Production Potential	Low.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium - High	Medium	Medium - High	Medium - High	Low

CONCLUSION Habitat could probably produce to historic levels. Manageability problem.

* Cowichan and Koksilah rivers.

3.5 West Coast Vancouver Island

This area includes Statistical Areas 20-27 (Fig. 3.5-1).

3.5.1 Stock Descriptions

West Coast Vancouver Island (WCVI) stocks are discussed by species in the following sections.

3.5.1.1 Sockeye Salmon

Kennedy Lake sockeye comprise 95% of the sockeye escaping to Area 24. These stocks have not been fished since 1971, except by a native food fishery. There are two runs to the Kennedy system; an early run which arrives in June and spawns in the Upper Kennedy River, and a late run which arrives in August/September and spawns in the Clayoquot River and on the beaches of Clayoquot Arm. The late run is the one which was previously fished commercially. The decline in these stocks is primarily due to over-fishing, but logging and road building have also contributed to their problems. It is unclear if any other factors are preventing rebuilding. Table 3.5-1 shows the trends in escapement for Kennedy Lake sockeye.

The stocks referred to as Barkley Sound sockeye are from Great Central Lake and Sproat Lake on the Somass River system, and Henderson Lake, some 15 miles seaward of the Somass River, in Alberni Canal. All three stocks are actively managed to varying degrees. Target escapements for each stock are listed in Table 3.5-2 and escapements for each stock since 1975 are shown in Table 3.5-3. Great Central Lake and Henderson Lake have been fertilized; Sproat Lake has not. Escapements to Great Central Lake and to Sproat Lake have often been at or above target. Escapements to Henderson Lake have not yet reached target, except in 1981, since stocks there are still building following enrichment. Escapements before 1980 for Henderson Lake should therefore not be compared to recent escapements, and are not listed. All three Barkley Sound stocks have been producing increased catches (Table 3.5-4).

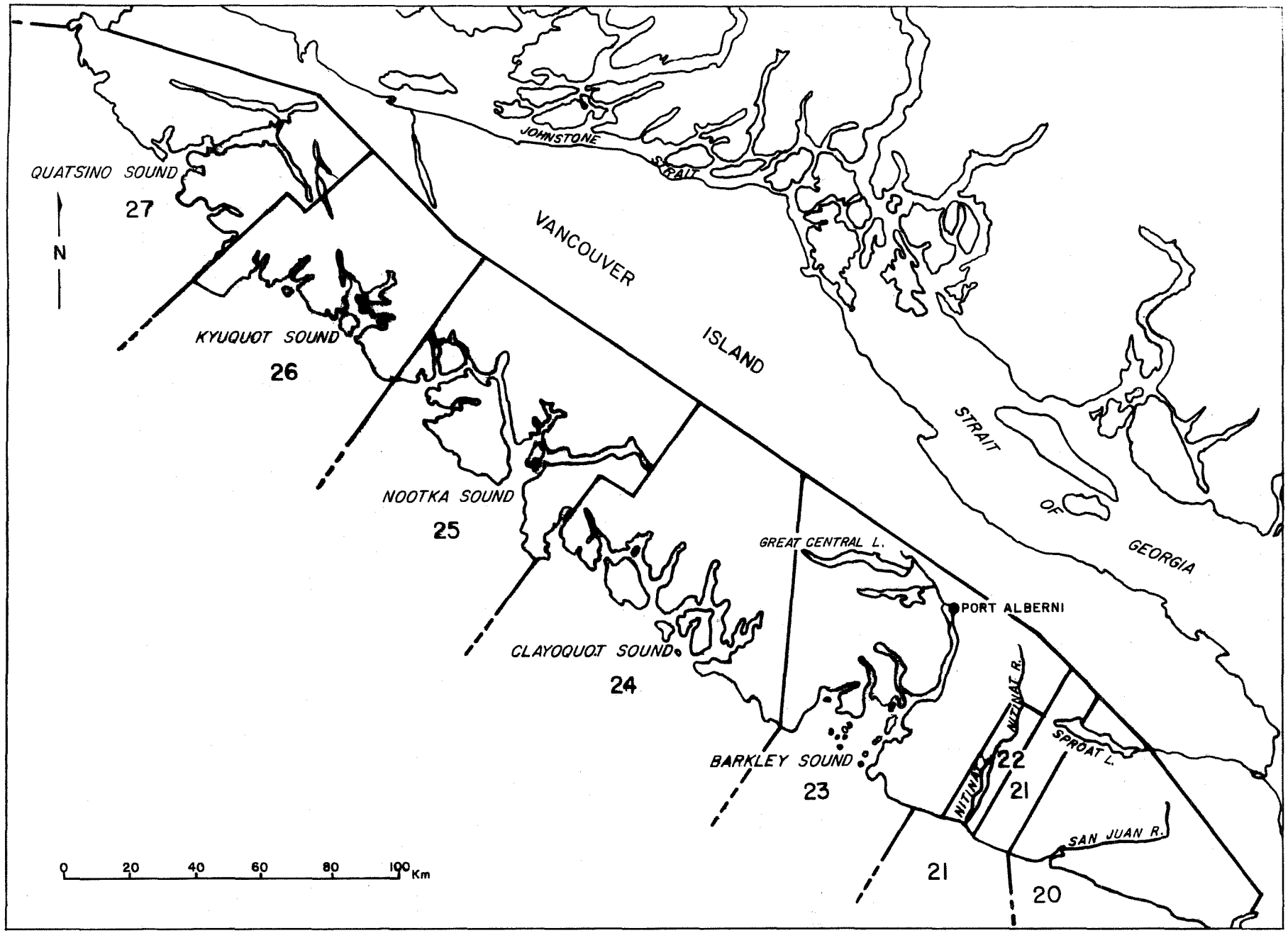


Figure 3.5-1. The west coast of Vancouver Island area.

Table 3.5-1. Escapements of Kennedy Lake sockeye, 1974-1983.

Year	Escapement
1974	45,373
1975	9,475
1976	15,539
1977	55,870
1978	53,346
1979	19,696
1980	12,924
1981	12,838
1982	93,960
1983	25,450

Table 3.5-2. Escapement targets for Barkley Sound sockeye stocks.

Stock	Escapement Target (1984)
1) Great Central Lake	200,000
2) Sproat Lake	100,000
3) Henderson Lake	50,000

Table 3.5-3. Escapements for Barkley Sound sockeye stocks, 1975-1984.

Year	Great Central Lake	Sproat Lake	Henderson Lake
1975	138,115	47,522	N/A
1976	100,613	47,709	N/A
1977	212,166	80,793	N/A
1978	114,440	37,538	N/A
1979	235,996	72,266	N/A
1980	142,391	107,282	21,000
1981	213,340	111,016	40,000
1982	169,385	215,445	56,000
1983	357,571	257,014	45,000
1984	152,168	87,616	35,000

Table 3.5-4. Catches of Barkley Sound sockeye, 1975-1983. Catches are apportioned to stocks using test fishery information.

Year	Great Central Lake	Sproat Lake	Henderson Lake
1983	469,060	287,724	104,679
1982	Not Available - No Test Fishery in 1982		
1981	563,145	285,921	66,237
1980	368,000	273,900	46,269

Table 3.5-5. Catch, escapement, total return and harvest rate of Hobiton Lake sockeye, 1974-1983.

Year	Catch	Escapement	Total Return	Harvest Rate
1974	N/A	3,100	N/A	N/A
1975	N/A	8,250	N/A	N/A
1976	N/A	6,250	N/A	N/A
1977	N/A	3,380	N/A	N/A
1978	N/A	2,400	N/A	N/A
1979	1,000	6,010	7,010	14.3
1980	3,000	7,010	10,010	30.0
1981	8,000	13,315	21,315	37.5
1982	26,000	40,200	66,200	39.3
1983	6,000	22,187	28,187	21.3

Hobiton Lake sockeye is an early-running stock, coming into Nitinat Lake in mid-April to July, and holding in Hobiton Lake until mid-October. Hobiton Lake was first fertilized in 1977, and since that time has supported a native food fishery only. Table 3.5-5 shows trends in catch, escapement and harvest rate.

3.5.1.2 Chum Salmon

There are 7 major aggregates of chum stocks in the WCVI area, of which three are of concern: the Kyuquot stock, the Nootka/Esperanza stock, and the Nitinat stock. Together they accounted for 73% of the total chum escapement in 1983. Escapement averaged 381,500 from 1960-1969, and increased to 485,500 from 1970-1979 and 598,600 from 1980-1983.

Area 26 chum stocks are actively managed as an aggregate group called the Kyuquot stock. Most streams in WCVI Area 26 have chum salmon returning to them in late September. The runs are 37% 3-year olds, 60% 4-year olds and 3% 5-year olds. The stocks are extremely variable. An initial phase of overfishing drove these stocks down, and they have not recovered due to environmental degradation (logging, road building, etc.). The escapement target for this area is 100,000. The escapement optimum has not been achieved since 1974, and only seven times since 1947. Table 3.5-6 shows catches, escapements, harvest rates and rates of return for the period 1974-1983.

Nootka/Esperanza chums provide the major salmon runs in Area 25. The Nootka/Esperanza runs are 27% 3-year olds, 66% 4-year olds and 7% 5-year olds. Catches and escapements are extremely variable, and have declined over the past decade, probably due to habitat degradation (logging, road building and mills). Table 3.5-7 indicates trends in catch, escapement, harvest rate and rate of return. The escapement target for this area is currently 150,000 chums, but the only time it has been reached in the past decade was in 1983, when there was no fishery. The target escapement has only been reached three times since 1947. In 1982, the harvest rate was 94%.

The reported escapements of Nitinat chums are extremely variable, and there have been fisheries only occasionally in the past decade. A chum hatch-

Table 3.5-6. Catch, escapement, total return, harvest rate and rate of return of Kyuquot chum salmon, 1974-1983.

Year	Catch	Escapement	Total Return	Harvest Rate	Rate of Return
1974	61,287	100,050	161,337	37.9	0.36
1975	37,667	34,475	71,142	52.9	0.68
1976	7,969	13,975	21,944	36.3	6.82
1977	52	16,550	16,602	0	6.29
1978	1,185	84,486	85,671	1	2.28
1979	0	14,248	14,248	0	N/A
1980	166,278	74,000	240,278	69.2	N/A
1981	50,521	50,000	100,521	50.3	N/A
1982	224,002	91,200	315,202	71.1	N/A
1983	0	86,200	86,200	0	N/A

Table 3.5-7. Catch, escapement, total return, harvest rate and rate of return for Nootka/Esperanza chums, 1974-1983.

Year	Catch	Escapement	Total Return	Harvest Rate	Rate of Return
1974	162,445	100,050	262,495	61.9	0.39
1975	63,196	65,975	129,171	48.9	0.67
1976	18,174	37,000	55,174	32.9	4.65
1977	2,282	58,375	60,657	3.9	3.66
1978	5,262	123,995	129,217	4.0	1.83
1979	0	40,206	40,206	0	N/A
1980	216,661	138,550	355,211	61.0	N/A
1981	41,255	121,120	162,375	25.4	N/A
1982	259,217	15,400	274,617	94.3	N/A
1983	0	161,125	161,125	0	N/A

Table 3.5-8. Catch, escapement, total return, harvest rate and rate of return of Nitinat chum salmon, 1974-1983.

Year	Catch	Escapement	Total Return	Harvest Rate	Rate of Return
1974	0	98,100	98,100	0	0.19
1975	0	9,900	9,900	0	1.49
1976	0	19,675	19,675	0	2.51
1977	0	43,700	43,700	0	1.82
1978	0	8,400	8,400	0	6.03
1979	0	4,530	4,530	0	N/A
1980	279,211	54,500	333,711	83.6	N/A
1981	0	115,000	115,000	0	N/A
1982	0	25,000	25,000	0	N/A
1983	0	7,960	7,960	0	N/A

ery on the system has just begun to produce harvestable returns in 1984. Catch, escapement, harvest rate and rate of return are shown in Table 3.5-8. The return migration generally occurs in the first two weeks of October. The escapement target for this area is currently 125,000 chums. This target has not been reached at all in the past decade, and only three times since 1947.

3.5.1.3 Chinook Salmon

There are twenty-three chinook stocks in the WCVI area, including the Gold, Nitinat and Marble River stocks. The major natural stock is in the Somass River, located within Area 23. It accounted for approximately 60% of the total chinook escapement in 1983. Escapement of WCVI chinooks has declined from an average of 31,000 from 1961-1970 to 23,000 from 1971-1980. Escapements from 1981-1983 averaged 18,382.

3.5.1.4 Coho Salmon

There are twenty-nine coho stocks in the WCVI area. The major stock in this area is in the San Juan River followed by that in the Gold River. Together they accounted for 54% of the total coho escapement in 1983. Escapements averaged 165,400 during the 1960's, declining to 125,900 during the 1970's. Escapements from 1981-1983 averaged 25,400.

3.5.2 Current Enhancement Activities

Enhancement facilities in the WCVI area are presented in Table 3.5-9. Enhancement activities are described below by species.

3.5.2.1 Pink Salmon

Waukwaas pinks are the only pink stock being enhanced in the area. The Stephens Creek facility, operated by the Port Hardy community group, incubates eggs in upwelling gravel boxes from which the emergent fry are released directly.

Table 3.5-9. Enhancement facilities in the West Coast Vancouver Island area (production capacity estimated from SEP biostandards).

Facility	Production Capacity		Target Stock 1984
	Releases	Returns	
Pink			
Port Hardy (Stephens Ck)	500,000	12,500	Waukwaas
Chum			
Nitinat	20,200,000	340,000	Nitinat
Tlupana	15,120,000	302,000	Tlupana, Conuma, Deserted, Sucwoa, Canton
Port Hardy (Stephens Ck)	1,550,000	31,000	Stephens, Waukwaas, Wanokana
Marble	40,000	320	Nequilt-Paalis
Total Chum	36,910,000	673,320	
Chinook			
Nitinat	2,500,000	75,000	Nitinat, Sarita
Tlupana	1,440,000	43,000	Conuma, Sucwoa, Tlupana, Conton
Robertson	9,000,000	272,000	Robertson, Nahmint
San Juan	315,000	9,450	San Juan
Thornton	300,000	9,000	Lower Kennedy, Robertson transplant to Thornton
Gold River	72,000	350	Gold
Marble	216,000	6,480	Marble
Sooke	72,000	350	Rocky
Total Chinook	13,915,000	415,630	

3.5.2.2 Chum Salmon

There are four chum enhancement projects in the WCVI area. Production from the Nitinat and Tlupana facilities is high; overall production from this area will exceed that of the lower Fraser, and will be about 60% of that in the Georgia/Johnstone Strait areas. Nitinat and Tlupana are by far the largest chum hatcheries in British Columbia, although they are small compared to facilities in Alaska and Asia. Nitinat and Tlupana enhancement projects are designed to stabilize and increase catch in the west coast inlets. West coast chum production is notoriously unpredictable due to impact of high stream flow rates on chum eggs during incubation. Tlupana hatchery chums made a significant contribution to the 1983 fishery, but were less abundant than expected in 1984. The first major returns to Nitinat supported a very successful terminal fishery in 1984.

Nitinat, Tlupana and the Stephens Creek facilities all rear chum fry prior to release, whereas the Marble project releases emergent fry. The Tlupana and Stephens Creek projects are both central hatcheries where eggs taken from streams are incubated and reared at the hatchery, then released as fry into their native streams. Ideally, maturing adults will return to the release site rather than the hatchery. Evidence from mark-release/recovery studies indicate this strategy is working at Tlupana. This suggests the central hatchery concept, which has been widely used during SEP Phase I (e.g., Chehalis, Inch, Kitimat, Bella Coola) will work as planned when streams where fry are released are separated by salt water, as they are at Tlupana and Stephens. Whether spawners will return to the stream or to the hatchery when stocks are taken from within a single watershed (e.g., Chehalis) will not be known until marked fish are recovered.

One effect of rearing fry before release (the Japanese hatchery method) may be a shift in age at maturity of returning adults. WCVI and Georgia Strait chum stocks normally mature at age 4, although a significant number of age 3 and a small portion of age 5 fish also mature. Two experimental tests of the Japanese method were done at Thornton Creek (WCVI) and at Rosewall Creek (MECVI) facilities. In both cases, age 3 returns outnumbered age 4 fish, and average body size was smaller. It remains to be seen if this will

happen at large chum hatcheries and, if so, whether changing the time or size of fish at release can result in larger-sized returning fish.

3.5.2.3 Chinook Salmon

Productivity estimates for WCVI hatchery and for wild chinook stocks should be reviewed. Eight WCVI hatcheries release primarily 90-day smolts. Releases from the Sooke and Gold River projects are pre-migrants. As elsewhere on the coast, the availability of brood stock constrains production in many cases (e.g., at Tlupana, Kennedy, Marble and Sooke). Smaller facilities deal mainly with local wild stocks or with threatened stocks further afield (e.g., Kennedy stock). Nitinat eggs were transplanted to Sooke a few years ago, but fish are now taken from local spawning populations. Robertson Creek stock is being released from Thornton to build a run to the Ucluelet area.

The large hatcheries at Nitinat, Robertson and Tlupana were designed for enhancement of single chinook stocks, but they are now handling several other stocks. Nitinat and Tlupana are large chum producers, and there is potential to convert some chum capacity to chinooks. Robertson Creek is the largest chinook hatchery in British Columbia. Its stock was developed from Stamp and Sproat stocks. It has been extremely successful through 1984, but predictions for 1985 and 1986 are poor. Survival rates for the Robertson stock have declined in recent years, with low rates expected for the 1981 and 1982 broods (See Section 4.0).

3.5.3 Fisheries

The following sections discuss WCVI fisheries by species.

3.5.3.1 Sockeye Salmon

There are no commercial fisheries for Kennedy Lake sockeye.

The three Barkley Sound stocks are harvested primarily by the Barkley Sound terminal net fishery that operates from early June to late July. The

area around Henderson Lake is closed later to commercial fisheries for protection of returning adults. This closure has not been effective. In past years the fishery was opened for 4 days/week. Increasing fleet size has required progressive reductions in days/week, in spite of increasing production. Table 3.5-10 shows total return of the three Barkley Sound stocks, and their overall harvest rate. This fishery is managed to control escapement. Electronic counters in the Somass River system count the returning adults to Great Central Lake and Sproat Lake separately. Henderson Lake returns come considerably later and are estimated visually; counts have been reliable only since 1980. An estimate of total returns is made on the basis of smolt-to-adult survival, but the data are so variable that the information is of little use for in-season management. In-season escapements are also compared to historical escapements for the same period. These data, in conjunction with catch data from hails on the grounds, are used to provide an index of stock abundance and form the basis for a qualitative judgement of stock abundance. A test fishery collects age and stock composition data immediately prior to the anticipated fishery. This yields a subjective impression of stock abundance, but the turn-around time for processing scales and fish samples makes the data of little use for in-season management.

There is no commercial fishery specifically for Hobiton Lake sockeye. There is, however, an Indian food fishery conducted by gillnetters and drag seiners at the mouth of the Hobiton River or at Nitinat Narrows (as in 1984). This fishery is administered by the Nitinat Band. The Lake Enrichment Section of the Pacific Biological Station advises the band regularly on stock abundance.

3.5.3.2 Chum Salmon

Kyuquot The fishery for Kyuquot chum stocks is a terminal fishery, with gillnetters and seiners harvesting the surplus exceeding target escapement. Each year, escapement predictions are determined by the local resource managers and published in the fishing guide. Each fall, regardless of the prediction, one or more seine test vessels attempts to estimate stock abundance to determine if harvestable surpluses exist. An inner boundary is established and test fishing data are interpreted subjectively to estimate

Table 3.5-10. Total return and harvest rate of Barkley Sound sockeye, 1975-1984.

Year	Total Return	Harvest Rate
1975	398,226	53.6
1976	82,335	82.1
1977	1,449,938	80.7
1978	347,315	56.9
1979	1,063,361	71.1
1980	936,380	73.3
1981	1,241,551	74.0
1982	795,112	51.6
1983	1,475,809	58.5
1984	1,040,901	78.6

stock abundance inside and outside the boundary. If these two estimates are favourable, a fishery is then opened. This management strategy lacks rigor, and initial indications of the 1984 fishery indicate that escapement may have suffered from the opening.

Nootka/Esperanza It is clear that fisheries in years other than 1980 and 1982 for Nootka/Esperanza chums should not have taken place. There were no mixed-stock concerns to address until 1984, when the first returns to the Tlupana Hatchery were expected. No fishery for natural stocks was anticipated, but a surplus of hatchery fish was anticipated for harvest. Initial information indicates that not enough hatchery fish returned and the terminal net fishery harvested natural stocks. Annual predictions of run strength are made by local staff, who also set target escapements. Each fall, test vessels monitor returns using a seine in the Inlet and a gill net at Nootka Light where seines are not effective. An inner boundary is created as a sanctuary, but fish tend to move in and out with the tides, and this boundary is not always effective. Data from these test fisheries determine whether or not to call an opening. This assessment system is subjective, lacks rigor and may result in harvesting natural stocks.

Nitinat The fishery for Nitinat chums is in a terminal area, and in the past has been fished by both gillnetters and seiners in Nitinat Lake. 1984 was the first year a fishery has been held since 1980, and the second year in a decade. Although returns warranted an opening in 1980, the harvest rate was great enough (83.6%) to reduce the target escapement. In 1984, the fishery caught 220,000 chums in Area 21, just seaward of the lake. The fishery was conducted outside the lake in order to improve fish quality, and because the Nitinat Bar has silted up considerably and was deemed a hazard to loaded vessels. Interception of other species was insignificant, and it is not known if other chum stocks were intercepted. Escapement estimates are not available yet.

The fishery is nominally managed on a fixed escapement basis. Escapement counts are not done rigorously or systematically, and a considerable difference in returns would probably not be detected. A test fishery in the

lake (and more recently off Nitinat Bar) yields qualitative information on run strength as well as age and sex compositions. These data determine if the area is opened or closed to fishing. A pre-season estimate of anticipated run strength is made but is not recorded, and consequently cannot be used in later years for verification. It may be that the fishery in 1984 caught mainly returning hatchery fish, but a greater catch was made in 1980 well before any hatchery returns were seen. It may be possible to apportion the catch to wild/hatchery categories based on mark-recovery program data.

3.5.4 Habitat Status

Habitat summaries for West Coast Vancouver Island sockeye, chums, chinooks and coho are presented in Tables 3.5-11 to 3.5-14, respectively. For a description of the habitat tables, see Section 2.2.4.

3.5.5 Stock Rebuilding Potential

Enhanced production for Kennedy Lake sockeye has not met expectations. What is keeping the lake below its expected productivity is unknown. It is clear, however, that management actions have nothing to offer for rebuilding, as there is no fishery there now. The Lake Fertilization Section at the Pacific Biological Station is currently investigating this lack of response of Kennedy Lake to fertilization. They point out that estimates of escapement to this system are inadequate, and that rebuilding may be occurring at a greater rate than is apparent. It is probably not coincidental that the highest escapements in a decade were reported in 1982 when a more intensive study of sockeye escapements was made using, in part, a mark-recapture technique.

In the Barkley Sound area, Great Central and Sproat lake stocks are probably not in need of rebuilding. Fine tuning and maintenance of runs are all that is necessary. Henderson Lake has not yet produced harvestable abundances, primarily due to the interception of Henderson stocks in the fishery. The Hobiton Lake sockeye stock does not require rebuilding as it is near optimum condition. It requires only proper management and continued fertilization to maintain it at current levels.

Table 3.5-11. West Coast Vancouver Island sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,151 ?	495	388

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 16

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging since turn of century. Low impacts. Flow stability not a problem for sockeye.
Current Status	All watersheds well into second growth. Lower-scale logging.
Future Outlook	Stable.
Natural Habitat Production Potential	Habitat is not a limiting factor.
Improved Production Potential	Lake fertilization.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	Lake fertilization

CONCLUSION Natural habitat not a constraint.

Table 3.5-12. West Coast Vancouver Island chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	* 4,240 ?	500	312

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 150

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural stream flow instability. Logging through entire area has impacted on estimated 50% of the streams with low - moderate impact. Some "spot" high impacts. Logged streams reforesting but there are probably long-term gravel loss problems.
Current Status	Logged watersheds recovering. Most of "easy" timber removed.
Future Outlook	Continued lower level of logging with improved attention to habitat protection. Long-term residual gravel loss effects unknown.
Natural Habitat Production Potential	If M.R.E. is correct, then potential is likely low. More probably potential is moderate and improving over long term.
Improved Production Potential	Gravel replacement if production increase is thought worthwhile.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	Medium	Medium - High	Medium	Medium

CONCLUSION Some major fleet management and fish quality problems are probably more important than habitat issues.

* This figure is highly suspect.

Table 3.5-13. West Coast Vancouver Island chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	46		18

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS ____

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging has taken place on all of the major chinook producers, but only one - Sarita River - shows significant residual impacts. No other real development impacts.
Current Status	Returning to second-growth forest. Better controls on continued logging.
Future Outlook	Improving as most major watersheds regenerate naturally.
Natural Habitat Production Potential	Return to historic levels - probably slower in Sarita River.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium - High	High	High	

CONCLUSION Success of Robertson Creek Hatchery demonstrates low level of industrial and estuarian development impacts. Robertson Creek Hatchery could be used to re-colonize "lost stock" habitats.

Table 3.5-14. West Coast Vancouver Island coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	290		27

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: *

HABITAT NOTES

Historic Status, Production Constraints and Development History	Coho likely to be species most affected by habitat impacts. Logging may have had a moderate - high influence, but maximum recorded high in 1970 follows a period of fairly heavy logging with habitat protection well below current levels. Natural flow fluctuations.
Current Status	Mostly recovering watersheds - no impacts other than logging.
Future Outlook	Gradual improvement as watershed cover returns. Improved habitat management and protection.
Natural Habitat Production Potential	Probably return to historic levels within 10 - 15 years.
Improved Production Potential	Almost certainly localized restoration and flow control and re-colonization possibilities.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High - Medium	High - Medium	High	High - Medium

CONCLUSION Decline from historic high escapements is not explained by a similar drop in overall habitat capability.

* General habitat notes.

A more rigorous approach to the management of Kyuquot Sound chum stocks may help, reduce the erratic fluctuations in stock size although they are probably a result of habitat problems. Stabilizing production (e.g., by building spawning channels which would not be prone to flooding) may increase the rebuilding potential. The same comments also apply to Nootka/Esperanza chums. If future Tlupana hatchery stocks are harvested at high rates, natural stocks may be negatively affected. Harvestable surpluses from the Nitinat hatchery may also result in mixed-stock problems (depending on the harvest strategy).

3.5.6 Management Conflicts

Management conflicts with respect to Kennedy Lake, Barkley Sound and Hobiton Lake sockeye are primarily related to the difficulty of obtaining reliable run size information for in-season management.

For chums in the WCVI area, commercial fisheries have fished beyond the escapement optimum of 100,000 Kyuquot on every occasion that there has been a fishery since 1975. This optimum may not have been in effect at those times, but is is obvious in retrospect that the fisheries in 1975 and 1981 were ill-advised. There are no mixed-stock problems for Kyuquot chums. Interception of coho is a small problem due to considerable overlap in the timing of coho and chum runs. Steelhead are also intercepted to some degree.

For Nootka/Esperanza chums, as for other WCVI chum stocks, the target escapement and methods of estimating escapement need to be thoroughly reviewed if managing by controlling escapement is to be effective. With a hatchery in the system, the harvest rate could be increased even with the uncertainties in estimating escapement, since hatchery returns should buffer wild stocks. This buffering concept needs further evaluation to test its validity, since if it is not effective the natural stocks may be overfished. If these stocks and fisheries are to be stabilized, stock-specific information about run timing and abundance is essential. These comments about target escapement and escapement estimation also apply to Nitinat chums. It has been suggested that Nitinat Narrows may be a good location for a hydroacoustic fence for counting adults returning into the lake.

3.5.7 Management Strategies for Stock Rebuilding

Several options or strategies for rebuilding depressed stocks are discussed below by species.

3.5.7.1 Sockeye Salmon

Rebuilding of Henderson stocks can be accelerated by employment or methods to protect returning Henderson adults until the stock reaches harvestable levels. These methods would undoubtedly also raise escapements to Great Central and Sproat lakes. It is believed that greater escapements will raise production in Henderson Lake, but Great Central and Sproat lakes may be close to their maximum production. Increasing escapements would be a useful short-term experiment to determine if these lakes are close to optimum escapement levels, in addition to helping rebuild Henderson Lake stocks. In order to avoid overfishing, a method for estimating actual abundance (rather than relative abundance) is required.

3.5.7.2 Chum Salmon

A number of management options should be considered for Kyuquot chums including:

1. Fishing at a fixed harvest rate, which would stop fishing below some threshold of abundance;

2. Waiting until some portion of the stock is in the streams, then holding a fishery. This fishery would have to reach a certain catch (as an indicator of abundance) before it could be extended;

3. Shifting to terminal fisheries, which would allow more control of the catch of individual stocks, but quality would decrease; and

4. Restricting the fishery to gillnetters only, which would probably reduce the harvest rate considerably.

Obtaining information for any management option will be extremely expensive. This geographic area does not lend itself to indexing by test fishing. All options requiring knowledge of harvest rates will need some estimate of stock abundance. If this is required in-season, the costs would be extremely high. Escapement estimates which are now only approximations will be very expensive to obtain rigorously. In all probability, catch and abundance information will have to be analysed after the season is over. Consequently, until stabilization occurs and improved estimation of return rates, harvest rates and abundance are available, a cautious approach to harvesting will be required.

The following options should be considered for Nootka/Esperanza chums:

1. Stabilize and enhance natural runs to raise their productivity to that of hatchery runs;

2. Reduce harvest rate to a level dictated by the least productive stream; and

3. Mark a significant proportion of the hatchery stock to allow discrimination between natural and enhanced stocks. Fisheries could then be moved into more terminal areas. They could be moved further seaward (for better fish quality) after stocks are rebuilt.

Rebuilding of Nitinat chums will require stabilization and enhancement of natural stocks to bring them to production levels similar to the hatchery.

3.5.8. Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill *et al.* (1983)[1].

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

3.5.8.1 San Juan Expansion (Project No. 20-4)

This project currently is a chinook and coho facility on Four Mile Creek. The proposal for expansion is to increase chinook production from the facility. This will also require an additional water supply. Current production is from 350,000 chinook eggs, yielding 7,560 adults, and from 1,500,000 coho eggs, yielding 18,300 adults. The proposal is to boost the number of chinook eggs taken to 600,000, yielding 13,500 adults - an increase of 6,000 adult chinooks.

3.5.8.2 Nitinat Expansion (Project No. 22-2B)

This project is for expansion of chinook rearing in the current Nitinat Hatchery. This expansion will include extra ponds and a new surface water supply from the Little Nitinat River. Chinook production will be increased by 60,000 adults.

3.5.8.3 Robertson Creek Hatchery Expansion (Project No. 23-15B)

This proposal is to increase rearing of chinooks at the Robertson Creek hatchery by 50%. Current production is from 9,000,000 chinook smolts. The number of eggs taken will be increased by 4,500,000.

3.5.8.4 Thornton Creek Facility Expansion (Project No. 23-32)

The Thornton Creek Facility started as a pilot Japanese style chum hatchery. Manageability concerns led to the de-emphasizing of chums, and to rearing of chinooks and coho from local streams, and rearing chinooks from Robertson Creek Hatchery. The proposal is to cut back chum production to a maintenance level, and to increase chinook and coho production. Current operations incubate 225,000 chum eggs, producing 3,240 adults; 275,000 coho eggs, producing 9,925 adults; and 100,000 chinook eggs, producing 2,160 adults. The proposal is to reduce chum eggs to 100,000, producing 1,440 adults; increase coho eggs to 325,000, producing 14,990 adults; and increase chinook eggs to 25,000, producing 5,000 adults.

3.5.8.5 Kennedy River (Project No. 24-4A)

This proposal is for a fence on the lower Kennedy River to aid primarily in assessment of sockeye. This structure may have additional benefits in predator control, stream flow stabilization, and assessment and egg taking activities for Kennedy River chinooks. The fence will not guarantee production, but will allow assessment which may bring the lake to its estimated potential, which is likely similar to that of Great Central Lake.

3.5.8.6 Kennedy River/Ahousat CEDP Expansion (Project No. 24-10B)

Currently, the Ahousat Band is testing a "cassette-type" facility with floating net pens nearby for rearing. At the same time, Kennedy River chinooks are being reared at Thornton Creek facility, transferred back to the Kennedy River, and released as 5 g smolts. This proposal is to rear Kennedy River chinook eggs for release as smolts in this cassette-type facility and net pen complex. The facility would take 100,000 chinook and 100,000 coho eggs, which would yield 3,000 adult chinooks and 7,500 adult coho. Currently, 50,000 coho eggs (to yield 1,080 adult coho) are being incubated.

3.5.8.7 Tlupana, Gold/Burman Expansion (Project No. 25-8B)

This proposal is for expansion of the Tlupana Hatchery to rear Gold River chinooks and Tlupana Inlet coho. These fish would be returned to their original streams. No suitable site or proven well exists on Gold River. The expansion will include extra ponds, wells and surface water supply. The project will yield 100,000 adult chinooks and 50,000 adult coho.

3.5.8.8 Marble River Facility (Project No. 27-3A)

At Marble River there is currently a 350,000-egg incubation facility and net-pen rearing operation which produces 5 g chinook smolts for release. It is proposed that the facility be expanded to add coho and steelhead. Current production is from 350,000 chinook eggs yielding 7,560 chinook adults. This proposal is to add 250,000 coho eggs (producing 9,385 coho adults) and 100,000 steelhead eggs (producing 1,000 adult steelhead) to the facility's capabilities.

3.5.8.9 McKay Cove Creek Pilot (Kyuquot Creek) (Project No. 26-2A)

Currently, there is a pilot training facility for the Kyuquot Band in the village. The proposal is to build a small facility on McKay Cove Creek to produce small numbers of chums, chinook and coho. The facility will be developed in conjunction with the DIA hydroelectric power development for Kyuquot village. Current production is from an egg take of 50,000 yielding 720 adult chums. Proposed production is for 100,000 chinook eggs yielding 2,160 adults, 100,000 coho eggs yielding 2,160 adults, and 350,000 chum eggs yielding 5,040 adults.

3.5.9 Predicted Results of Management and Enhancement Options

In the following sections, management and enhancement options are discussed by stocks affected.

3.5.9.1 Kyuquot Chums

The management options for rebuilding Kyuquot chums generally fall into two categories both of which were evaluated using a simulation model:

1. Fix harvest rates (possibly scheduled to abundance); and
2. Fix catch when abundance exceeds a pre-determined threshold.

Fixed harvest rates evaluated were 15%, 20%, 25%, 30% and 35%. Results from these runs are summarized in Table 3.5-15. The mean return rate of 1.55 for Kyuquot chum stocks implies a maximum sustainable harvest rate of 35%. Variations in productivity, even when reduced by 3/4, made a harvest rate of 35% too high to sustain, as shown by the falling trend of escapements. Lower harvest rates appeared to be sustainable, but only rates of 20% or less permitted the system to achieve its target escapement. The 15% harvest rate showed rising escapements, indicating that stocks were being under-harvested. In general, then, 20% should be considered the target long-range average harvest rate.

Table 3.5-15. Summary of results for fixed harvest rate rebuilding regimes for Kyuquot chums.

Fixed Harvest Rate	Catch		Escapement		NPV (1984 $ millions)
	Average	Trend	Average	Trend	
15%	29,000	rising	165,000	rising	2.4
20%	24,000	constant	97,000	constant	2.5
25%	28,000	constant	85,000	constant	3.0
30%	26,000	constant	60,000	constant	3.2
15%	28,000	falling	52,000	falling	3.7

Table 3.5-16. Summary of results for fixed catch regimes for Kyuqot chum salmon.

Fixed Catch/ Threshold	Catch		Escapement		NPV (1984 $ millions)
	Average	Trend	Average	Trend	
50/50	30,000	constant	145,000	rising	3.6
75/50	30,000	constant	97,000	rising	3.8
100/50	29,000	constant	53,000	constant	4.1
75/75	35,000	constant	148,000	rising	3.6
100/75	34,000	constant	89,000	rising	3.8
125/75	37,000	constant	75,000	constant	4.1
150/50	34,000	constant	69,000	constant	4.0
50/100	30,000	rising	334,000	rising	2.7
75/100	36,000	rising	208,000	rising	3.4
100/100	41,000	constant	140,000	rising	3.9
Unlimited/100	38,000	constant	84,000	constant	4.1

Another management approach that would be easier to implement is a regime in which a fixed catch is taken only if stock abundance exceeded some pre-determined threshold. There are several compromises in this sort of management strategy. Generally, the lower the threshold, the more years when fishing would be allowed. However, this also leads to a greater risk to stocks, unless a lower catch rate is fixed to be consistent with achieving the escapement target and maintaining a sustainable fishery. Results of these options are summarized in Table 3.5-16.

There is a fundamental problem with regimes in which the threshold is set at 50,000; at fixed catches that allowed target escapements, the harvest was not enough to keep the trend constant. On the other hand, only an unlimited catch above a threshold of 100,000 (the escapement target) kept escapement from rising over the long term. Fishing to control escapement, however, is not possible without modifying the fishing fleet's operations.

This stock rebuilding option (unlimited catch above a threshold of 100,000 or fishing to control escapement) revealed some important characteristics of Kyuquot chum stocks. Even when the first priority of management was to allow an escapement of 100,000, average escapement was only 85,000. If, in practice, a fixed catch were permitted above a pre-determined threshold, the threshold should be set at this level. However, average catch was only 39,000, which is not enough to support a fishery. A more sophisticated strategy is thus required to best manage Kyuquot chum stocks.

Past experience has shown the Kyuquot chum stocks will not rebuild even when not fished. Since there is no reason to believe that this condition will change, some form of intervention is required if Kyuquot chums are to provide a lucrative, sustainable fishery. There are at least three options;

1. Build side channels to reduce variability of productivity;

2. Out-plant Kyuquot stocks to Tlupana to increase survival and reduce variability; and

3. Build a hatchery at Kyuquot Inlet.

These are listed in increasing order of capital required. Side channels would provide lower daily operating costs, although the out-planting option is meant to be short term and may, therefore, provide the greatest cost-effectiveness. If successful, out-planting will give stocks the needed boost to lift them to a higher equilibrium population level, after which satelliting could be discontinued. Furthermore, out-planting would increase productivity and reduce variability more than effectively than would a side channel, and would allow for the possibility of investigating whether productivity variability occurs in the freshwater or saltwater life-cycle stage.

3.5.9.2 Nootka Chums

Natural and enhanced Nootka chum stocks are first harvested in an outside mixed-stock fishery. Enhanced stocks are further harvested in a terminal fishery after they have separated from natural stocks. The management schemes modelled are all variations of harvesting a fixed catch above a pre-determined threshold. Results are summarized in Table 3.5-17. The first three rebuilding options are for unlimited catch above a predetermined threshold. NPV's were indistinguishable with total primary catch of natural and enhanced stocks equalling 273,000, 274,000 and 302,000, respectively. Catch and escapement of natural stocks declined when the threshold was less than 300,000, making these options unfeasible for natural stock rebuilding. The threshold of 300,000 "worked" because of three factors:

1. The escapement target for natural stocks is 150,000;

2. Tlupana hatchery is assumed to return approximately 315,000 annually; and

3. Natural and enhanced stocks are harvested together in the primary fishery and are assumed to be caught in proportion to their relative abundances.

This option was sustainable in the sense that all catch and escapement trends were level; it was optimal in the sense that the escapement target was met, subject to uncertainties about survival.

Table 3.5-17. Summary of results for fixed catch and harvest rate regimes for Nootka chum salmon.

Option	Primary Harvest: Natural Mean (Thousands)	Primary Harvest: Natural Trend	Primary Harvest: Enhanced Mean (Thousands)	Primary Harvest: Enhanced Trend	Terminal Catch Mean (Thousands)	Terminal Catch Trend	Escapement Mean (Thousands)	Escapement Trend	NPV (1984 $ millions)
Fixed Catch/ Threshold Regimes									
1. U/100	46	down	227	down	73	up	12	down	25
2. U/200	97	down	177	level	122	up	62	down	26
3. U/300	152	level	150	level	150	level	135	level	27
4. 200/100	88	level	112	level	188	level	195	up	20
5. 250/100	91	down	157	up	143	down	127	down	23
6. 225/100	89	level	135	level	164	level	155	level	21
Fixed Harvest Rate Regimes									
7. 10%	33	level	31	level	268	level	293	level	12
8. 20%	64	level	63	level	237	level	256	level	16
9. 30%	93	level	94	level	205	level	217	level	20
10. 40%	115	level	126	level	174	level	172	level	23
11. 45%	117	level	142	level	158	level	143	level	24
12. 50%	115	level	157	level	142	level	115	level	25
13. 55%	107	down	173	level	127	level	87	down	25

Sustainable options were possible with thresholds of less than 300,000, but lower catches were required to maintain natural stock abundance. Options 4 and 5 are examples. A fixed catch of 200,000 above a threshold of 100,000 yielded stable catches, although it was biased towards enhanced stocks and terminal fisheries. This reduced the NPV's. Average escapement of natural stocks was above target and rising, indicating that too few natural fish were being harvested. The decline in productivity associated with excess escapements represented a real waste that should be avoided if possible. Given management uncertainties, however, it would be best in practice to err on the side of conservation. Raising the fixed catch to 250,000 (Option 5) created an unsustainable situation in which catch and escapement of natural stocks declined. The compromise position between these extremes -- a fixed catch of 225,000 above a threshold of 100,000 -- represented the largest catch for this threshold consistent with sustainable catch and escapement of natural stocks.

Note that the compromise between threshold and catch noted for Kyuquot chum stocks was not necessary to make here because, with enhanced production, there was no need to minimize the years of no fishing. Therefore, as the analysis indicated, it was better to ensure the escapement target was met (i.e., to fish to escapement) than to bear the risks of reducing the threshold escapement.

Table 3.5-17 also displays stock rebuilding options that rely on fixed harvest rates. The maximum sustainable rate in theory (i.e., as a function of the mean return rate) is about 55%. Variability in the distribution of the observed return rate, however, reduces this to an effective maximum sustainable harvest rate of 50%.

3.5.9.3 Nitinat Chums

The analysis of Nitinat chum natural stock rebuilding was begun by investigating how quickly stocks would rebuild if the fishery were closed. Escapements in excess of the target were achieved in one cycle. Maximum sustainable escapement of unfished stocks averaged 280,000 after three cycles. As there was no catch, there was no net benefit from this option. It was useful only as a guide to productivity.

With an escapement target for natural stocks of 125,000, returns of enhanced stocks averaging 315,000 and a mixed-stock fishery with no opportunity to separately harvest hatchery fish, various options were examined in which all fish about a pre-determined threshold would be harvested. As the threshold rose, catch and escapement of natural stocks also rose, but catch of enhanced stocks fell. The results, summarized in Table 3.5-18, indicated that a threshold between 100,000 and 200,000 was required to ensure the survival of enhanced stocks (i.e., the natural escapement decreased when the threshold was 100,000 and rose when it was 200,000). The economic results indicated, however, that increased catch of natural stocks cannot keep pace with lost harvest of enhanced stocks: the NPV increased with lower thresholds. This pattern was found to persist when the escapement threshold was lowered even further. Total catch and NPV were maximized when enhanced stocks were actively managed, but natural stocks were lost under such a management regime.

An attempt was then made to devise a strategy that would be better economically than that in which only enhanced stocks were actively managed. The "no fishing" option indicated that the target escapement of 125,000 fish from wild stocks would produce, on the average, 280,000 returning adults, resulting in a harvestable surplus of 155,000. With 315,000 enhanced returns being fished for with wild stocks, and assuming that catch is proportional to abundance, the harvest of hatchery fish would be 175,000, leaving 140,000 (i.e., 125,000 more than required) as brood stock. This pattern is illustrated below (in thousands of fish):

Stock	Escapement Target	-->	Returning Adults	=	Catch	+	Escapement
Natural	125	-->	280	=	155	+	125
Enhanced	15	-->	315	=	175	+	140
Total	140	-->	595	=	330	+	265

Table 3.5-18. Summary of results for fixed catch regimes for Nitinat chum salmon.

Option	Harvest				Escapement				NPV (1984 $ millions)
	Natural		Enhanced		Natural		Enhanced		
	Mean (Thousands)	Trend	Mean (Thousands)	Trend	Mean (Thousands)	Trend	Mean (Thousands)	Trend	
No Fishing	0		0		280*	level	315	level	0
U/100	14	down	220	level	5	down	95	level	17
U/200	46	up	155	up	41	up	159	down	13
U/300	90	up	120	up/level	105	up/level	195	down	12
U/50	8	down	266	level	1	down	49	level	19
U/25	8	down	290	level	1	down	25	level	20
U/15	8	down	300	level	0	down	15	level	21
No Fishing for One Cycle									
335/265	98	up	140	level	113	up	175	level	11
300/300	91	level	120	level	136	level	195	level	10
No Fishing for Three Cycles									
335/265	124	down	148	level	141	down	168	level	5
315/285	118	level	139	level	149	level	177	level	5
300/300	111	level	129	level	157	level	186	level	5
U/140			437	level			140	level	30
U/160			426	level			160	level	29

* For this option only, the mean natural escapement is computed only for years following three cycles from the initiation of stock rebuilding.

As indicated above, once natural stocks were rebuilt, it should be possible to harvest 330,000 above a threshold escapement of 265,000. Variability of productivity, however, requires that there be a buffer (i.e., harvests should be lower) to minimize the risks of overfishing. More conservative options, therefore, were also investigated, with the provision only that they supplied harvests of at least 300,000 (i.e., the sustainable harvest of hatchery fish) (Table 3.5-18).

There were two sets of results: one allowed for one cycle without fishing and the other allowed for three cycles without fishing. In both cases, it was possible to establish a sustainable fishery for both natural and enhanced stocks, but total catch never reached 300,000. This level would be required if it were desired to improve economically on the option in which the fishery is managed to take enhanced stocks only. The complete closures required to rebuild wild stocks further eroded economic benefits to the point where none of these options could be recommended. The conclusion thus far must be that Nitinat chum stocks should be managed as enhanced stocks, and that the best way to do this is to harvest everything above the enhanced escapement target of 15,000.

There is evidence that Nitinat wild and enhanced stocks intermingle to a high degree, so there is no sense in defending the genetic integrity of wild stocks; all progeny have ancestors that went through the hatchery. Consequently, both the hatchery and natural spawning grounds can be allowed to produce. Once the overall target escapement of 140,000 is achieved (i.e., 125,000 for natural spawning grounds and 15,000 for the hatchery), all the remaining stock can be harvested. Again, it may be desirable to allow for a buffer for target escapement to account for variability in productivity. Results of these options are presented in Table 3.5-18.

In these options, all stocks were being treated as one; hence, there was no need to differentiate wild from enhanced stocks. Total escapement was divided, with the hatchery getting 15,000 and the natural spawning grounds the rest. However, excess natural escapement did not contribute to increased natural production in the model, because of the discontinuous way in which biological compensation was modelled. In the second option, therefore,

escapement was larger by 20,000, but returning stock size was unchanged. Catch and NPV were therefore reduced relative to the first option.

In reality, it may not be possible to enumerate threshold escapement accurately, so a buffer would be desired. The costs of a buffer would not be as great as the model indicated, since productivity actually changes continuously with stock abundance, so that "excess" escapement would make a (possibly small) contribution to abundance.

It is also likely that the total harvest would be divided between fisheries outside and within Nitinat Lake. Economic benefits would thus be reduced because of lower flesh quality of lake-caught fish.

3.6 Mainland Inlets

This area includes Statistical Areas 11, 15 and 16, and the mainland portions of Areas 12 and 13 (Fig. 3.6-1).

3.6.1 Stock Descriptions

Heydon, Fulmore and Phillips lakes sockeye stocks have been aggregated based on similar timing and stock size. All three are small coastal systems that are low in productivity. Sockeye spawning in rivers draining into each lake are characteristically 4- and 5-year-olds; the largest component spends three years in fresh water. They migrate through upper Johnstone Strait from mid-June to late July, returning to the mainland inlets of Area 12 (Fulmore) and Area 13 (Phillips and Heydon). These fish are passively managed due to their concurrent migration with Nimpkish stocks and the overlap of their run with early Fraser River stocks. The early Nimpkish closures reduce the harvest of this aggregate stock in upper Johnstone Strait. Recent escapements for the aggregate range from 10,000-12,000. Escapement has been low but stable, with strength in the Phillips component and weakness in the Fulmore component.

Sockeye are also found in Sakinaw Lake, which is similar in size to Fulmore, and is located on the Sunshine Coast in Area 16. Not as remote as the other sockeye stocks, the Sakinaw stock may be stressed as a result of urban development. The Sakinaw stock is composed primarily of 5-year-old lake-spawning sockeye. They migrate through Johnstone Strait, peaking during the first two weeks of July. They are considered to be an early-running stock. There are no fisheries specifically for this stock, although Sakinaw fish are intercepted by Johnstone Strait fisheries for Fraser River sockeye (early Stuart, Nadina, Gates and Raft stocks) and for Nimpkish sockeye. Reliable escapement counts (obtained at a fish ladder) indicate a decline; the 1983 escapement was 1,600. The upper limit of potential spawners is restricted by the availability of spawning habitat. In addition, rearing is limited by trout predation on sockeye smolts. Domestic pollution has created problems in both the spawning and rearing environments for Sakinaw sockeye.

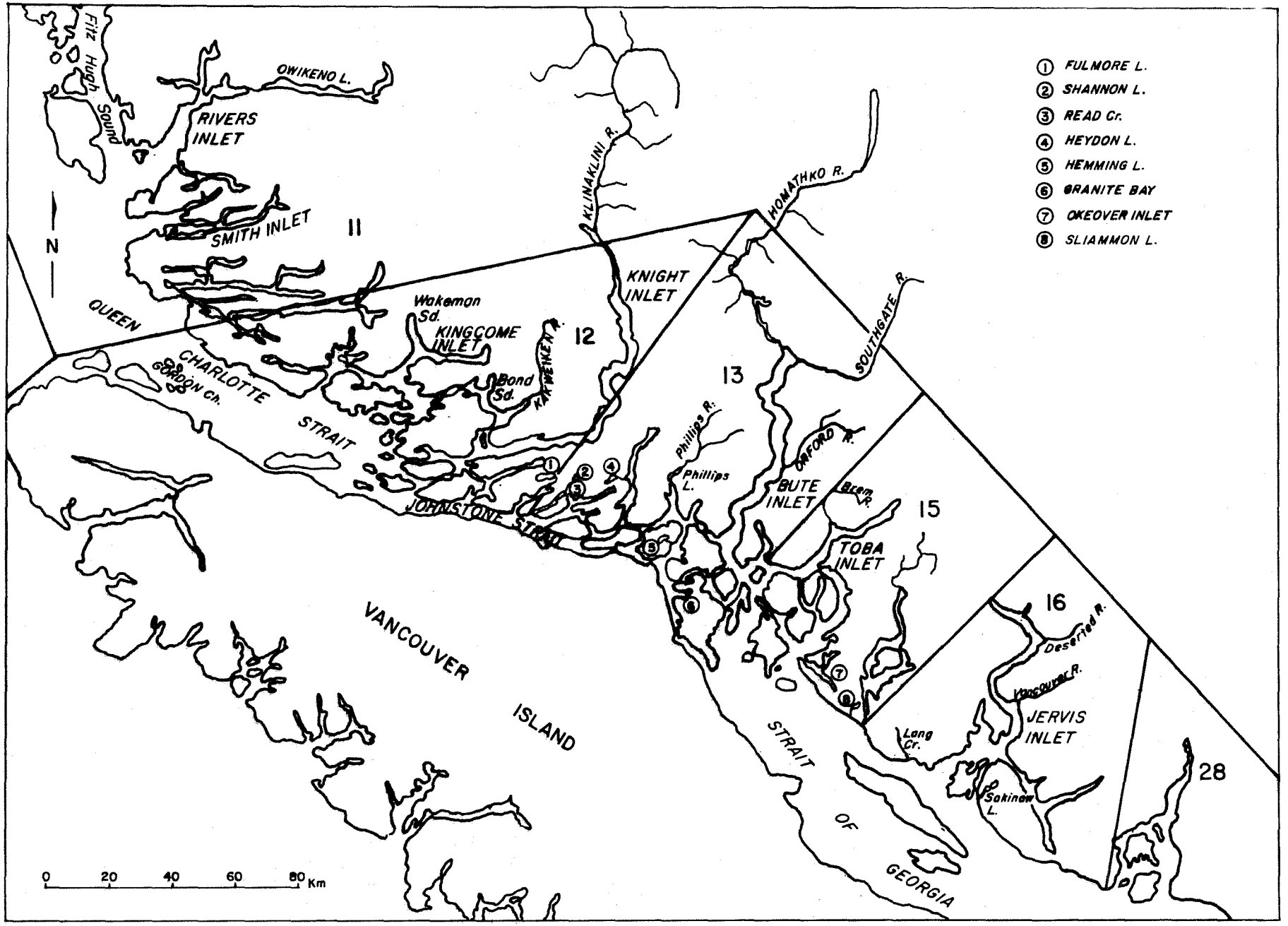


Figure 3.6-1. The Mainland Inlets area.

Pink salmon stocks return to the mainland inlets of Statistical Area 12, and can be aggregated into Kingcome/Wakeman stocks and Bond/Knight stocks. At the present time these stocks are slightly depressed, due in large part to severe freshwater flooding (see Appendix 2). Approximately 75% of Kingcome/Wakeman pinks migrate through M.U. 12-13, 12-17, 12-41 and 12-39 from the third week in June until the first week in August, peaking in the second week of July. There is limited exploitation of these stocks, as only 25% pass through the Upper Johnstone Strait net fishery. The Bond/Knight pink stocks migrate through M.U. 12-13, 12-7, 12-6, 12-39 and 12-26 from the first week in July until the first week in August, peaking the fourth week in July. The Glendale stock, which is part of this group, runs about two weeks later than the other groups in this aggregation and is believed to enter the upper Johnstone Strait fishing area, where an unknown portion may be harvested.

Toba and Jervis odd-year pink stocks return to mainland inlets from the north via Johnstone Strait and the south via Juan de Fuca Strait. The Toba Inlet stocks are split 93.1% (northern) and 6.9% (southern); Jervis Inlet stocks are split 62.5% (northern) and 37.5% (southern). The timing of their migration through Johnstone Strait and Juan de Fuca is concurrent with other odd-year pinks and Fraser River pink and sockeye. These stocks are severely depressed and little is presently known about their rates of productivity. The escapement target is 340,000, which has not been attained since the early 1960's. This optimum is probably too high; 215,000 is a more reasonable estimate.

There are thirty-eight chum stocks in the mainland inlet area. The major producers are the Southgate River and Viner Creek, which accounted for 43% of the total chum escapement in 1984. The 1980-1984 average escapement was approximately 350,000. Past escapements averaged 203,000 during the 1960's and 330,000 during the 1970's. These stocks are, with the exception of Bute Inlet, well below capacity with little sign of rebuilding. The optimum number of spawners for these inlets totals 770,000.

There are thirteen chinook stocks in the mainland inlet area. The Homathko and Klinaklini rivers produce most of the chinooks, accounting for approximately 56% of the total chinook escapement during 1983. Escapements have declined from 29,000 in the 1960's to 18,000 in the 1970's, to an average of 9,300 from 1981-1983.

There are sixty-seven coho stocks in the mainland inlet area, including the Homathko River, Sakinaw Lake system, Southgate River and Hemming Lake system. The Kakweiken River in Area 12 is the major coho producer, accounting for approximately 25% of the total coho escapement. Escapements averaged 116,000 during the 1960's, declined to 73,000 during the 1970's and have decreased further to an average of approximately 30,500 from 1981-1983.

3.6.2 Current Enhancement Activities

Enhancement facilities in the mainland inlet area, and their production capacities, are presented in Table 3.6-1. They are discussed below by species.

3.6.2.1 Pink Salmon

Mainland inlet pink enhancement projects include Vancouver River and Granite Bay. At the Vancouver River hatchery, eggs are incubated in upwelling gravel boxes until the fry emerge and are released. The small Granite Bay project is publicly operated.

3.6.2.2 Chum

Mainland inlet chum enhancement projects include three facilities at Sechelt, Sliammon and Vancouver River, and two facilities at Drew Harbour and Hyacinthe Creek. At Drew Harbour and Hyacinthe Creek, chum eggs are incubated in artificial containers and released at emergence. The other three projects incubate and rear chums prior to release. Vancouver River Hatchery is the only facility in Georgia/Johnstone Strait that enhances a number of different chum stocks.

3.6.2.3 Chinook Salmon

Mainland inlet chinook enhancement includes projects at Memekay and Devereux. Two minor projects at Sechelt and Vancouver River utilize transplants from Capilano Hatchery, since chinook populations are low in these systems. Releases from the Vancouver River Hatchery are expected to overwinter because of cold temperatures before migrating. A return rate an order

Table 3.6-1. Enhancement facilities for pink, chum, chinook and coho salmon in the Mainland Inlet area (production capacity estimated from SEP biostandards).

Facility	Production Capacity		Target Stock 1984
	Releases	Returns	
Pink			
Vancouver River	2,000,000	50,000	Jitco
Granite Bay	80,000	2,000	Granite Bay
Total Pink	2,080,000	52,000	
Chum			
Sechelt	80,000	1,600	Sechelt
Sliammon	1,500,000	30,000	Sliammon
Vancouver River	500,000	10,000	Jitco, Deserted, Skwawka, Hunachin
Hyacinthe Creek	400,000	3,200	Hyacinthe
Drew Harbour	80,000	640	Drew Harbour
Total Chum	2,560,000	45,440	
Chinook			
Memekay	72,000	2,160	Memekay
Sechelt	50,000	2,100	Sechelt (Capilano transplant)
Vancouver River	50,000	240	Capilano transplant
Devereux	200,000	6,000	Devereux
Total Chinook	372,000	10,500	
Coho			
Powell River	300,000	5,400	Lang, Kelly
Sechelt	50,000	4,800	Sechelt (Capilano)
Sliammon	100,000	9,000	Sliammon, Okeover
Vancover River	100,000	3,000	Jitco
Scott Cove	400,000	18,000	Scott Cove
Hyacinthe Creek	400,000	6,000	Hyacinthe
Hemming Lake	141,000	1,700	Hemming
Memekay	160,000	2,400	Memekay
Total Coho	1,651,000	50,300	

of magnitude higher is expected for the Sechelt chinook project, where fish are held in sea pens. The majority are released as 90-day smolts, and the balance are reared a full year prior to release. Memekay chinooks are released as pre-migrants.

The Devereux pilot facility was built primarily to determine whether IHN virus in resident kokanee will affect chinooks. Marking of the Devereux stocks will also provide ocean catch distribution data for stocks in areas where such data are not currently available. Devereux was not run in 1984 due to brood stock capture problems. Its first year of operation will be 1985.

3.6.2.4 Coho Salmon

A variety of release strategies and fish culture methods are used for coho production in mainland inlet facilities. Fry are released in spring from the Powell River and Sechelt projects; in late summer from the Powell River and Sliammon projects; and as yearling smolts from Sechelt and Sliammon. Projected survival rates for these three release periods are 1.5%, 3.0% and 15%, respectively. Coho yearling smolt are raised at Sechelt and Sliammon in sea pens, a method proven successful in Washington and in pilot studies in Indian Arm. Sechelt coho production was initiated using coho transplanted from Capilano. Transplants have been discontinued, and maturing fish are captured in the Sechelt area for brood stock purposes.

Scott Cove, Hyacinthe Creek, Hemming Lake and Memekay use planting of coho fry or fingerlings as their production strategy. The Hemming Lake project consists of flow storage, which should improve fish passage and improve freshwater survival.

3.6.3 Fisheries

Heydon, Fulmore and Phillips lakes sockeye stocks are not actively managed, and in recent years have been affected primarily by the fishing rate for early Fraser River sockeye stocks. The timing of runs and migration patterns overlap with those of Fraser stocks; this factor, combined with comparatively small numbers, makes differential management of this stock aggregate unfeasible, especially if early and mid-season Fraser sockeye stocks are running in

large numbers in Johnstone Strait. Harvest rates thus depend on Fraser sockeye. In general, harvest rates are variable, and range from 30-40% for Area 12 and 15-25% for Area 13. Most fish are harvested in Johnstone Strait. The northern Vancouver Island troll fishery in Gordon Channel has had much impact, but has been closed in recent years. The Sakinaw Lake sockeye stock is passively managed; its harvest is controlled by management of Nimpkish and early Fraser sockeye.

Kingcome/Wakeman and Bond/Knight pink stocks are managed to control escapement to individual river systems. The target escapements are 354,500 (even-year) and 696,500 (odd-year). These stocks are geographically and temporally separated, and can be managed as discrete units.

Toba and Jervis odd-year pinks are passively managed, as harvest rates are set on Fraser-bound stocks in the two approach areas. With the existing management approach to maximize the harvest of Fraser River pink and sockeye stocks outside the Convention area, it is impossible to manage these stocks actively.

See Section 3.10 for a discussion of chum fisheries in the mainland inlets.

3.6.4 Habitat Status

Habitat summaries for sockeye, pink (odd and even) and chum salmon are presented in Tables 3.6-2 to 3.6-4. Chinook and coho habitat descriptions may be found in Sections 3.2.4 and 3.3.4. For a discussion of the habitat tables, see Section 2.2.4.

3.6.5 Stock Rebuilding Potential

The current escapement target for Heydon, Fulmore and Phillips lakes stocks of sockeye is 20,000-30,000. In most years (with the exception of early Stuart years) these stocks are harvested at a rate of 30-40%. The stock strength has been held at the present depressed level by a combination of over-exploitation and instability of the freshwater habitat. These sockeye stocks have low productivities, and cannot be rebuilt by management activities

Table 3.6-2. Mainland Inlet area sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	133	30	12

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 25

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging has produced overall low impacts (varies among creeks).
Current Status	Logging continuing at lower level. Low impacts.
Future Outlook	Logging at a lower level - low impacts.
Natural Habitat Production Potential	At historic levels.
Improved Production Potential	Unknown - probably low.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	Medium - High	High	Low	Unknown

CONCLUSION A low-scale fishery - habitat not an issue.

Table 3.6-3. Mainland Inlet area pink (odd and even) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,795 E + 0	500-1,000 E 1,040 0	665 E 1,166 0

MANAGEMENT STYLE: Active ____ Passive ____ Unknown ____ 50% est.

NUMBER OF STREAMS: 65*

HABITAT NOTES

Historic Status, Production Constraints and Development History	Subject to natural flow instability. Probably aggravated by logging. Logging has produced low - moderate impacts.
Current Status	Lower reaches of a number of systems logged; now moving into higher elevations.
Future Outlook	Moderate logging to continue. Improved concern for habitat assumed. Most watersheds stabilizing through second growth.
Natural Habitat Production Potential	Should return to historic high.
Improved Production Potential	A number of fishway and channel improvement possibilities.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High	High - Medium

CONCLUSION A history of natural flow instability but production remains high - perhaps because of diversity of system.

* Includes all mainland inlets.

Table 3.6-4. Mainland Inlet area chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,727	920	36

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 128

HABITAT NOTES

Historic Status, Production Constraints and Development History	Subject to natural flow instability. Probably aggravated by logging. Logging has produced low - moderate impacts.
Current Status	Lower reaches of a number of systems logged; now moving into higher elevations.
Future Outlook	Moderate logging to continue. Improved concern for habitat assumed. Most watersheds stabilizing through second growth.
Natural Habitat Production Potential	Should return to historic high.
Improved Production Potential	A number of fishway and channel improvement possibilities.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
High	High	High	High	High - Medium

CONCLUSION A history of natural flow instability but production remains high - perhaps because of diversity of system.

alone. They lend themselves well to low-level enhancement techniques designed to increase egg-to-fry survival. It is predicted that the target escapement can be attained within three cycles through maintenance of the present management regime plus ongoing enhancement.

There has been only slow rebuilding of Sakinaw Lake sockeye stocks towards the target escapement of 50,000; the data indicate that low productivity in the last several years has reduced returns. Harvest rates for Sakinaw sockeye are dependent on the Johnstone Strait sockeye fishery. Over-fishing does not appear to be the primary cause of the depressed status of Sakinaw sockeye. It is likely that a large increase in escapement is required before increased production can be realized. Rebuilding by management actions alone will probably not be successful. Given the desire to sustain and increase this population, low-level enhancement should be considered to give this population a boost. Enhancement efforts similar to those seen in community development projects would be appropriate. Full production would cause returns of 35,000-70,000 adult sockeye. Lake fertilization could double this level.

Management difficulties and habitat limitations (flooding) will seriously limit the process of rebuilding Kingcome/Wakeman and Bond/Knight pink stocks to the target escapement levels of 355,000 (even) and 1,000,000 (odd).

Toba and Jervis stocks are currently unmanageable. Therefore, enhancement is the only way to rebuild these stocks.

See section 3.10 for a discussion of stock rebuilding potential for inside chums.

3.6.6 Management Conflicts

It appears that the sockeye stocks in Heydon, Fulmore and Phillips lakes have similar management conflicts. Their run timing overlaps with Nimpkish River and early Fraser River sockeye and mainland inlet pinks. Harvest rates have shown considerable variation but would average 30-40%. Certainly the closures to the upper portion of Area 12 for Nimpkish sockeye have reduced the overall harvesting; however, the Johnstone Strait fishery will require further restrictions for rebuilding. Any management schemes designed to open larger

portions of upper Johnstone Strait in Queen Charlotte Sound for early Stuart Fraser or Nimpkish sockeye will result in long-term declines for the Heydon, Fulmore and Phillips lakes sockeye stocks.

Conflicts that have precluded rebuilding Sakinaw sockeye include recent decreases in stock productivity (as measured by escapement), loss of spawning habitat due to urban problems, and interception in the Johnstone Strait fisheries. Early Johnstone Strait fisheries for early Stuart stocks (before the third week of July) harvest Sakinaw sockeye at a rate of 40-60%. When enhanced production from Nimpkish Lake fertilization is available to fisheries, increased harvest rates for the Nimpkish stocks may decrease Sakinaw returns, if interception occurs beyond the Nimpkish terminal areas.

There are currently a number of conflicts that require careful consideration with respect to rebuilding Kingcome/Wakeman and Bond/Knight pink stocks. It will be difficult to attract sufficient fishermen from Johnstone Strait to harvest available surpluses if Fraser sockeye stocks are available concurrently. On the other hand, the opposite problem could arise if the mainland pink fishery were opened after the Johnstone Strait fishery has concluded. There may be problems in years of low mainland pink production with over-harvesting by the mixed-stock fishery in Johnstone Strait. There have been serious problems estimating stock abundance in the mainland inlets area. Echo-sounding was attempted, but the approach was unsuccessful because of schools of juvenile black cod rearing in the area. Also, due to problems in obtaining reliable stock estimates in terminal areas and escapement counts, it is extremely difficult to maximize the total allowable catch. Finally, this area is prone to severe flooding problems about once every five years; this will continue to be a limiting factor for pink stocks.

The major problem associated with the rebuilding of Toba and Jervis pink stocks is their overlap in timing with Fraser sockeye stocks in the Johnstone and Juan de Fuca Strait fisheries. As the sockeye migrate twice as fast as these pinks it means that they are fished twice while migrating through the areas. The result is harvest rates that are unacceptably high (80%).

See section 3.10 for a discussion of management conflicts for chums in the mainland inlets area.

3.6.7 Management Strategies for Stock Rebuilding

Strategies are described by stocks below.

3.6.7.1 Heydon, Fulmore, Phillips Lakes Sockeye

Management needs for these systems are similar to those for the Nimpkish River. A reduction in the overall harvest rate and a stabilization of the freshwater environment is required to rebuild these stocks. The early closure above Gordon Channel and postponement of the Johnstone Strait fishery until the third or fourth week in July must continue. Fisheries for early Stuart stocks within Johnstone Strait should be reduced and replaced with a more intense fishery in Sabine Channel. Harvest of enhanced Nimpkish sockeye stocks should be restricted to areas which do not affect passing stocks. Maintenance of the pink corridor closures along Area 12 and 13 mainland shores is necessary to maintain these sockeye stocks.

With regard to enhancement, two linked approaches are required. The first objective should be to increase the escapement to each of these systems. Maintaining or reducing the harvest rates combined with the use of small-scale boxes on side channels are required. Once stocks have been improved, a lake fertilization program should be initiated. The estimated production from these lakes is estimated to be 80,000-160,000 at optimum escapement and 200,000-300,000 if fertilized.

3.6.7.2 Sakinaw Lake

To rebuild Sakinaw Lake sockeye stocks, it will be necessary to reduce the overall harvest rate, and minimize the loss or degradation of habitat. A reduction in the overall harvest rate will entail either a closure or movement of fisheries. Closing the Johnstone Strait interception fishery until the third or fourth week in July would limit it to the last third of the Sakinaw run. In addition, an additional week's delay in opening the Area 13 fishery would permit migration through the area. Harvests of early Stuart sockeye take place in both Johnstone Strait and the Fraser River. The limited abundance and low diversion rate of early Stuart stocks through Johnstone Strait suggests that the elimination of the Johnstone Strait fishery for this Fraser

stock would not be a serious loss, and would benefit the concurrently migrating Sakinaw sockeye stocks. The fishery for enhanced Nimpkish sockeye production must be initiated in areas that will not intercept Sakinaw sockeye; it must also be delayed as long as possible to allow Sakinaw stocks to escape. The potential for rebuilt Sakinaw sockeye stocks to contribute significantly to a fishery is very limited, since total adult production is expected to be 35,000-70,000. However, rebuilding this stock through small-scale enhancement is feasible and desirable.

3.6.7.3 Pink Salmon

There are a number of management options that are available to assist in the stock rebuilding process for Kingcome/Wakeman and Bond/Knight pink stocks. These include:

1. Elimination of Statistical Area 11 troll fisheries;

2. Elimination or postponement of the Gordon Channel net fishery until the third week in August, which would reduce the total catch by 10%;

3. Allowing gillnet fisheries only above Lewis Point, which would reduce the total catch by 10%;

4. Elimination or postponement of the Queen Charlotte troll fishery until the third week in August, which would reduce the total catch by 50%; and

5. Maintaining the Double Bay closure (M.U. 12-5) to protect Knight Inlet pink escapement.

There are also a number of enhancement options that can be considered, including:

1. Avoiding large-scale production facilities in this area because of the potential for increases in harvest rates in Johnstone Strait;

2. Instituting flood control or small-scale stabilization spawning channels; and

3. Building spawning channels for smaller stocks so that they remain stable while fisheries are directed on major stocks.

The management program that will rebuild Toba and Jervis pink stocks consists of:

1. Reducing the Area 12 harvest by altering a gillnet only fishery in the Gordon Channel area;

2. Closing Double Bay to allow the pinks into the pink corridor in Johnstone Strait;

3. Decreasing the seine fishery time in Johnstone Strait;

4. Extending the corridor concept in Johnstone Strait below Chatham Point; and

5. Reducing catches of these stocks by U.S. pink fisheries.

In addition, there are enhancement procedures that should be implemented:

1. Increase the size of the enhancement facility on the Skwanka River and use it as an outplanting facility for other rivers; and

2. Build a large facility with sea-pen rearing that can provide an adult return of 500,000.

Execution of this rebuilding procedure is dependent on information about Toba and Jervis stock distribution (by time and area) in the approach route mixed-stock fisheries.

3.6.7.4 Chum Salmon

See Section 3.10 (Inside Chums) for a discussion of management strategies for chum stock rebuilding.

3.6.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1981)[1].

3.6.8.1 Read Creek Storage (Project No. 13-10)

Read Creek is a small drainage flowing into Topaze Harbour on the mainland portion of Area 13. Stream records show coho, chum, and odd- and even-year pink salmon spawning, although numbers are much reduced. A small storage facility on Shannon Lake is proposed. This dam would have a gate operated by a patrolman in the area. Read Creek has had significant runs of up to 75,000, but is normally constrained by low flows, which usually coincide with pink salmon spawning. The site potential is estimated to be 42,000 pinks (primarily an even-year run), 1,300 coho and 7,000 chums.

3.6.8.2 Phillips River Channels (Project No's. 13-19A, 13-19B)

In 1984, a channel was completed for pinks. Other proposed channel developments include an upper river channel (above Phillips Lake) for pinks and sockeye; and a lower river channel extension for pinks. These projects will be completed if the stocks produced from the 1984 channel do not compromise the wild stock rebuilding program by creating unmanageable economic pressure to increase exploitation rates in mixed-stock fisheries. Expected production from the Phillip River projects is presented below:

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

Year	River	Species				
		Sockeye	Pink	Chum	Chinook	Coho
1984	Lower Channel		245,000	1,000	1,000	1,000
1987	Upper Channel	20,000	400,000		1,000	1,000
1987	Hatchery[1]				15,000	
1989	Lower Channel Extension		275,000	1,000		1,000

[1]Chinook production may be provided using off-site facilities at Quinsam River or Southgate River (see below, section 3.6.8.3).

3.6.8.3 Phillips River Chinook Hatchery (Project No. 13-19C)

Phillips River chinook stocks are very depressed, averaging less than 500 escapement from 1970 to the present. A pink salmon spawning channel which was completed in 1984 will have an adult production of 400,000 pinks in both odd and even years. It is expected that, when pinks reach full production, terminal fisheries will be required in Phillips Inlet to catch fish not harvested in Johnstone Strait, or those exceeding target escapements.

Although there is not complete overlap in migration timing for pinks and chinooks, there will likely be some interceptions of chinooks in the terminal pink harvests. The project proposed to mitigate chinook losses is a small hatchery that would also speed rebuilding of the Phillips River chinook population. Incubation of Phillips chinook salmon may be feasible at Quinsam Hatchery or some other site for back-planting to the Phillips River. Total adult chinook production will be 15,000 adults.

3.6.8.4 Bute Inlet Chinook Hatchery (Project No. 13 - 30B)

The Orford summer chum spawning channel is proposed to produce 100,000 chums, as well as the naturally spawning stocks in the Orford River. At full production this is estimated to be 250,000-350,000 chums. It is expected that 40-50% of this production will be harvested by the terminal Bute Inlet fishery, which currently includes gillnetters only. Chinook salmon returning to the Orford, Southgate and Homathko rivers share similar migration timing with

Orford chums, and would be available to the terminal net fleet in high numbers. There is an active and growing sport fishery for Bute Inlet chinook stocks. Chinook escapements have been declining over the last 10 years. It is proposed to build a chinook hatchery in Bute Inlet, most likely on the Southgate River, to incubate chinooks for the Southgate, Orford and Homathko stocks. Production levels would initially be equally divided among the three river systems. Orford may require the first effort, as its chinook production is the lowest of the three rivers. Proposed production would be 45,000 (15,000 per river).

3.6.8.5 Phillips Sockeye Spawning Channel (Project No. 13 -19D)

Although the system is not a large producer, Phillips Lake sockeye are well below optimum escapements. It is proposed to construct a small spawning channel for sockeye near the area where they currently spawn. This would provide both better flow and gravel selection compared to the natural site, which is prone to flooding. Increased production from the channel would improve the chance of proceeding with the Phillips Lake fertilization program, which is currently limited by low smolt numbers. The additional production of sockeye would be 20,000 adults.

3.6.8.6 Orford River Summer Chums Channel (Project No. 13-30A)

Construction of a spawning channel to increase the production of the Orford River by 100,000 adult chums is proposed. The additional production of Orford chum salmon will have a negative impact on chinook salmon returning to all rivers in Bute Inlet, especially if terminal harvesting is increased. This will require the mitigation outlined in Section 3.6.8.4.

3.6.8.7 Brem River (Project No. 15-1)

The Brem River is a small system entering Toba Inlet. Production of both pink and chum salmon has been limited by a velocity barrier in the lower river. The current proposal is to facilitate fish passage through a set of rock falls approximately 2.5 km from the mouth. This should open 50 km of rearing area, and increase spawning areas for pink and chum salmon. Feasibil-

ity studies suggest there would be an increase of 2,400 chums and 6,300 pinks. Present flow problems do not appear to limit coho or chinooks.

3.6.8.8 Okeover Creek CEDP Expansion (Project No. 15-3B)

Okeover Creek coho production in the upper watershed is limited by a total barrier to upstream migration. The current plan is to take coho eggs from Okeover Creek and incubate at the Sliammon CEDP hatchery. Fry will be returned to the Okeover system to colonize the upper Okeover watershed. Sea pens will be used to rear a portion of the stock in the Okeover estuary. Full production would be 11,250 coho; however, it may take one full cycle before this can be achieved, as current production is depressed and the required number of eggs may not be available.

3.6.8.9 Deserted River Side Channel CEDP (Project No. 16-7A)

The Deserted River is a remote river entering Princess Royal Reach in Jervis Inlet. Currently, the Sechelt Indian Band has a small CEDP hatchery project for chums on this river. Severe flooding appears to be one of the limiting factors in production, and the current proposal is to construct an unmanned side channel for chums, coho and pinks. Estimated full production from the side channel is expected to be 4,000 chums, 200 coho and 2,800 pinks.

3.6.8.10 Lang Creek Expansion (Project No. 16-11A)

Lang Creek, in the Powell River area, currently has a CEDP project for incubation of coho eggs from Lang Creek and other local creeks. It is proposed to double the capacity of the facility from 250,000 coho eggs (7,500 adults) to 50,000 eggs. The proposal also includes colonizing the upper, inaccessible watershed with coho fry produced. There would be a small requirement for short-term feeding.

3.6.9 Predicted Results for Management and Enhancement Options

Results from modeling the effects of management strategies and an enhancement option are reviewed below for chums.

3.6.9.1 Bute Inlet Summer Chums

Bute Inlet summer chums are the first chum stock to migrate through Johnstone Strait; the runs commence in mid- to late August. As such, they are managed as an incidental stock to Fraser sockeye and pink salmon. Loughborough/Bute stocks are harvested concurrently in Areas 12 and 13 along with Fraser sockeye. Exploitation rates are geared to harvesting various cycles of Fraser sockeye, so that harvest rate varies by year.

For the purpose of this analysis, the exploitation rates for Orford chum salmon in Area 12 were assumed to be 30% in years when Chilko or Horsefly stocks dominate, 60% when the large Adams run occurs, and 50% when the combined Adams, Stellako and Chilko stocks dominate the fishery. Exploitation in Area 13 was assumed to be a constant 20%. Past escapements have been well below target levels and terminal fisheries for this stock have been closed. Management of Areas 12 and 13 is not anticipated to change; therefore, the Base Case was used for comparison to the proposed enhancement options.

If current management were to continue (Option 1 - Base Case), it is predicted that the Orford chum stocks would decline. Figure 3.6-2 shows escapement declining from 60-80% of target to 10-20% of target in 40 years. Similarly, catch of Orford chums is also projected to decline, from predicted catches of 30,000-60,000 in the next 10 years to less than 20,000 in 40 years (Fig. 3.6-3). This Base Case scenario results in an NPV of $42,000,000.

The enhancement option (Option 2) proposes development of an unmanned spawning channel (Project No. 13-30A) which would accommodate 23,000 spawners and produce an additional 100,000 chum salmon. Any escapement of enhanced fish in excess of the channel capacity was assumed to spawn in the river, and to have the same productivity as the wild stocks. Stocks were subject to the same fisheries as outlined in the Base Case; in addition, the terminal fishery could harvest any surplus over the escapement target. Escapement of Orford chum salmon was predicted to gradually increase and fluctuate from 60-100% of target (Fig. 3.6-2). Catch declined in the first five years, and then increased to fluctuate from 65,000-90,000 (Fig. 3.6-3). The NPV of this enhancement option was estimated at $12,100,000. The model thus predicts a significant improvement in escapement and catch over those expected under the Base Case scenario.

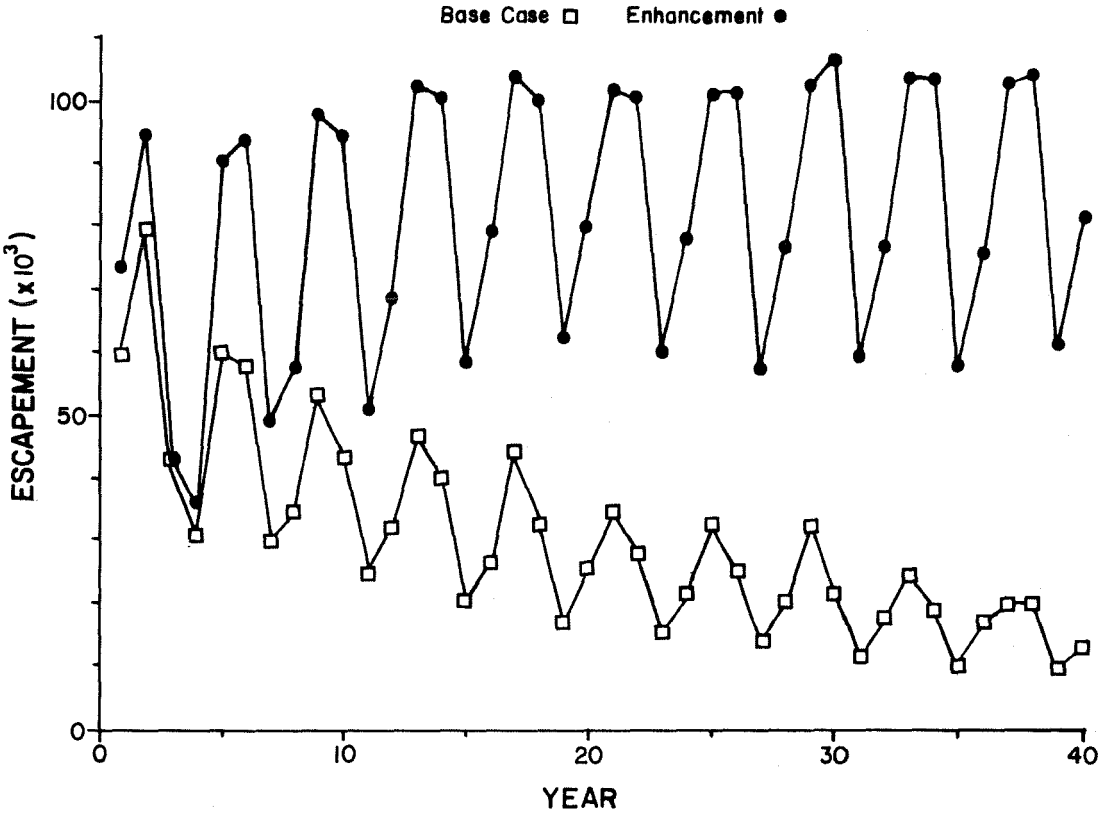


Figure 3.6-2. Predicted escapement of Orford chums under the Base Case (wild) and Option 2 (enhanced).

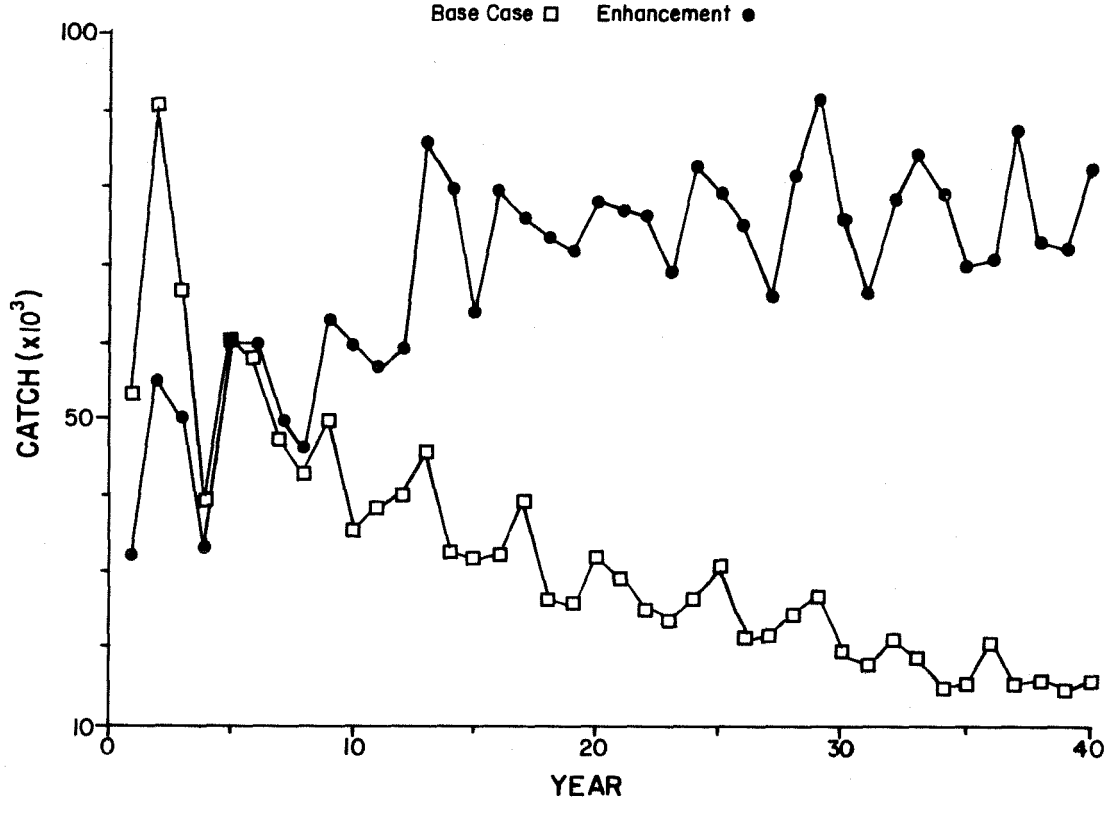


Figure 3.6-3. Predicted catch of Orford chums under the Base Case (wild) and Option 2 (enhanced).

3.7 Howe Sound, Burrard Inlets

This section describes Statistical Area 28 (Fig. 3.7-1).

3.7.1 Stock Descriptions

Main stocks in this area include odd-year pinks in the Squamish and Indian rivers; chinooks in the Squamish, coho in the Capilano, Squamish and Seymour, and chums in the Cheakamus and Squamish.

Odd-year pink salmon from the Howe Sound and Burrard Inlet areas spawn primarily in the Squamish and Indian rivers, respectively. There is no specific productivity information available for Howe Sound and Burrard Inlet pinks. The runs to these rivers (particularly the Squamish) were once substantial, and contributed to interception fisheries along their routes of migration. In recent years, however, escapements have declined precipitously. The pink salmon escapement to the Squamish River averaged 162,000 from 1951-1959, but has declined to an average of only 6,700 over the last three cycles. The 1983 escapement was 1,400, a record low. Escapement of pinks to the Indian River averaged 63,000 in the 1950's; the three most recent cycles averaged 30,000 indicating that this stock has fared relatively better than Squamish River pinks. The Squamish River is subject to periodic flooding, which probably affects productivity.

Howe Sound and Burrard Inlet pinks approach their home streams both from the north through Johnstone Strait and from the south through Juan de Fuca Strait. Tagging in 1959 indicated that approximately equal proportions migrated by each route. Howe Sound pinks are among the earliest running of all pink stocks in this area and are present in Johnstone and Juan de Fuca Straits from late July to late August with a peak in early- to mid-August. Burrard Inlet pinks run slightly later, peaking in both Johnstone and Juan de Fuca straits in the second or third week of August. Throughout their migration, they intermingle with Fraser and Puget Sound pink stocks, as well as with Fraser sockeye.

There are ten chum stocks in this area. The Cheakamus and Squamish rivers produce most of the chums in Area 28, accounting for 81% of the total

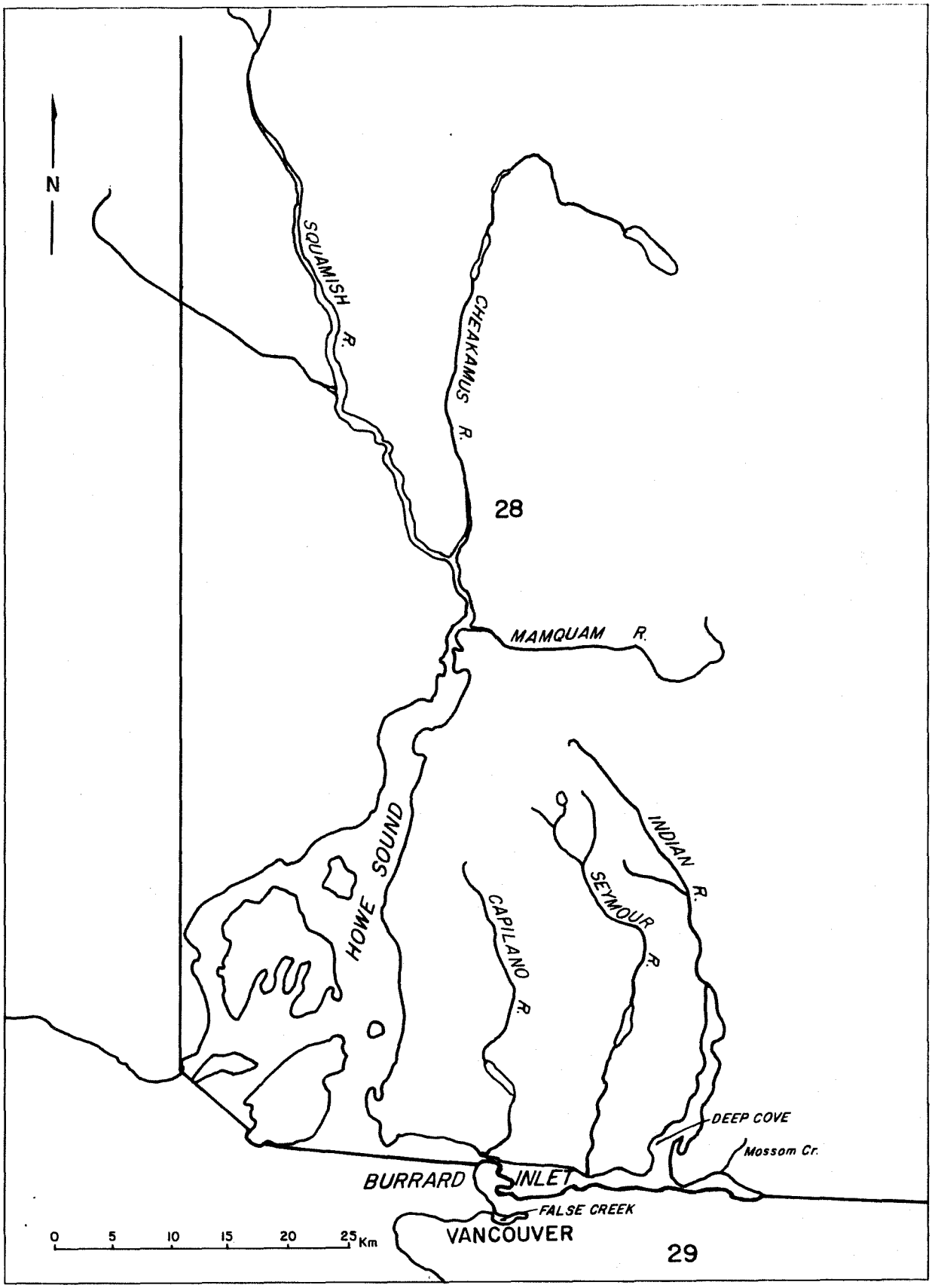


Figure 3.7-1. Howe Sound - Burrard Inlet (Statistical Area 28).

chum escapement for Howe Sound and Burrard Inlet in 1984. Escapement from 1960-1969 averaged approximately 49,000 and declined to 14,000 from 1970-1979. The 1980-1984 average escapement was about 162,000, not far below the optimum escapement of 193,000. The stock is currently rebuilding to capacity.

Squamish chinook stocks have declined sharply from historic levels of abundance and are currently among the most depressed on the coast. Chinook escapements have declined at an average rate of 6% per year (approximately 520 spawners per year) since 1951, and by over 15% per year (1,340 spawners per year) since 1970. Actual escapements have declined from an average of 16,600 for the period 1951-1956 to a recent (1979-1983) average of 3,300 (Fig. 3.7-2). The 1983 escapement of 2,980 was one of the poorest on record, well below the escapement target of 35,000. Returns of CWT-marked Squamish chinook indicate a coast-wide distribution as far north as Alaska, with substantial catches by the Georgia Strait sport and troll fisheries and the central and northern British Columbia net fisheries. While the total exploitation rate is unknown, it is assumed to be similar to that of other British Columbia chinook stocks, i.e., probably about 90%, and above the level which populations can support.

The Capilano River is the largest coho producer in this region. Returns to the Capilano River have been dominated by products of the Capilano River hatchery. Recorded escapements (derived primarily from the "trap and truck" operation prior to construction of the hatchery and more recently from hatchery returns) strongly reflect enhancement activities in the watershed; a recent 5-year average is 6 times the level recorded in the early 1950's. Target escapements are based entirely on hatchery production requirements, and generally vary from year to year. Escapements in excess of brood stock requirements have occurred since the hatchery began production.

The Squamish River is the second largest coho producer, and the largest wild coho producer, in this region. Production to date has been entirely wild stocks; however, two minor facilities expect enhanced stocks to return in 1985. Coho escapements have shown an erratic but declining trend over the period of record. Escapements since 1951 have declined at an average rate of 2% per year, with more severe declines of 10% per year recorded since 1970. Although the escapement required for optimum production is unknown, the accel-

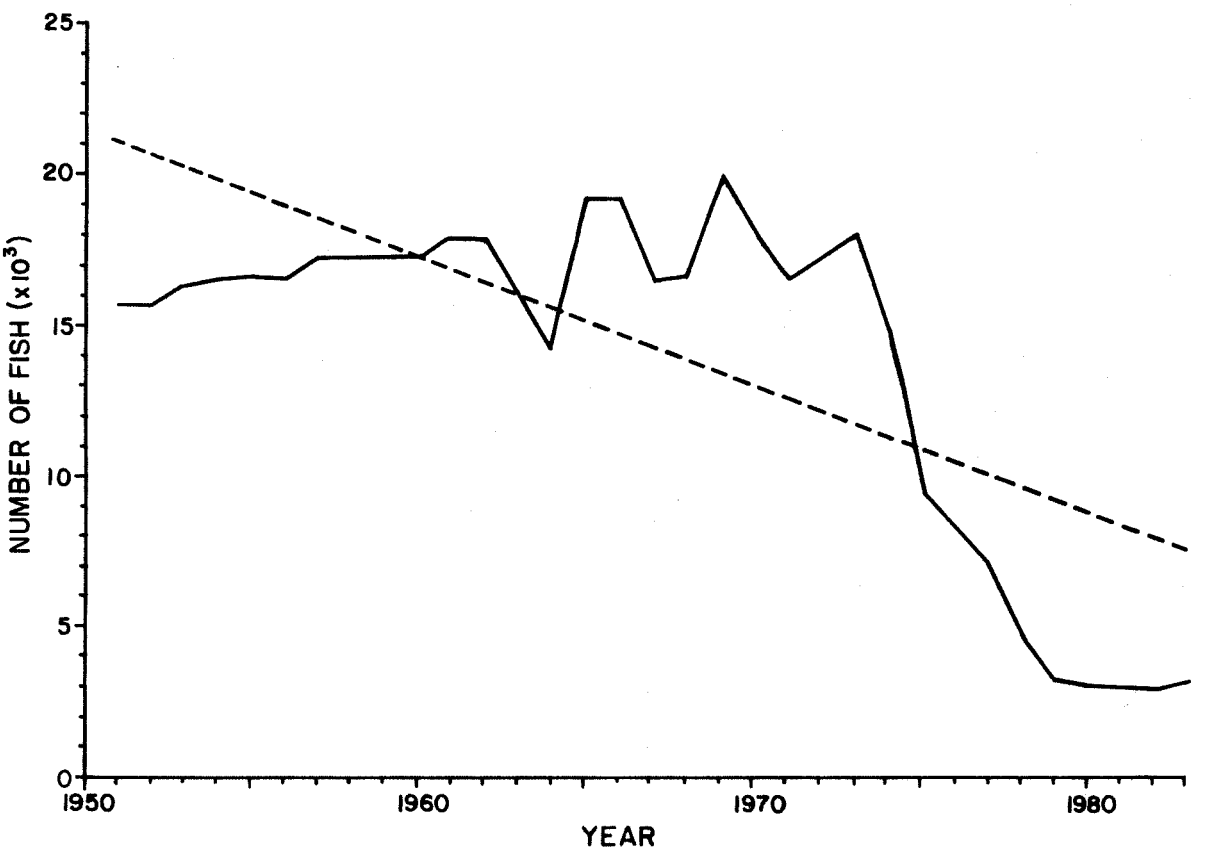


Figure 3.7-2. Squamish River chinook escapement.

erated rate of decline noted since 1970 indicates that Squamish River coho stocks are among the most depressed in the Area 28/29 production group.

The Seymour River is the third largest coho producer in this area. Escapements have increased by almost four times between 1951-1955 and the present, although much of this increase is attributable to a small enhancement facility which has operated in the watershed since 1977.

3.7.2 Current Enhancement Activities

Enhancement facilities in the Howe Sound - Burrard Inlet area, and their production capacities, are presented in Table 3.7-1.

3.7.2.1 Chum Salmon

Virtually all chum enhancement work in Burrard Inlet/Howe Sound streams is on stocks in the Squamish River or its major tributary, the Cheakamus. There are three groundwater-fed channels (Judd Slough, Upper Paradise, Lower Paradise) and one improved side channel (Mamquam) on the Squamish. These channels are intended to improve incubation conditions for naturally-spawning chum salmon. The public projects at Upper Paradise and Mossom Creek involve incubation in gravel boxes with release of emergent fry. The Upper Paradise project is located at the Vancouver Outdoor School.

3.7.2.2 Chinook Salmon

Howe Sound/Burrard Inlet chinook enhancement projects for the Capilano and Squamish stocks both produce 90-day smolts. This is the normal life history of the Big Qualicum stock which was transplanted to create the Capilano chinook run, but most wild Squamish chinook appear to be stream-type (one-year old) smolts. Returns to the Tenderfoot Hatchery on the Squamish are expected to be at a similar rate to those to the Capilano, despite this life-history difference. The Capilano Hatchery has been extremely successful, particularly for coho salmon, but also has established a significant chinook population where none existed historically. A unique feature of the Capilano River is that it is the only stream with a major hatchery which has virtually no natural spawning or rearing capacity. This is because the Cleveland dam

Table 3.7-1. Enhancement facilities for chum, chinook and coho in the Burrard Inlet/Howe Sound area (production capacity estimated from SEP biostandards).

Facility	Production Capacity		Target Stock 1984
	Releases	Returns	
Chum			
Judd Slough	1,757,000	24,600	Squamish
Lower Paradise	2,421,000	33,900	Cheakamus
Upper Paradise	2,692,000	37,700	Cheakamus
Mamquam	1,000,000	14,000	Squamish
Mossom	80,000	640	Mossom (Alouette transplant)
Upper Paradise	120,000	960	Cheakamus
Total Chum	8,070,000	111,800	
Chinook			
Capilano	2,200,000	67,000	Capilano (B. Qualicum transplant)
Tenderfoot	1,080,000	32,400	Ashlu, Squamish, Cheakamus, Mamquam
Total Chinook	3,280,000	99,400	
Coho			
Tenderfoot	270,000	40,500	Cheakamus, Squamish, Mamquam
Capilano	1,400,000	167,000	Capilano
False Creek	20,000	3,000	Seymour transplant
Seymour	200,000	9,750	Seymour
Deep Cove	150,000	22,500	Capilano transplant
Noons Ck.	34,000	5,100	Noons
Upper Paradise	40,000	600	Cheakamus
Total Coho	2,114,000	248,450	

just upstream of the hatchery blocks access to the upper river, where most spawning and rearing used to take place. Without the hatchery, there is little doubt the chinook run would be lost and that coho and steelhead runs would be a fraction of current levels.

Capilano is the site of many innovative studies for chinook including feminization to increase the proportion of females in the hatchery returns; rearing density studies and; rearing to yearling smolt vs. release of 90-day smolts. It has been the source of eggs for enhancement work at Sechelt and Vancouver River and for former programs at False Creek (the children's fishery) and Indian River. Chinook production capacity has been expanded at Capilano during 1983 and 1984 with the development of underground rearing ponds. Fish in these ponds will be raised under artificial lighting; the technique is being assessed using mark release/recovery experiments.

In 1985, some Capilano chinook will be reared in sea pens at Deep Cove, and their post-release survival will be compared to that of releases on the same dates directly from the hatchery. Sea-pen rearing is potentially an important technique for future chinook enhancement efforts in British Columbia, especially in systems such as the Indian River where water quality is suspect.

The Squamish chinook run is severely depressed and Tenderfoot Hatchery production has been limited by brood stock availability. Initial plans were to take eggs from various tributaries within the Squamish then return the smolts to these same tributaries. Since some of the target stocks are virtually extinct, releases will now be made from the hatchery with the hope that returning spawners will be easier to capture. This will increase the number of eggs that can be taken from the next generation, and will result in a more rapid rebuilding rate. Another new method to increase Squamish chinook production is also being tried. A commercial fish farmer has been contracted to rear about 4,000 smolts of the 1984 brood year from Tenderfoot Hatchery to maturity. Eggs taken from mature fish in 1987 and 1988 will be returned to Tenderfoot for incubation, rearing and release. The 4,000 smolts should yield 1,000,000 eggs, compared to about 50,000 eggs if the young were simply released without rearing.

3.7.2.3 Coho Salmon

Burrard Inlet/Howe Sound coho facilities account for 25% of the coho enhancement capacity in Georgia/Johnstone straits. Every hatchery technique used for coho in British Columbia is also used in this area, including early fry releases at the Upper Paradise facility and the Seymour facility; fry and fingerling colonization of the upper Capilano; and smolt releases from fresh water (Tenderfoot, Capilano, Seymour and Noons Creek) and from sea pens (False Creek and Deep Cove).

Capilano Hatchery is the largest producer in the area, and has been so successful that over-escapement of coho has been cited as a major management problem in Burrard Inlet and Howe Sound. Recent research at Capilano Hatchery indicates that escapement levels can be decreased, while current smolt release levels can be maintained by sterilizing coho juveniles. Sterilized fish do not undergo normal maturation processes, and do not return to fresh water. Some marked, sterilized Capilano coho have been recovered in the fisheries at age 6 compared to normal age 3 maturity. By sterilizing 50% of Capilano coho juveniles, escapement will be reduced by 50%, hopefully alleviating management problems while maintaining catch contribution at high levels. Another interesting applied study done at Capilano Hatchery has demonstrated that adult run timing is an important factor when selecting brood stock, and can help to maintain the genetic diversity of each stock.

Capilano coho fry are planted in the upper river above the dam in sufficient numbers to ensure an escapement of about 2,000 adults. This number is sufficient to keep the hatchery operating at full capacity in the event of a major failure, such as in 1974, when most fish in the hatchery were killed by accidental chlorine contamination of the water supply.

False Creek was formerly the site of the children's chinook fishery, but this has been discontinued. The coho at False Creek will be moved to Deep Cove in spring 1985, and the False Creek site will be closed. The Deep Cove sea-pen rearing project, along with expansion at Capilano, Chilliwack, Big Qualicum and Quinsam, was implemented in response to perceived increased angler demand during EXPO '86. The Deep Cove fish were transferred as finger-

lings from Capilano, and the process is expected to continue, although on a smaller scale in the future.

In the late 1970's, Capilano coho were reared and released from sea pens at the head of Indian Arm in a pilot study. In the same years Capilano coho were released from Capilano Hatchery and from sea pens in Sechelt Inlet. The catch distribution of the Indian Arm and Capilano Hatchery releases was very similar, while catch distribution of the Sechelt releases was more northerly, with the greatest catch in Statistical Area 16. These results demonstrated that stock distribution in the ocean is strongly influenced by release location, and offers a management option for increasing catch of coho in specific areas of Georgia Strait.

Tenderfoot Hatchery is the primary enhancement facility on the Squamish River system. Tenderfoot is involved in large-scale production of the nearby Cheakamus stock and smaller scale production of the Mamquam and upper Squamish (and tributaries) stocks. Hatchery staff work closely with the Upper Paradise public project group.

3.7.3 Fisheries

Area 28 odd-year pinks are passively managed. Because of the numerical dominance of Fraser stocks, there are few, if any, opportunities for selective management of these stocks.

In response to observed declines in Squamish River chinooks, a number of measures have been implemented in order to reduce harvest rates and increase returns to the spawning grounds. The measures include enhancement of chinooks within the Squamish River system and severe restriction of the terminal area fisheries, as well as general conservation measures applied in response to the coast-wide chinook decline. Management measures are summarized below:

1. Net Fishery: The terminal commercial net and troll fisheries in Howe Sound were eliminated in 1968. The average catches in those fisheries during the period 1951-1965 were 34,000 pinks, 23,000 chums, 4,000 chinooks and 3,000 coho.

2. Sport Fishery: Since 1982, the Squamish River and upper two-thirds of Howe Sound have been closed to sport fishing during the period when the majority of Squamish chinooks are migrating through the area on their way to the spawning grounds (July 15 through September 15).

3. Indian Food Fishery: In the past, the Indian food fishery has been restricted for varying periods during the chinook migratory and spawning period. During 1983, the fishery was restricted to 1 day per week between August 17 and September 15.

3.7.4 Habitat Status

Habitat summaries for pink (odd-year) and chum salmon are presented in Tables 3.7-2 and 3.7-3. Chinook and coho habitat descriptions may be found in Section 3.8-4. For a discussion of habitat tables see Section 2.2.4.

3.7.5 Stock Rebuilding Potential

As noted above, the small size of the pink salmon stocks in this area compared to the Fraser stocks with which they are caught precludes any major adjustments in harvest rates to specifically protect these stocks. The earlier run timing, particularly of Howe Sound pinks, relative to Fraser pinks suggests that these are intercepted mainly during sockeye fisheries. However, it would be unrealistic to forgo major sockeye catches to rebuild small pink stocks. There should be some benefits, however, if exploitation rates are decreased somewhat to improve sockeye escapements. Because of the currently larger population, Burrard Inlet pinks should benefit most from a reduction in the sockeye exploitation rate. Enhancement by means of a facility is probably the only practical way of rebuilding Howe Sound pinks, although recovery would likely take a long time, given the current stock size. Unless exploitation rates are reduced, enhancement will have to be maintained; otherwise, the run will once again decline.

3.7.6 Management Conflicts

As indicated above, the major constraint to rebuilding pink stocks by reducing exploitation rates is the coincident timing of runs of these stocks

Table 3.7-2. Howe Sound/Burrard Inlet pink (odd) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	584	500	14?

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 2

HABITAT NOTES

Historic Status, Production Constraints and Development History	Squamish and Indian rivers. Natural flow fluctuations. Forestry impacts have compounded flow problems in some systems - generally low forest impacts. Urban development, diking, flood control has had low - moderate impacts.
Current Status	Declining forestry activity; stable urban development.
Future Outlook	Probably maintenance of status quo. Slight increase in settlement development, etc. being offset by better awareness of habitat needs.
Natural Habitat Production Potential	Probably stable at historic levels.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
Medium - High	Medium - High	Medium - High	Medium - Low	Unknown

CONCLUSION Management problem since run timing coincides with major Fraser River stocks.

Table 3.7-3. Howe Sound/Burrard Inlet chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	2,507	192	200

MANAGEMENT STYLE Active 75%
Passive
Unknown

NUMBER OF STREAMS 16

HABITAT NOTES

Historic Status, Production Constraints and Development History	Natural flow fluctuations. Forestry impacts have compounded flow problems in some systems - generally low forest impacts. Urban development, diking, flood control has had low - moderate impacts.
Current Status	Declining forestry activity - stable urban development.
Future Outlook	Probably maintenance of status quo. Slight increase in settlement development, etc. being offset by better awareness of habitat needs.
Natural Habitat Production Potential	Probably stable at historic levels.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium - High	Medium - High	Medium - High	Medium - Low	Unknown

CONCLUSION

with major Fraser sockeye and, to some extent, with other pink stocks in the main fishing areas.

3.7.7 Management Strategies for Stock Rebuilding

A general reduction in harvest rates in the interception fisheries to increase escapements of Fraser River sockeye and pinks would incidentally benefit Howe Sound and Burrard Inlet pinks. Specific management actions to conserve these stocks are likely to be impractical, although better information on migratory timing in areas such as the West Coast troll fishery and in Johnstone Strait would help to identify any opportunities.

Construction of a spawning channel or hatchery for pinks on the Squamish River should be considered. The existing small facility at Tenderfoot Creek could possibly be used to advantage in this regard. An enhancement facility on the Indian River should also be developed to increase productivity of pinks and other salmon species. Because Squamish and Indian river pinks spawn in rivers discharging into the head of inlets, there is an opportunity to manage these stocks independently after they have separated from the mixed stock areas. The possibility of eventually enhancing the stocks to a relatively high level and managing for enhanced fish within the inlets should be considered. Given the current state of the stocks, the Indian River appears to have greater potential in this regard than the Squamish.

3.7.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill *et al.* (1983)[1].

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

3.7.8.1 Squamish River Estuary Rehabilitation (Project No. 28-16)

Rehabilitation of the Squamish River estuary is proposed. The estimated incremental production would be 5,700 coho and 2,000 chums.

3.7.8.2 Indian River Pink Channel (Project No. 28-18)

It is proposed that a side channel be constructed on the Indian River. Adult production would be 25,000 (odd years only). Another side channel is also proposed for production of 50,000 chums.

3.7.8.3 Tenderfoot Pink Pilot

This proposal involves a temporary incubation box to test the pink production and increase brood stock for larger facilities. Estimated full production from the pilot is 30,000.

3.7.8.4 Tenderfoot Facility

This proposal involves construction of small chum channel in addition to the existing facility. Estimated production is 50,000 adults.

3.8 Fraser River

The Fraser River area is shown in Figure 3.8-1.

3.8.1 Stock Descriptions

Fraser River stocks are described by species in the following sections.

3.8.1.1 Sockeye Salmon

There are many individual sockeye stocks that rear in approximately 20 lakes in the Fraser River watershed. The stocks range in size from a few thousand fish to several million. Together they form the largest sockeye run in British Columbia. Fraser River sockeye runs were formerly much larger than at present, averaging 10,500,000 from 1894-1913, with a peak of 36,500,000 in 1913.

A striking feature of Fraser River sockeye populations is the occurrence of quadrennial "cyclic dominance"; i.e., the number of returning adults is much greater every fourth year. The phenomenon is largely confined to those races spawning upstream from Hope. Prior to 1914, dominance was a feature of sockeye races from all major upriver producing areas. They were dominant in 1913; however, the Hell's Gate Canyon blockage in 1913 destroyed a substantial part of the run. Coupled with an intensive fishery for the same cycle in 1917, which allowed only a small escapement, the cycle was reduced to approximately the level of other cycles, and eliminated dominance. In addition to the Hell's Gate obstruction, a logging splash dam at the outlet of Adams Lake and a placer mining storage dam at the outlet of Quesnel Lake contributed to the decline of the Fraser sockeye populations. Removal of these dams, construction of fish passage facilities at Hell's Gate and at several other locations, and regulatory control of the fishery to allow larger escapements have led to increased production.

In some areas dominance has recently reappeared but has not occurred in the same cycle for all stocks. In the Stuart and Quesnel stream systems, for example, dominance has returned to the original 1913/1917 (=1981/1985) cycle, whereas in the Shuswap system it now occurs in the 1982 cycle, especially in

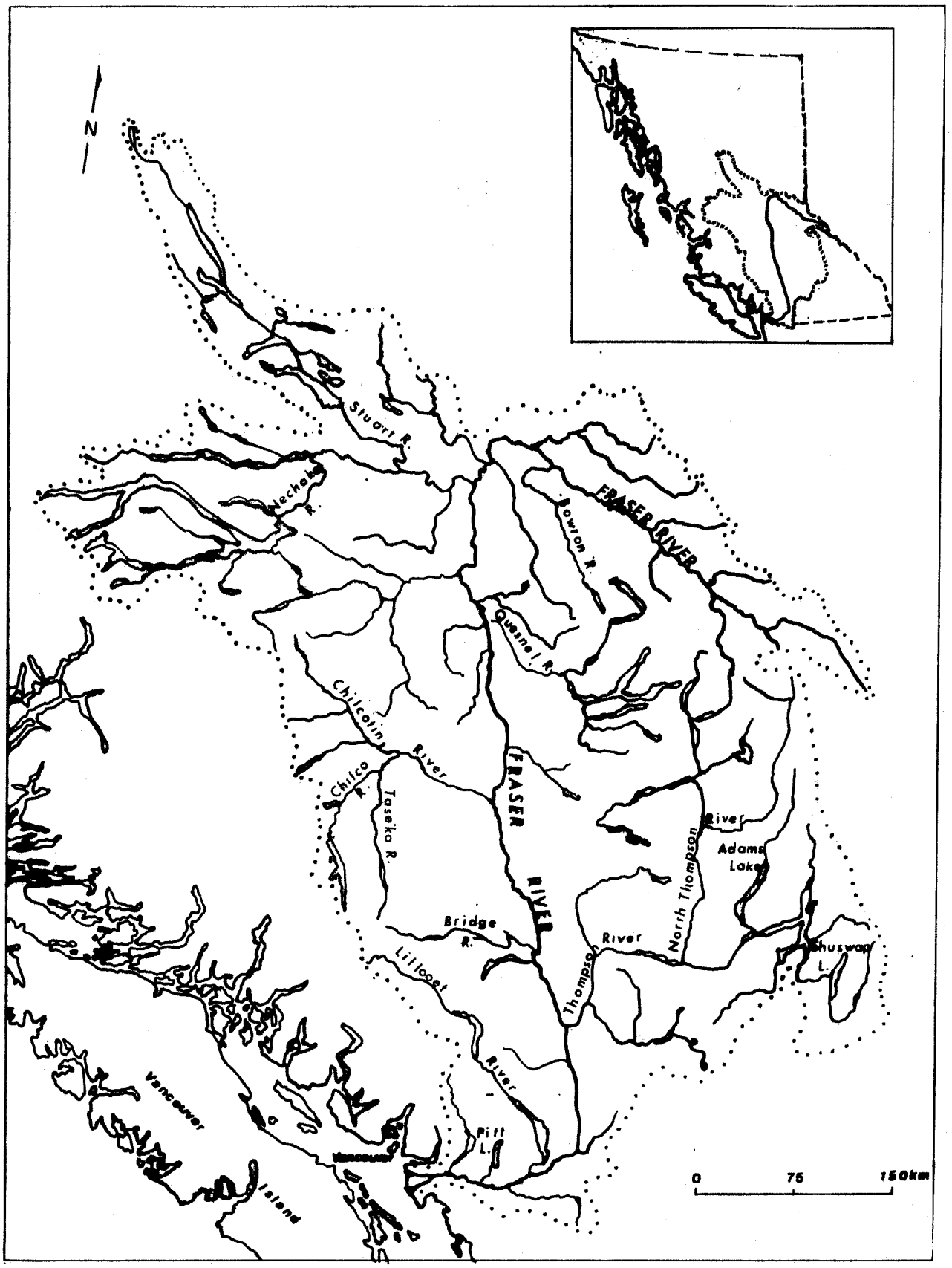


Figure 3.8-1. Fraser River area.

the Adams River run. The 1982 cycle, with an average run of 8,700,000, is presently the largest on the Fraser; the 1984 cycle is the smallest, with an average run of 3,500,000 (monthly Chilko stocks). Because of the predominance of different stocks in each cycle, the stock composition and timing of the adult migratory runs change according to the cycle year, adding to the complexity of managing the fishery. The reasons for cyclic dominance are not clear.

Approximately 90% of Fraser River sockeye return to spawn at age 4; 10% spawn at at age 3 (jacks) and 5. Some stocks characteristically have a higher proportion of age 5 fish than do others, particularly those from lower Fraser such as Pitt, Birkenhead, Weaver (in some years) and Cultus. Age 3 sockeye are most abundant in Birkenhead, Weaver, Portage, Gates, Chilko, Horsefly and Adams races.

Migratory Routes and Timing Maturing Fraser River sockeye make landfall along the north and central coasts of British Columbia and the west coast of Vancouver Island before migrating southward, entering Georgia Strait through either Juan de Fuca Strait or Johnstone Strait. From 1952-1977, an annual average of 16% of the sockeye migrated through Johnstone Strait. Since 1978 the proportion of the run migrating through Johnstone Strait has increased to an average of 54%, with a high of 80%. This change in migratory routes is related to alterations in oceanographic conditions. Generally, the later-running stocks such as Adams and Weaver are now likely to swim through Johnstone Strait than are stocks with earlier runs.

Adult sockeye migrate through the lower Fraser River in abundance from late June until early October. The approximate timing of the major stocks is shown in Figure 3.8-2. The migratory behaviour and rate of migration of Fraser sockeye as they approach the river mouth are not the same for all stocks. Generally, the stocks migrating earliest move rapidly through the interception areas and proceed into the river without delay. Stocks running later tend to migrate more slowly and, upon entering the Strait of of Georgia, hold for three to six weeks (in the case of Adams and Weaver) before entering the river. Fraser sockeye in Juan de Fuca and Johnstone straits appear 5 to 10 days earlier (except for late-running stocks) than at the mouth of the Fraser River.

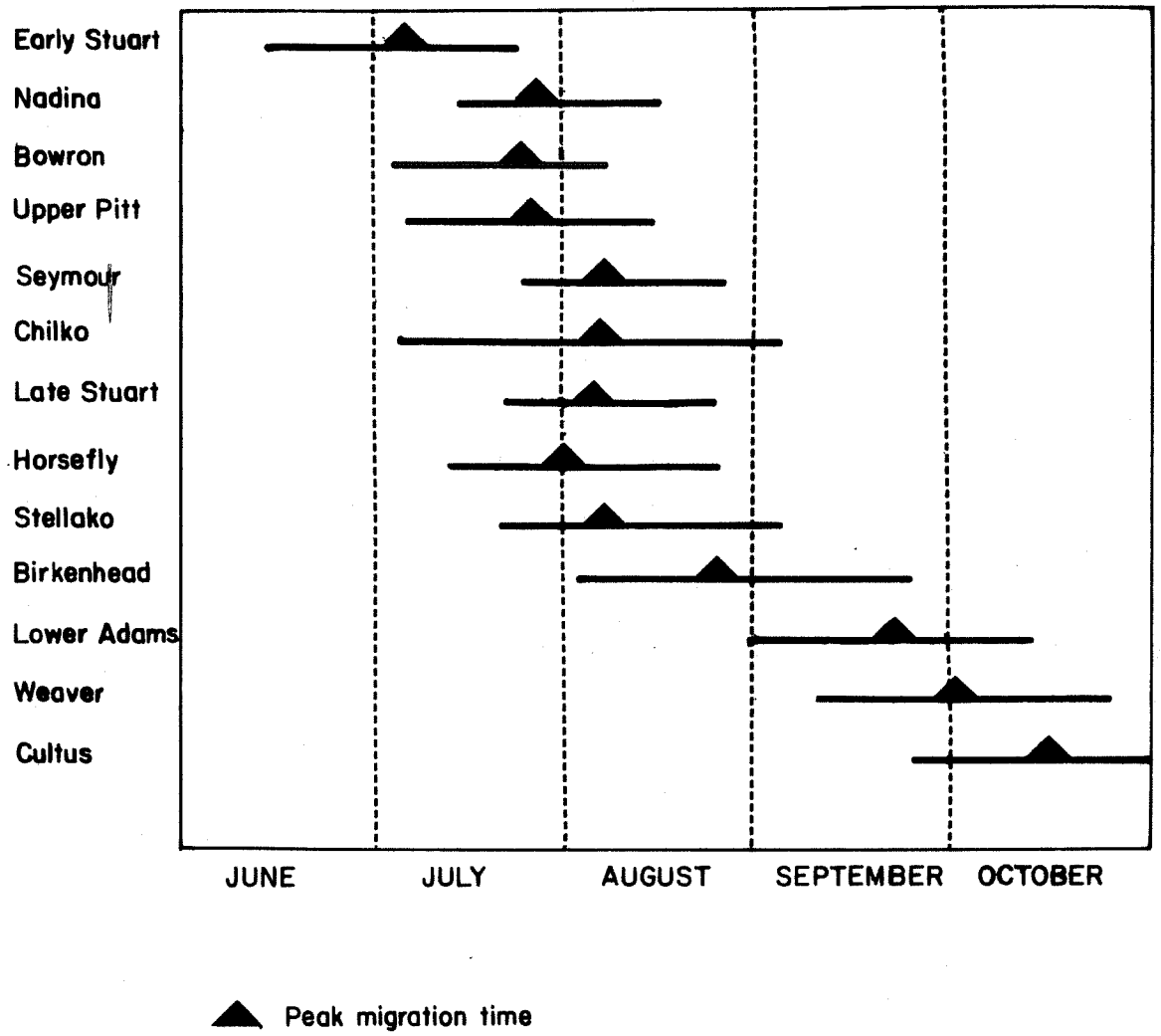


Figure 3.8-2. Approximate migration timing of sockeye through the lower Fraser River.

Catches and Escapements From 1964-1983, the average total run of Fraser River sockeye was 5,800,000. The catch was 4,500,000, and the spawning escapement 1,300,000. The 1982 cycle (dominant Adams River run) has had the largest runs, with an average size of 8,700,000 since 1966. Escapements have increased substantially in the last two years for this cycle, reaching 4,000,000 in 1982 (Fig. 3.8-3). The exploitation rate for the 1982 cycle is the lowest of any cycle averaged at about 71% for all fisheries combined.

The 1981 and 1983 cycles are usually similar in size, averaging 5,700,000 and 5,900,000, respectively (Table 3.8-1). Catches and escapements are also similar for these two cycles, as are exploitation rates, which average about 80%. The predominant stocks are early- and late-running Stuart, Quesnel, Birkenhead and Weaver (1981 cycle) and Chilko, Stellako, Adams and Weaver (1983 cycle).

The 1980 cycle is the smallest, with an average run of only 3,200,000. The catch of this cycle has averaged 2,400,000; the escapement has averaged 711,000 and has been increasing. Chilko is by far the largest stock, comprising about 60% of the total run; the remainder is made up mainly of Birkenhead, Stellako and Weaver stocks.

Productivity The total return of adult sockeye (catch plus escapement) per spawner for 1964-1979 brood years averaged 5.3 for all cycles combined, with a range of 3.2 - 6.9 (Table 3.8-2). The 1982 cycle had the lowest average productivity (4.6). The highest average productivity, 6.1, occurred for the 1981 cycle. All cycles exhibited considerable annual variability in productivity.

Stock Interactions As a result of the extended period during which runs occur (two to three months for all stocks combined), the migratory pathways utilized and the numerical dominance of Fraser River sockeye, fisheries for these stocks have significant and often undesirable effects on other stocks present at the same time. The stocks most affected include Johnstone Strait/Georgia Strait pinks; and chinooks and coho in Johnstone, Juan de Fuca and Georgia straits. U.S. fisheries in northern Puget Sound are also affected. Within the Fraser River, commercial and Indian food fisheries catch chinooks, coho and early-running chum stocks.

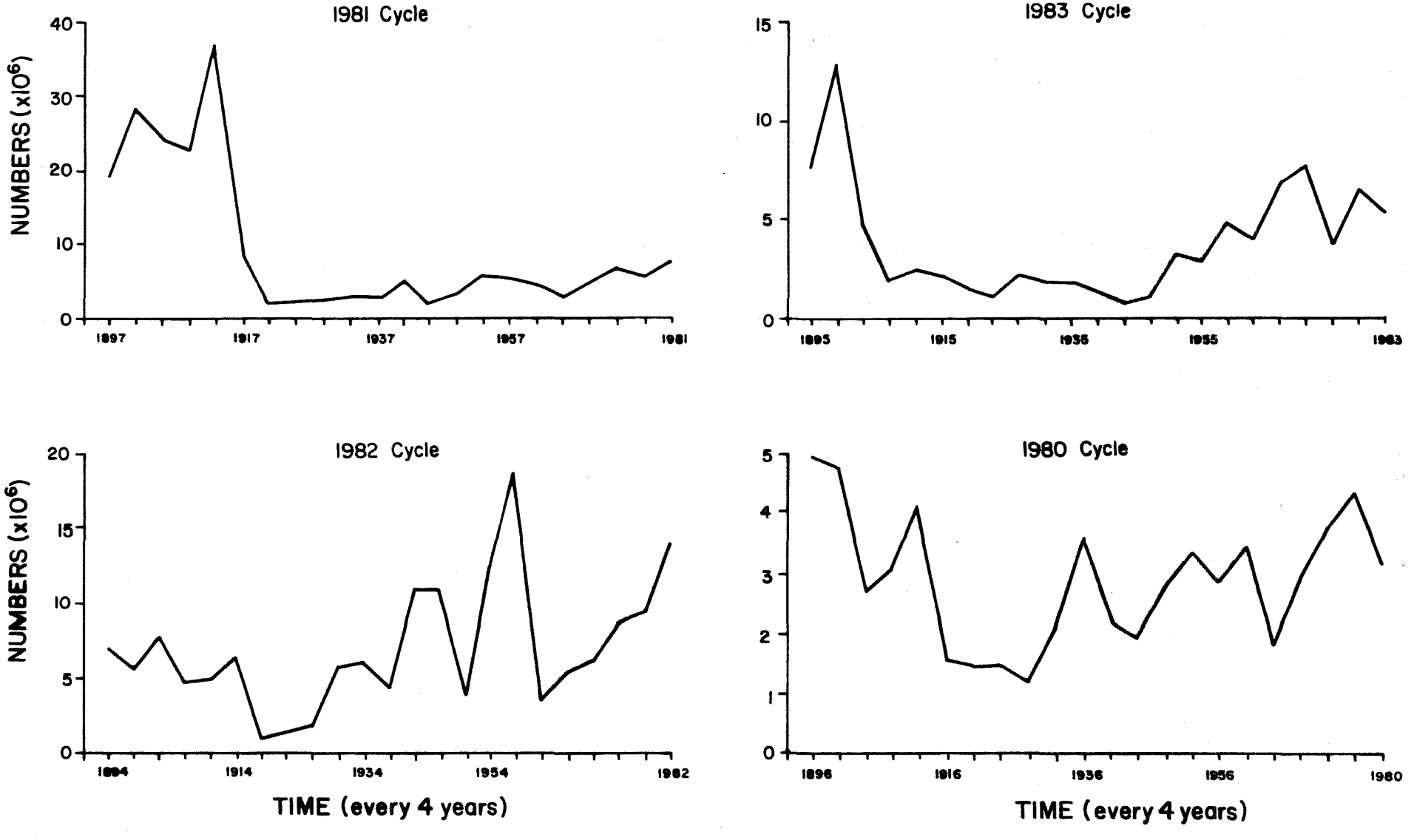


Figure 3.8-3. Historical total runs of Fraser River sockeye by cycle.

Table 3.8-1. Fraser River sockeye catch, escapement and total run (numbers are in thousands of fish).

Year	Catch**	Escapement*	Run*	Exploitation Rate (%)
1983 Cycle				
1983	4,191	976	5,167	81.1
1979	5,019	1,407	6,426	78.1
1975	2,687	991	3,678	73.1
1971	6,857	747	7,604	90.2
1967	5,146	1,354	6,500	79.2
MEAN	4,780	1,095	5,875	80.3
1982 Cycle				
1982	9,909	4,024	13,933	71.1
1978	6,996	2,514	9,480	73.5
1974	6,859	1,757	8,616	79.6
1970	4,188	1,943	6,131	68.3
1966	3,519	1,919	5,438	64.7
MEAN	6,289	2,431	8,720	71.4
1981 Cycle				
1981	6,269	1,443	7,712	81.3
1977	4,667	1,113	5,780	80.7
1973	5,696	1,181	6,877	82.3
1969	3,877	1,007	4,884	79.4
1965	2,261	845	3,106	72.8
MEAN	4,554	1,118	5,672	79.3
1980 Cycle				
1980	2,288	848	3,136	73.0
1976	3,514	823	4,337	81.0
1972	2,885	830	3,715	77.7
1968	2,287	627	2,914	78.5
1964	1,258	426	1,684	74.7
MEAN	2,446	711	3,157	77.0

* From IPSFC Annual Reports.
** By subtraction.

Table 3.8-2. Fraser River sockeye returns per spawner.

Brood Year	Brood Year Escapement*	Return*	Productivity
1983 Cycle			
1979	1,407	5,167	3.67
1975	991	6,426	6.48
1971	747	3,678	4.92
1967	1,354	7,604	5.62
MEAN	1,125	5,718	5.18
1982 Cycle			
1978	2,514	13,933	5.54
1974	1,757	9,480	5.40
1970	1,943	8,616	4.43
1966	1,919	6,131	3.19
MEAN	2,033	9,540	4.64
1981 Cycle			
1977	1,113	7,712	6.93
1973	1,181	5,780	4.89
1969	1,007	6,877	6.83
1965	845	4,884	5.78
MEAN	1,036	6,313	6.11
1980 Cycle			
1976	823	3,136	3.81
1972	830	4,337	5.23
1968	627	3,715	5.92
1964	426	3,914	6.84
MEAN	676	3,525	5.45
Overall Mean			5.34

* numbers are in thousands of fish.

3.8.1.2 Pink Salmon

The Fraser River supports the largest pink salmon run in British Columbia, with an annual average of 12,100,000 fish over the last five cycles. Although information on the size of historical runs is meagre, reports of Fishery Officers early this century indicated that millions of pink spawned in Seton Creek and the Thompson and Nicola rivers. Runs before 1913 have been estimated at 28,000,000. The Hell's Gate rock slide of 1913 drastically reduced the Fraser pink run by completely blocking access to upriver spawning areas. Installation of the Hell's Gate fishway in 1946, construction of spawning channels at Seton Creek, and some reduction of exploitation rates in peak years has resulted in reinvasion of upriver areas by pinks, and larger escapement to the Fraser in general. Increased escapements have led to larger runs in recent years (Fig. 3.8-4).

Fraser pinks can be broadly grouped into early- and late-running segments, although the difference in timing is only 7-10 days. The early-running stocks have comprised more than 90% of the total escapements in recent years. Fraser River pinks spawn in odd years only, as do other southern Georgia Strait pink stocks.

Migratory Routes and Timing Upon reaching the coastal zone, maturing pink salmon approach the Fraser either from the north through Johnstone Strait or from the south via Juan de Fuca Strait. An average of 29% of the Fraser pinks migrated through Johnstone Strait from 1959-1981 with relatively small annual variations. In 1983, however, an estimated 66% went through Johnstone Strait, a record high.

Fraser River pink salmon first enter Juan de Fuca and Johnstone straits in early to mid-August, and rapidly increase in abundance, with peaks from mid-August through mid-September. In both areas they mingle with pink stocks from other Canadian and Puget Sound streams. The run timing of Canadian Fraser pinks in Johnstone and Juan de Fuca straits is a little later than that of other pinks, although there is some overlap. Puget Sound pinks and Fraser pinks migrate at similar times through Juan de Fuca Strait. They migrate through the lower Fraser River from late August to mid-October, with a peak in mid-September.

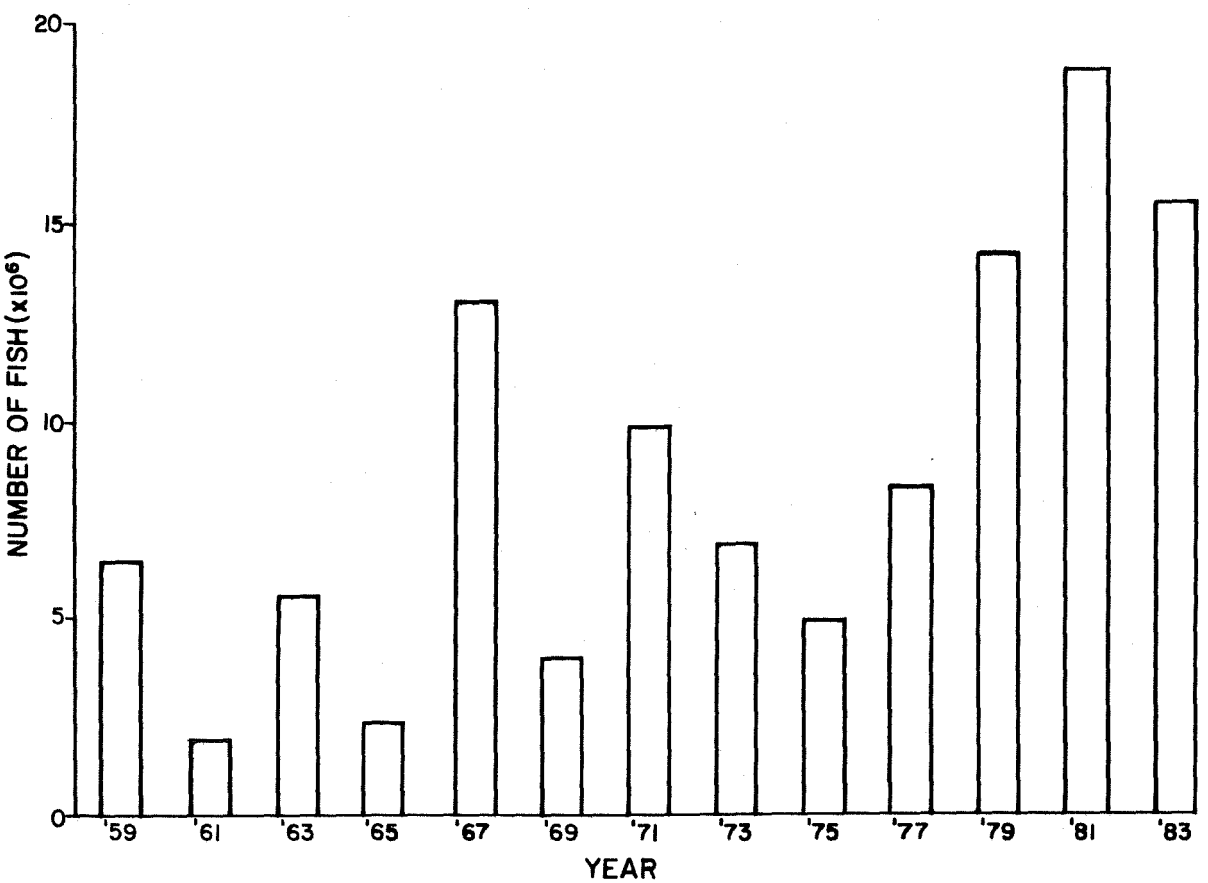


Figure 3.8-4. Fraser River odd-year pink salmon runs from 1959 to 1983.

Fraser River pinks migrate relatively quickly from outer Johnstone and Juan de Fuca straits to the Strait of Georgia, then wait for about 2-3 weeks before entering the river. Tagging in 1959 indicated a travel time of eight days from upper Johnstone Strait to Texada Island and another 12 days to the Fraser River. Fish approaching from the south took six days to migrate from Juan de Fuca Strait to Point Roberts and another ten days before appearing in the Fraser Gulf fishery.

Catches and Escapements From 1959-1983, the catch of Fraser River pinks in all areas averaged 6,300,000. As a result of larger escapements, catches in the last three cycles have increased, ranging from 10,500,000 - 13,900,000 (Table 3.8-3). In the last five cycles, 72% of the total catch was taken by Canada.

The principal spawning areas for Fraser pinks are the mainstem of the Fraser River between Chilliwack and Hope (the largest population), Thompson River, Seton Creek, and in the Harrison and Chilliwack rivers (Table 3.8-4). Pinks spawning in the latter two areas are considered to have late runs while the others have early runs.

Escapements have increased rapidly over the past four cycles from an average of 1,500,000 from 1959-1975 to an average of 3,800,000 from 1977-1983. The early runs have accounted for all the increase, especially the mainstem Fraser stocks. Escapement to the Thompson River, a major area that had been receiving increasing numbers of spawners, declined suddenly in 1983 to less than half that of 1981. Late-running pinks in the Harrison River appear to be limited by availability of spawning areas, while in the Chilliwack River periodic flooding limits production.

Productivity The return of adults (catch in all areas plus escapement) per spawner has averaged 4.5 since the 1959 brood year with a range of 1.2 - 10.8. Freshwater survival has averaged 13.1% (range 9.0 - 18.7%), while marine survival averaged 3.1% (range 0.8 - 5.4%).

Stock Interactions Fraser pink runs coincide in timing with many other stocks in the major catch areas. These other stocks are thus often subjected to undesirable fishing pressure. Pinks destined for other Canadian and U.S.

Table 3.8-3. Catch, escapement and total run of Fraser River pink salmon (in thousands).

Year	Canada				U.S. Catch	Total U.S. and Canada Catch	Escapement	Run	Rate (%)
	Convention Area Catch	Non-Conv. Area Catch	Indian Food Fishery	Total Catch					
1959	1,976	1,257	18	3,251	2,150	5,401	1,077	6,478	83
1961	276	402	30	708	118	826	1,094	1,920	43
1963	1,434	805	35	2,274	1,133	3,407	1,953	5,360	64
1965	330	359	29	718	391	1,109	1,191	2,300	48
1967	3,687	3,697	24	7,408	3,634	11,042	1,831	12,873	86
1969	762	629	26	1,417	9806	2,323	1,529	3,852	60
1971	1,846	3,743	32	5,621	2,282	7,903	1,804	9,707	81
1973	1,670	1,237	43	2,950	2,048	4,998	1,754	6,752	74
1975	1,147	1,216	41	2,404	1,094	3,498	1,367	4,865	72
1977	1,610	2,107	29	3,746	2,039	5,785	2,388	8,173	71
1979	3,300	3,469	57	6,826	3,713	10,539	3,561	14,100	75
1981	3,905	6,164	56	10,125	3,787	13,912	4,488	18,400	76
1983	1,037	7,635	84	8,756	1,777	10,533	4,632	15,165	69
MEAN									
1959-83	1,768	2,517	39	4,323	1,929	6,252	2,205	8,457	69
MEAN									
1975-83	2,200	4,118	53	6,371	2,482	8,853	3,287	12,141	72

Table 3.8-4. Pink salmon escapement to the Fraser River (in thousands of fish).

	1977	1979	1981	1983	Average
Early					
Lower Fraser	775	1,522	2,252	3,307	1,964
Fraser Canyon	10	26	43	46	31
Seton-Anderson	435	713	626	501	569
Thompson	973	885	1,166	512	884
Misc.	8	9	10	7	8
Subtotal	2,201	3,155	4,097	4,373	3,456
Late					
Harrison	133	273	317	150	218
Chilliwack	54	133	74	108	92
Subtotal	187	406	391	258	310
TOTAL	2,388	3,561	4,488	4,632	3,767

streams, chinooks, coho, and some of the weaker late Fraser sockeye stocks are all caught especially in the Johnstone Strait, Juan de Fuca and U.S. fishing areas. In some years, there is limited fishing for pinks off the Fraser, which results in incidental catches of chinook and coho.

Another type of interaction noted is that large numbers of pink salmon juveniles may reduce the survival of chum juveniles. Survival of chums of odd-numbered brood years, when pinks also spawn in the Fraser, is lower than that of even-year chums. A similar relationship has been found between pinks and chums of Puget Sound. This depressed survival of chums could be of concern if Fraser River pink production were increased significantly.

3.8.1.3 Chum Salmon

The Fraser River chum stock is currently rebuilding after a period of stable but low abundance. Escapement averaged 268,000 from 1960-1969, and increased to 440,000 from 1970-1979 and 459,000 from 1980-1984. The current chum target escapement has been estimated to be over 700,000.

3.8.1.4 Chinook Salmon

Declining chinook catches in the 1970's and an increased awareness of chinook conservation problems resulted in greater effort being expended in assessing chinook escapements in the Fraser River. At the same time, road access to many remote spawning areas has improved, and greater use has been made of helicopter and fixed-wing aircraft to increase counting efficiency. In general, these factors alone would tend to increase escapement estimates whether or not numbers of spawners actually increased. Nonetheless, estimates of chinook escapement to the Fraser are believed to be a good index of spawner abundance. Chinook test fishing began in the lower Fraser in 1980, and takes place each year throughout the chinook migration. Although the data set is small, a strong correlation exists between the test fishery index and total estimated escapement ($r^2 = 0.98$).

Terminal harvest of Fraser River chinooks has been severely restricted in recent years in an attempt to maintain escapement levels despite increasing harvest rates in interception fisheries and declining returns to the river.

Four fisheries are managed in the Fraser area: Area 29 gillnet and troll commercial fisheries; the Fraser River Indian food fishery; and the non-tidal sport fishery. Escapement, catch, and estimated harvest rate of the terminal fisheries are presented in Table 3.8-5, with the total run partitioned into early, middle and late periods.

Commercial and sport terminal fisheries have been most severely restricted. The terminal large-mesh gillnet fishery for chinooks was eliminated in 1980; the gillnet mesh size for sockeye and pinks was reduced from 5.875 to 5.5 inches to reduce the incidental chinook catch; and the troll fleet cannot retain chinooks while fishing for sockeye and pinks in Area 29. These restrictions have reduced the commercial catch of chinooks from an average of 84,461 (1970-1980) to an average of 22,625 (1981-1984), which reduced terminal commercial harvest rates from 46.7% to 21.2%. During the same period, terminal harvest rates in the Indian food fishery have more than doubled from 9.6% (1970-1980) to 20.1%.

Total escapement of chinook salmon to the Fraser as estimated by Fishery Officers' counts is shown in Figure 3.8-5. The increase with time can probably be attributed to increased enumeration efforts and improved access. Declines since the late 1970's are of great concern, since the average terminal harvest has been reduced by over 70,000.

Fraser chinook stocks are usually categorized as early-, middle- and late-running. Early-running stocks move through the lower river prior to mid-June and consist primarily of stocks from Nechako and Stuart rivers and other tributaries upstream of Prince George. Mid-season chinooks migrate through the lower Fraser between mid-June and the end of August, and include the Quesnel/Horsefly and Chilko/Taseko systems of the middle Fraser, as well as the Thompson drainage. Late-running chinooks move through the lower river in September and October, and consist almost entirely of Harrison dark chinooks. Fraser chinooks are grouped similarly in this report, except that mid-season Chilko/Taseko and Quesnel/Horsefly stocks are grouped with early-running upper Fraser stocks.

Upper Fraser River The upper Fraser River chinook stock group consists of three stocks in Fraser tributaries and mainstem areas above Hope, excluding

Table 3.8-5. Catch and escapement of chinook from terminal fisheries averaged over the years 1970-80 and 1981-84.

Run Timing	1970-80 Number	1970-80 Harvest Rate (%)	1981-84 Number	1981-84 Harvest Rate (%)
Early (May 1 - July 15)				
Escapement	22,495		26,436	
Catch				
Commercial	27,871	41.9	2,079	5.5
Sport	6,950	10.4	0	0.0
Indian Food Fish	9,232	13.9	9,495	25.0
Total	44,053	66.2%	11,574	30.4%
Middle (July 15 - Aug. 30)				
Escapement	25,707		22,172	
Catch				
Commercial	36,028	51.6	12,592	30.2
Sport	3,078	4.4	0	0.0
Indian Food Fish	5,005	7.2	6,803	16.4
Total	44,111	63.2	19,395	46.7
Late (Aug. 30 - Oct. 15)				
Escapement	17,818		17,000	
Catch				
Commercial	20,562	46.5	7,954	26.4
Sport	2,686	6.1	0	0.0
Indian Food Fish	3,175	7.2	5,151	17.1
Total	26,423	59.7	13,105	43.5
Total				
Escapement	65,929		62,858	
Catch				
Commercial	84,461	46.7	22,625	21.2
Sport	12,714	7.0	0	0.0
Indian Food Fish	17,411	9.6	21,448	20.1
Total	114,586	63.4	44,048	41.2

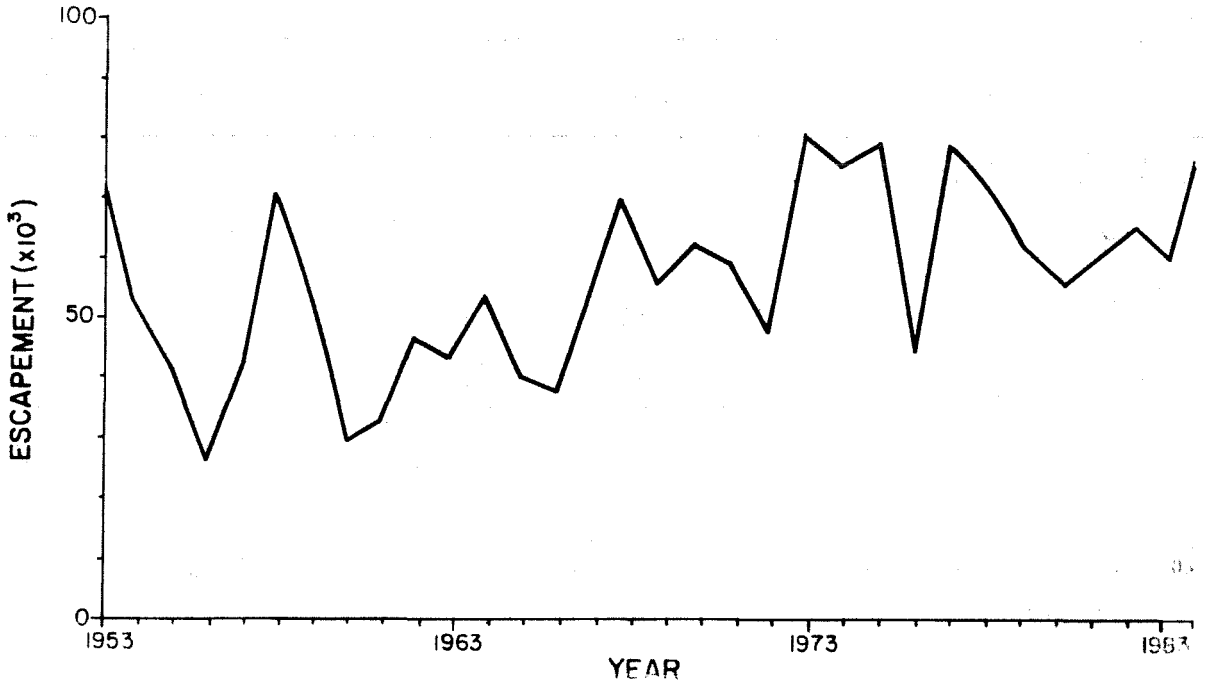


Figure 3.8-5. Total Fraser River chinook escapement.

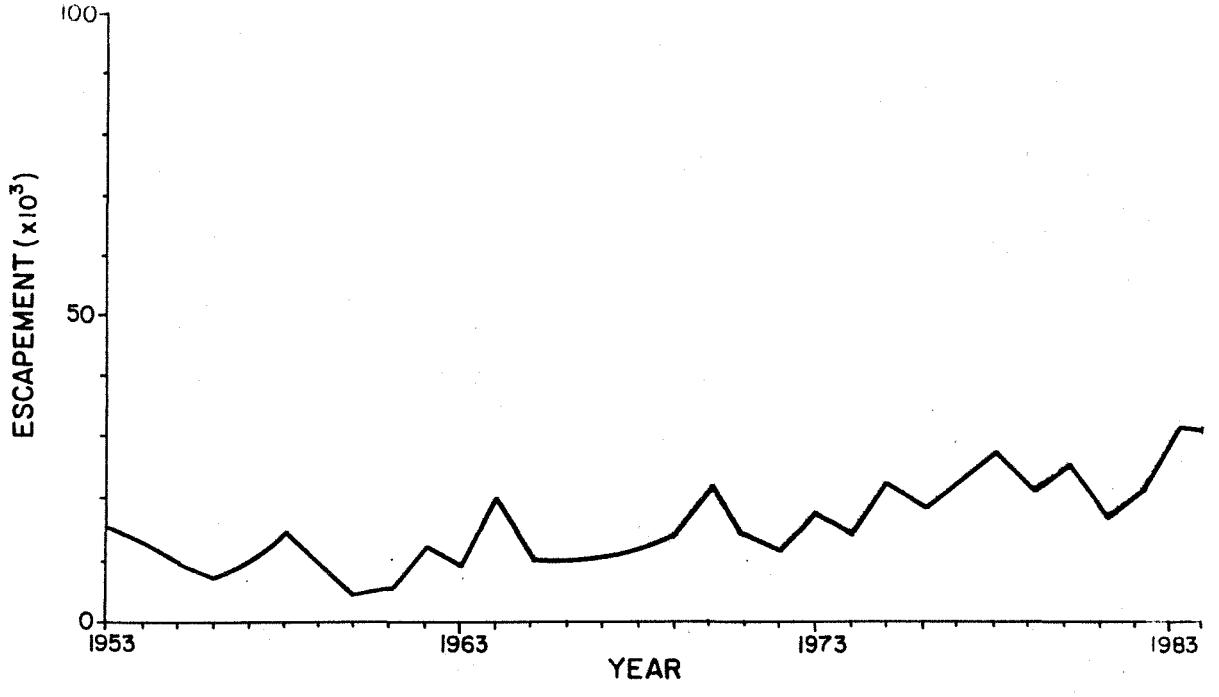


Figure 3.8-6. Upper Fraser River chinook escapement.

the Thompson system. The major stocks contributing to chinook production from the Fraser River above Hope include:

Stock	Timing	Mean Escapement (1979-84)*
Bowron	Early	2,298
McGregor	Early	1,198
Upper Fraser (Mainstem)	Early	3,083
Nechako	Early	1,506
Stuart	Early	711
West Road & Cotton Rivers	Early	2,195
Salmon & Willow	Early	999
Slim Creek	Early	1,723
Quesnel/Horsefly	Middle	1,633
Chilko/Taseko	Middle	5,963

* Preliminary data for 1984.

These stocks are predominantly stream-type chinooks which leave the river as smolts in early spring and pass through Georgia Straight as yearlings, thereby avoiding high ocean exploitation rates as two-year-old fish in inside waters. Tagging studies indicate these stocks migrate to Alaskan waters as maturing fish, and are taken in significant numbers in Alaska and northern troll fisheries, and off the northwest coast of Vancouver Island. Earlier runs are harvested at a lower rate, because they miss the terminal Fraser net fisheries for sockeye. They will probably benefit from delayed openings in Alaska and northern troll fisheries. These delays occurred in 1984, and may continue as a result of quotas imposed by the Canada/U.S. agreement. Earlier-running stocks have received the greatest benefits, since total terminal harvests have been cut in half, despite increased Indian food fish catches.

As might be expected, Upper Fraser chinook escapements have increased significantly since 1981 (Fig. 3.8-6), and are likely to continue increasing if interception rates in major hook-and-line fisheries are decreased. Early-running stocks will likely rebuild more quickly than mid-season stocks.

Thompson River Thompson drainage chinook stocks run in the middle of the season moving into the lower Fraser in late July and August. Major contributing stocks include:

Stock	Timing	Mean Escapement (1979-84)*
Clearwater (July 15/Aug. 30)	Middle	2,800
Finn Creek	Middle	846
North Thompson	Middle	1,733
Lower Shuswap	Middle	5,250
South Thompson	Middle	4,417
Nicola	Middle	3,308

* Preliminary data for 1984.

These are predominantly ocean-type fish which migrate to the sea in their first year. However, some runs (e.g., Nicola) are stream-type fish maturing at four years of age. Returns of wild fry tagged in 1978 indicate that these fish are heavily harvested in northern and Alaskan troll fisheries, but are also intercepted in Johnstone Strait and Fraser River net fisheries.

Chinook escapements to the Thompson drainage have been relatively constant over the last 30 years, averaging about 25,000 fish annually (Fig. 3.8-7). The failure of these stocks to rebuild in recent years despite the decrease of 25,000 (16%) in the average annual catch is cause for concern. It is likely that these stocks will respond to declining harvest rates in Alaskan and northern troll fisheries. Possible benefits from reductions in the Johnstone Strait fisheries may be reversed by increased Fraser River gillnet fishing for sockeye and pink salmon.

Tagging studies indicate that Harrison chinooks are harvested in very large numbers in the Georgia Strait sport and troll fisheries and off the west coast of Vancouver Island. Escapements to the lower Fraser increased during the 1960's and early 1970's (Fig. 3.8-8), but have decreased slightly in recent years in spite of a reduction of 16% in the terminal harvest rate. These stocks will benefit significantly from quotas in Georgia Strait and off the west coast of Vancouver Island.

3.8.1.5 Coho Salmon

Fraser River coho stocks can be conveniently divided into two main groups: the upper and lower Fraser River areas. The lower Fraser group consists of stocks that spawn in Fraser River tributaries downstream from Hope. The upper Fraser group consists of stocks that migrate past Hope and spawn as

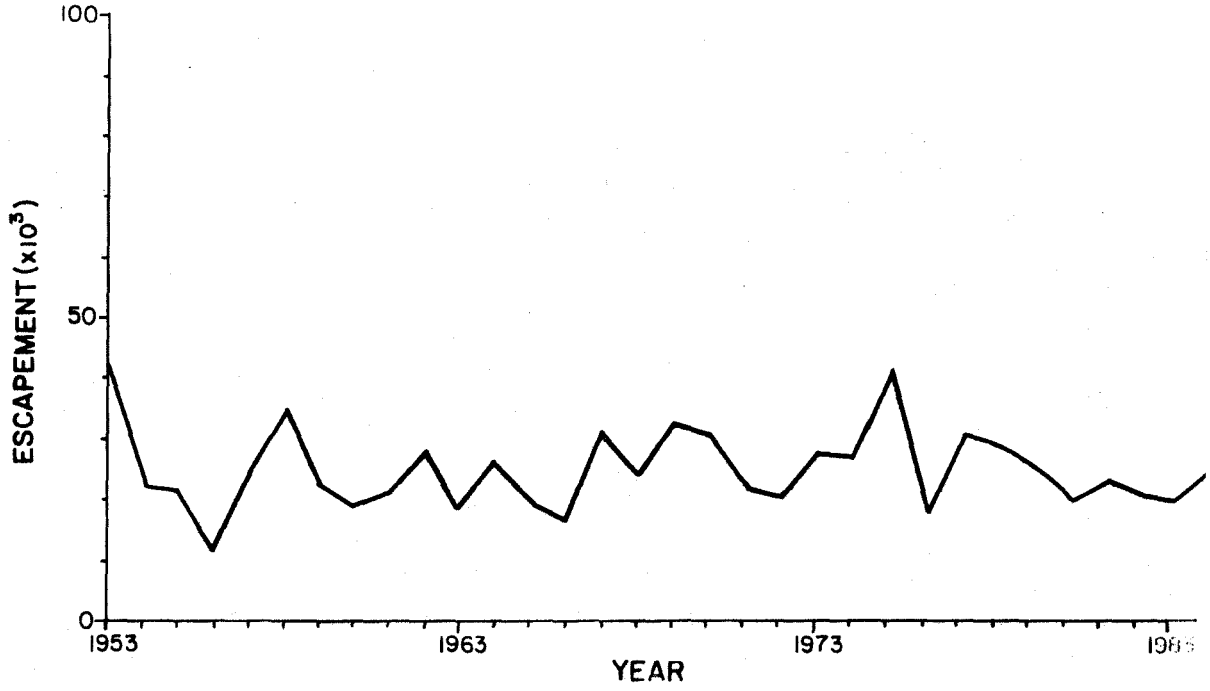


Figure 3.8-7. Total Thompson River chinook escapement.

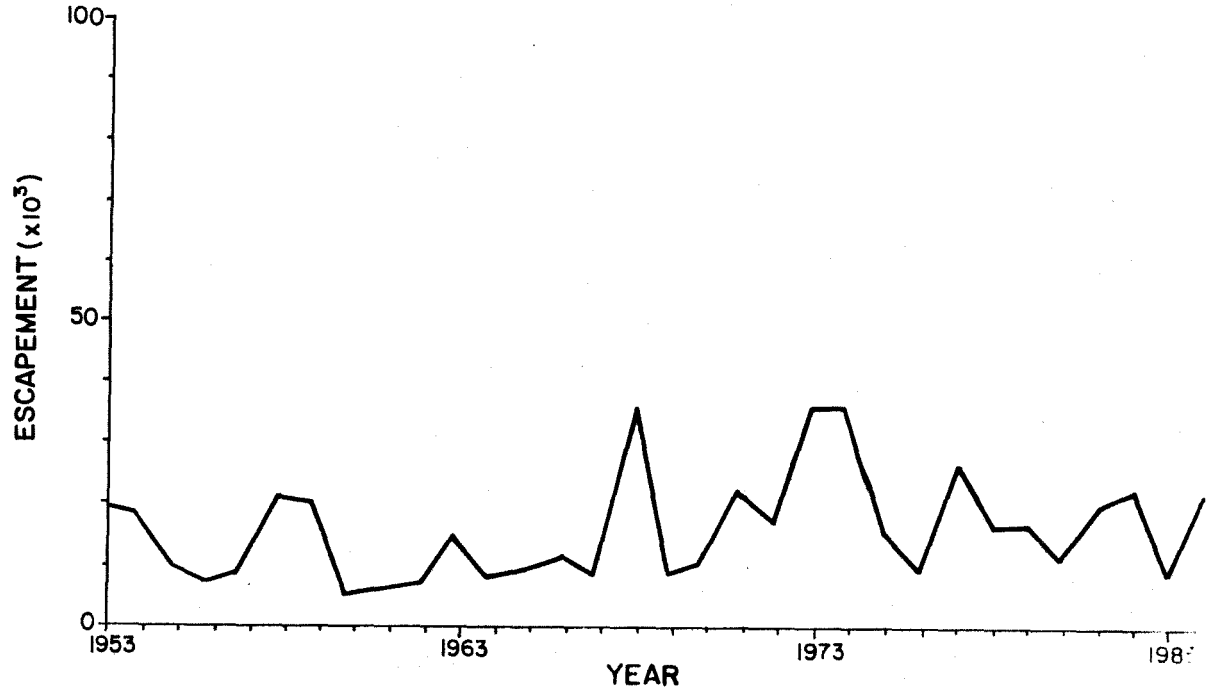


Figure 3.8-8. Lower Fraser River chinook escapement.

far upstream as the Quesnel River system, although the majority of spawning occurs in the Thompson system. These stocks are unique among Fraser River coho in that the escapement is composed almost entirely of adult salmon; precocious males have not yet been observed in any upper Fraser stock.

The timing of migration through the Fraser River is imprecisely known for specific stocks. They migrate through the Fraser River primarily between late August and mid-October, and are therefore vulnerable to commercial fisheries, the non-tidal sport fishery and the Indian food fishery. This may result in terminal harvest rates that are considerably higher for the upper Fraser stocks than for the lower Fraser stocks. A specific target escapement has not been developed for the upper Fraser stock; however, the stock is thought to be the most depressed component of the Fraser River coho resource.

Overall, Fraser River escapements have been erratic, but show a clear decline at rates of 1% per year since 1951, and 4% per year since 1970 (Table 3.8-6). Although a test fishery intended specifically to index Fraser River coho escapement has not yet been established, an index of coho abundance has been developed by combining coho data from the IPSFC sockeye test fishery (which generally ceases operation by mid-October), with coho data from the chum test fishery (which operates from early October through mid-December). This index confirms a significant decline in returns to the Fraser River, at least since 1970. While uncertainties in escapement enumeration and determination of the escapement level required for optimum yield preclude a full analysis of Fraser River stock status, these declines are cause for concern, and indicate that current escapements are well below the goal for Fraser River coho.

Since the Fraser River is the major contributor of coho on the West Coast, a more detailed stock description, organized by major river systems, is presented below.

Chilliwack River Coho spawn both in the Chilliwack River mainstem (1979-83 average = 4,400) and in a number of tributaries, the most important of which are Dolly Varden Creek (1,700), Post Creek (300) and Salwein Creek (500). Spawning also occurs to a limited extent in about 18 other tributaries, although the recorded numbers are usually less than one hundred in each. The total recorded wild spawning escapement to the Chilliwack River

Table 3.8-6. Trends in Fraser River wild coho spawning escapements as indicated by Fishery Officer estimates - 1970-1983. The hatchery component has been subtracted from total escapement figures and the results scaled to 1970 escapement = 1.00.

Year	Fraser River (Areas 28 & 29)
1970	1.00
1971	1.47
1972	0.64
1973	0.92
1974	1.90
1975	1.23
1976	0.56
1977	0.88
1978	1.12
1979	0.69
1980	0.65
1981	0.65
1982	0.73
1983	0.79

averaged 7,600 from 1979-1983, less than half the 1951-1960 average of 17,500. The time of spawning for different stocks ranges from October to January or February. CWT returns suggest that the major fisheries catching Chilliwack River coho are the Georgia Strait sport fishery, Georgia Strait and South West Vancouver Island troll fishery and Washington net fisheries. Smaller but still significant catches are taken by other troll fisheries as far north as the central coast in various net interception areas and by the Fraser River Indian food and sport fisheries. Annual variations occur in the proportions taken in the various fisheries.

Harrison River The Harrison River watershed supports a substantial coho resource, which has had an average spawning escapement of 13,400 from 1979-1983. Average escapements have changed little since the 1950's, although annual fluctuations have occurred in the estimates. Stocks can be roughly divided into populations spawning in tributaries of the Harrison River and Harrison Lake, and populations spawning in the Lillooet River and tributaries above Harrison Lake.

Of the Harrison River and Harrison Lake coho, the largest spawning populations occur in the Chehalis River (1,200 average for 1979-83), Harrison River (900) and Weaver Creek (900). The Chehalis and Weaver populations have declined drastically from the 1950's (6,100 and 1,900, respectively). There is no information on the Harrison population in the early years. Small numbers of coho (usually less than 200) also spawn sporadically in a number of other tributaries.

The major populations of Lillooet system coho spawn in the upper Lillooet River (1979-83 average = 3,900) and Birkenhead River (2,500). The Lillooet River escapement is increasing, probably as a result of recent increased effort in spawning enumeration. The Birkenhead average has decreased slightly. A major coho population was observed in the lower Lillooet River for the first time in 1982 (2,000 spawners), and the Sloquet River has occasional estimates of large populations (e.g., 3,600 in 1982). About ten other tributaries in this area support small coho populations.

Information on the catch distribution of Harrison system coho is currently limited to preliminary CWT data from one year for Birkenhead coho. These

data indicate a distribution similar to that of upper Pitt River coho, with relatively low catches within Georgia Strait and higher catches in the southwest Vancouver Island troll fishery in particular, and in the northwest Vancouver Island troll fishery. There appears to have been a general movement of coho outside of Georgia Strait in 1983 and 1984, so CWT data may not be representative of the long-term situation.

Miscellaneous Lower Fraser Tributaries Coho escapements to miscellaneous tributaries in the lower Fraser averaged 12,400 from 1979-1983, similar to the estimates of the 1950's and 1960's but lower than the 20,700 average for the 1970's. The tributaries entering the north side of the Fraser River below Hope currently support an average of 8,700 coho. The most important population spawns in the upper Pitt River with an average (1979-1983) of 4,400 (Table 3.8-7) and a maximum of 35,000. Tributaries discharging into the south side of the lower Fraser have supported a recent average of 3,700 spawning coho. Estimates between 1977 and 1983 were based on either intensive "dead pitching" or counting fences and are considered to be more reliable than earlier estimates based on visual observations.

CWT data for upper Pitt and Salmon river coho provides information on their catch distribution. Compared to Salmon River coho, the proportion of upper Pitt River coho taken by troll fisheries outside of Georgia Strait was higher while proportions taken by the Georgia Strait sport and troll were

Table 3.8-7. Coho escapements to lower Fraser River tributaries.

North Side Tributaries		South Side Tributaries	
Stream	1979-1983 Average	Stream	1979-1983 Average
Upper Pitt R.	4,400	Salmon R.	2,300
Alouette R.	800	Clayburn Cr.	200
Coquitlam R.	200	Elk Cr.	200
Kanaka Cr.	200	Nathan Cr.	600
Silverdale Cr.	100	West Cr.	100
Stave Cr.	100	Yorkson Cr.	100
Widgeon Cr.	400		
Whonnock Cr.	200		
Hicks Cr.	400		
Inch Cr.	100		
Norrish Cr.	300		
Siddle Cr.	500		
Nicomen Slough	600		

lower (about 1/3 by troll and 1/2 by sport fisheries). Other fisheries catching significant numbers of coho from these two stocks include net fisheries in Johnstone and Juan de Fuca straits, the Fraser River and Puget Sound and troll fisheries up to the central coast. There is probably also some harvest by the Indian food and sport fisheries.

North Thompson: The North Thompson River supports 4,600 coho (1979-1983 average), fewer than in the 1950's (6,300) or the 1970's (6,800). Coho are reported regularly from about 20 North Thompson tributaries. The most important of these include Albreda (average 500), Barriere (700), Blue (400) and Clearwater (200) rivers and Dunn (400), Lemieux (300), Lion (700) and Louis creeks.

Preliminary estimates from one year (1981 brood) of CWT data for Lion, Lemieux and Wirecache creek stocks indicate that the majority of these fish are caught by the southwest Vancouver Island troll fishery, with much smaller proportion taken by the northwest Vancouver Island troll and Georgia Strait sport fisheries. The Georgia Strait troll fishery and the net fisheries took few North Thompson River coho. The apparently high proportion of coho migrating outside of Georgia Strait in 1983/1984 may have provided an unusual catch distribution.

South Thompson The South Thompson River supports 4,700 coho spawners (1979-1983 average); less than half the 1951-60 average of 10,900. The major tributaries with coho stocks are Eagle (1,400), Salmon (1,200), Lower Shuswap (400) and Middle Shuswap (400) rivers. Approximately 15 other streams support the remaining coho populations. At present no specific information on the catch distribution of South Thompson River coho is available.

Miscellaneous Upper Fraser Tributaries This group includes tributaries of the Thompson mainstem as well as streams discharging into the Fraser between Hope and Lillooet. Escapements have apparently declined from an average of 6,200 in the 1960's to 2,000 from 1979-1983. The Nicola River and tributaries are the major producers of the lower Thompson with a recent average of 400 spawners, a major decrease from the 1950's and 1960's, when estimates of 3,000 - 4,000 were recorded. In the area from Hope to Lillooet, there are

about seven streams where coho are recorded regularly. The most notable of these are Bridge River (300) and Gates River (1,100). There is no information presently available on the catch distribution of these coho.

Boundary Bay Three streams discharging into Boundary Bay support significant runs of coho: Little Campbell, Nicomekl and Serpentine River. Current escapements average 4,500 annually and while there have been marked fluctuations since the early 1950's, no trend is apparent. The Little Campbell River currently supports the largest population (2,100) followed by the Serpentine with 1,600 and the Nicomekl with 1,200. A small hatchery has recently been established on the Little Campbell River to culture coho, chinook and steelhead.

3.8.2 Current Enhancement Activities

3.8.2.1 Sockeye Salmon

There are four significant enhancement projects for Fraser River sockeye. These include three spawning channels at Weaver Creek, Gates Creek, and Nadina River; and an incubation channel at Pitt River. In full operation these facilities should produce 835,000 adults on the average, although the total could be much higher in some years, for example Weaver Channel alone produced a run of over 900,000 in one year. Weaver and Pitt facilities produce approximately the same numbers every year, whereas Gates and Nadina channels currently have significant production for only two of the four cycles.

3.8.2.2 Pink Salmon

Table 3.8-8 shows pink production for Fraser River enhancement projects. There are currently three spawning channels and a gravel box simulation project for pink salmon in the Fraser River. A small channel on Jones Creek in the lower Fraser was first operated in 1955 to compensate for loss of spawning grounds resulting from a hydro-electric development. The spawning channel on Jones Creek has produced odd-year pinks since 1955 and accommodates 2,100 adults. While there has been no direct measure of yield through mark-release/recovery studies, and pink populations are lower than recorded prior to hydro-

Table 3.8-8. Production capacity of Fraser River pink and chum enhancement facilities (based on SEP biostandards).

Facility	Production Capacity: Juveniles Released	Production Capacity: Adult Production	Target Stocks - 1984
Pink			
Jones	700,000	20,000	Jones
Alouette	500,000	12,500	Harrison transplant
Total Pink	1,200,000	32,500	
Chum			
Chehalis	10,080,000	201,000	Harrison, Weaver, Squakum, Chehalis
Chilliwack	3,000,000	60,000	Chilliwack
Inch	5,760,000	115,200	Stave, Blaney, Inch
Chehalis	625,000	5,000	Harrison
Alouette	1,000,000	20,000	Alouette
Hopedale	173,000	2,460	Chilliwack
Worth	451,000	6,300	Nicomen
Railroad	1,914,000	26,800	Nicomen
Peach	883,000	12,360	Chilliwack
Chilqua	248,000	3,240	Hatzic (Fraser)
Street	242,000	3,390	Chilliwack
Billy Harris	930,000	13,000	Harrison
Lt. Mountain	1,736,000	24,300	Harrison
Kanaka	80,000	640	Kanaka
Little Campbell	7,000	140	Little Campbell
Total Chum	27,131,000	493,830	

electric development on the stream, the channel has successfully maintained a moderate escapement level of approximately 2,000 fish.

The Alouette project produced pinks in 1983 and this work may be continued with the odd-year run in 1985. Pink eggs are incubated in gravel boxes then reared prior to release at the same time as wild fry migration. Due to poor success in rearing pink salmon in fresh water, attempts may be made to slow down development during incubation so that emergent fry timing will correspond more closely with wild fry timing.

The other two facilities, located on Seton Creek in the upper Fraser, went into operation in 1961 and 1967, to compensate for habitat loss associated with a hydro-electric project. The combined annual adult production from all three facilities is about 700,000. The magnitude of the enhanced production is relatively minor compared to the total production, and therefore does not affect harvest rates. Because of the increased productivity of pinks using the Seton Channel, over-escapements to Seton Creek occur regularly.

3.8.2.3 Chum Salmon

Table 3.8-8 shows the chum production from Fraser River enhancement projects. Two technologies are used for chum enhancement on the Lower Fraser. One involves incubation of naturally-spawned eggs in groundwater channels or improved side channels with voluntary emergence and downstream migration. Most channels in this area, with the exception of Alouette, are on the Vedder or Harrison systems. The Chehalis CEDP facilities use a variation of this technology and consist of gravel pits containing groundwater into which eggs are planted manually. Again migration is voluntary. The second major technology is the so-called Japanese hatchery method, the key features of which are incubation and rearing in groundwater with resultant release of fry that are two or three times larger than wild fry at normal fry migration dates. Expectations are that rearing will at least double survival rates from release to return.

All major chum stocks on the Lower Fraser are being enhanced with the possible exception of the mainstem stock whose strength remains unknown. Two

major hatcheries (Chehalis and Inch) were designed to deal with several stocks. Chehalis in particular has produced a multitude of production lots of not only separate stocks but also run-timing segments within each stock. It is hoped that escaping hatchery chum will distribute themselves and spawn naturally in their native streams rather than flood into the hatcheries. At Chilliwack, where fry are released directly from the hatchery, distribution of marked spawners will be monitored over the next year or two. If disproportionate numbers return to the facility, release strategies will be revised with transport of fry to river spawning areas for release. At Chehalis, it is considered that some natural spawning grounds could be over-used if all hatchery-produced fry were released into their native stream. Thus, enough Weaver and Squakum fry are returned to these streams to provide optimum spawning numbers in three and four years hence (considering wild spawning levels), while the balance of these stocks is released directly from the hatchery. The assumption that release site will dictate return site is being tested through marking studies.

Combined Lower Fraser/Georgia Strait chum enhancement production capacity is approximately 1,500,000. These fish could be harvested in Johnstone Strait, in terminal fisheries along Georgia Strait, in the mouth of the Fraser, or at the hatcheries. With mixed-stock fishing problems in mind and the possibility of alleviating these problems through enhancement of specific segments of each stock's timing, SEP has differentially marked fry which were progeny of groups which differed in run timing within a stock. From past adult tagging studies, it is possible to predict that eggs spawned in late November will yield fish migrating through Johnstone Strait in late October. If the returns of marked fry indicate that run timing of chum salmon is hereditary (as is the case for coho), and if times when low exploitation rates in Johnstone Strait or the Lower Fraser can be identified, i.e., when fishing will not significantly affect wild chum salmon, it may be possible to direct most of the Georgia Strait/Fraser chum enhancement efforts to produce fish harvestable in traditional mixed-stock fishing areas.

3.8.2.4 Chinook Salmon

Upper Fraser River Table 3.8-9 lists the production capacity for chinooks at facilities in the Upper Fraser area. Two basic approaches are

taken in Upper Fraser enhancement efforts. The first is to out-plant pre-migrant fish which are expected to over-winter either in the release stream or lower in the Fraser drainage. This is the strategy for the Penny project. The second approach is to release larger fish early enough in the year so that they will migrate to sea soon after release (migrant releases). Releases from Quesnel and Fort St. James are assumed to behave in this manner. Survival is felt to be much greater for migrant releases.

Quesnel was designed as a central hatchery with the capability of enhancing several stocks each year. However, Slim Creek chinook eggs have not been taken during the past two years, since the stock was considered strong. More emphasis has been placed on the MacGregor stock. Studies at Quesnel have included analyses of optimum release time and size at release, release strategy, and the inheritability of flesh colour. Penny and Fort St. James were both initiated as pilot projects to assess feasibility of fish culture in available water supplies with low temperature and high iron content, respectively. Production has also provided an opportunity to assess post-release survival and homing relative to release characteristics.

Very little is known about the life history of Upper Fraser chinook stocks. In particular, the relationship between stream-type vs. ocean-type behaviour, the rearing areas for juveniles and migrational behaviour are all unknown (some stocks may utilize several rearing areas sequentially). Upper Columbia River hatchery production, especially in Idaho, might provide insights applicable to Upper Fraser chinook enhancement; however, the Idaho program has produced few returns, and useful conclusions cannot be made. No data are yet available with which to assess the contribution of Upper Fraser chinook facilities.

Thompson River Table 3.8-10 lists the production capacity of facilities found in the Thompson River area. The basic assumption for chinook enhancement in the Thompson drainage is that the stream rearing area is not fully utilized; therefore, all releases are of pre-migrants into selected areas. Eagle, Clearwater, Spius and Shuswap are pilot hatcheries; all except Shuswap were designed to handle several stocks, with target stock eggs imported to the hatchery and fry returned to the source. Thompson chinook life history is poorly understood; the pilot hatcheries were designed to produce enough fish

Table 3.8-9. Production capacity of Upper Fraser chinook enhancement facilities (based on SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Quesnel	1,730,000	38,800	Quesnel, Bowron, Cariboo, Horsefly, Indian Pt., Naziec, Baezaeko, William, Cotton, MacGregor
Fort St. James	170,000	5,700	Stuart
Penny	150,000	1,125	James
Total	2,050,000	45,025	

Table 3.8-10. Production capacity of Thompson River chinook enhancement facilities (based on SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Eagle	1,000,000	13,000	Eagle, Salmon
Clearwater	1,000,000	19,000	Clearwater, Raft, Finn, Lemieux
Spius	800,000	13,000	Spius, Coldwater
Shuswap	80,000	1,800	Shuswap
Loon	150,000	3,300	Bonaparte, Deadman
Kingfisher	70,000	350	Lower Shuswap River
Total	3,100,000	50,450	

to allow statistically valid mark-release/recovery studies. Studies are planned to examine survival at different dates and sizes of release (including small yearling smolt releases); survival at different planting densities and sites, and the effect of release strategy on homing. Also, interactions between wild and hatchery fry during freshwater rearing are expected to be examined.

Lower Fraser River Table 3.8-11 lists the production capacity for chinooks of facilities in this area. Enhancement activities in the Lower Fraser area have dealt primarily with the production of Harrison River chinooks at the Chehalis and Chilliwack hatcheries. The objective of the program was to provide a high-quality freshwater (and possibly gillnet) fishery. The current "90-day smolt" release strategy has been successful. On the other hand, the same strategy has not been successful for Birkenhead stocks. As a result, various release strategies are now being used at Birkenhead in an attempt to increase post-release survival. The Little Campbell River flows directly into Georgia Strait. The Little Campbell releases are pre-migrants, but most likely smolt as sub-yearlings. One point of interest is that many marked adult chinook captured in the Little Campbell originate from U.S. hatcheries.

3.8.2.5 Coho Salmon

Tables 3.8-12 and 3.8-13 list coho enhancement activities in the Lower Fraser area and the Thompson area, respectively. These areas are further partitioned into the major drainage units, and are discussed separately below.

Chilliwack Coho enhancement activities in this area include a major facility at Chilliwack, and a Public Involvement Program at Center Creek. Both smolt and pre-migrant fry are released into the watershed. The Chilliwack Hatchery is designed to draw brood stock from major tributaries including the Upper Chilliwack River (Dolly Varden Creek). It is intended that production releases in these systems will return escapements to optimal historic levels by release of fry (in most cases), or of smolts in the case of Dolly Varden Creek. Most of Dolly Varden Creek is in the U.S. and is inaccessible to fry plants. Most smolts will be released from the hatchery.

Table 3.8-11. Production capacity of Lower Fraser chinook enhancement facilities (based on SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Birkenhead	180,000	4,000	Birkenhead
Chehalis	2,160,000	64,800	Harrison
Chilliwack	1,440,000	43,200	Harrison, Chilliwack
Little Campbell	36,000	170	Little Campbell
Stave	50,000	240	Harrison transplant
Total	3,866,000	112,410	

Table 3.8-12. Production capacity of coho enhancement facilities in the Lower Fraser drainage (based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
Birkenhead	25,000	3,800	Birkenhead
Chehalis	507,000	75,000	Weaver, Chehalis, Harrison Coho, Squakum, Evans, Hicks/ Maria
Chilliwack	2,040,000	306,500	Dolly Varden, Post, Salwein
Inch	288,000	43,000	Inch, Nicomen, Fiddle, Norrish, Blaney
Alouette	100,000	15,000	Alouette
Brunette	34,000	5,100	Brunette
Centre Creek	100,000	1,500	Chilliwack
Kanaka	97,000	1,455	Kanaka
Little Campbell	81,000	1,215	Little Campbell
TOTALS	3,272,000	452,570	

Table 3.8-13. Production capacity of coho enhancement facilities in the Thompson drainage (based on SEP biostandards).

	Production Capacity		Target Stocks
Facility	Releases	Returns	1984
Eagle	750,000	30,000	Eagle, Salmon
Clearwater	500,000	18,000	Lion
Spius	600,000	23,000	Coldwater
Barriere	175,000	4,125	Dunn, Lemieux, Fenne
Louis Creek	200,000	3,000	Louis
Kingfisher	40,000	600	Lower Shuswap
TOTALS	2,265,000	78,725	

Excess escapements to the hatchery will be either harvested at the rack or used to establish a hatchery production stock. Adult returns to Chilliwack in 1983 offered the first useful data for assessment of Lower Fraser River coho enhancement. Survival rates were slightly below those projected. In addition, the return data provided new insights into homing success as a function of release strategy. These returns also made a very successful sport fishery possible.

Harrison Coho stocks are enhanced in this area by a central satellite facility on the Chehalis River, and a small-scale facility (primarily for chinooks) on the Birkenhead River. Like Chilliwack hatchery, Chehalis hatchery is designed to draw brood stock from major tributaries and rivers in the Harrison area, and provide smolt releases at a level that will re-establish optimal historic production levels. All excess escapements to the hatchery will be either harvested at the rack or used to establish a hatchery production stock. The enhancement of the Birkenhead coho stock was initiated in 1983 primarily to assess the migration route and harvest area of an upriver coho stock.

Miscellaneous Lower Fraser Area Additional coho enhancement in the Lower Fraser River is primarily based on releases of yearling smolts. Pre-migrant fry releases are conducted by PIP at Kanaka Creek. The Inch Creek facility, like the other major facilities in the Lower Fraser area, is designed to draw brood stock from the Alouette River to the Harrison area. The objective of production releases in these systems is to enable the production to return to optimal historic levels, with excess escapements being harvested at the rack or used to establish a hatchery production stock.

North Thompson Area Enhancement in this area is based on the assumption that coho stocks require rebuilding, and that stream rearing area is not fully utilized. The Clearwater pilot hatchery was designed specifically for experimental studies on optimal rearing and release strategies, and on the impact of hatchery fish on wild production. Relevant studies are similar to those performed on chinooks, and include the following:

1. Size and time of release studies in which the major interest is pre-

migrant release of small fry, not possible without cold water supplies;

2. Determination of natural rearing capacity in order to establish planting densities that saturate available habitat;

3. Post-release rearing and migrational behaviour studies;

4. Effects of hatchery released fish on wild juveniles (e.g., predation and displacement of wild fry by hatchery fish); and

5. Maximizing genetic contribution of returning hatchery adults to wild stock reproduction.

Studies proposed for 1985/86 address all of the above items. It should be pointed out that this work is co-ordinated with production plans of the Barriere and Louis Creek CEDP facilities, and that work will be required for several years. One major difficulty in studying interactions between hatchery and wild stocks and in determining optimal release strategies at Clearwater is that there are no cold water supplies in the area.

South Thompson Area This area includes major experimental pilot facilities on the Eagle and Shuswap River systems. In addition, a small community project utilizing a Shuswap coho stock is operating on Kingfisher Creek, a tributary of the Shuswap. The facilities in this area are operating with the same experimental priorities outlined above for North Thompson. No adult return data are yet available, since the first releases of juveniles occurred in 1984.

Miscellaneous Upper Fraser/Thompson This area includes a major experimental pilot facility on Spius Creek in the Thompson drainage and minor coho production at the large chinook project on the Quesnel River. The Spius facility is performing similar research to that conducted by the Clearwater pilot hatchery. Enhancement studies of coho at Quesnel are designed to assess migration and harvest data for an upriver coho stock. McKinley Creek coho are one of the few coho stocks above the Thompson River confluence.

3.8.3 Fisheries

3.8.3.1 Sockeye Salmon

Fraser sockeye are caught in coastal waters as they approach the river on their spawning migration, as well as in the river itself. Relatively small catches are taken by net fisheries in Areas 1 and 2W and, in some years at least, in the Alaskan fishery at Noyes Island. The principal catches in the south are made by the troll fishery off the west coast of Vancouver Island; Johnstone Strait net and troll fisheries; Juan de Fuca net and troll fisheries (the Fraser River and nearby Georgia Strait waters); and the U.S. net fisheries in northern Puget Sound and off Point Roberts.

The catches and proportion of catches taken by the major fisheries are summarized in Table 3.8-14 with early- and late-running stocks shown separately. The major late-running stocks include Adams, Lower Shuswap and Weaver; early-running stocks include most of the remainder. Early stocks tend to be taken in proportionately greater numbers in the Fraser River commercial gillnet and Indian food fisheries than are late stocks. The latter contribute more to troll fisheries than do early sockeye. Recent increases in the diversion rate through Johnstone Strait have led to substantially higher catches of up to several million sockeye in that area in some years.

The past management approach depended on whether the fisheries were situated inside or outside of Convention waters. Fisheries within Convention waters have been under the jurisdiction of the IPSFC, who were also responsible for setting escapement goals. The IPSFC generally managed with the goal of producing target escapements of individual major stocks. Minor stocks tended to be passively managed, and the less productive ones were sometimes overharvested in fisheries for other stocks. The escapement goals established for individual stocks differed between cycles in order to take variations in abundance and productivity into account. Cyclic differences in abundance of the major stocks also altered fishing patterns from one cycle to another. The IPSFC relied on a well developed management system consisting of a series of strategically-placed test fisheries within Convention waters, coupled with stock separation. Separation was based on migratory timing and scale characteristics, and provided information on the abundance of individual stocks at various points along the migration routes. This information was

Table 3.8-14. Average catch and percent of early- and late-running Fraser River sockeye by major fisheries from 1970 to 1982 (numbers are in thousands of fish).

Run Timing	Johnstone* Strait	West Coast Troll	Juan de Fuca Strait	Fraser River Area	U.S. Net	Indian Food Fishery
Early						
Catch	666	178	461	643	1,075	221
%	20.50	5.50	14.20	19.80	33.10	6.80
Late						
Catch	552	261	376	202	593	26
%	27.30	12.90	18.60	10.00	29.30	1.30

* Includes Statistical Areas 11, 12, 13 and 16.

then related to harvest rate predictions and escapement goals to assist in the establishment of fishery patterns.

Canadian fisheries outside of the Convention Area are the responsibility of DFO. The general approach in these areas has been to fish according to total sockeye abundance rather than to manage individual stocks. On occasion, though, at the request of the IPSFC, harvest rates specific times have been decreased to protect selected stocks (e.g., closures in the Indian food fishery to protect early Stuart sockeye).

3.8.3.2 Pink Salmon

Commercial fisheries for Fraser River pinks use essentially the same areas as for Fraser sockeye. The troll fishery works off the west coast of Vancouver Island, in Juan de Fuca and Johnstone straits, in northern Puget Sound, and in the Strait of Georgia in the vicinity of the Fraser River. Because pinks deteriorate in quality as they near the Fraser, the majority are taken in the interception areas away from the river. Management of pink salmon within Convention waters has been the responsibility of IPSFC since 1957.

Canadian commercial catches of pinks have averaged 6,300,000 since 1973; two thirds of that is taken from non-Convention waters. The Convention area catch has been declining in recent years, causing the IPSFC considerable concern because it decreases their ability to manage the stock effectively. The high diversion through Johnstone Strait in 1983 resulted in a particularly large catch in that area (6,900,000). Catch outside the Convention Area was approximately 79% of the total catch in all areas. In years of normal diversion, the troll catch off the west coast of Vancouver Island has been very large with up to about 3,000,000 pinks taken. Fraser River pinks are managed to produce target escapements, with an ultimate goal of approximately 6,000,000 for the entire river. Unlike sockeye, individual stocks of Fraser pinks cannot be distinguished in the fisheries and therefore cannot be managed separately.

Pink salmon are of little interest to Indian food fisheries along the Fraser. The recorded catch, which averages about 50,000 per year, is largely

incidental. Many pinks are apparently discarded by the Indians. There is some sport fishing for pinks as they migrate toward the Fraser River, particularly in the Victoria area. Catch estimates are unavailable but are likely to be small relative to the size of the runs.

3.8.3.3 Chum Salmon

See Section 3.10.

3.8.3.4 Chinook Salmon

See Section 4.0

3.8.3.5 Coho Salmon

See Section 5.0.

3.8.4 Habitat Status

Tables 3.8-15 to 3.8-33 describe the habitat status for sockeye, pink, chum, chinook and coho salmon in the Fraser River system. For a description of the habitat tables, see Section 2.2.4.

3.8.5 Stock Rebuilding Potential

3.8.5.1 Sockeye Salmon

The rearing capacity of Fraser River watershed lakes greatly exceeds that utilized by the current production of sockeye juveniles. Two possible exceptions are Shuswap and Chilko lakes which are more fully utilized by dominant cycle stocks. Approximately 45% of this unutilized capacity is in the Stuart River system, with additional large reserves in Francois, Quesnel and Adams lakes. There is therefore a considerable opportunity to increase production of additional fry to take advantage of the existing rearing capacity. In the years of dominant cycles, production of some stocks may be limited by the availability of spawning gravel. This appears to be the case for the late Stuart stocks, for example. There is also some evidence to suggest that

Table 3.8-15. Lower Fraser sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	150		

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 3

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most spawning is Upper Pitt River and Cultus Lake. Cultus Lake is mainly protected by Provincial Park status. Logging in Upper Pitt River drainage has created unstable conditions.
Current Status	Conditions are stable in Cultus Lake, and logging is progressing further away from the valley bottom in Upper Pitt River.
Future Outlook	Good conditions are envisioned for Cultus Lake in future. Improved stabilization should result in Upper Pitt River.
Natural Habitat Production Potential	Fry rearing in Pitt Lake may exceed spawning capability of the system.
Improved Production Potential	None identified.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium	Medium	Medium	Unknown

CONCLUSION

Table 3.8-16. Harrison sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	95		80 (1981 cycle)

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 4

HABITAT NOTES

Historic Status, Production Constraints and Development History	Almost all spawning takes place in Weaver Creek, Weaver Channel, and Harrison River. Subject to periodic flooding, scouring and sedimentation from clear-cut logging.
Current Status	Probably increasing in stability.
Future Outlook	With attention focussed on habitat problems, improved conditions are likely.
Natural Habitat Production Potential	Probably near capacity.
Improved Production Potential	None identified.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium	Medium	Medium	Unknown

CONCLUSION Systems are probably increasing in stability. Weaver Channel clouds natural capability somewhat.

Table 3.8-17. South Thompson sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	1,600		

MANAGEMENT STYLE: Active X; Passive ____; Unknown ____

NUMBER OF STREAMS: 13

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most spawning in Adams River, South Thompson River, Shuswap Lake, Shuswap River. Most runs tied to Adams cycle. Most systems logged in past.
Current Status	Fairly stable. Adams River has protected status.
Future Outlook	Little future change on major systems. Increased habitat protection and co-operative management is likely.
Natural Habitat Production Potential	Upper Adams River could be brought to historic levels through plantings. Adams River at capacity.
Improved Production Potential	Lake rearing may be limiting, but no enrichment plans set as yet.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	Unknown

CONCLUSION System may be near capacity. Rebuilding effort will likely continue on Upper Adams stock. Lake enrichment feasibility unknown.

Table 3.8-18. Stuart sockeye (early and late runs) habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	500		

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 33

HABITAT NOTES

Historic Status, Production Constraints and Development History	System has limited spawning habitat and underutilized lake rearing. Logging: Moderate - heavy impacts.
Current Status	Most of drainage has silty soils which are susceptible to logging and road construction damage. Need better planning with habitat management to protect spawning habitat.
Future Outlook	Continued forestry and road construction. Increased habitat protection and liaison with logging companies is presumed.
Natural Habitat Production Potential	Few large producing streams. Small producers may be at capacity. Drainage may be near capacity.
Improved Production Potential	Lake fertilization, would probably need channel to produce more fry.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium	Medium	Medium	High*

CONCLUSION

* Despite the high escapement, habitat condition and potential are only rated Medium because of the problems with logging and road building on sensitive soils.

Table 3.8-19. Chilcotin sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	600		

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 2

HABITAT NOTES

Historic Status, Production Constraints and Development History	The drainage has undergone little developmental activity.
Current Status	Most habitats are in a natural state. Good.
Future Outlook	No damaging developmental activities are foreseen. Good.
Natural Habitat Production Potential	Probably near capacity at present.
Improved Production Potential	Lake enrichment has been suggested by SEP but plans are on hold.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	High

CONCLUSION The system is in good condition, with expected good conditions in the future. Lake enrichment could increase fry rearing capability.

Table 3.8-20. Northeast Fraser drainage sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	35		

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 1

HABITAT NOTES

Historic Status, Production Constraints and Development History	Bowron River. All spawning in Provincial Park. Little activity in watershed.
Current Status	Habitat secured by Park status. Fairly stable habitat and escapement.
Future Outlook	Good, continued Park protection.
Natural Habitat Production Potential	At historic high level.
Improved Production Potential	None known.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	Low	Unknown

CONCLUSION

Table 3.8-21. Nechako sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	350		

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 4

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging: Past log drive on Stellako River.
Current Status	Stable. Nadina Channel in production.
Future Outlook	Continued logging but at higher elevations. Increased stability at lower elevations with second growth.
Natural Habitat Production Potential	Probably at historic peak.
Improved Production Potential	None identified.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Low

CONCLUSION

Table 3.8-22. Quesnel sockeye habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	700		

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 2

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most spawning in lower reaches of Horsefly River. Logging in upper watershed. Temperature control dam on McKinley Creek (tributary).
Current Status	Fairly stable, presumed benefits from central dam.
Future Outlook	Continued logging, but at higher elevations. Improved stability is likely with second growth.
Natural Habitat Production Potential	May be near capacity.
Improved Production Potential	Fertilization of Quesnel Lake (on hold).

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	High*

CONCLUSION

* With Quensel Lake fertilization, fry rearing capacity could be increased.

Table 3.8-23. Lower Fraser pink habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands			

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 22

HABITAT NOTES

Historic Status, Production Constraints and Development History	Almost all spawn in Fraser River (Chilliwack to Hope). Gravel removal, channelling and diking in the Lower Fraser, have been damaging to pink spawning.
Current Status	Habitat is improving in Lower Fraser with elimination of most gravel operations.
Future Outlook	Continued improvement is expected.
Natural Habitat Production Potential	May be near capacity.
Improved Production Potential	Low.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	Low

CONCLUSION Habitats are probably improving with elimination of gravel operations and increased stability after channelling.

Table 3.8-24. Chilliwack-Vedder pink habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	350		

MANAGEMENT STYLE: Active X; Passive ; Unknown

NUMBER OF STREAMS: 2

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging, dredging and resulting scouring have had severe effects on pink spawning.
Current Status	The system continues to suffer from periodic floods and scouring.
Future Outlook	Stabilization may take many years.
Natural Habitat Production Potential	Apparently habitats are underutilized by pinks, but improved stabilization is needed.
Improved Production Potential	None identified.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium	Medium	Medium	Unknown

CONCLUSION

Table 3.8-25. Harrison pink habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	650		

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 4

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most spawning is in Harrison River. Subject to periodic scour and sedimentation from dredging.
Current Status	Stability is probably increasing.
Future Outlook	Will depend on co-operation with transportation interests on Harrison River.
Natural Habitat Production Potential	Apparently habitat is underutilized by pinks.
Improved Production Potential	None identified.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium	Medium	High	Unknown

CONCLUSION

Table 3.8-26. Thompson River pink habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands			

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 1

HABITAT NOTES

Historic Status, Production Constraints and Development History	Mainstem spawning habitat in Thompson River below Savona has had little development impact.
Current Status	Natural state.
Future Outlook	May be some loss from CN Rail Twin Tracking but compensation is probable.
Natural Habitat Production Potential	Pink numbers appear to be increasing, and utilizing habitats progressively upstream. Habitats probably underutilized.
Improved Production Potential	None identified.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Unknown

CONCLUSION

Table 3.8-27. Seton-Anderson pink habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands			700

MANAGEMENT STYLE: Active X; Passive; Unknown

NUMBER OF STREAMS: 6 (including 2 channels

HABITAT NOTES

Historic Status, Production Constraints and Development History	Seton creek has been dammed for hydro power. Channels and fishway constructed as compensation. Controlled flows in channels.
Current Status	* Natural system has been radically changed by hydro dam.
Future Outlook	Good, with spawning channels and fishway.
Natural Habitat Production Potential	Unknown.
Improved Production Potential	Channels in place.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High*	High	Unknown	Channels in place

CONCLUSION

* Radically altered by power dam.

Table 3.8-28. Lower Fraser chum habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands			

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 47

HABITAT NOTES

Historic Status, Production Constraints and Development History	Major spawning systems are Harrison, Vedder, Sweltzer, Chilliwack, Chehalis. Development activities resulting in instability, flooding and scouring have had heavy impacts on chum spawning in most major spawning streams.
Current Status	Residual effects of past logging and channelling remain.
Future Outlook	Over the long term, stabilization will be reached.
Natural Habitat Production Potential	Probably return to near historic levels.
Improved Production Potential	None identified.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium	Medium	High	Unknown

CONCLUSION

Table 3.8-29. Lower Fraser chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	37		16

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS ____

HABITAT NOTES

Historic Status, Production Constraints and Development History	Settlement, agricultural, forestry and hydro development has had a low - moderate impact on chinook habitat. Historic high escapement post-dates most development activity. General water quality effects in lower river are unknown.
Current Status	Probably stable - development has probably peaked and is offset by renewed awareness of habitat value.
Future Outlook	Probably status quo, limited and better-controlled development.
Natural Habitat Production Potential	Probably return to near historic levels.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		Medium - High	Medium - High	Medium - High	Unknown

CONCLUSION Historic high (1973) post-dates much of the Lower Fraser development that could affect habitat.

Table 3.8-30. Upper Fraser chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	* 32		* 24

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS ____

HABITAT NOTES

Historic Status, Production Constraints and Development History	Logging in Upper Fraser has had a generally low impact on chinook habitat. There appears to be considerable unused quality habitat.
Current Status	Considerable unused, apparently suitable habitat.
Future Outlook	Long-range hydro-electric possibility on McGregor; otherwise modest logging with low impacts. No other significant impacts anticipated.
Natural Habitat Production Potential	Return to historic levels.
Improved Production Potential	Unknown.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	

CONCLUSION Habitat does not seem to be a constraint.

* Probably reflect more intensive census methods.

Table 3.8-31. Thompson River chinook habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	42		21

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS ____

HABITAT NOTES

Historic Status, Production Constraints and Development History	Forestry, settlement, agricultural and industrial activity in watershed has had low - moderate effect on overall habitat. Some "spot" problems; but not on a drainage-wide basis.
Current Status	Appears to be considerable unused habitat unaffected by any development.
Future Outlook	Probably status quo for habitat impacts. Good opportunity for co-operative management.
Natural Habitat Production Potential	Probably at historic levels.
Improved Production Potential	Unknown.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	

CONCLUSION Habitat is not a major constraint. Maximum escapement figures may not reflect historic high.

Table 3.8-32. Lower Fraser coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands	170		

MANAGEMENT STYLE: Active ; Passive X ; Unknown

NUMBER OF STREAMS: 96

HABITAT NOTES

Historic Status, Production Constraints and Development History	Forestry, agriculture and urban development have had low - moderate effects on coho habitat. Flow fluctuations, flood control pumps and water withdrawal have reduced summer rearing while channelling has reduced winter habitat.
Current Status	Development has probably peaked, but many residual impacts remain.
Future Outlook	Probably continuation of present condition with hopes for improvement through co-operative habitat management.
Natural Habitat Production Potential	Possible return to historic levels.
Improved Production Potential	Many opportunities for co-operative management and local restoration projects.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	Medium	Medium	Medium	Medium

CONCLUSION

Table 3.8-33. Thompson River coho habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
*			

MANAGEMENT STYLE: Active ____ Passive X Unknown ____

NUMBER OF STREAMS: 42

HABITAT NOTES

Historic Status, Production Constraints and Development History	Most systems have suffered from channelling and water withdrawal.
Current Status	Developments have probably peaked but residual problems remain.
Future Outlook	Probable continuation of current conditions, but better co-operative arrangements could result in improvements.
Natural Habitat Production Potential	Most potential is in N. Thompson where there are more tributaries with extensive wetlands for rearing.
Improved Production Potential	Many opportunities for co-operative management and restoration.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	High

CONCLUSION

* No data provided.

simply increasing spawning escapements for non-dominant cycles will not necessarily lead to greater returns. Two stocks that are currently being rebuilt at fairly spectacular rates through increasing escapements are Horsefly (1981 cycle) and Lower Shuswap (1982 cycle). Escapement to the Horsefly River has increased from 900 fish in 1941 to 677,000 in 1981, and escapement has almost tripled in the last two cycles. A very large spawning area is available although its capacity is unclear. The fact that 4,000,000 sockeye spawned there in 1909 suggests that it is substantial. Escapement of the last three cycles to the Lower Shuswap River increased dramatically from 29,000 in 1970 to 514,000 in 1982. The spawning area available is as great as in the Lower Adams River, which had an escapement of 2,100,000 in 1982, indicating that there is still substantial room for further growth of the Lower Shuswap stock. However, the rearing capacity in Shuswap Lake may be the main limiting factor to production.

The cyclic dominance of interior Fraser River sockeye is unique and has given rise to considerable debate as to its cause. The IPSFC has tended to manage the stock in a manner that maintains and reinforces the cyclic pattern. It was generally believed that the rearing lakes would not support large populations of sockeye juveniles in all years and that the highest average production would be obtained by maintaining the cycles. There is, in fact, some evidence to suggest that simply increasing spawning escapement for the non-dominant cycles will not necessarily lead to greater returns. However, sockeye systems outside of the Fraser produce substantial runs for all cycles, and some interior Fraser stocks have large production over more than one cycle (Chilko, for example). This suggests that greater production may be possible in non-dominant cycle years, at least for some stocks.

The optimum spawning escapements for individual salmon stocks are rarely known with any degree of certainty, and this is also true for Fraser sockeye. However, using the available stock recruitment data and measures of spawning gravel rough, estimates of the goals for each cycle are:

Cycle	Target (in millions)	Escapement in Most Recent Year (in millions)
1981	2.6	1.4
1982	4.0	4.0
1983	1.7	1.0
1984	1.0	0.9

For the 1981 cycle, a Horsefly River escapement of 1,500,000 is assumed. Given the recent growth pattern and available spawning area, this goal should be possible to achieve after a period of stabilization. Escapement goals of 2,000,000 for the Lower Adams and 1,000,000 for the Lower Shuswap stocks are set for the 1982 cycle. For the 1983 cycle, the greatest increase will come from the subdominant Lower Adams stock, where an escapement goal of 670,000 has been set. This may be compared to the actual 1983 escapement of 204,000. Greater escapements of early Stuart, late Nadina, Stellako and Birkenhead will also contribute to stock increases. Current escapements for the 1984 cycle are assumed to be close to optimum, with only relatively minor changes proposed with the exception of Birkenhead and Harrison.

3.8.5.2 Pink Salmon

There are large spawning areas for pink salmon available in the mainstem Fraser, Thompson and Nicola rivers and other tributaries. The IPSFC has suggested a spawning goal of 6,000,000. At an average return of 4.5 per spawner, an escapement of this magnitude would produce a run of 27,000,000 adults, about 11,000,000 more than the average of the last three cycles. This is virtually the same as the estimate of total abundance of pinks prior to 1913 (when the Hell's Gate slide reduced the run). Since recently increased escapements have led to higher catches, the goal of 6,000,000 seems realistic and may even be low. With runs as large as those seen recently, this escapement goal could easily be achieved in one cycle by simply reducing the exploitation rate. For example, for a run of 15,000,000, a 60% exploitation rate (instead of the present average 73%) would provide a catch of 9,000,000 and an escapement of 6,000,000.

3.8.5.3 Chum Salmon

See Section 3.10

3.8.5.4 Chinook Salmon

See Section 4.0.

3.8.5.5 Coho Salmon

See Section 5.0.

3.8.6 Management Conflicts

Management conflicts are described below on a species-by-species basis.

3.8.6.1 Sockeye Salmon

International Agreement While many Fraser sockeye stocks are currently being successfully rebuilt by the IPSFC, the overall rate of rebuilding is possibly somewhat slower than desired. Without a salmon interception agreement, there was a strong incentive for Canada to maximize the catch of Fraser sockeye outside of Convention waters. This was done at the cost of good management, and in some cases probably limited the ability of the IPSFC to achieve escapement goals. In addition, there was a high cost to other species as a result of excessive exploitation rates in Johnstone Strait. With an interception agreement, Canada has responsibility for establishing escapement goals, and can set the pace of rebuilding. In the early 1970's, Canada imposed a moratorium on the construction of new enhancement facilities for Fraser sockeye and pink salmon because of uncertainty with regard to the benefits for Canada.

Indian Food Fishery The Fraser River Indian food fishery has increased substantially in the past decade; catches in some years have exceeded 400,000 sockeye. The exploitation rate is extremely high for some stocks, particularly early-running stocks that migrate far upriver through a gauntlet of food fisheries. These fisheries cut potential spawning escapements in half in some years. In order to maximize the effectiveness of a rebuilding program, a more sophisticated management system for this fishery must be developed so that harvest rates can be tailored to stock-specific requirements.

3.8.6.2 Pink Salmon

As in the case of Fraser sockeye, lack of a salmon interception agreement with the United States has had some implications with regard to stock rebuild-

ing, although effects on pinks have not been as severe as on sockeye. During years of especially high diversion (e.g., 1983) the number of fish caught outside of Convention waters may have limited the ability of the IPSFC to achieve target escapements. In most years, however, greater escapements could be achieved by curtailing Convention Area fisheries. The practice of maximizing catches in Johnstone Strait outside of Convention waters also resulted in undesirable incidental catches of other species.

3.8.6.3 Chum Salmon

See Section 3.10

3.8.6.4 Chinook Salmon

See Section 4.0.

3.8.6.5 Coho Salmon

See Section 5.0.

3.8.7 Management Strategies for Stock Rebuilding

Several options for rebuilding stocks in the Fraser River area are described below, by species.

3.8.7.1 Sockeye Salmon

Reduction in Exploitation Rates Given the cyclic differences in spawning escapements and exploitation rates, it is tempting to advocate substantial reductions in exploitation rates to increase escapements in years of non-dominant cycles. However, as noted previously, there does appear to be some biological basis for maintenance of the cycles. In some cases where escapements of specific non-dominant cycle stocks have been increased, there has not been a resultant increase in production. While this may not hold for all stocks, it does suggest that a fairly cautious approach should be taken. Undoubtedly there are selected stocks where gains in production could be made through greater escapements, and these should be identified wherever possible. It may

be possible to lower exploitation rates over some time periods which would increase escapement for the affected stocks; however, the catch forgone from stocks currently producing to capacity will have to be evaluated. Before any significant changes are made in the management approach developed by the IPSFC, an exhaustive analysis of the available data should be undertaken.

With a salmon interception agreement with the United States, there is no longer be an incentive for Canada to maximize the catch of Fraser River sockeye and pink salmon outside of the Convention Area. This will allow the exploitation rate in Johnstone Strait to be reduced, thereby aiding the rebuilding of other species such as pink and chinook salmon. However, as there would be some transfer of effort to the Fraser River area to harvest sockeye forgone in Johnstone Strait, this would tend to put additional fishing pressure on chinooks and coho in that area. Some of the catch forgone in Johnstone Strait could be transferred to the Juan de Fuca Strait fishery resulting in higher exploitation rates in that area.

Exploitation by the Indian food fishery is currently high for some stocks; therefore, to assist in the rebuilding process this fishery should be more intensively managed and its harvest rate reduced as required to achieve escapement goals.

Enhancement Since many of the sockeye stocks have relatively low production in years of non-dominant cycles, natural stock rebuilding will be slow in these cases. To speed up the rate of rebuilding and, in a few cases, to equalize production over the cycles, it may sometimes be possible to utilize small incubation facilities such as portable, temporary hatcheries incubation boxes, and spawning channels to increase survival to the fry stage. In some areas, gravel improvement may be beneficial. The stock rebuilding exercise for Fraser River sockeye examined rebuilding potential; please refer to Section 3.8.8 for recommendations regarding opportunities for enhancement.

Information Requirements With a salmon interception agreement it will be possible to unify the management approach to Fraser River sockeye, and to achieve escapement and catch allocation objectives. As described previously, the IPSFC has a very sophisticated management system within Convention waters, and also conducts some sampling of fish caught outside of Convention waters for stock analysis. The goal should be to extend this type of system into

non-Convention areas, particularly Johnstone Strait and the west coast troll fishery. Within Johnstone Strait, test fisheries should be established at the upper and lower ends of the strait to evaluate the abundance of sockeye entering and leaving the area. A regular sampling program for sockeye should be initiated to provide scales for stock differentiation, age, and fish size for sockeye taken in the Johnstone Strait, west coast troll, and Area 2W fisheries.

3.8.7.2 Pink Salmon

The escapement goal of 6,000,000 set by the IPSFC could be easily attainable in the next cycle (1985) if the run is similar to that of recent years. The actual 1985 escapement goal is 5,000,000 with a predicted run of 16,000,000. In fact, 6,000,000 should be considered only as an interim target, since the real optimum is unknown. The implications of reducing the average harvest rate to increase spawning escapements should be thoroughly evaluated and discussed with industry.

3.8.7.3 Chum Salmon

See Section 3.10.

3.8.7.4 Chinook Salmon

See Section 4.0.

3.8.7.5 Coho Salmon

See Section 5.0.

3.8.8 Future Stock Enhancement Activities

Following is a description of future enhancement project that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

3.8.8.1 Tachie River Sockeye Spawning Channel (Project No. PG-18A)

The Tachie River supports a population of late Stuart sockeye which rear in Stuart Lake. A pilot spawning channel in the mainstem of the river is proposed, with future expansion if it proves successful. The production estimate for the Tachie River channel is relatively low (63,000 for the 1981/1985 cycle).

Late Stuart sockeye have a migration run which peaks in the lower Fraser River about the beginning of August. Chinook stocks such as Chilko, Shuswap and North Thompson would potentially be affected at this time. Production from the pilot phase of the Tachie channel project would not be of concern, but major expansion could cause impacts.

3.8.8.2 Fraser River Pinks Spawning Channels (Project No's. K-30, CH-11)

Two spawning channels for pink salmon are proposed in the Chilliwack River and the second in the Thompson River. The Chilliwack channel is a reduced version of a project originally proposed by the IPSFC in 1972. The site was prepared several years ago and is ready for construction of the channel. The channel would help to stabilize pink salmon production in the Chilliwack River. It could later be expanded to provide additional production if required. The Thompson River project is a side channel development which could also be expanded in the future if warranted. Total production would be approximately 350,000 adults, including 250,000 from Chilliwack and 100,000 from the Thompson River.

3.8.8.3 Chum Projects

Following are four small projects for production of chums:

Ryder Creek (Project No. CH-15) This proposal involves development of 1,000 square metre side channel for chum production by redevelopment of an existing channel. Estimated production is 4,000 adults.

Sweltzer Creek (Project No. CH-16A) This proposal involves gravel addition below the outlet of Cultus Lake. This area will be utilized by pink and chum stocks. Estimated production is 12,000 adults.

Nathan Creek (Project No. 29-7) This proposal involves a transplant of coho and chum is part of habitat rehabilitation project. A 100,000 egg incubation box will be used to produce the stock for transplanting. Estimated production is 1,000 adults.

West Creek (Project No. 29-8A) This proposal involves development of 1,000 square meter side channel for chum production (expansion of existing area). Estimated production is 4,000 adults.

3.8.8.4 Bonaparte River (Project No. K-32A)

The construction of a fence and the establishment of a trucking operation of Bonaparte chinook over an impassable obstruction is proposed. This project would make available 50 km of unused chinook rearing and spawning habitat. The expected production is estimated to be 7,000 adults. Dependent on egg-to-fry survival rates from the project it is estimated that it may take up to three cycles to build the available spawners to target escapement.

3.8.8.5 Small Coho Projects

These are a group of projects which are small in scale and embody both hatchery technologies and habitat improvements.

Project and No.	Type	Estimated Production
Avola (K-2)	Hatchery with stock being imported	2,000
North Thompson (K-4E)	Hatchery expansion at Dunn Lake	1,500
Finn (K-1B)	Habitat restoration	100
Louis (K-8B)	Habitat restoration and protection	200
Salmon River (K-24A)	Habitat restoration and protection	?
Deadman (K-31C)	Habitat restoration and protection	?
Nicola (K-33C)	Intakes screening	?
Iona Slough (29-12)	Estuary rehabilitation	1,100
Serpentine River (29-14)	Hatchery	10,000
Little Campbell River (29-15)	Obstruction removal	1,000
Hopedale Slough (CH-12B)	Habitat restoration	200
Chehalis (MH-8)	Spawning channel	400
Silverdale (MH-11)	Stream rehabilitation	400

The total production expected from this group of projects is approximately 17,000 adults. This expectation is only an estimate and must be corroborated by more detailed study.

3.9 Northern Transboundary Rivers

3.9.1 Taku River

The Taku River originates in northwestern British Columbia on the Stikine Plateau, flows southwest through the Alaskan Panhandle and drains into Taku Inlet 20 km east of Juneau, Alaska (Figure 3.9.1). It is formed by the merging of its two principal tributaries, the Inklin and Nakina rivers. The Taku River drainage area is approximately 16,000 km^2, 95% of which lies within Canada.

3.9.1.1 Stock Description

The Taku River produces all five species of Pacific salmon, which are harvested in several fisheries. There are several stocks of each species within the Taku system but separation of stocks is difficult since escapement data are inconsistent. Therefore, the system is managed based on species rather than specific stocks within the system. Most escapement estimates are based on percent harvest rate in the Alaska fishery. Virtually all spawning of chinook, sockeye and pink salmon is in Canada. Pink salmon stocks are the largest while sockeye is the most important run to the Taku River, followed by coho, chinooks, chums and pinks.

The five principal sockeye salmon stocks in the Taku River system spawn in Kuthai Lake and Silver Salmon River; Little Trapper Lake; Nahlin River; Taku River; and Tatsamenie Lake and Tatsatua River. Radio tagging studies conducted in 1984 suggest that the Little Trapper Lake stock arrives in the lower river in early July, while the other stocks arrives throughout July and August. Historically, 73% of the Taku sockeye salmon run are five-year olds, and 18% are four-year olds, and the remainder is composed of three-year and six-year old fish. Mean escapement of sockeye to the Taku system from 1971-1980 was estimated at 60,000. Recent escapements determined from mark-recapture studies have gradually increased from 42,400 (1981) to 130,600-165,500 (1983) and 106,100-114,800 (1984). Recent weir counts of sockeye at Little Trapper Lake were 7,500 in 1983 and 13,084 in 1984. Preliminary escapement goals of 80,000 and 71,000 have been set by Canada and the U.S., respectively; however, studies conducted in 1983 and 1984 have indicated that this may be low. Catch data also indicate an increase in sockeye salmon abundance. Mean

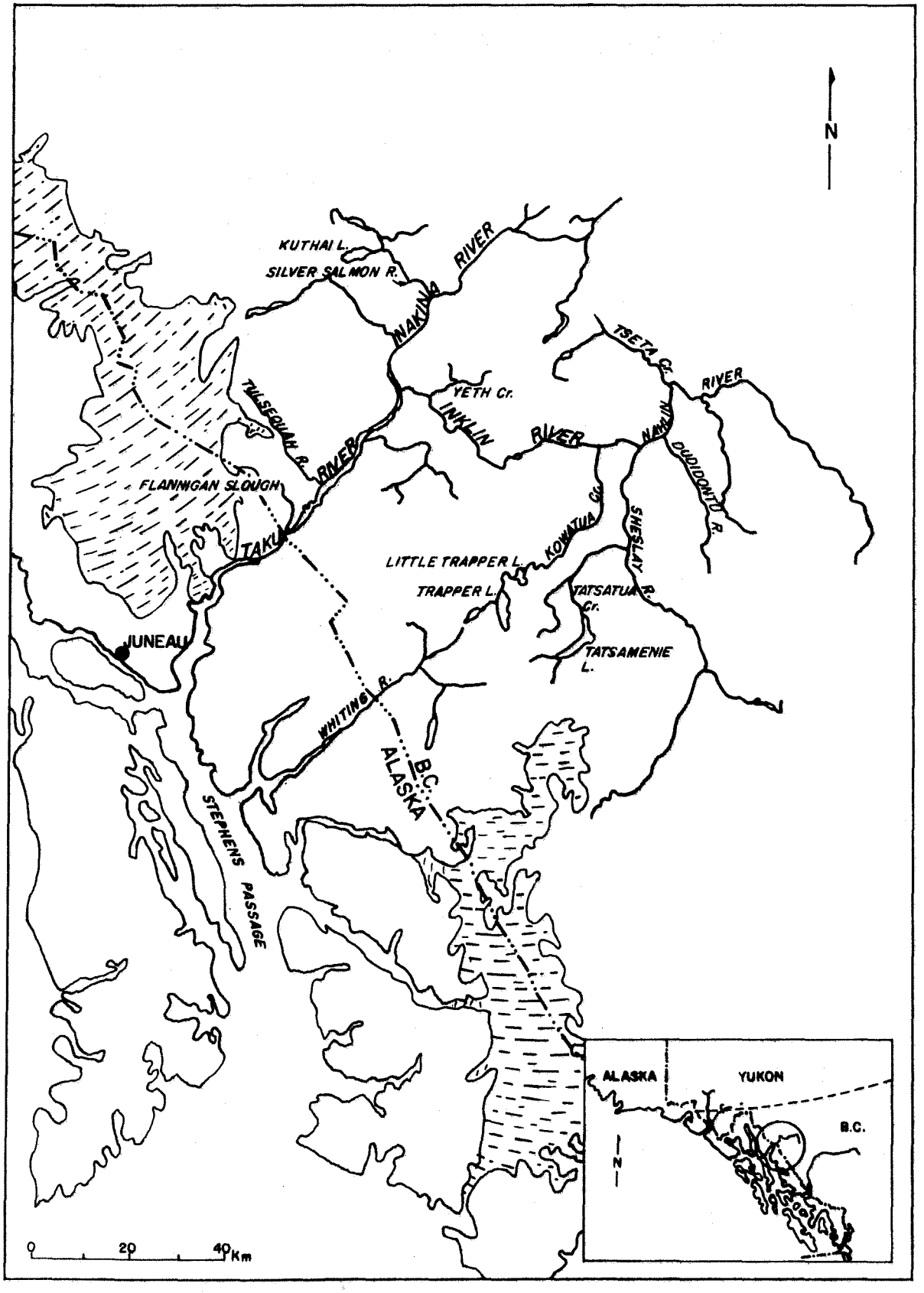


Figure 3.9-1. The Taku River.

harvest in District 111 (Alaska) has increased from 58,200 to 81,800 in the periods 1969-1978 and 1979-1983, respectively. Average harvest in the Canadian fishery was 16,000 from 1979-1983.

The highest escapements of pink salmon to the Taku system are the even-year Nakina River stock, which peaked at 250,000 in 1980. Smaller stocks are known to spawn in the Nakina River in odd years, and in the Taku River in both even and odd years. However, an unusually high odd-year escapement was noted in the Nakina River in 1983, although its actual size was not known. The mean escapement of pinks in the Taku system from 1971 to 1980 was roughly estimated to be 100,000. The 1984 escapement was estimated at 135,900 spawners. Escapements have generally been in the lower end of the preliminary escapement goal range of 150,000 to 250,000 fish. Catch data suggest that pink salmon are increasing; however, District 111 catches include interception of other pink salmon stocks. Mean catch of pink salmon in District 111 was 72,600 in 1969-1978 and 175,300 in 1979-1983. Canadian commercial harvest of pink salmon averaged 13,300 from 1979-1983.

The fall runs of chum salmon to the Taku River system have been significant but erratic. Summer chum runs are minor in size compared to fall runs. A few specific spawning areas in the system have been identified, including Flannigan Slough and other side channels and back sloughs along the mainstem Taku, especially opposite King Salmon River. Age structure of returning stocks is dominated by four-year old fish (74%) with the remainder returning as five-year olds. The mean escapement of chum salmon from 1971-1980 was 35,000. An escapement of 225,727 chums was estimated in 1981 from mark- and recapture studies. However, the 1982 and 1984 returns were very low, with below average catches and escapement estimates of only 20,000 in each year. There is no accurate target escapement set for Taku chum salmon because of historically poor escapement and catch data. A preliminary escapement goal objective of 50,000 to 80,000 has been set by the U.S. and Canada. Exploitation of chum stocks has increased slightly. Mean harvest in District 111 was 61,700 from 1969-1978 and 58,900 from 1979-1983. In addition to American catches, the Canadian commercial fishery harvested an average of 10,300 chums from 1979-1983.

Six stocks of chinooks are used annually as an index of total escapement to the system. The principal stock is in the Nakina River; and others are in the Kowatua, Tatsamenie, Dudidontu, Tseta and Nahlin rivers. Chinooks enter the river between late April and mid-June, prior to the arrival of most sockeye. The chinooks are primarily five- and six-year olds. The escapement record for chinooks is more extensive than for other species since aerial escapement counts and a carcass weir program have been conducted frequently since 1951. These records indicate a decline in escapements from 1951-1970 and an increase between 1971-1980. The mean estimated escapement from 1971-1980 was 8,000. The peak recorded escapement of 9,800 in 1981 was well below preliminary Canadian and U.S. management goals for the system (30,000 and 25,600 spawners, respectively). The mean catch of chinook salmon in District 111 has declined from 14,100 in the 1950's to 3,900 in the 1970's. However, recent management has been directed at minimizing chinook catches primarily through late openings. The District 111 fishery opens after most chinook salmon have entered the Taku River. The decline in catch therefore does not reflect changes in stock abundance.

Coho spawn primarily in the smaller tributaries of the Taku River drainage. Coho salmon arrive at the Taku River in August and are intercepted in the fall chum salmon fishery. CWT data in 1976 and 1977 indicated that Taku coho stocks contribute significantly to several fisheries, including the Alaskan terminal drift gillnet fishery and outside troll fisheries, and the Canadian in-river gillnet fishery. The mean estimated escapement to the Taku River from 1971-1980 was 30,000 spawners. Recent escapements have been near or above this level with estimates of 32,900 in 1981 and over 50,600 in 1984, within the range of 27,000-35,000 spawners identified as the preliminary escapement goal. Coho catches have been relatively stable. Mean harvest in District 111 was 35,600 from 1969-1978, compared to 27,000 from 1979-1983. An additional average of 6,100 coho salmon were harvested in the Canadian fishery from 1979-1983.

3.9.1.2 Fisheries

Taku River salmon stocks are presently managed by the governments of Canada and the U.S. The Alaskan fishery has operated for about 80 years, while the Canadian fishery has operated since 1979. The Alaskan District 111 gillnet fishery is managed to control catches of Taku and Snettisham stocks.

The Taku Inlet gillnet fishery (sub-area 111-32) is the last Alaskan interception fishery for Taku River stocks. The Canadian gillnet fishery occurs in the river from the U.S./Canada border to a point 19 km upstream. In addition to commercial fisheries, significant tidal and freshwater sport fisheries and a minor subsistence fishery located within Canadian sections of the Taku all take Taku River salmon.

The commercial gillnet fisheries are mainly for sockeye, coho and chum salmon. In the summer, the fishery is managed based on sockeye run strength whereas in the fall, it is managed based primarily on chum abundance. The terminal and in-river fisheries are managed to minimize interception of chinook salmon stocks. Restricted fishing times and delayed openings in the early part of the sockeye and pink salmon fishery minimize interception of chinooks, which arrive in the Taku between late April and mid-June, prior to peak arrival of the other fish species. During the fall chum salmon fishery, effort in the Alaskan drift gillnet fishery is frequently restricted to daylight hours to minimize coho salmon catches when low returns of coho are anticipated. The outside troll fishery poses the greatest threat to chinook and coho salmon; until recently this fishery has been relatively uncontrolled.

3.9.1.3 Current Enhancement Activities

Limited salmon enhancement activities have occurred in the Taku River system. Blockage removal by DFO in 1977 on the Nakina River has increased spawning distribution of pink salmon and provides easier access for chinook and sockeye to spawning areas.

Harvesting in Alaskan District 111 could be affected by four existing hatcheries in the vicinity. The Salmon Creek facility in Gastineau Channel was operated until 1984. A production of 30,000 adult coho is expected in 1985; however, many of those fish will be harvested in the mixed-stock troll fisheries prior to reaching the Taku Inlet and Gastineau Channel area. The Kowee Creek and Sheep Creek hatcheries in Gastineau Channel have a combined permit for 50 million pink and/or chum salmon eggs. Production capacity for pinks should be achieved in 1985 and 1986. Although Gastineau Channel offers a large terminal fishing area in which hatchery returns can be harvested without adversely affecting natural stocks, contributions of fish to the

District 111 gillnet fishery may be significant if chum production is expanded, or if the fleet fishes more intensely for pink salmon in future years.

The large state-operated Snettisham hatchery is located at the head of Speel Arm in Port Snettisham. The majority of the planned production of this facility will be summer-run chums; at capacity, an average adult return of 1,200,000 is expected. Most of these fish are expected to be harvested by the District 111 gillnet fishery. The management of the fishery in the Taku Inlet and Stephens Passage area will continue to be based on sockeye salmon and/or pink salmon run strength. This will require very careful monitoring in order to avoid over-exploitation of Taku sockeye. Speel Arm (and, at certain times, outer Port Snettisham) will be used as a terminal harvest area. The Snettisham facility will also produce chinooks and coho, many of which will be harvested by distant troll fisheries. Chinooks that return to Port Snettisham will be harvested in the terminal area once needs for brood stock are met. The returning coho will mix with natural Taku and Stikine river stocks, and the hatchery contribution rate will have to be carefully monitored through a CWT program to ensure that managers can maintain the wild stocks.

3.9.1.4 Habitat Status

A habitat summary for Taku River sockeye, pink, chum, chinook and coho salmon is presented in Table 3.9-1. For a description of habitat tables, see Section 2.2.4.

3.9.1.5 Management Conflicts

Conflicts discussed below include uncertainties in data, and problems related to mixed-stock fisheries.

Management Uncertainties Historical stock size estimates are poor for the Taku River system. Except for chinook salmon, escapement information is incomplete and provides no consistent base upon which to make annual comparisons. Stock composition of the commercial fishery catches in District 111 is just beginning to be examined. Stock separation started in 1983 with sockeye. In the mid 1970's, Alaskan fishing effort shifted from major seine fisheries in approach waters to terminal gillnet fisheries, thus compounding the

Table 3.9-1. Taku River salmon habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands			

MANAGEMENT STYLE: Active _____ Passive _____ Unknown _____

NUMBER OF STREAMS: *

HABITAT NOTES

Historic Status, Production Constraints and Development History	95% of watershed in Canada. A virtually pristine system. Natural turbidity.
Current Status	Pristine.
Future Outlook	Possible mining developments - low impacts.
Natural Habitat Production Potential	At historic level.
Improved Production Potential	Obstruction removal possibilities.

STATUS SUMMARY

Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
	High	High	High	Medium - Low

CONCLUSION Good example of historic stock declining despite pristine habitat with no impacts.

* General habitat notes. No stock data provided for stock rebuilding.

difficulties of determining stock trends based on catch. Interception of Taku stocks by other commercial fisheries is unknown, although it is suspected that there is significant interception of Taku chinooks and coho in the South East Alaskan troll fishery. Tidal and freshwater sport catches of Taku stocks are unknown. As a result of these uncertainties, run forecasting is poor, escapement requirements for the system are not accurately defined, and proper allocation schemes are difficult to derive and to enforce.

Mixed-Stock Harvest The Taku River salmon runs are harvested by mixed-stock fisheries. The terminal and near-terminal fisheries in District 111 harvest Taku, Speel and Whiting river stocks, and intercept chums and pinks migrating through Stephen's Passage to other systems. Chinooks and coho are also intercepted by outside troll fisheries. The contribution of the Taku salmon stocks to these mixed-stock fisheries is unknown.

3.9.1.6 Stock Rebuilding Potential

Stock rebuilding potential in the Taku system is difficult to assess since the escapement requirements and status of the stocks are poorly understood. The rebuilding concept is further complicated by the international aspect. The success of a rebuilding program will require full co-operation and agreement between Canada and the U.S.

Based on preliminary escapement objectives, a stock rebuilding program would target on all species except perhaps coho salmon. However, coho salmon stocks would require careful management to maintain escapement levels near the high end of the escapement range. Chinook salmon rebuilding has already been initiated by minimizing interception catches. A rebuilding program could increase sockeye and pink salmon production and stabilize chum salmon returns. As spawner-recruit relationships are identified, escapement goals may be refined.

3.9.1.7 Management Strategies for Stock Rebuilding

A variety of options are discussed below along with some consequences of their being adopted.

1. Expend More Effort on Estimating Reliable Escapement Data: The sockeye salmon in-river mark-recapture program initiated in 1981 should be continued and expanded to include coho, chum and pink salmon stocks. The spawning ground surveys for chinook and sockeye salmon should continue, since they would improve escapement estimates and provide data on age, size, sex characteristics and run timing. Radio telemetry studies which also began in 1984 should be continued to provide stock-specific information on timing, spawning distribution and migratory behaviour.

2. Estimate Interception Rates: Scale pattern analysis has proven to be an accurate method for separating Taku and Snettisham runs of sockeye salmon harvested in District 111. Additional work is required to determine if scale pattern analysis can be used to separate sockeye salmon stocks within the Taku River drainage. Electrophoretic studies should be continued to determine the possibility of identifying the contribution of Taku River chum and pink salmon to mixed-stock fisheries. Stock separation studies should be initiated for coho as well. Interception rates of coho and chinook salmon in various fisheries could be determined through reinstating the CWT program.

3. Refine Escapement Goals: Stock-recruitment relationships cannot be identified until the quality of escapement, catch and age data is improved over an adequate time period. However, an analysis of historical catch data and an assessment of potential spawning and rearing areas could help in refining escapement goals and planning management actions.

3.9.1.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

Ladder to Open Sockeye Access to Trapper Lake (Project No. T2) This lake is larger than Little Trapper Lake and potential spawning grounds may be

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

present. No cost estimate has been made, but the use of a steep pass may be possible. Additional research on potential spawning and rearing habitat in Trapper Lake is required. Predator/prey relationships vis a vis lake trout must be considered since there is a lake trout population present.

Increase Tatsamenie Lake Production Through Incubation Boxes, Fry Plants, and/or Lake Fertilization (Project No. T4) Sockeye currently reach this large lake, but production appears to be limited by a lack of suitable spawning area. Limnological studies and preliminary investigations of current sockeye utilization of the lake are needed.

Open Access to King Salmon Lake (Project No. T4) Sockeye have been recently documented in this lake, but outlet blockage currently limits access. Fry plants may be required to restore this run once access is improved. Stream rehabilitation would be relatively inexpensive, and should be contemplated soon before the brood stock disappears.

Open Sockeye Access to Small Lakes (Project No. T4) Kennicott and Hackett Lakes are currently blocked to salmon access by beaver dams. Sockeye, coho and steelhead utilize lower sections of the Hackett River; upstream spawning distribution is limited by beaver dams. Dam removal should be considered to increase sockeye access to these lakes.

3.9.2 Stikine River

The Stikine River originates in the Stikine Plateau of northwestern British Columbia and drains an area of 51,200 km^2. It flows for approximately 640 km before reaching the Pacific Ocean near Wrangell, Alaska (Figure 6.9.2). Approximately 95% of the Stikine drainage is located within Canadian territory.

3.9.2.1 Stock Description

All five species of Pacific salmon spawn in the Stikine River system. Harvest focuses on sockeye, coho and chinook salmon. Chum and pink salmon production is minor in the Canadian portion of the drainage. There are several stocks of each species within the Stikine system but separation of

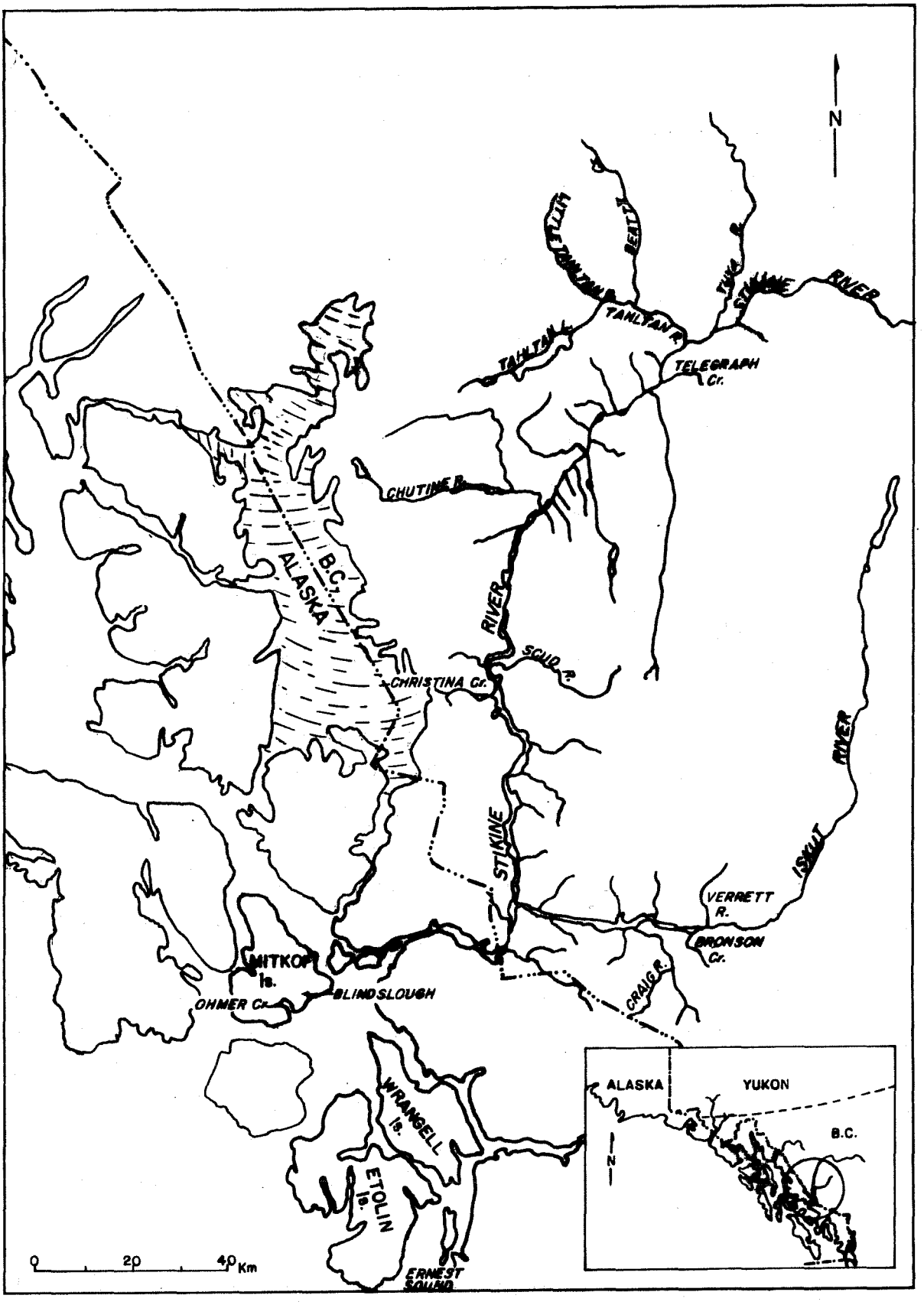


Figure 3.9-2. The Stikine River.

stocks is difficult since escapement data is inconsistent or lacking except for some index stocks of chinook and sockeye salmon. Therefore, management has been based largely on species rather than specific stocks within the system, with one exception: the largest and most important stock in the Stikine is the Tahltan Lake sockeye, which is managed as a stock.

Sockeye Salmon There are several sockeye salmon stocks in the Stikine River system. In 1984, 42 spawning areas were identified in aerial surveys. Presently, due to limited stock-specific data, Stikine sockeye are separated into two stocks, the lower Stikine and Tahltan Lake. Preliminary research indicates that these two stocks can be separated through differences in scale patterns, egg diameter and presence or absence of a protozoan brain parasite. Further analysis is underway to determine the possibility of identifying Chutine Lake and River, Scud River, Christina Lake, Iskut-Verrett and Iskut-Bronson stocks.

Escapement estimates for sockeye throughout most of the system have been limited. However, an enumeration weir has existed at Tahltan Lake since 1959. Stock separation studies have indicated that Tahltan Lake produces 40-60% of the Stikine sockeye. The weir counts show a steady increase especially for cycles which have traditionally been less abundant (Fig. 3.9-3).

This improvement is further evidenced by comparing the five year mean annual weir counts from 1960-1964 and from 1980-1984: 13,000 and 28,000 respectively. Mean sockeye escapement to the Stikine system was estimated at 33,000 from 1971-1980. However, this estimate was biased by the lack of information regarding contribution of the Tahltan. It was believed to be higher than stock separation is showing and therefore the escapement estimate would be low. Recent escapement to Tahltan Lake weir and the total Stikine system have been well above the average of the past decade, with estimates of 51,000 and 110,000 in 1981 and 32,800 and 83,100 in 1984, respectively, compared to the preliminary escapement goal range of 87,500 to 100,000 spawners.

Sockeye salmon catches in those commercial fisheries intercepting Stikine sockeye stocks (Alaskan Districts 106 and 108) have increased approximately 100% in the past three decades. Preliminary tagging studies conducted in 1983

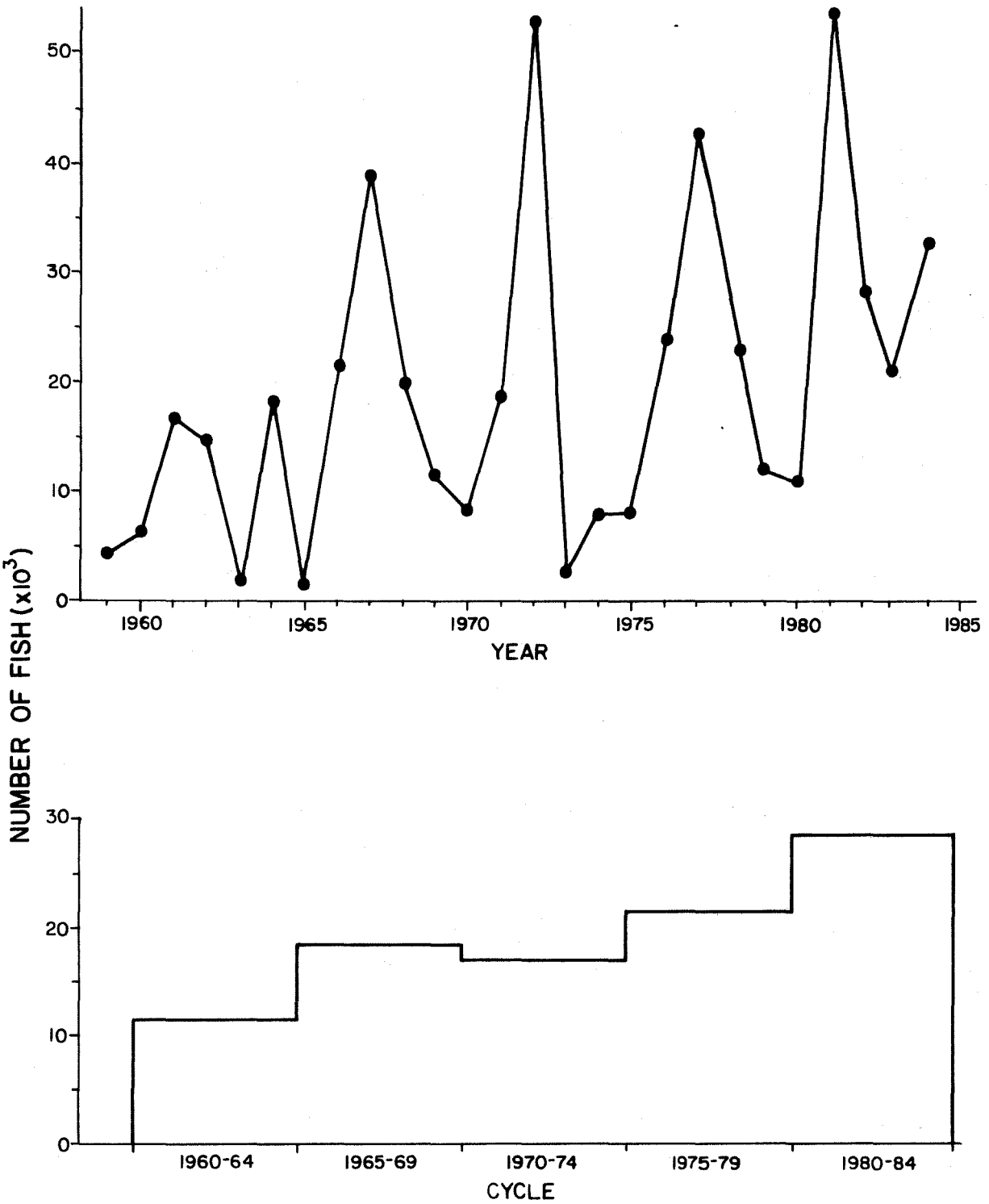


Figure 3.9-3. Tahltan weir counts (sockeye).

indicate that the Tahltan Lake fish have a distinct run timing and geographical pattern. Tagged fish passing through the Tahltan weir migrated almost exclusively through the Sumner Strait area, primarily in June. Approximately half the fish migrating through the Strait had passed prior to the opening of the District 106 gillnet fishery. Considering this distinct timing, further analysis of historical catch data is necessary to determine if the increase in sockeye salmon catches reflects an increase in returns of the Stikine stocks. The 1984 return of sockeye was below average.

Coho Salmon The distribution of spawning coho salmon in the Stikine is not known, although spawners have been noted in the Chutine, Craig, Iskut and Verrett rivers. Traditionally, escapement surveys for coho have not met with much success since this species frequently spawns in areas not conducive to aerial or foot enumeration. Poor understanding of spawning and rearing distributions make it difficult to assess the proportion of Canadian or American coho salmon production from the Stikine River system. Preliminary studies indicate that juvenile coho exclusively use tributaries and tributary backwaters. CWT studies on juvenile coho salmon have been conducted to determine timing, migration pathways and relative contribution of Stikine River stocks to the troll fishery. Alaskans have estimated the mean annual spawning population of coho in the Canadian portion of the Stikine to be 13,500. Canada estimated a mean escapement of 34,000 coho salmon to the Stikine from 1971-1980. The 1984 return was below average, but index escapement was comparatively above those recorded in recent years. The preliminary U.S./Canada target escapement is 38,000-50,000. Coho catches by the terminal fishery (District 108) have declined in the last three decades, while catches in the approach area (District 106) have increased. Overall the total catch has remained relatively stable. Problems in analysing catch data are complicated because many stocks (including several hatchery stocks) contribute to the District 106 gillnet fishery.

The only indicator of coho run strength has been the magnitude of the terminal area and in-river catches. By assuming certain harvest rates based on tagging information extrapolated to specific effort levels, it is possible to develop escapement estimates. With a peak terminal catch of 125,700 in 1941, it appears that coho stocks are presently very depressed in numbers. The decline in coho is believed to stem from over-harvesting by outside troll

fisheries, where the pressure on individual stocks is less conspicuous than in the terminal fisheries.

Chinook Salmon Chinook salmon returns in the Stikine system are poorly understood. Aerial surveys have been conducted on the four major known spawning populations since 1975, and biological characteristics (age, sex and size) of the stocks have been sampled. Escapement counts from 1975 to 1984 have averaged 3,094, with highest proportions observed in Little Tahltan Creek (45%) and the mainstem Tahltan (39%). Beatty Creek and Andrews Creek consistently support small populations of chinook salmon. The mean overall escapement to the Stikine system from 1971-1980 was estimated at 6,000 spawners. Observed and estimated escapements are well below the preliminary U.S./Canada target escapement of 20,000-25,000 chinook salmon.

Catch of chinook salmon in the commercial fisheries in Districts 106 and 108 have declined approximately 50% in the last three decades. However, this has been partially the result of management actions in terminal areas which have become more restrictive. There is no longer a specific fishery for chinooks in District 108 and 106. Interception rates of chinook salmon by troll fisheries and high seas net fisheries are not known. Ongoing juvenile tagging studies will provide information on their contributions to various fisheries, and assess the feasibility of stock separation based on scale analysis.

3.9.2.2 Fisheries

Stikine River stocks are managed jointly by the U.S. and Canadian governments. There are two major Alaskan gillnet fisheries for Stikine River salmon stocks. In the Canadian Stikine, there is a commercial in-river gillnet fishery and a native subsistence fishery. Stikine stocks are also intercepted by outside troll, ocean net and terminal sport fisheries.

The Alaskan gillnetters fish primarily for sockeye and coho salmon. The terminal fishery is located in District 108 adjacent to the mouth of the Stikine, near Wrangell, Alaska. District 106, the approach fishery, is located in the coastal archipelago. Catches in District 108 have generally declined over the past four years, while catches in District 106 have increased. There appears to be a re-allocation of terminal catches in District

108 to the fishery in District 106. These catches also reflect more prevalent closures in District 108 since it is the terminal fishery. District 106 is a mixed stock fishery which harvests of fish from several hatcheries. Therefore, management for Stikine stocks is difficult. Stock-specific timing information was used to minimize harvest of Stikine sockeye salmon in 1984 by delaying the opening of the fishing season until mid-July, when most Stikine sockeye had migrated through Sumner Strait. Additional management actions have been proposed by ADF&G to reduce troll interceptions of Stikine-bound coho.

The Canadian commercial fishery began in 1975, but operated at a low level until 1979 because of limited markets and the lack of processing and storage facilities. Since 1979, harvests have increased to 16,800 sockeye, 8,400 coho and 1,200 chinook salmon (1979-1983 means). When expected returns are low, the fishery is closed to maximize escapement.

The native food fishery is located near Telegraph Creek. Recent average harvests from 1975-1980 have averaged 3,000 sockeye, 675 chinooks and less than 50 coho salmon. It is suspected that subsistence catches were substantially higher in the past than in recent years.

The Alaskan and Canadian commercial gillnet fisheries are managed to minimize interception of chinook salmon stocks.

3.9.2.3 Current Enhancement Activities

Currently, there are limited salmon enhancement activities occurring in the Stikine watershed. Stream blockages have been removed on the Tahltan River (1965) and on Beatly Creek (1982). In addition, there has been flow control operating on Tahltan Lake since 1959. There are several existing and proposed Alaskan hatcheries in the vicinity of the mouth of the Stikine. Production from these hatcheries may be harvested by mixed-stock fisheries with Stikine River stocks, and potentially will complicate management of the Stikine stocks. If the hatchery stocks are harvested efficiently, the Stikine stocks will likely be over-harvested, since hatchery stocks can sustain a higher exploitation rate than can wild stocks.

The state-owned Crystal Lake Hatchery is located on Blind Slough and drains into Wrangell Narrows. Chinook production is currently the focus of this facility. CWT returns from chinooks from this facility indicate that it will contribute significantly to the harvests of chinooks in the central and northern inside waters of Southeastern Alaska. The small numbers of summer chums produced should contribute to the District 106 gillnet fishery. Coho production should also contribute to the District 106 gillnet fishery, as well as to the troll fishery over an extensive area. Some remote releasing of chinook and coho smolts has occurred in Ohmer Creek, which drains into District 108 on the southern end of Mitkof Island. Returns from these releases will contribute to the District 106 and District 108 gillnet fisheries, and will be harvested in a terminal area near Ohmer Creek. Smolt production capacity at this facility is currently maximized due to successful brood stock acquisition programs in recent years. The chinook donor stock was obtained from Andrews Creek, a U.S. Stikine River tributary.

Burnett Inlet Hatchery, a private non-profit facility on the west side of Etolin Island, is located within District 106. This facility is building brood stock, and has requested increases in its capacity. The pinks and summer chums produced by this facility are expected to contribute significantly to the District 106 gillnet fishery. A portion of the production will probably return from the south through lower Clarence Strait. Coho production will contribute to distant troll fisheries as well as to the District 106 gillnet fishery.

Crittenden Creek Hatchery is to be located in Eastern Passage near Wrangell, approximately 5 miles from the Stikine River flats. The hatchery permit is held by a private individual; however, no construction has yet started. The pink and summer chum salmon production planned for this facility would contribute to the gillnet fishery in Districts 106 and 108. Test fishing conducted in 1983 indicated that the portion of Eastern Passage that will be used for special and terminal harvest areas is relatively free of natural stocks, and should provide a good segregated harvest area if the hatchery is built.

Santa Anna Hatchery, a private non-profit facility to be located in Ernest Sound, will contribute some of its pink and summer chum production to

the District 106 gillnet fishery. A portion of the production will probably return from the south through lower Clarence Strait. At this time no construction has begun on this facility.

Hatchery operators have been notified that no increases in numbers of pink salmon eggs will be permitted in facilities that will return pinks through the District 106 gillnet fishery. The ceiling has been established to ensure that management of the mixed-stock gillnet fishery for pinks in District 106 in late July and August will not be rendered less effective due to the presence of hatchery stocks. The ceiling may be altered after the actual effects of currently permitted pink production on management is evaluated.

Due to the identification of a large terminal harvest area in Eastern Passage, there has been interest in placing a large facility there. No permit for such a facility has yet been issued. The southern Southeast Regional Aquaculture Association made one small remote release of coho in this area; fish returned in 1984. Approximately 5,000 of these returning coho were harvested in a terminal area in Eastern Passage. It is unclear at this time whether further releases will occur.

3.9.2.4 Habitat Status

A habitat summary for Stikine River sockeye, pink, chum, chinook and coho salmon is presented in Table 3.9-2. For a description of habitat tables, see Section 2.2.4.

3.9.2.5 Management Conflicts

Conflicts discussed below indicate uncertainties in data and the problems of mixed-stock harvests.

Management Uncertainties Assessment and predictive capabilities necessary for management of Stikine stocks is limited by poor escapement estimates, inability to separate stocks and unknown interception rates in various fisheries. Although sockeye salmon originating in the Stikine can be separated from Alaskan and Nass-Skeena stocks, potential differences in exploitation

Table 3.9-2. Stikine River salmon habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands			

MANAGEMENT STYLE: Active _____ Passive _____ Unknown _____

NUMBER OF STREAMS: *

HABITAT NOTES

Historic Status, Production Constraints and Development History	95% of watershed in Canada. Virtually pristine. Natural turbidity. Some small-scale logging in B.C. and Alaska portions - low impacts.
Current Status	Minor headwater settlement. Transportation and mining impacts.
Future Outlook	Probably unchanged except for potential low-impact mining. Longer range potential for hydro development with uncertain impacts. Lead time exists for flow planning that could help mitigate hydro impacts.
Natural Habitat Production Potential	At historic level.
Improved Production Potential	Potential for major fishway on Tuya River and other fishway and/or obstruction removal possibilities.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	High

CONCLUSION Good example of historic stock declining despite pristine habitat with no impacts.

* General habitat notes. No stock data provided for stock rebuilding.

rates between Tahltan Lake and the other Stikine sockeye salmon stocks cannot yet be evaluated. Weir counts at Tahltan Lake provide good escapement and run timing data for that stock, but escapement and timing estimates for the lower Stikine stocks are poor. Returns of coho salmon from the Stikine are poorly understood since escapement data are virtually nonexistent, spawner distributions are unknown, and contribution of Stikine coho to the various fisheries is unknown. Similarly, chinook salmon stocks within the Stikine cannot be separated nor can interception in troll and ocean net fisheries be estimated. The numerous uncertainties help make management of the Stikine stocks quite difficult.

Mixed-Stock Harvests The Stikine river sockeye, chinook and coho salmon stocks are harvested by several mixed-stock fisheries. The approach fishery in District 106 is directed toward several stocks of all five species, including hatchery returns. In 1983, Stikine sockeye stocks identified by scale analysis were also intercepted by upper Clarence Strait and Cape Fox fisheries. Coho and chinook salmon originating in the Stikine are likely to be intercepted by numerous fisheries in Southeastern Alaska.

3.9.2.6 Stock Rebuilding Potential

Stock rebuilding potential in the Stikine system is difficult to assess since the escapement requirements and status of the stocks are poorly understood, particularly for coho and chinook salmon. The rebuilding concept is further complicated by the international aspects of the area. The success of a rebuilding program will require full co-operation and agreement between Canada and the U.S.

Current management policies are directed at rebuilding sockeye, chinook and coho salmon stocks in the Stikine. When sockeye salmon returns are anticipated to be poor, the fishery in District 106 is closed until mid-July, i.e., after the Tahltan Lake sockeye have migrated through the area. Further emphasis should be directed at determining run timing and migration routes of lower Stikine sockeye stocks. Terminal and in-river fisheries have minimal harvests of chinooks, since their early runs allow management actions that are directed at rebuilding the runs. However, interception of coho and chinook salmon by the troll and high-seas fisheries must be assessed and controlled,

if required in order to succeed in a stock rebuilding program. Rebuilding potential of all stocks would be enhanced if spawner-recruit relationships were understood, and annual run size and escapement were accurately estimated in-season.

3.9.2.7 Management Strategies for Stock Rebuilding

Several possible options for rebuilding stocks are discussed below.

1. Expend More Effort on Estimating In-Season Escapement A program testing hydroacoustics as a means of enumerating the in-river Stikine sockeye salmon run has been conducted for the past three years. Although costly, this program could provide accurate and timely in-season estimates of escapements needed for effective management. Other population assessment methods including test fisheries should also be evaluated, because the hydroacoustic program is rather costly. Alternative methods tested in 1984 include:

1. Test fishing and sampling in the lower river;
2. Enumeration of Tahltan Lake sockeye escapement through a weir;
3. Enumeration of sockeye smolts emigrating from Tahltan Lake; and
4. Spawning ground surveys.

All these studies could include sampling various portions of the run for biological characteristics to identify and separate Stikine River stocks. The hydroacoustic program could be expanded to provide estimates of coho salmon escapement of the system. Radio telemetry studies on coho salmon are also recommended to determine coho salmon spawning distribution in Canadian and U.S. portions of the river. Chinook escapement estimates could be improved by expanding the spawning ground surveys, and establishing a counting weir or carcass weir on Little Tahltan and/or Tahltan rivers.

2. Estimate Interception Rates Further investigation is recommended to identify various sockeye stocks in the Stikine system, or at least to separate Tahltan Lake stocks from lower river stocks, in order to evaluate potential differences in interception and exploitation rates. Scale analysis, egg size, presence or absence of a protozoan brain parasite or electrophoresis are possible techniques which are presently being investigated. These methods of

stock separation should also be tested on coho and chinook salmon stocks to determine if they are a feasible approach to determining which stocks are intercepted to various fisheries. A CWT program for juvenile coho and chinook salmon would provide the necessary information on interception rates in various fisheries in Southeastern Alaska and the Gulf of Alaska.

3.9.2.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al. (1983)[1].

Tahltan Lake Fertilization (Project No. S-5) Preliminary limnological sampling in 1978 indicated this lake would be a good candidate for fertilization. A bathymetric profile and plankton sampling were accomplished in 1982. Results are pending. A smolt enumeration and sampling program was conducted in 1984. Preliminary results indicated an egg-to-smolt survival of 0.5%.

Fry Plants to Supplement Low Cycle Years of Sockeye (Project No. S-1B) Potential enhancement opportunities exist through "satelliting" or remote fry releases of sockeye. Two basic techniques could be developed to accomplish this: a) the construction of incubation boxes in known spawning areas, or b) the utilization of existing hatcheries to incubate eggs taken from spawning stocks, with subsequent planting of fry back at the sites where eggs were taken. Preliminary examinations of Tahltan Lake suggest that there is a good opportunity to test remote incubation box designs near the lake outlet. Colonization of the Tuya River might be possible using a hatchery facility to supply fry for release into the stream system.

Tuya Block Removal (Project No. S-1A) The Tuya River may have the potential of more than doubling Stikine salmon production. The SEP explored the possibility of removing the Tuya River obstruction, and determined that it

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

would be feasible, but quite costly. Chinooks, sockeye, steelhead, and coho currently return to the Tuya River mouth, although not in large numbers. The capability of existing habitat should be assessed before an investment is made to expand available habitat. It may be possible to colonize the upper Tuya watershed; however, sockeye may have difficulty establishing themselves in lakes occupied by other species. More technical advice is needed before experimenting in these drainages.

Stream Improvement A catalogue of Stikine tributaries currently suffering from fish passage problems is being developed by the Northwest Enhancement Society. Following field investigations conducted in 1984, several small enhancement projects regarding stream improvement may be identified. Before beginning these projects, the availability and utilization of existing spawning and rearing habitat should be assessed to determine the necessity of providing access to more habitat.

3.9.3 Alsek River

The Alsek River originates in southwestern Yukon, flows south through northwestern British Columbia where it is joined by its major tributary, the Tatshenshini River, and then flows southwest through the Alaskan panhandle, emptying into the Pacific Ocean about 80 km south of Yakutat, Alaska (Fig. 3.9-4). The Alsek River has a course of 200 km, draining approximately 16,200 km^2, 95% within Canadian territory.

3.9.3.1 Stock Description

Sockeye, chinook and coho salmon are the principal species produced in the Alsek River system. Chum and pink salmon stocks are minor. Several stocks of each species have been identified, primarily in the Tatshenshini River drainage. The limit to salmon migration in the Alsek is about 20 km upstream of its junction with the Tatshenshini River. Estimates of total escapement and productivity are poor for all species. Escapement data from 1959-1976 are limited to periodic aerial and foot surveys. In 1976, a weir on the Klukshu River was installed and has since been used as an index of species abundance throughout the system. The most significant stock in the Alsek system is the Klukshu sockeye salmon run.

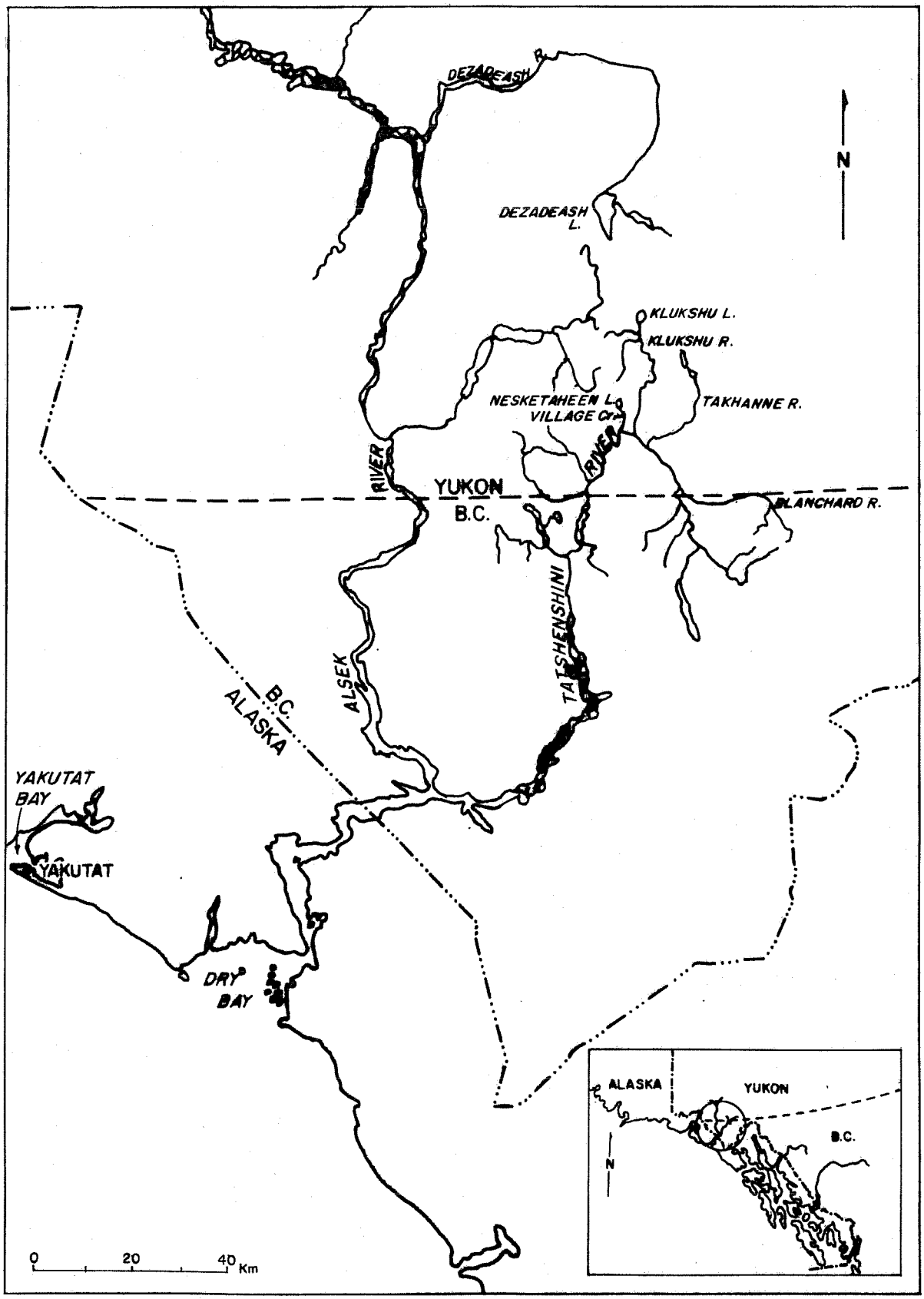


Figure 3.9-4. The Alsek River.

The three major stocks of sockeye are the Klukshu Lake and River; Neskataheen Lake and Village Creek; and Blanchard River runs. Based on a mark-recapture study in 1983, the Klukshu stock is estimated to be 40% of the total sockeye escapement to the Alsek system. Mean estimated escapement to the Alsek was 26,800 from 1976-1983. The 1984 estimate was 21,200. The escapement goal range of 33,000-58,000 is well above recent estimates. Sockeye salmon catches in the Alaskan commercial fishery in Dry Bay averaged 31,300 from 1976-1983. Catches have been relatively stable in the last four decades; however, since fishing efficiency has increased, this suggests a decline in stock abundance. The Canadian in-river Indian food fishery harvested an average of 4,500 sockeye from 1976-1983. Alaskan and Canadian sport harvests are minor, averaging 100 and 600 sockeye, respectively.

Escapement and spawner distribution data for coho salmon are generally lacking. Coho salmon are enumerated at the Klukshu weir, but their late arrival precludes complete enumeration, since the weir freezes before the run is finished. For stock estimation purposes, it is assumed that Klukshu coho comprise 30% of the total escapement to the Alsek River. Counts through the weir from 1976-1984 averaged 920. Escapement goals determined by the U.S. and Canada are 5,400 to 25,000 respectively. Catches of coho salmon by the terminal fishery in Dry Bay have significantly declined in the last four decades, from an average of 28,400 in the 1940's to 6,400 in the 1970's. Recent harvests (1976-1984) have slightly increased to 8,300 fish. The average Canadian harvest (from 1976-1980) including commercial, subsistence, and sport fisheries was 137 coho salmon.

Escapement and spawner distribution data for chinook salmon are limited. Major Tatshenshini chinook spawning streams include: The Klukshu River, Blanchard River, Takhanne River and Goat Creek-upper Tatshenshini River. Escapements to the Tatshenshini tributaries are monitored by the Klukshu enumeration weir and aerial surveys. The relative contribution of the Klukshu run to overall escapement is unknown. Counts through the weir from 1976-1983 averaged 2,700. The 1984 count was lower than average; only 1,670 spawners were enumerated. Weir counts have been significantly lower than the escapement goal range of 7,200 to 12,500 for the whole system. Although catches of chinook salmon in terminal areas have decreased significantly in the last four decades, they are not a reliable indicator of abundance, since management of

the terminal fishery has focused on reducing pressure on chinooks. Canadian sport and native fisheries have been restricted to provide for increased escapements. Combined, these fisheries harvested a mean of 400 chinook salmon from 1976-1980. In 1984, 700 chinook were harvested in the Canadian portion of the river; 500 were attributed to the sport fishery. The principal concern regarding chinook harvests is the unquantified pressure of the troll and other intercepting fisheries on the stocks. Recent production of chinook salmon should have significantly exceeded the stock estimated from terminal catches and escapements, if outside interception was minimal.

3.9.3.2 Fisheries

The Alsek salmon stocks are generally managed based on a comparison of historical fishery performance (catch per unit effort data) and the Klukshu weir counts. The current ability to establish and meet spawning and allocation goals is poor. Management could be greatly improved if total return data were available. Management of the various fisheries is controlled by U.S. and Canadian governments. The Alsek stocks are fished in the mouth in the Dry Bay gill net fishery by Alaskan commercial fishermen. The commercial gillnet fisheries are primarily for sockeye salmon. Since 1983, the fishing season has been delayed by two weeks and restricted to limited openings for the remainder of the season. These actions were taken in an effort to rebuild the early run sockeye and chinook escapements. There is no commercial Canadian fishery on the Alsek. Canadian subsistence and sport fisheries exist in the Klukshu and other Tatshenshini tributaries. This area provides one of the most intensive and popular sport fisheries in the Yukon.

In the Canadian fisheries, effort in the Klukshu area has been reduced prior to 15 August in order to rebuild early sockeye stocks. The subsistence fishery operating at the outlet of Klukshu Lake (Klukshu village) for sockeye salmon takes fish which have already been enumerated through the weir. Canadian sports fishery regulations in the Alsek system prohibit retention of sockeye prior to 18 August, and limit possession to one chinook.

3.9.3.3 Current Enhancement Activities

No salmon enhancement activities have been implemented in the Alsek River system. An international agreement is necessary to ensure that Canada will

benefit from future enhancement activities.

3.9.3.4 Habitat Status

A habitat summary for Alsek and Tatshenshini River sockeye, pink, chum, chinook and coho salmon is presented in Table 3.9-3. For a description of habitat tables, see Section 2.2.4.

3.9.3.5 Management Conflicts

Issues treated below include the effects of uncertainties about fisheries data, and the problems of mixed-stock harvests.

Management Uncertainties The present Alsek stock status monitoring programs consist of:

1. Monitoring catches of all species;

2. Sampling commercial sport and subsistence catches for age, sex and size;

3. Enumeration of escapements into the Klukshu River;

4. Sampling of Klukshu escapement for age, sex and size; and

5. Aerial surveys of some tributary escapements.

Management ability is limited by inaccurate forecasts of total inshore returns. Escapement data, particularly for coho, are incomplete, and survival data are lacking. With the exception of the 1983 study to determine the component of the Klukshu sockeye run, no stock separation studies have been done. There are no estimates of the interception rates of adjacent or outside fisheries on Alsek stocks.

Mixed-Stock Harvest There is a terminal fishery for Alsek stocks. Sockeye salmon originating in the Alsek may also be harvested by adjacent fisheries such as the Yakutat Bay and Copper River or Bering River in Prince William Sound. Alsek chinooks and coho are likely intercepted by outside

Table 3.9-3. Alsek and Tatshenshini River salmon habitat description.

STOCK DATA	Maximum Recorded Escapement	Target/ Optimum Escapement	Current Average Escapement
Thousands			

MANAGEMENT STYLE: Active ____ Passive ____ Unknown ____

NUMBER OF STREAMS: *

HABITAT NOTES

Historic Status, Production Constraints and Development History	93% in Canada. Historic glacial barrier on Upper Alsek. Pristine - natural turbidity.
Current Status	Pristine.
Future Outlook	Possibility of mining - low impacts.
Natural Habitat Production Potential	At historic level.
Improved Production Potential	Some SEP proposals.

STATUS SUMMARY	Current Target Achievability	Current Status	Future Outlook	Natural Production Potential	Improved Production Potential
		High	High	High	Low

CONCLUSION Good example of historic stock declining despite pristine habitat with no impacts.

* General habitat notes. No stock data provided for stock rebuilding.

gillnet and troll fisheries such as Fairweather, Yakutat, Prince William Sound and high seas areas. Interception of Alsek stocks in these other fisheries should be assessed so that appropriate management actions can be enforced.

3.9.3.6 Stock Rebuilding Potential

Since the Alsek is an international river, the success of stock management programs will depend upon co-operation between Canada and the U.S. Management is currently aimed at rebuilding Alsek stocks. By addressing the management uncertainties, mixed-stock harvests, and interceptions, management of Alsek stocks would be improved. Current management practices should be continued. Regulations in the terminal and in-river fisheries are aimed at rebuilding the early-running sockeye and chinook salmon stocks. Declines in coho catches and in chinook returns suggest that troll fisheries are over-harvesting coho and chinook stocks. The success of rebuilding programs for these species is dependent upon assessment and control of these outside interception fisheries.

3.9.3.7 Management Strategies for Stock Rebuilding

Two management options for stock rebuilding are described below.

1. Expend More Effort on Estimating Total Run Strength in the Lower River The highest priority for the Alsek sockeye fishery is to estimate total escapement past the Alaskan fishery in the lower river. Current escapement assessment programs should be continued and expanded to include mark-recapture and feasibility studies using hydroacoustics. A regular spawning ground indexing program would not provide accurate escapement data for coho salmon, since they usually use a large number of discrete spawning areas. The estimation of total escapement will provide the necessary information to base escapement goals on stock-recruitment analysis. Until these data are available, the existing system of using historical catch data, quality and quantity of habitat, and Klukshu River returns should continue to be used and refined.

2. Estimate Interception Rates A priority for chinook and coho salmon management is to determine the rate of interception in outside fisheries.

A CWT program for juvenile chinooks and coho is recommended in order to accumulate information on smolt production and harvest of stocks in offshore fisheries. Scale pattern analysis has proven to be an accurate method of separating sockeye salmon stocks in other regions. Studies to determine the feasibility of stock separation by scale patterns, electrophoresis and parasite occurrence should be investigated. If feasible, interception rates of Alsek sockeye salmon stocks could be determined in terminal and adjacent fisheries.

3.9.3.8 Future Stock Enhancement Activities

Following is a description of future enhancement projects that are compatible with management practices. Accompanying each project title is the project number from Lill et al (1983)[1].

Klukshu Lake Fertilization (Project No. A2) Preliminary feasibility studies conducted in the mid-1970's indicated that Klukshu Lake would be an excellent candidate for enrichment. Limnological conditions seem appropriate, and easy road access makes this project very attractive. Rearing capacity and potential predation should be examined prior to embarking on this opportunity.

Smolt/Fry Plant - Dezadeash Lake (Project No. A1) Salmon runs to the Dezadeash Lake drainage have been eliminated during the past century by glacial advances crossing the Alsek River. It is unknown whether the hydraulics of Turnback Canyon currently impose a velocity barrier. Determination would be possible through the transplant of sockeye, chinook, coho smolts or fry to Dezadeash Lake and monitoring of subsequent adult returns both above and below the canyon.

Fry Plant - Howard Lakes (Project No. A4) These lakes are drained by the Takhanne River, and access is blocked to salmon. Continued sockeye fry planting may be possible to utilize the potential rearing area. Chinooks,

[1]Lill, A.F., B. Shepherd, J. Wild, J.W.C. McNally and D. Marshall. 1983. Opportunities for salmonid enhancement projects in British Columbia and the Yukon. Unpublished Report for Department of Fisheries and Oceans. Revised January 1985.

sockeye, and possibly coho currently ascend the Takhanne River to the base of Million Dollar Falls. Fry planting of coho and chinooks is also a possibility, but specific recommendations should await the outcome of ongoing experiments. Existing spawning and rearing capabilities within accessible sections of the Alsek watershed should be assessed prior to implementing enhancement projects designed to increase available habitat.

Remote Incubation Box Enhancement Several chinook, sockeye, and coho spawning areas with road access could be potential sites for incubation boxes. Experimentation of proper design should be initiated and tested under the severe climatic conditions prevalent in these areas.

3.10 Inside Chums

3.10.1 Stock Description

Fall chum salmon returning to the inside waters of southern British Columbia comprise more than 150 individual stocks. Recent returns (catch plus escapement) have averaged about 2,200,000, only about 60% of the average run of 3,800,000 in the early 1950's, although marked annual fluctuations in run strength are characteristic of these stocks. For details of historical catches and escapements see Appendix 2.

Comparison of recent escapements with those of the 1950's is difficult because of increases in the effort and changes in methods used to determine spawning escapement levels in more recent years. This is particularly true in the Fraser River, where the 1950-1959 average recorded escapement was only 89,000, compared to the 1980-1983 average of 402,000. Even now, the estimates are considered to be of poor quality. However, if it is assumed that recent estimates are at least reasonable, current escapements to the Fraser are well below the goal of 700,000. For many other production areas, current escapements do seem to be much lower than those of the 1950's, and are well below target. For all stocks combined, the 1980-1983 escapement of 1,400,000 is only 52% of the target escapement of 2,700,000. Escapements by production area are summarized in Table 3.10-1.

The total catch of inside fall chums since 1950 has ranged from 35,000-3,100,000, with annual fluctuations reflecting variations in fishing effort and run size. The catch from 1973-1982 averaged 929,000, with a range from 120,000-2,900,000. The harvest rate has averaged about 34% recently.

The number of adult chum salmon returning from each spawner for the 1969-1979 brood years has averaged 1.7 for all production areas combined, with a range of 0.8 - 4.3. Rates of return for chum from individual production areas (with the exception of the Fraser River) are not available.

Of the total returning stock 30% are age 3 fish, 65% are age 4 fish, and 5% are age 5 fish. Substantial annual and stock-specific variations occur. Enhanced chum stocks have a greater proportion of age 3 fish, and few age 5 fish compared to wild stocks.

Table 3.10-1. Spawning escapement of chum salmon to southern British Columbia production areas (thousands of fish).

	1950-59	1960-69	1970-79	1980-83	Target	1980-83 as % of Target
Upper Vancouver Is.	22	9	1	N/A	33	0
Kingcome	46	18	39	12	113	11
Bond-Knight	141	82	68	43	220	20
Johnstone Strait	72	29	17	24	137	18
Loughborough-Bute	50	32	140	217	150	145
Mid-Vancouver Is.	161	152	232	242	305	79
Toba Inlet	65	22	18	14	136	10
Jervis Inlet	65	48	70	75	150	50
Lower Vancouver Is.	75	32	54	59	147	40
Southern Vancouver Is.	111	77	88	138	238	58
Howe Sound	60	39	123	140	300	47
Burrard Inlet	14	6	16	21	50	42
Fraser River	125	320	440	418	700	60
TOTAL	1,007	866	1,306	1,403	2,679	52

It has been assumed that virtually all returning Johnstone Strait and Fraser River chum stocks migrate through Johnstone Strait as they approach their natal streams. It is possible that a small proportion of Georgia Strait and Fraser chums migrate through Juan de Fuca Strait, but this has not been confirmed. The precise migratory routes of stocks through the Strait of Georgia have not been defined. A small but variable number of Puget Sound chums migrate through Johnstone and Georgia Straits along with Canadian chums.

Chum salmon migration through Johnstone Strait commences in late August (Bute Inlet and early Fraser stocks) and continues until late November. Peak abundance generally occurs in October. Each stock has a characteristic migratory period. Average migratory timing for each stock has been defined through tagging studies (Fig. 3.10-1). At any given time, there are numerous stocks migrating through Johnstone Strait, which makes stock-specific management difficult if not impossible in this area. There is substantial overlap of individual chum stocks in Johnstone Strait and in the Fraser River (Figs. 3.10-1 and 3.10-2). Recent information has indicated that, even in some terminal areas such as off the Qualicum, Nanaimo and Fraser River, substantial numbers of chums destined for other areas may be mixed with local stocks. Many chum stocks delay for two to four weeks in the terminal area prior to entering their spawning streams.

Within the Fraser River, chums occur in abundance from late September to mid-December. Peaks in the lower Fraser usually occur in mid- to late October, and from late November to early December. Figure 3.10-2 shows the average migration timing of major chum stocks through the lower Fraser.

Late Fraser River sockeye (primarily Adams River and Weaver Creek) and Fraser pink salmon coincide in timing with chums in Johnstone Strait during the first three weeks of September and with chums in the Fraser area until early October. Fisheries directed at sockeye and pinks in these times and areas catch chums incidentally. Chinook and coho salmon migrating during September and October also coincide in timing with fall chums. This is the period of peak abundance for some fall chinook and coho stocks; hence, they are subject to incidental harvest during chum fisheries. It has been observed that chum productivity is lower in odd-numbered brood years when Fraser River pinks are abundant. As the runs of Fraser pinks increase, this could have a significant impact on chum production.

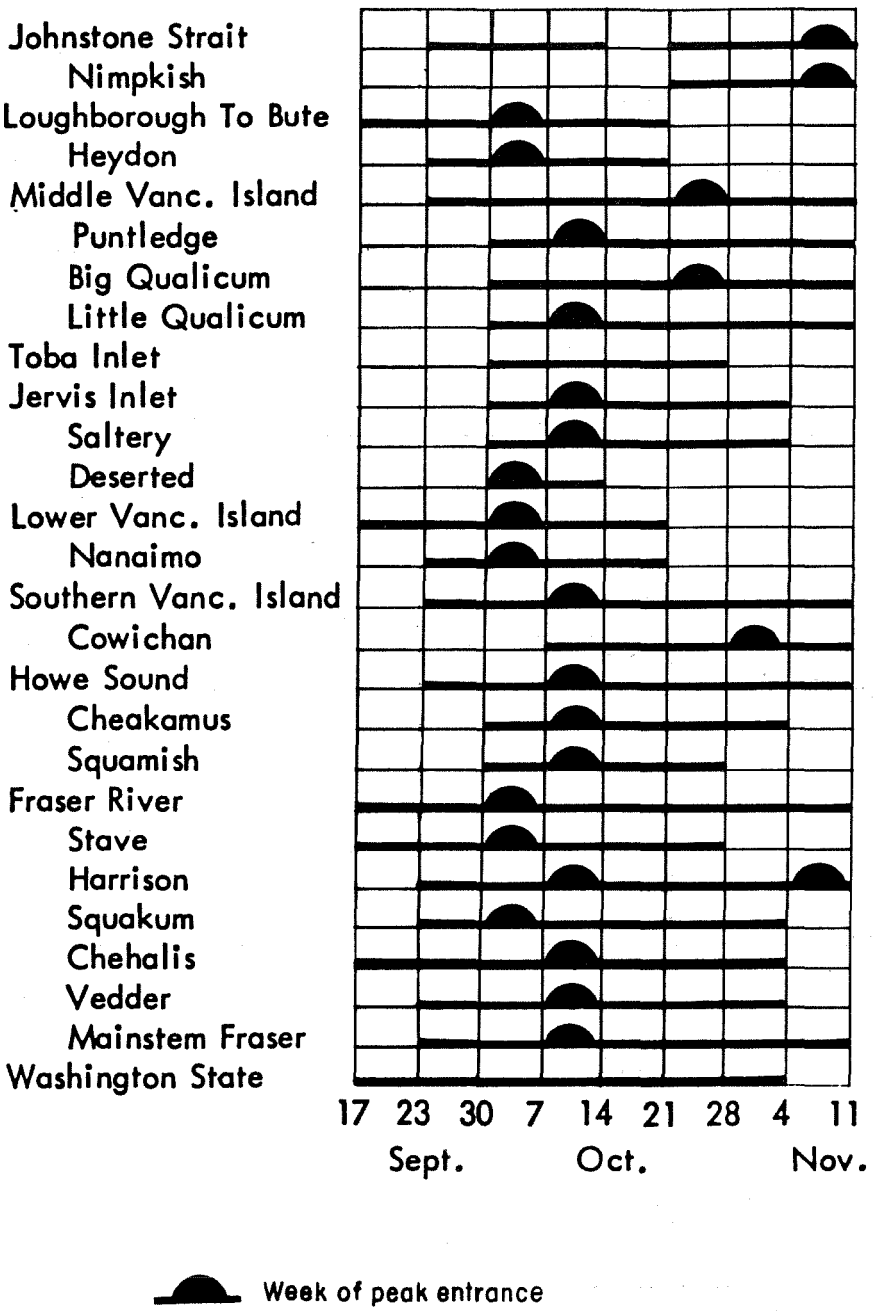


Figure 3.10-1. Timing of chum salmon entering Johnstone Strait.

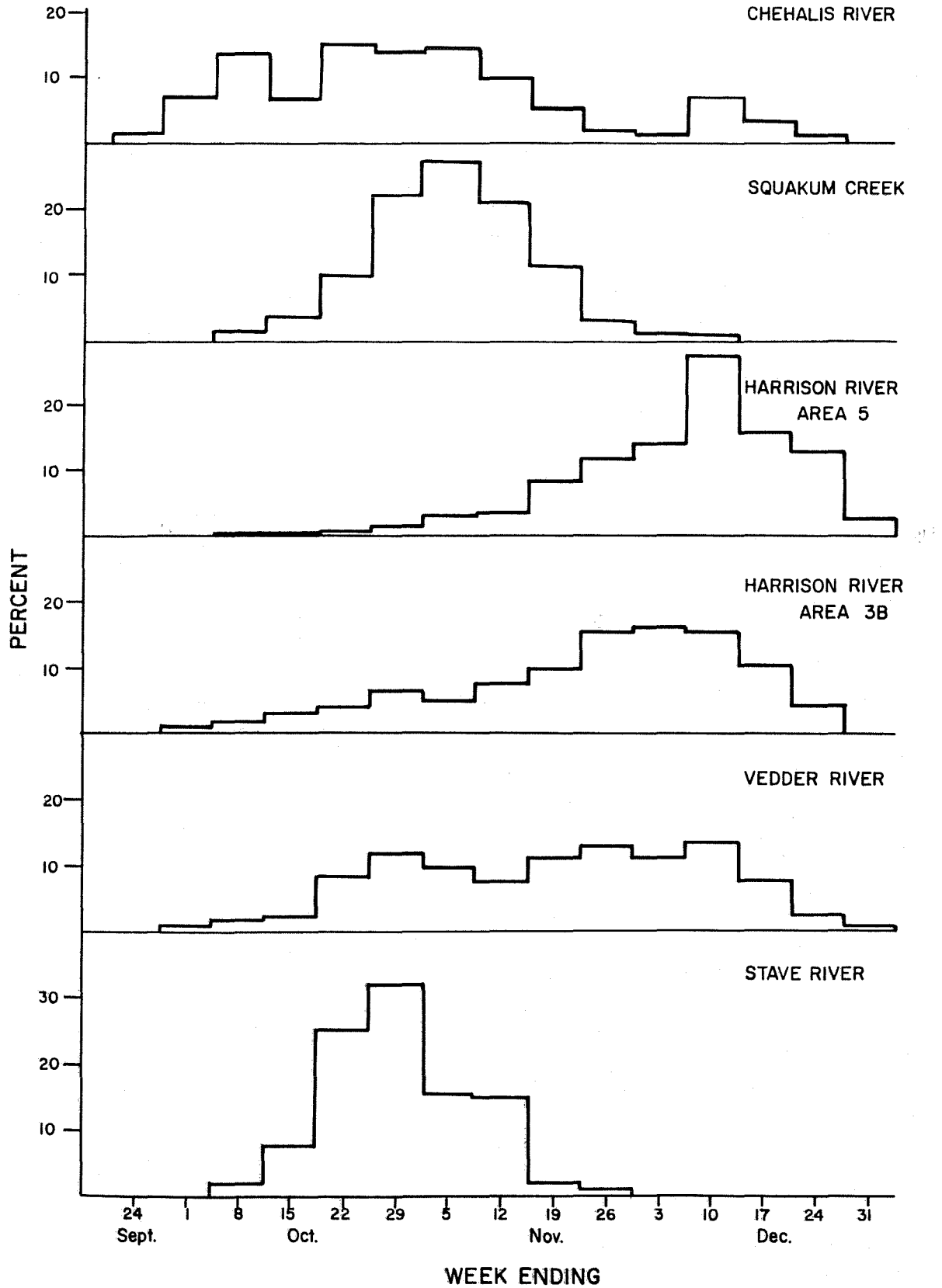


Figure 3.10-2. Average migration of major tributary chum salmon populations in the lower Fraser River, 1964 to 1969.

3.10.2 Fisheries

The main commercial fishing areas for inside chum salmon are Johnstone Strait, Area 14 (Qualicum), Fraser River and U.S. Areas 7 (San Juan Islands) and 7A (Point Roberts). Johnstone Strait is a mixed-stock area where all stocks are harvested to some extent. Chums caught in this area are high quality "silver bright" fish that fetch a relatively high price. In general, the largest proportion of the total catch is taken in Johnstone Strait. Area 14 is a terminal area for chums destined mainly to the Big Qualicum and Little Qualicum Rivers. The majority of these stocks are enhanced. Fish caught in this area early in the season are of relatively high quality; later in the season, the quality deteriorates, resulting in a corresponding decrease in the price paid to fishermen. The Fraser River could also be considered to be a terminal fishing area, although it is still a mixed-stock fishery in that there are numerous individual Fraser stocks present at any given time. Recent electrophoretic analyses have revealed that passing Canadian non-Fraser (mainly Howe Sound) and U.S. chums are also present in the area just off the Fraser River mouth. The chums in the Fraser area are generally dark and of lower value than those caught in Johnstone Strait. Chums caught in the U.S. Areas 7 and 7A are believed to comprise a higher proportion of Canadian origin fish, particularly those destined for the Fraser River. In recent years, these fisheries have operated only when fisheries have been conducted in Johnstone Strait or the Fraser River.

Until recently, management of southern inside chums suffered from a lack of a real commitment to ensure that the stocks were managed to achieve their full potential. Fisheries were often opened without regard to their effects on spawning escapement, and were often designed to minimize pressure on DFO. As a consequence, the stocks were overfished in many years. Recent analyses have demonstrated that by lowering average harvest rates, production and catches will increase over the long term. Since 1983, a new approach has been developed jointly with industry, which is designed to rebuild wild chum stocks by lowering harvest rates to increase escapements. The general strategy is to adjust the harvest rate during the run within the Johnstone Strait/Fraser River fishing area. The harvest rate in any given year is dependent on the total size of the run passing through Johnstone Strait, and is increased in a stepwise manner according to a pre-arranged plan as the run projection increases. Enhanced stocks (at present mainly Qualicum) are harvested to some

extent in Johnstone Strait, but are also harvested in the terminal area, where target escapements are fixed.

3.10.3 Management in the Fraser River

The Fraser River was once a major fishing area for chums. Fishing was permitted four or five days per week, and catches were up to several hundred thousand annually. Closures for conservation and a trend toward harvesting in Johnstone Strait where the quality of chums is better have all but eliminated the Fraser chum fishery in recent years.

The recently implemented rebuilding program for chums should eventually increase both production and catches, although the proportion of the catch to be taken in the Fraser River has not yet been determined. This management scheme is designed to rebuild wild chum stocks by controlling harvest rates in a stepwise manner up to a maximum of 40% of total chum abundance in Johnstone Strait. With this approach, management of Fraser River wild stocks is keyed to escapement. In fact, the only area in the south coast where this is not the case is Area 14, where harvest rates are controlled by hatchery returns. This has some important implications for the Fraser River, because current hatchery production is approximately 500,000 adult chums, of which a maximum of 40% (200,000) would be harvested. In many years, the exploitation rate would be much lower than 40%. Chums not harvested would either supplement wild spawners or be taken as a rack harvest at the hatcheries.

In designing the hatchery program for the Fraser River, the intention was to enhance most of the stocks and to use some of the returning hatchery fish to augment wild spawning. If this were successful, harvest rates within the river would be increased to take advantage of the additional fish from enhancement projects. At the present time, all the major Fraser chum stocks and many of the smaller ones are being enhanced, but it will be several years before it can be determined whether or not enhanced stocks are satisfactorily contributing to natural spawning. If the results over the next few years indicate that the program is successful, rates could be raised to take some of the surplus. There are several approaches that could be considered. One would be to manage to produce wild escapements of 700,000 (plus additional fish required for hatchery brood stock), and to catch any surplus within the

river. Test fisheries could be used to determine in-season abundance. Another approach would be to fish at some predetermined exploitation rate within the river, after it has been determined that there would be sufficient chums to meet escapement goals. Since these approaches depart from the current management program accepted by industry, further consultations will be required before changes could be implemented.

If hatchery returns do not distribute themselves on the natural spawning grounds in a desirable manner and augment wild spawning, it will be necessary to manage Fraser River wild chums actively, or accept large hatchery surpluses.

3.10.4 Current Enhancement Activities

Enhancement of chum salmon begin in 1967 when the first artificial chum spawning channel was built on the Qualicum River. The Phase I SEP brought numerous facilities devoted to chum production in the Johnstone Strait, Georgia Strait, and Fraser River areas (Table 3.10-2). Returns of hatchery chums are projected to increase rapidly over the next few years to an average of 1,000,000-5,000,000 adults per year by 1990. Enhanced chum stocks will therefore comprise a substantial proportion of the total chum runs through Johnstone Strait. For example, if the wild chum run were 2,000,000, enhanced fish would be about 40% of the total production.

The main method for enhanced chum production is to use artificial spawning channels, followed by artificial incubation and rearing (Japanese channels) and side channel development (Fig. 3.10-3). The main production areas for enhanced chums are Fraser River (500,000), Georgia Strait (1,000,000) and Johnstone Strait (58,000).

At present there is no practical method for distinguishing enhanced from wild chum in the fishing areas except by extensive tagging programs. Electrophoretic work can, however, distinguish between Fraser River, Georgia Strait, and Puget Sound chum stocks. Current enhancement on the Fraser is producing about 80% of those stocks, with an average escapement of over 500 adults. It is therefore possible to treat and fish the Fraser stocks as one enhanced stock. This could result in enhancement of some of the weaker, presently

Table 3.10-2. Production capacity of chum enhancement facilities in the Georgia Strait - Johnstone Strait area (based on SEP bio-standards).

Facility	Production Capacity		Target Stocks 1984
	Resources	Returns	
Johnstone Strait			
Nimpkish	1,000,000	20,000	Willow
Port Hardy	1,650,000	33,000	Various
Drew Harbour	80,000	640	Drew Harbour
Hyacinthe	400,000	3,200	Hyacinthe
Mossam	80,000	640	Mossam
Marble	40,320	320	Marble
Georgia Strait			
Little Qualicum	49,100,000	311,000	Little Qualicum
Big Qualicum	56,800,000	386,000	Big Qualicum
Puntledge	6,000,000	120,000	Puntledge
Cowichan	1,000,000	20,000	Cowichan
Nanaimo	1,000,000	8,000	Nanaimo
Sechelt	80,000	1,600	Sechelt
Sliammon	1,500,000	30,000	Sliammon
Vancouver R.	500,000	10,000	Various
Westholme	9,360,000	26,200	Chemainus
Judd Slough	10,010,000	24,600	Squamish
Lower Paradise	6,060,000	33,900	Cheakamus
Upper Paradise (SPU)	6,730,000	37,700	Cheakamus
Upper Paradise (PIP)	120,000	960	Cheakamus
Little Campbell	72,000	144	Little Campbell
TOTAL	151,582,000	1,067,904	

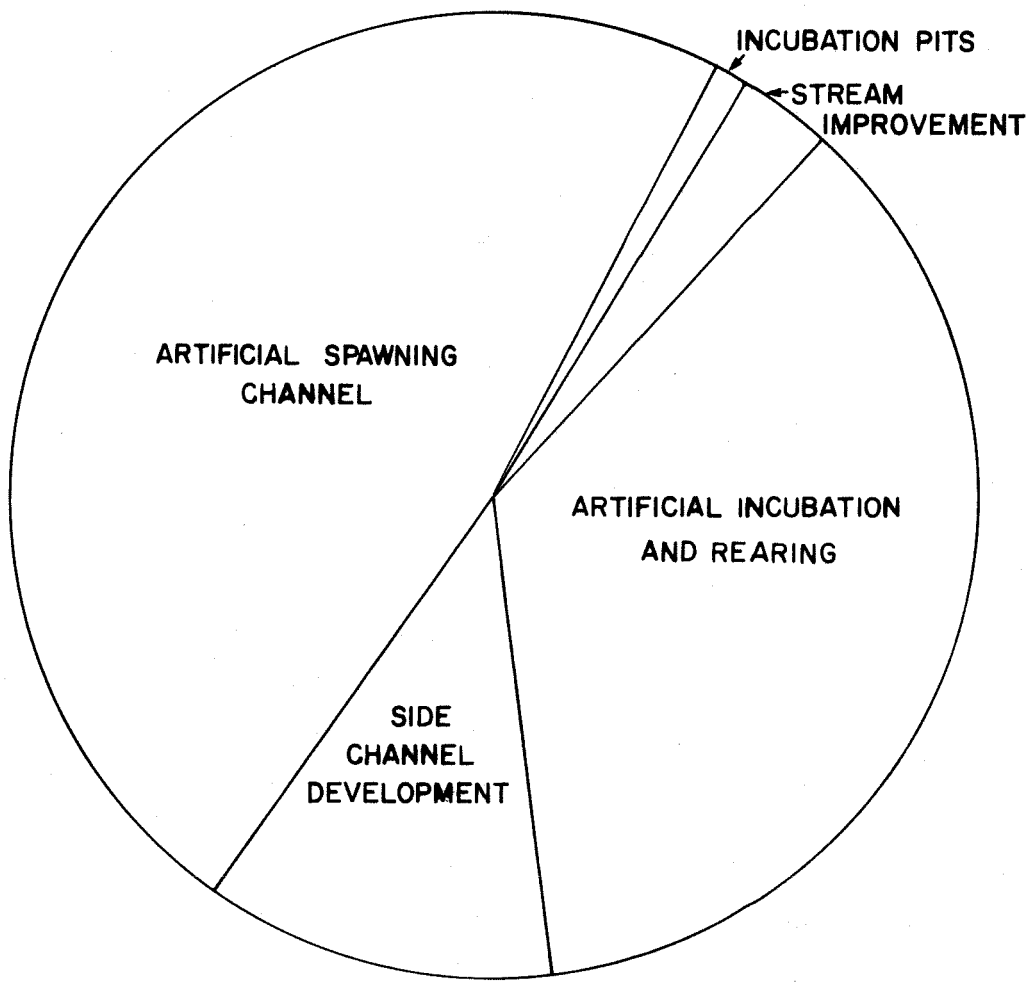


Figure 3.10-3. Chum enhancement methods for the Johnstone Strait, Georgia Strait, and Fraser River area.

unenhanced stocks at the expense of the stronger enhanced stocks. This strategy could provide protection to all systems. It is also possible to enhance some portion of a run, e.g., only late-running fish.

Unless enhancement is carried out on all the additional systems in Georgia Strait, the current management strategy (terminal fisheries for surplus enhanced stocks) is the best strategy. In addition, further large-scale enhancement of Fraser stocks should be delayed until current enhancement is fully operational and a management strategy for dealing with enhanced chums in Johnstone Strait has been developed.

3.10.5 Stock Rebuilding Potential

Comparison of recent and historical escapement estimates suggests that spawning escapements could be increased substantially in most areas. Although there has undoubtedly been deterioration of some spawning areas through poor logging practices or other forms of human activity, for the most part the capacity of the spawning beds is thought to be similar to that of the 1950's. One factor that does affect the rate and success of rebuilding is the occurrence of periodic floods. The frequency of flooding may have increased in certain areas as the result of logging or road building.

The time required to rebuild stocks by reducing harvest rates is, of course, greatly influenced by current escapements. For some systems, present escapement is so low as to make stock rebuilding by reducing harvest rates impractical, at least within a reasonable span of time. Most stocks, however, still have significant escapements; for these, harvest rate reduction is considered to be a viable approach.

3.10.6 Management Conflicts

Since the current approach depends on determining the run size early in the season in order to set the harvest rate, the accuracy of the run size estimate affects the success of the strategy. Also of importance is the proportion of enhanced and Puget Sound chums present, as these will affect total run size and hence the selection of harvest rate. Since the proportion of enhanced stocks will increase over the next few years, these will have to be taken into account.

At present the Fraser River is managed by controlling wild chum escapement, so that catches at any given harvest rate have to be allocated in some equitable manner between Johnstone Strait and the Fraser River. Also, because there are also fisheries which operate at similar times at Point Roberts and the San Juan Islands, U.S. catches of inside chums must be taken into account.

Because the Johnstone Strait net fleet is very large, it has been virtually impossible to exploit the runs evenly. Since there are a multitude of stocks with different run timing, some stocks will be overfished and others underfished. However, reduction of the fishing area by opening only selected sub-areas for short periods of time should help to spread out the harvest.

Another factor to be considered is the lobbying for additional fishing time by fishermen who either have failed to accept the plan, or do not understand that there are times when there are relatively large numbers of fish returning which cannot be fished. There may also be lobbying to take a greater proportion of the catch in Johnstone Strait, where the quality is higher.

3.10.7 Management Strategies for Stock Rebuilding

As mentioned earlier, DFO (with industry input) has recently developed a new management approach for inside chum salmon. In the course of developing this approach a number of alternatives were examined. These, along with some others, are summarized below; modeling results for these Options are provided in Section 3.10.9.

Option 1. Scheduled Harvest Rate (The approach in current use): The total harvest rate in all fisheries combined is dependent on the magnitude of the run through Johnstone Strait; the size of the run is determined early in the season. In the absence of specific information on numbers of fish from enhanced and U.S. stocks, for the first two years they would be assumed to be fixed. Allowance was also made for catches in U.S. Area 7 and 7A. One of the objectives was to ensure that Fraser escapements were at least 500,000. The schedule adopted was:

a) 0-2,600,000 run: In order to assess total abundance, no commercial fishing would be permitted except in Johnstone Strait during the

third week of September. Indian food fisheries in Johnstone and Georgia Straits and in the Fraser River would be permitted. Together with test fishing, the harvest rate would be 5-10%.

b) 2,600,000-3,200,000 run: A harvest rate of 20% would be permitted, including Indian food fishing. Commercial harvests would be allocated between Johnstone Strait, Fraser River and U.S. fisheries.

c) 3,200,000-4,600,000 run: A harvest rate of 30% would be permitted.

d) 4,600,000 and higher run: A harvest rate of 40% would be permitted. Putting an upper limit to the harvest rate would result in relatively large escapements, possibly exceeding provisional target escapements in some cases. By evaluating subsequent returns from large escapements, potential long-term spawning requirements could be more accurately determined.

This option had the advantage of fairly rapid rebuilding (estimated 3 cycles or 12 years), while still providing a considerable amount of fishing time.

Option 2. Fixed Escapements: The escapement would be set at the perceived optimum of 2,700,000, and commercial fishing permitted only when the run exceeded this number. This option has the advantage of potentially rebuilding stocks more quickly, and once the stocks were rebuilt there should be relatively few years with no fishing. A disadvantage was that unless adjustments were made to take enhanced fish into account, the harvest rate for wild stocks would be greater than desired.

Option 3. Fixed Harvest Rate: The harvest rate could be fixed at some predetermined level, and fishing permitted each year regardless of run size. Modelling has indicated that a harvest rate of 30-35% would rebuild stocks in about 20 years and provide substantial catches during the rebuilding process. A lower harvest rate (about 20%) would rebuild stock more quickly but may result in forgone catches in the long term. A harvest rate of about 40% would maintain current stock levels if returns to escapement remain average, but will not rebuild stocks.

Option 4. Mixture of Scheduled Rate Harvests and Fixed Escapements: This mixture of Options 1 and 2 involved incremental changes in harvest rate as run size increased. However, for runs above the escapement goal of 2,500,000, escapement was set at 2,500,000. For runs about 4,600,000 management would revert to a harvest rate policy of, e.g. 40%. This should rebuild stocks more rapidly than Option 3 but would result in lower catches than would a straight 30% harvest rate policy.

The options discussed above are designed to rebuild wild stocks within the south coast area. While setting harvest rates in Johnstone Strait at a level compatible with wild stock productivity, there will coincidentally be some harvest of enhanced stocks. Since enhanced stocks have much greater rates of productivity than do wild fish, they can tolerate additional harvesting. The principal example of this in the south coast area is Qualicum River chums. Management approaches to this stock are discussed in Section 3.3.

3.10.8 Future Stock Enhancement Activities

No further major enhancement of Fraser River chums should take place until the results of Phase I chum production is evaluated and a workable management approach developed. At present, all the major chum stocks and many of the minor ones are enhanced. Additional major enhancement for rebuilding of stocks is not required. The present approach is to utilize enhanced chum to supplement natural spawning, thereby making full use of the natural spawning grounds. As this approach is only being tested now, it will be several years before it can be fully evaluated. If the approach is successful, harvest rates in the Fraser could be increased to take advantage of returning hatchery fish; otherwise, low harvest rates will be required and will lead to large hatchery surpluses.

Habitat improvements including spawning and rearing channels are acceptable. Increased production of enhanced stocks is also acceptable provided the enhancement rates and scale are not too large. Surplus production from these types of projects will help to augment wild spawning.

3.10.9 Predicted Results

To evaluate the options described in Section 3.10.7 each option was incorporated into a stochastic model. Four hypothetical stocks were created and moved through several fisheries. Figure 3.10-4 outlines the approach. To initialize the model, past escapements for the Fraser and all other southern area chums were incorporated. For the first set of model and experiments, the Fraser enhanced stock levels were held at 75,000, the mid-Vancouver Island chums at 450,000 and the U.S. chums at 150,000. Table 3.10-3 details the timing of rebuilding for Fraser and other chums, and the average wholesale revenue generated over 20 years. The table illustrates the range of options available to rebuild stocks in both the Fraser and all other areas. The choice of Option 1 was a result of the desire to provide fishermen harvest opportunities in as many years as possible, as well as rebuilding all stocks within three cycles.

Given the results of these model runs, further experiments were run with returns of 1,500,000 more fish from enhanced stocks to the Johnstone Strait - Fraser River areas by 1986. Table 3.10-4 summarizes the results of model runs utilizing this increased escapement in conjunction with a revised harvest strategy. The results of the model for Option 5 indicated that modification of current management strategy would be required to achieve rebuilding if enhanced production were substantially increased. Options 6 and 7 had increased threshold requirements at each harvest rate. Rebuilding only occurred (within three cycles) once the initial threshold exceeded 4 million.

This description illustrates the need for altering the current management strategy, given the expected growth in enhanced returns. Further review of the options and presentation to the Johnstone Strait - Fraser River Chum Advisory Board is required prior to recommending an approach. In general, enhancement could increase the speed of rebuilding all chum stocks. However, enhancement should be designed to increase the potential of stock aggregates concurrently, rather than in separate sectors as has currently been done. The policy should be to create small outplanting facilities with similar productivities within all geographic groupings.

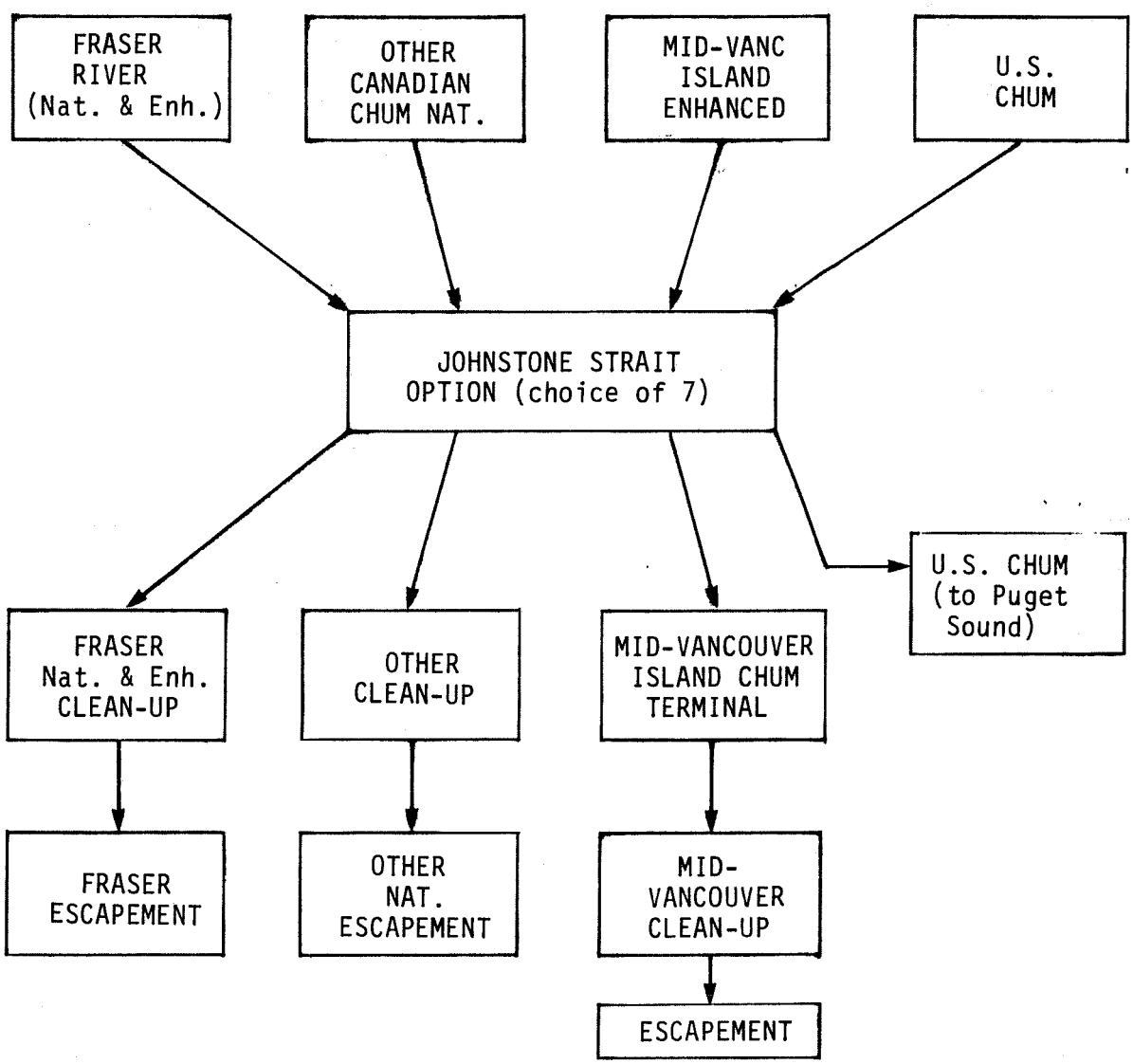


Figure 3.10-4. Model of chum movements through inside fisheries.

Table 3.10-3. Summary of model evaluations for Options 1 to 4.

Option		Rebuild		Total Value (millions of $)
		Fraser	Others	
1.	Status quo	1988	1995	3.17
2A.	Fixed escapement @ 2.5 million	Maintain 650,000	No rebuilding	3.49
2B.	Fixed escapement @ 4.0 million	1985	1988	3.29
3A.	Fixed harvest rate of 20%	1988	1995	2.61
3B.	Fixed harvest rate of 30%	1992	1999	3.28
3C.	Fixed harvest rate of 40%	<650,000	No rebuilding	3.15
4.	Advisory	1989	Slow rebuilding	3.31

Table 3.10-4. Summary of model evaluations for Options 5 to 9.

Option[1]	Rebuilding		Total Value (millions of $)
	Fraser	Others	
5. Current Management 0-2.6 @ 7% 2.6-3.2 @ 20% 3.3-4.6 @ 30% >4.6 @ 40%	1985	maintains at 1 million	4.60
6. 0-3.5 @ 7% 3.5-4.2 @ 20% 4.2-5.6 @ 30% >5.6 @ 40%	1985	slow rebuilding	4.22
7. 0-4.0 @ 7% 4.0-4.6 @ 20% 4.6-6.0 @ 30% >6.0 @ 40%	1985	1985	4.37
8. Fixed harvest-rate of 30%	1985	slow rebuilding	4.20
9. Fixed harvest-rate of 40%	1988	maintains at 0.8 million	4.67

[1] 0-2.6 @ 7% = up to 2.6 million returns will be harvested at a rate of 7%.

3.11 Integrated South Coast Management

3.11.1 Introduction

The U.S./Canada treaty will have two long-awaited effects on the management of south coast and Fraser stocks and fisheries. First, it permits management of fisheries on an integrated basis, since Canada will have control over all fisheries in Canadian waters. In the future, managers will be able to plan the harvest of major Fraser sockeye and pink stocks previously managed by the IPSFC. Second, the treaty establishes allocation rules to ensure that Canada will benefit from enhancement of Fraser sockeye. However, there is a serious risk that increased harvesting of Fraser sockeye stocks may interfere with rebuilding of other stocks, e.g. chinooks, coho and pinks that are already depressed because they are taken with Fraser sockeye in Johnstone Strait and/or Juan de Fuca Strait.

The degree to which Fraser sockeye enhancement will conflict with rebuilding must be addressed in the light of greater flexibility in future fishery management. Approximately 100 stocks (natural and enhanced) and 40 fisheries must be considered. The DFO is currently carrying out a major analysis to address this complex question. A very preliminary evaluation of part of the question is presented in the remainder of this section.

3.11.2 Method of Evaluation

A spreadsheet simulation model was used to assess current fishing patterns on Fraser sockeye and evaluate the effects of management changes. The latter was accomplished by a two-step process:

1. Examine changes in fishing patterns required to catch the surplus sockeye produced by natural stock rebuilding and by new enhancement facilities; and

2. Evaluate the effects of new fishing patterns on low productivity sockeye stocks with low productivity, as well as on Fraser River chinook and coho stocks.

Figure 3.11-1 displays the sequence of calculations in the simulation model.

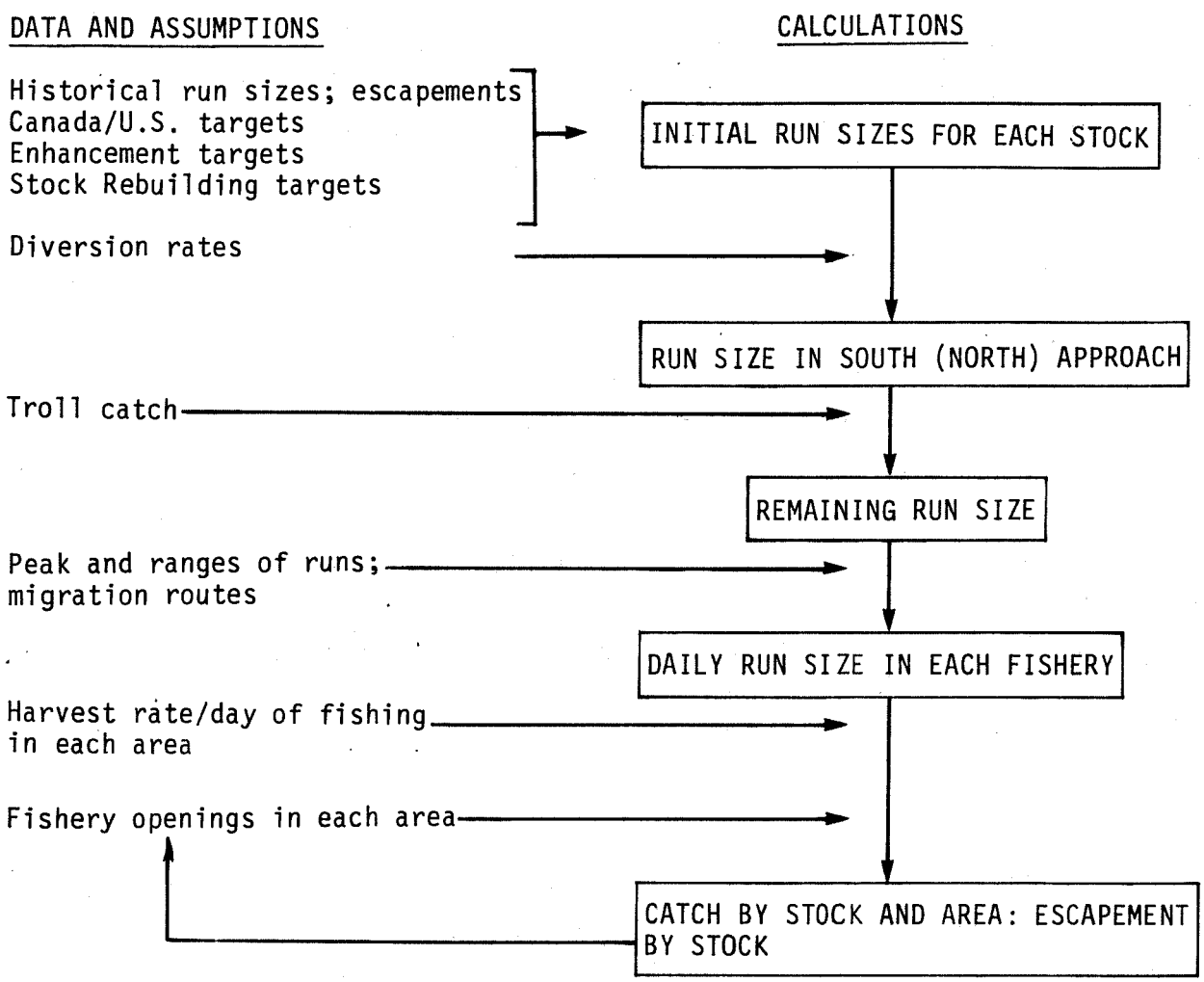


Figure 3.11-1. Sequence of calculations for the simulation management model.

3.11.3 Strategies

There are two major strategies under consideration for increasing production of Fraser River sockeye stocks: natural stock rebuilding, and enhancement activities. To assess the change in fishing patterns arising from these two strategies, each of the four cycle years was considered under three scenarios:

1. Base Case;

2. Stock rebuilding scenario; and

3. Stock rebuilding and enhancement scenario.

In brief, the Base Case (Option 1) used projections of 1985-1988 run sizes; the stock rebuilding Option (2) used returns from optimum escapements; and the stock rebuilding and enhancement scenario (Option 3) used returns from optimum escapements plus production from enhancement activities. The diversions of southbound Fraser River sockeye through Johnstone Strait (rather than to the west of Vancouver Island) has a significant impact on fishing patterns. Therefore, additional stock rebuilding and enhancement scenarios were run to evaluate the effects of different diversion rates.

3.11.4 Predicted Results

In order to harvest the additional sockeye produced by stock rebuilding and major enhancement projects, it was necessary to alter current fishing patterns. Required changes are described for each cycle year.

3.11.4.1 1985 Cycle Year

The major increases in sockeye production would occur in early Stuart and Horsefly runs, which return during the early part of the season (late June to early August). In order to harvest the surplus production, fishing effort must be increased, particularly early in the season in Areas 20 and 29.

Sockeye stocks with lower productivity may be overfished, especially some mid-summer stocks (e.g, Chilko, Stellako) which migrate with the Horsefly run. Chinook stocks, however, would be severely affected because of the intensive fishing during the peak chinook runs (June and July). If the diversion of sockeye through Johnstone Strait were low, fishing patterns in the U.S. would not change appreciably. However, a high diversion rate would result in intensive fishing in U.S. waters in order to harvest the U.S. sockeye quota. This fishing pressure would have major adverse impacts upon U.S. chinook stocks under the Base Case; however, stock rebuilding and enhancement would alleviate this situation.

3.11.4.2 1986 Cycle Year

The dominant run in the 1986 cycle year is that of the Adams River. Lake fertilization for Adams River sockeye is the major potential source of increased production. Further enhancement of Adams sockeye may aggravate existing management problems for the 1986 cycle year as follows:

1. Increased fishing effort in Area 29 would have significant effects on chinook stocks during early August;

2. Late openings in Area 20 would adversely affect both immature and adult coho;

3. Several sockeye stocks would not meet target escapement; and

4. There would be little flexibility to vary fishing patterns, since the low quality of Adams sockeye in terminal areas would result in intensive fishing in Johnstone Strait and Juan de Fuca Strait to harvest the available surplus.

3.11.4.3 1987 Cycle Year

Major stock rebuilding and enhancement activities for early Stuart, Stellako, Chilko and Adams sockeye were evaluated. Harvesting the surplus production may require important changes in fishing patterns in several areas (e.g., Areas 20, 29, U.S. 7A, and Johnstone Strait). The possible effects of such changes are outlined below:

1. Heavy fishing in Area 29 during late July and early August would coincide with the peak of several Fraser River chinook runs;

2. Increased sockeye fishing in Johnstone Strait would be detrimental to several stocks of pink salmon (some spawning in rivers near Johnstone Strait, some Fraser River pinks, and some U.S. pink stocks); and

3. Fishing in Area 20 during late August and September would be expected to harm coho stocks.

3.11.4.4 1988 Cycle Year

The stock rebuilding and enhancement activities considered for the 1988 cycle year were relatively minor. The largest proposed increase in production was slated for Chilko stocks, primarily from fertilization. In addition, production from several miscellaneous stocks might increase due to natural stock rebuilding and the construction of spawning channels. The following changes in fishing patterns compared to the Base Case might occur:

1. One additional day of fishing per week would possibly take place in Area 20 during the last week of July and the first week of August, and an additional week of fishing would possibly occur towards the end of August; and

2. Area 7A (U.S.) would possibly be closed one week earlier.

Increases in early harvesting in Area 20 could reduce escapements of chinook stocks. There is, however, some uncertainty over the vulnerability of chinook stocks in Area 20. Also, the high harvest rate of the Stellako sockeye represents a potential problem, since the 1988 cycle is considerably less productive than the dominant cycle.

3.11.5 Direction for Further Assessment

The preceding analysis has indicated that there could be significant detrimental effects of major enhancement projects on the Fraser River. This preliminary assessment of major projects suggests further analysis is required.

The following points are intended to provide direction for a more detailed assessment of the effects of major Fraser River enhancement projects.

3.11.5.1 Changes in Fishing Patterns

Currently, the simulation model "moves" projected salmon stocks through a number of sequential fisheries. Fishing plans (e.g., area and duration of fisheries) are designed to allow the U.S. catch to reach its goals, and allow optimum escapement for the major stocks. Since there is considerable overlap in the timing of sockeye stocks returning to the Fraser River, several stocks may be caught in a given fishery. In order to harvest the additional sockeye produced by major enhancement projects, it is necessary to alter the fishing patterns modelled in the Base Case. The increase in fishing pressure required to harvest enhanced stocks causes relatively weak natural stocks to decline over time. An alternative approach for future assessment is to let natural stocks dictate fishing plans (i.e., apply Base Case harvest rates to total production).

3.11.5.2 Uncertainty Associated with Enhancement Projects

Stocks expected to be produced by enhancement projects are aggregated in the model. There are no sensitivity analyses done on production expected from enhancement. There is, however, considerable uncertainty associated with lake fertilization, as well as some uncertainty associated with the construction of spawning channels. Therefore, it may be useful to conduct sensitivity analyses on production from enhancement, and to assess spawning channels and lake fertilization projects separately.

3.11.5.3 Indian Food Fishery

The Indian food fishery accounts for 400,000 to 500,000 Fraser River sockeye annually. This harvest is deducted from escapement after commercial harvests and taken into account. It would be possible to incorporate the Indian food fishery into the overall harvesting strategy, thus making Indian harvests more stock-specific and consistent with target escapements.

3.11.5.4 Miscellaneous Stocks

For each cycle year, the model treats the five major sockeye stocks individually, while all the relatively small stocks are aggregated into a single miscellaneous category. The run timing of miscellaneous stocks is distributed normally over the season. However, it would be more accurate to have a uniform distribution of the run timing of miscellaneous stocks.

3.11.6 Impact of Additional Sockeye Production on Chinook and Coho

Further investigation is required to assess the impact of more intensive sockeye fishing on chinook and coho stocks. Currently, the assessment is hampered by:

1. the inability to determine the stock composition of chinooks and coho harvested in several areas (e.g., chinooks in Area 29).

2. the uncertain effects of reduced chinook catches by major hook-and-line fisheries for particular stocks. Catch quotas may reduce the harvest of all chinook stocks (i.e., by reducing catch throughout the season) or reduce the harvest of some stocks a great deal while harvesting others at a high rate (by opening late and closing early).

3.11.6.1 Diversion Rates

Better estimates of diversion rates are required to assess accurately the effects of fisheries in various areas. More information on diversion rates can be obtained from test fishing and echo sounding.

3.11.6.2 Johnstone Strait Fishery

The effects of reducing the fishing area in Johnstone Strait (i.e., to the Lewis Point boundary) should be modelled.

3.11.6.3 Strait of Georgia Troll Fishery on Adams River Sockeye

The effects of a troll fishery for Adams River sockeye in the Strait of Georgia should be modelled.

4.0 CHINOOK SALMON RESOURCE MANAGEMENT PLAN

4.1 Overview

Since there are major differences between the dynamics of hook-and-line and net fisheries, the following discussion has been organized differently from those dealing with the harvest of sockeye, pink and chum salmon.

Chinooks are harvested primarily by the commercial troll fishery and the ocean sport fishery, and incidentally in the terminal and ocean net fisheries. Chinooks captured in a troll fishery cannot readily be allocated to any particular river system or stock; furthermore, their long migrations and long ocean residence time can expose them to several fisheries sequentially. Management is further complicated by the fact that many different chinook stocks are taken in the same fishery at the same time and that fish forgone or missed by one fishery may simply be harvested somewhere else. Consequently, in most ocean situations, chinooks can be managed only as large stock groups, not as individual stocks. Thus, the following section is not divided into discussions of specific stocks or areas, but deals with five broad stock groupings and with major interception fisheries. Options for rebuilding chinook stocks are defined in terms of possible regulatory actions for major interception fisheries, and are assessed in relation to rebuilding of wild stocks as represented by indicator stocks in each of the major stock groupings (see Glossary for definition of interception fishery)

The management of Canadian chinook stocks requires co-operation and agreements between Canada and the U.S. The new Canada/U.S. salmon agreement, therefore, is central to the formulation of rebuilding plans for chinook in this report. Strategies for rebuilding chinook stocks must be driven by the life-history strategies of the fish. Canadian chinooks migrate north and, as a consequence, Alaskan troll fisheries catch large numbers of Canadian fish, i.e., those originating in Canadian streams. On the other hand, the Canadian troll fishery off the west coast of Vancouver Island catches large numbers of chinooks originating in Washington and Oregon. Few Alaskan or northern British Columbia chinooks are vulnerable to Canadian interception fisheries.

Chinooks have the most complex life history of any species of Pacific salmon. There are many variations in time of emergence, freshwater residency strategies, ocean dispersal and age of maturity. In effect, many sub-groups of chinook salmon behave as if they were different species. These sub-groups have different productivities, optimum escapements and optimum exploitation rates. Regulatory changes designed to rebuild depressed chinook stocks must take into account these different life-history strategies and the expected impact on each of the chinook sub-groups.

The management implications of various chinook life-history strategies as well as the commitments and management implications of the Canada/U.S. Treaty must be thoroughly understood before stock rebuilding strategies can be sensibly discussed.

4.1.1 Management Implications of Chinook Life-History Strategies

Chinooks typically emerge from the gravel from early March to late May, depending on the ambient water temperature during incubation and the time of spawning. Chinooks spawning in the colder interior streams of the Fraser and Skeena emerge relatively late, while the warmer rivers of Vancouver Island and lower Fraser River produce much earlier seaward migrations. Chinook fry, after their initial downstream dispersal, are often classified into two major life-history patterns, based on length of the freshwater rearing period. Fish following these patterns are:

1. "Ocean-type" migrants that have a limited post-emergent freshwater phase of some 0 - 150 days; and

2. "Stream-type" migrants that have an extended freshwater phase of up to a year or more.

It should be noted that a river system can support both migrant types; however, the characterization of a stock into migrant types is a potentially useful management tool.

4.1.1.1 Ocean-Type Fry Migrants

Ocean-type migrants are reared in fresh water from 0 - 150 days after emergence from the gravel, before commencing their seaward migration. Examination of scales from returning adults indicates that this is the dominant lifehistory pattern among chinooks. This pattern is primarily followed by stocks that have later runs, which are usually referred to as "fall run" fish. However, the distinction can be ambiguous, because many fish that run in early summer also use this life-history strategy. Peak seaward migration time varies with emergence time: e.g., migrations from warmer Vancouver Island streams often peak in early June, while migrations in colder rivers such as some Fraser tributaries peak in late July.

Some ocean-type migrants migrate to sea immediately as fry, a strategy which seems to be confined entirely to late-run or "fall-run" stocks in Georgia Strait. The Cowichan, Nanaimo and Harrison (a Fraser River tributary) rivers have stocks that largely follow this life-history strategy. These stocks, particularly the Harrison stock, appear to be very productive, possibly because of the presence of a large estuary. Rivers such as the Big Qualicum, with little or no estuary, do not have a large component of fry migrating to sea immediately after emergence.

4.1.1.2 Stream-Type Fry Migrants

Chinook juveniles which remain in fresh water for an entire winter and migrate to the sea in their second spring, are commonly referred to as "stream-type" chinook. Such fish are usually less common than the ocean-type chinook. River systems in which chinooks tend to overwinter are generally more northerly in location, such as the Taku River in northern British Columbia; or more distant from the sea, such as the upper tributaries of the Columbia River and the upper Fraser River; or have early spring runs, such as the Willamette River in Oregon. Peak seaward migration probably occurs in April or May of the year following emergence.

4.1.1.3 Ocean Distribution

Information on the ocean distribution of chinooks comes from a variety of sources: tags which are implanted on the high seas and then tracked to the

river of origin; examination of scales for age at the time fish are caught to determine life-history type; and the marking of juvenile fish at the time of release. These studies all confirm that once chinooks reach the ocean they move northward along the coast. This means that any ocean fishery tends to exploit stocks that originate to its south. Chinook are largely coastal feeders, staying in areas that are vulnerable to all major gear types that exploit Pacific salmon. Some are caught by seiners, or by sport gear (as shakers) in the spring of the year following their seaward migration.

Evidence from scale identification programs has shown that stocks with different life-history strategies may have significantly different ocean distributions. Stream-type stocks have a more seaward distribution than ocean-type stocks, which are caught in proportionately greater numbers in the coastal troll fisheries. Also, ocean-type stocks appear to be more productive than stream-type stocks.

4.1.1.4 Spawning Migration and Timing

Some chinook salmon mature after only one full year at sea (precocious males or "jacks"). The majority spawn after two or three years at sea. Therefore, the dominant age class is age four for ocean-type fish and age five for stream-type fish (in British Columbia). Some chinooks may spend a fourth year at sea and return at age five or six. The latter are more common in cold northerly streams. Chinooks are therefore vulnerable to harvest for a long period of their life, which makes their management very complex.

Some chinook stocks begin their spawning migration early in the spring. These stocks usually follow the stream-type life-history strategy and are generally termed "spring runs". Typically, stocks which return to the natal river prior to mid-June fall into this category. Important British Columbia spring-run stocks include those returning to the Skeena, Nass, Bella Coola and Fraser rivers. The correlation between stream migrants and spring runs is not perfect. For example, Atnarko River chinook are primarily ocean-type migrants but the run returns during spring. "Summer runs", which return to the natal river from late June to early August, are mixed ocean- and stream-type in life-history strategy. The most prominent return to the Fraser River is a summer run. Stocks returning to the natal river in August can be considered

to be in this category, and include stocks from the South Thompson and its tributaries. Many stocks from the east coast of Vancouver Island, and the Harrison River stock are "fall-run" chinooks, returning to the natal river from late August to early October. The distinction between summer and fall runs is difficult during August. For example, some stocks which return in August to the Columbia, Somass and Thompson rivers have been classified as "fall-runs".

4.1.2 Management Implications of the Canada/U.S. Treaty

In the spring of 1985, Canada entered into a coast-wide salmon interception agreement with the United States. A key component in the agreement is an annex (the Chinook Annex) which forms the basis of joint regulation of chinook catches in the mixed stock ocean fisheries, especially by hook-and-line gear. By signing this agreement, Canada is committed to a 15-year (3-cycle) rebuilding program for the most depressed naturally-spawning chinook stocks. In the next two years (1985 and 1986), all major coastal interception fisheries have been assigned catch ceilings. From 1987 onward, Canada is committed to continue the rebuilding process. During the rebuilding period, however, user groups will be guaranteed a minimum catch.

An important aspect of the Chinook Annex is the setting up of a joint Technical Committee which will oversee the rebuilding process for the two countries. According to the agreement, this committee will assess the rate of rebuilding and the abundance of stocks, and recommend adjustments to catch levels that will be allowed in succeeding years. By participating in this committee, Canada's management of chinook stocks will be subject to scrutiny by technical experts in the new committee.

Previously, this Technical Committee has been a scientific forum for the analysis and exchange of chinook data. In spite of the weakness of the available data, scientists from both countries have been able to agree on the rates of chinook productivity, on estimated levels of chinook abundance, and on methods by which the data are to be analysed. The committee has submitted two joint reports detailing the current problems with chinook management and providing some guidance in the choice of broad management options. The committee jointly developed an assessment model to evaluate each country's negotiating

proposals. The stock rebuilding strategy that evolved in the negotiations and the numerical levels of catch in the Annex are a direct result of the discussions and deliberations of the joint Technical Committee. The actual catch numbers used and the choice of a three-cycle rebuilding schedule were arrived at through negotiation.

4.2 Stock Description

For the purpose of these discussions, chinook stocks are grouped into five major stock complexes. The stocks in each complex originate in the same general geographic area, have similar life histories and ocean distributions, and are subject to similar ocean fishing patterns. The nature of the fisheries makes these stock complexes the smallest feasible management units.

The status of each of the following stock complexes will be discussed individually:

1. North Coast (Statistical Areas 1 - 5);
2. Central Coast (Statistical Areas 6 - 10);
3. Georgia Strait (Statistical Areas 11 - 19 and 28);
4. West Coast Vancouver Island (Statistical Areas 20 - 27); and
5. Fraser River and Tributaries (Statistical Area 29).

The Fraser River has been further divided into three major sub-stocks to account for differences in geographic location, life history, ocean migration patterns and interception rates in ocean fisheries. In addition, the Squamish River is included under the designation of the Lower Fraser area. Escapements by these stock complexes since 1953 are presented in Table 4.2-1.

Ideally, stock status is assessed through stock recruitment analyses. However, such analyses depend on a determination of stock-specific harvest rates and escapements. For most wild chinook stocks, total harvest cannot be directly determined nor can total catch be allocated between various fisheries. Consequently, the best indices of stock health for chinook are trends in catch, effort, and escapement. Trends in catch and effort will be discussed on a coastwide basis (Section 4.4), while general escapement trends will be considered for each stock complex. The stock descriptions presented below are summaries of the more detailed descriptions to be found in North and South Coast sections (Sections 2.0 and 3.0).

4.2.1 North Coast

North Coast chinook stocks are composed almost entirely of populations from the Nass and Skeena Rivers. The Yakoun River in Masset Inlet is the only

Table 4.2-1. Chinook escapements.

Year	Chinook Escapement by Stock Group								
	North Coast	Central Coast	W. Coast Van. Is.	Georgia Strait	Lower Fraser	Upper Fraser	Thompson River	Total Fraser	Total B.C.
1953	34,100	28,600	40,800	96,700	19,100	14,300	42,600	78,600	278,900
1954	42,100	39,700	35,100	104,100	18,300	13,200	22,400	53,900	274,800
1955	48,200	34,600	29,600	96,900	10,500	9,700	21,000	41,200	250,400
1956	49,100	51,000	33,900	77,500	6,900	8,300	11,400	26,600	238,000
1957	60,700	23,200	30,100	79,400	9,300	9,600	24,800	43,700	237,100
1958	58,600	50,300	32,000	84,800	21,600	15,100	34,900	71,600	297,300
1959	119,500	20,800	21,800	75,900	20,400	9,000	22,500	51,900	289,900
1960	36,100	22,300	22,900	61,400	5,400	4,300	20,100	29,800	172,500
1961	24,000	27,900	22,700	49,700	6,700	6,000	21,000	33,600	158,000
1962	31,100	37,600	22,900	69,600	7,100	12,800	27,900	47,800	208,900
1963	38,200	73,700	28,500	64,900	15,800	9,200	18,500	43,400	248,800
1964	43,200	62,800	46,400	77,500	8,800	20,300	26,000	55,000	284,800
1965	44,900	40,800	30,800	95,000	10,100	11,300	19,800	41,100	252,600
1966	42,100	58,800	38,500	75,200	11,500	10,300	16,000	37,800	252,400
1967	53,300	55,800	31,600	51,900	8,700	11,700	31,000	51,500	244,000
1968	52,300	27,200	31,000	63,300	35,400	11,800	23,800	71,000	244,900
1969	59,800	26,400	26,500	58,500	9,500	14,600	32,200	56,300	227,500
1970	41,000	29,000	29,000	96,000	11,000	21,900	30,100	63,000	258,000
1971	41,000	67,000	28,000	61,000	23,000	14,700	21,800	59,500	256,500
1972	38,000	39,000	28,000	62,000	16,900	11,500	20,000	48,400	215,400
1973	52,000	47,000	34,000	72,000	36,600	17,600	27,300	81,500	286,500
1974	49,000	44,000	27,000	55,000	36,400	13,900	26,100	76,400	251,400
1975	37,000	18,000	23,000	51,000	16,200	22,800	41,100	80,100	209,100
1976	25,000	40,000	24,000	54,000	9,100	18,300	17,000	44,400	187,400
1977	38,000	42,000	22,000	51,000	27,100	22,700	30,300	80,100	233,100
1978	35,000	35,000	20,000	41,000	16,300	27,800	28,500	72,600	203,600
1979	26,000	29,000	21,000	49,000	16,400	21,100	25,200	62,700	187,700
1980	33,000	19,000	16,000	36,000	11,000	25,900	19,400	56,300	160,300
1981	33,000	18,000	14,000	34,000	20,900	17,000	23,500	61,400	160,400
1982	23,500	24,300	21,000	24,400	23,900	21,800	20,000	66,300	159,500
1983	25,400	21,000	17,800	24,000	7,700	32,400	20,000	60,100	148,300
1984	50,000	26,000	17,000	19,000	21,000	31,500	25,400	77,900	189,900
Escapement Goals	58,000	46,000	36,000	72,000	36,000	44,000	44,000	124,000	334,000

other noteworthy chinook producer. Estimates of chinook escapements are poor; however, long-term trends seem to indicate a slight decline (Fig. 4.2-1). In addition, a counting fence on the Babine River in operation since 1946 has also shown a decline.

The Cranberry River is the major chinook stock source in the Nass River drainage. The Bear, Morice and Kitsumkalum rivers on the Skeena have all had escapements in excess of 4,000 in recent years and represent the bulk of the escapement to the Skeena. Chinooks produced in these rivers mature primarily at 5 years of age (or older), unlike more southerly stocks, and are more likely to spend at least one winter in fresh water. This greater age at maturity and greater dependence on fresh water probably indicates that these stocks are less productive than other stocks, and therefore can only sustain lower harvest rates.

The non-tidal sport fishery for chinook has been severely restricted, and the directed commercial net fishery has been eliminated by regulations. A modest sport fishery and a net fishery for sockeye and pink salmon still exploits chinook stocks as do the troll fisheries in Alaska and northern British Columbia and the Indian food fisheries on both rivers. Restrictions on the troll fishery in 1984 probably contributed extensively to the improvement in escapement seen in 1984. The run of chinooks through the terminal fishery takes place from March to late July with the peak in early July; spawning takes place from late July to mid-October.

4.2.2 Central Coast

The major chinook producers in the Central Coast are the Kitimat, Bella Coola and Rivers Inlet systems. Because of their early run timing, the Bella Coola stocks are the only Central Coast stocks with a recent history of terminal harvest. Current escapements are well below historic levels (Fig. 4.2-2).

4.2.3 Georgia Strait and Johnstone Strait

Georgia Strait chinook stocks consist of runs returning to streams in Johnstone Strait, the east coast of Vancouver Island and Georgia Strait mainland, but excluding the Fraser. Reported escapement of these stocks exceeded

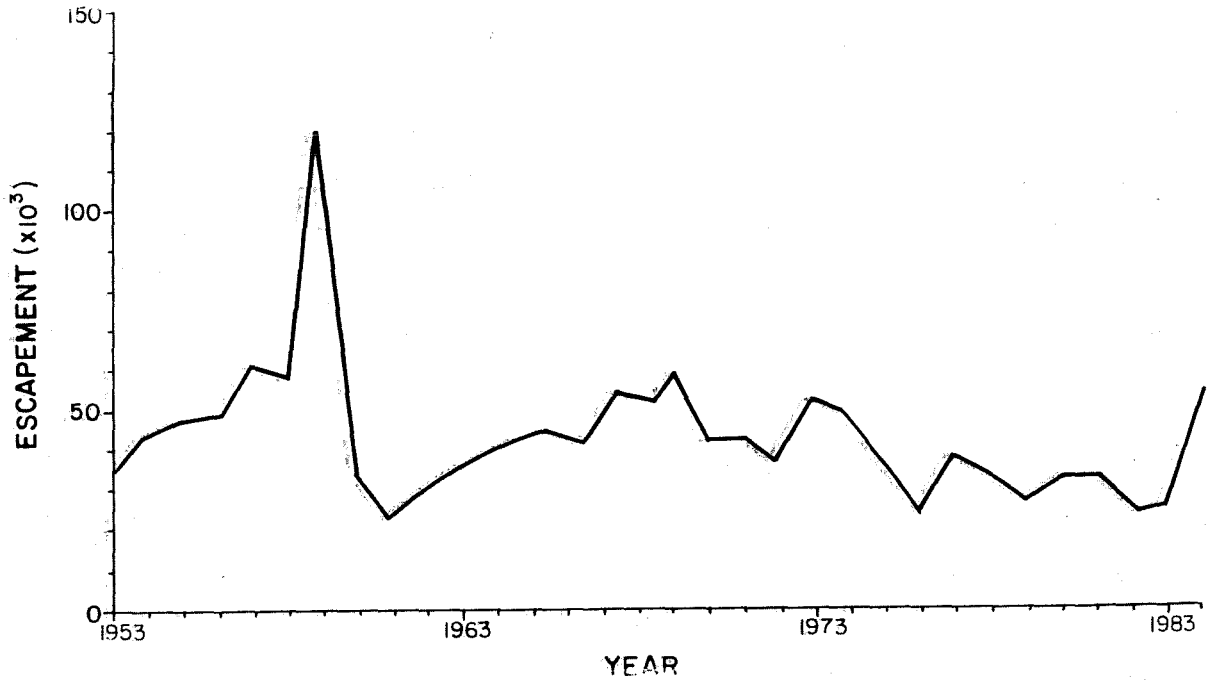


Figure 4.2-1. North coast chinook escapements.

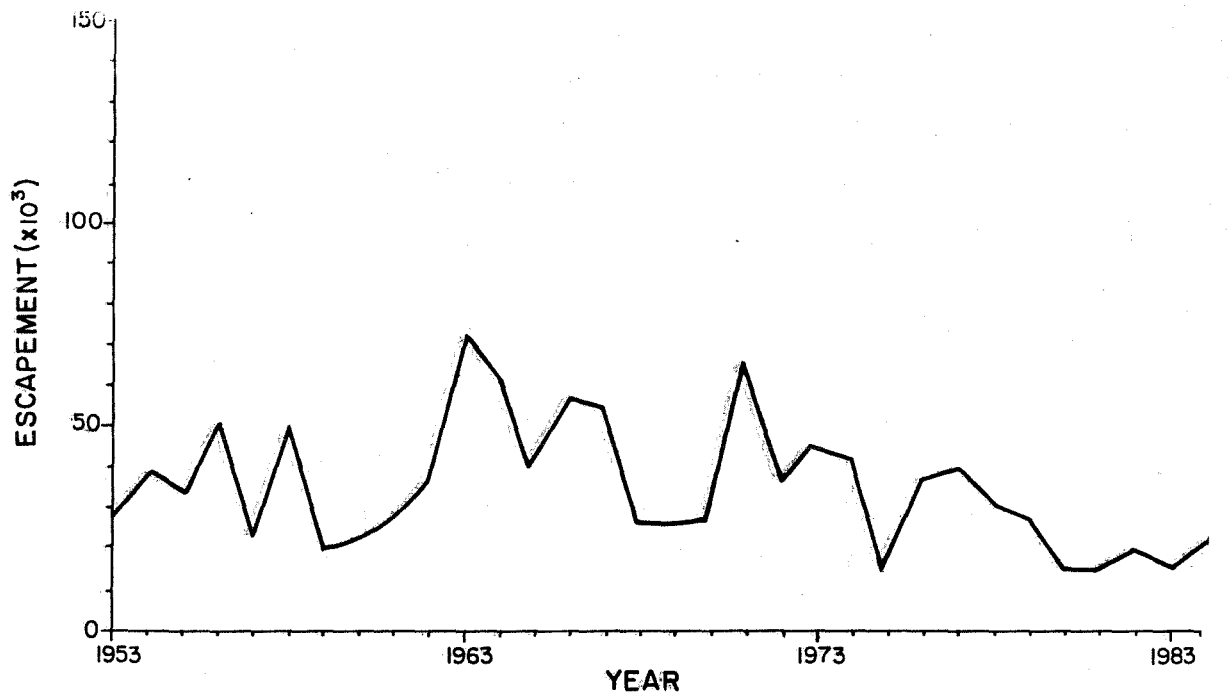


Figure 4.2-2. Central coast chinook escapements.

100,000 in the early 1950's, but has declined to less than 30,000 in recent years. Georgia Strait chinook stocks are still managed on the basis of natural chinook stocks, although many rivers have enhancement facilities. These chinook stocks presently produce less than a third of the escapement goal of 72,000 (Fig. 4.2-3). In fact, in 1983 and 1984, hatcheries in Georgia Strait had difficulties in obtaining sufficient brood stocks.

4.2.4 West Coast Vancouver Island

Chinook stocks on the west coast of Vancouver Island are primarily fall-run ocean-type stocks. These fish mature primarily as three- and four-year-old fish with runs of wild stocks returning to the San Juan, Somass, Nitinat, Sarita, Nahmint, Kennedy, Gold, Burman and Marble rivers. Chinook escapements to all streams on the west coast of Vancouver Island averaged slightly more than 30,000 during the 1950's, and have declined steadily since then. Escapements during the last five years averaged only 18,000 fish (Fig. 4.2-4). However, these streams are remote and poorly enumerated in most cases. In general, West Coast Vancouver Island stocks are considered to be extremely depressed. Existing escapement records probably also include significant straying from Robertson Creek hatchery stocks, which would mean that wild escapements are probably considerably lower than those reported.

4.2.5 Fraser River and Tributaries

Declining chinook catches in the 1970's coincided with an increased awareness of chinook conservation problems, and resulted in greater effort being expended to assess chinook escapements in the Fraser River. At the same time, road access to many remote spawning areas has improved, and greater use has been made of helicopter and fixed-wing aircraft to increase counting efficiency. In general, these factors alone would tend to increase escapement estimates independent of trends in spawner abundance. Nonetheless, estimates of chinook escapement to the Fraser are believed to be a good index of spawner abundance. Chinook test fishing began in the lower Fraser in 1980, and takes place each year throughout the chinook migration. Although the data set is small, a strong correlation exists between the test fishery index and total estimated escapement ($r^2 = 0.98$).

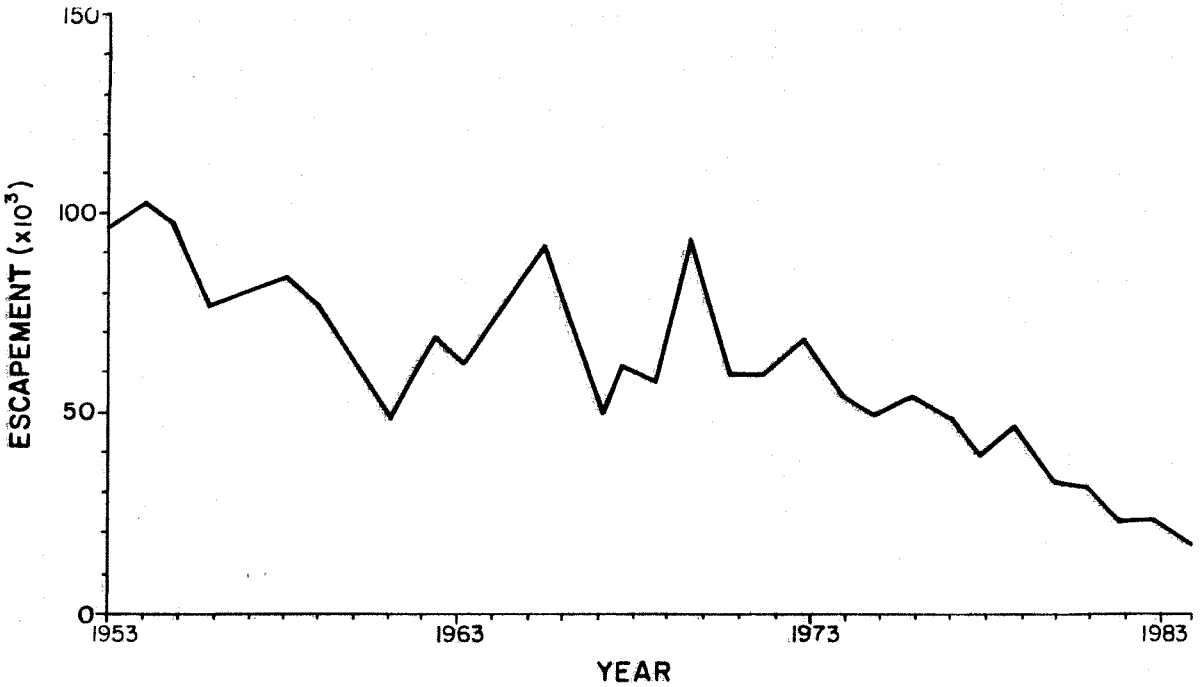


Figure 4.2-3. Georgia Strait chinook escapement.

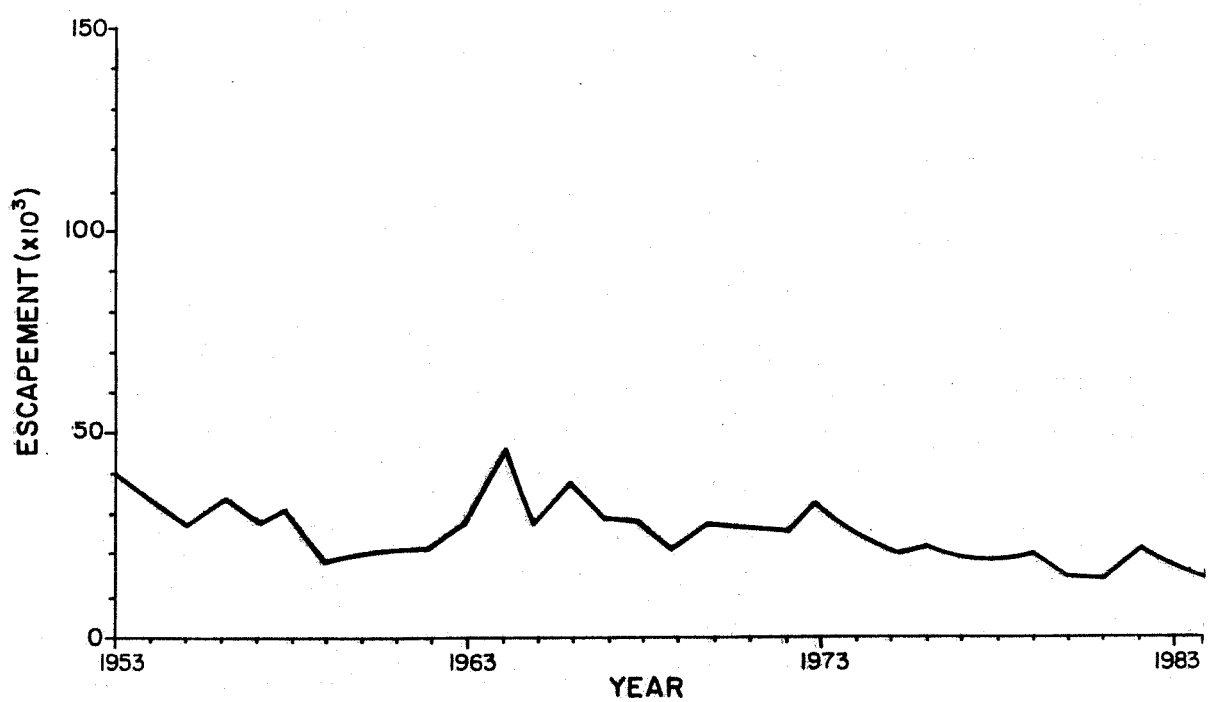


Figure 4.2-4. West coast Vancouver Island chinook escapement.

Fraser chinook stocks can be categorized as early-, middle- and late-timing stocks. Early-timing stocks move through the lower river prior to late June and consist primarily of stocks from Nechako and Stuart rivers and other tributaries upstream of Prince George. Middle-timing chinooks migrate through the lower Fraser between mid-June and the end of August and include the Quesnel/Horsefly and Chilko/Taseko systems of the middle Fraser, as well as the Thompson drainage. Late-timing chinooks move through the lower river in September and October, and consist almost entirely of Harrison white chinooks. Escapement catch and estimated harvest rate of the Fraser River terminal fisheries are presented in Table 4.2-2, with the total run partitioned into early, middle and late periods.

Total escapement of chinook salmon to the Fraser as estimated by Fishery Officers' counts is shown in Figure 4.2-5. The increasing trend with time can probably be attributed to increased enumeration efforts and improved access. Declines since the late 1970's are of great concern in view of a reduction in the average terminal harvest of over 70,000.

Table 4.2-2. Catch and escapement from the Fraser River terminal fisheries averaged over the years 1970-80 and 1981-84.

	1970-80		1981-84	
	Pieces	Harvest Rate	Pieces	Harvest Rate
Early (May 1 - July 15)				
Escapement	22,495		26,436	
Catch Total	44,053	66.2%	11,574	30.4%
Commercial	27,871	41.9	2,079	5.5
Sport	6,950	10.4	0	0.0
Indian Food Fish	9,232	13.9	9,495	25.0
Middle (July 15 - Aug. 30)				
Escapement	25,707		22,172	
Catch Total	44,111	63.2	19,395	46.7
Commercial	36,028	51.6	12,592	30.2
Sport	3,078	4.4	0	0.0
Indian Food Fish	5,005	7.2	6,803	16.4
Late (Aug. 30 - Oct. 15)				
Escapement	17,818		17,000	
Catch Total	26,423	59.7	13,105	43.5
Commercial	20,562	46.5	7,954	26.4
Sport	2,686	6.1	0	0.0
Indian Food Fish	3,175	7.2	5,151	17.1
Total				
Escapement	65,929		62,858	
Catch Total	114,586	63.4	44,048	41.2
Commercial	84,461	46.7	22,625	21.2
Sport	12,714	7.0	0	0.0
Indian Food Fish	17,411	9.6	21,448	20.1

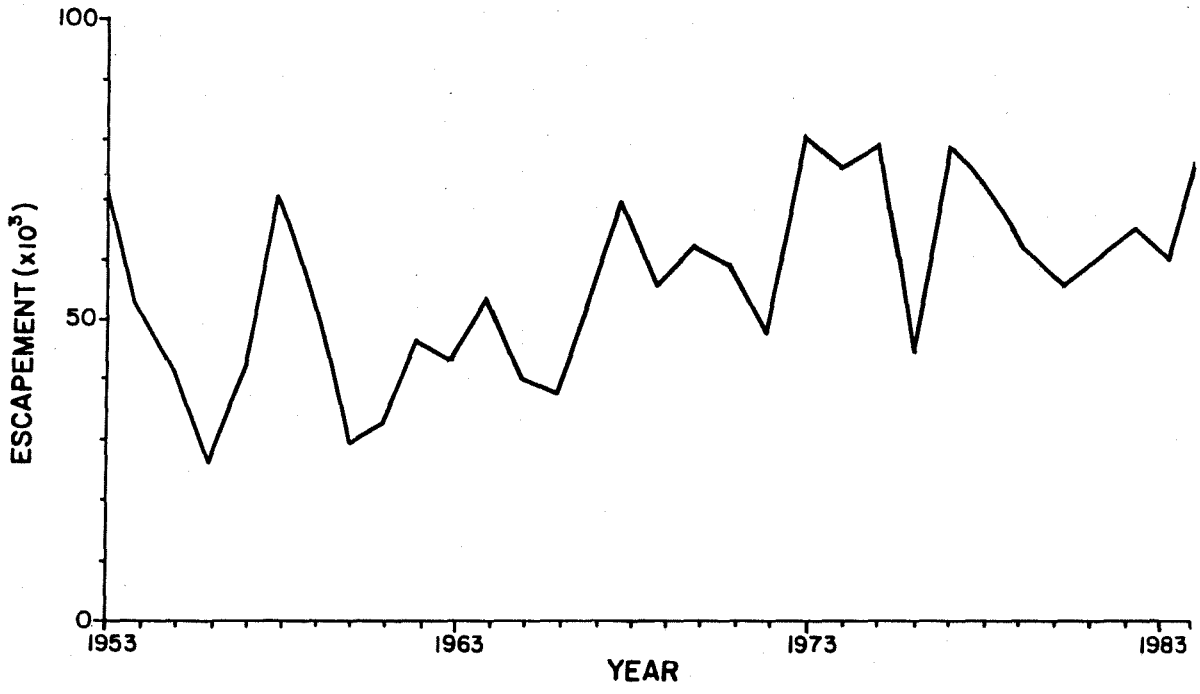


Figure 4.2-5. Total Fraser River chinook escapement.

4.3 Current Enhancement Activities

Enhancement activities for chinook salmon are presented below, grouped into the same stock complexes used for stock descriptions (Section 4.2).

4.3.1 North Coast

North Coast chinook enhancement projects deal with a wide range of stocks, from interior stocks such as Babine to coastal stocks such as Kincolith. Various strategies are used for releasing juveniles. The effect of release strategies for the Upper Skeena area (Babine) are uncertain; however, releases of fish of variable size and age from Kispiox and Terrace facilities should provide useful data for optimization of hatchery yield. Low numbers of wild spawners (i.e., brood stock) limit production from the Kispiox, Masset, Toboggan and Emerson facilities.

The only data available for assessment of North Coast hatchery chinook produced are for Fulton River production of Babine stock of the 1975-1979 brood years. Generally, return rates were low. Table 4.3-1 lists the production capacity of facilities found in the North Coast area.

4.3.2 Central Coast

The only SEP facility in the Central Coast region designed for chinook production is the Kitimat hatchery. An extremely successful pilot operation was run from 1976-1983, with construction of the major multi-species, multi-stock hatchery in 1983. Kitimat hatchery plans included enhancement of Kitimat, Little and Big Wedeene, Hirsch, Dala, Kildala and Bish chinook stocks. Due to budgetary constraints and to logistical problems (e.g., a lack of spawners), the Wedeene and Bish stocks are not being enhanced at this time.

Atnarko chinook enhancement was an addition to the Snootli chum hatchery. Most of the chinook production is returned to the Atnarko River, although some have been released into lower Bella Coola streams which formerly had chinook runs. Wannock River chinook, which are extremely depleted, are also partially reared and tagged by Snootli hatchery staff. The fish are then pen reared to the smolt stage by a local Indian band or released directly into the Wannock River.

Table 4.3-1. Production capacity of North Coast chinook enhancement facilities (estimated from SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Fort Babine	30,000	140	Babine
Kincolith	300,000	1,440	Kincolith
Kispiox	195,000	4,060	Kispiox
Masset	250,000	7,500	Yakoun
Terrace	350,000	8,380	Kitsumkalum, Cedar, Copper
Toboggan	100,000	1,500	Toboggan
Emerson	115,000	550	Bulkley, Morice
Total	1,340,000	23,570	

Table 4.3-2. Production capacity of Central Coast chinook enhancement facilities (estimated from SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Kitimat	2,160,000	64,800	Kitimat, Hirsch, Dala, Kildala
Snootli	430,000	13,000	Atnarko
Oweekeno	200,000	960	Wannock
Total	2,790,000	78,760	

Most chinooks in this area are released as "90-day smolts". Production in all cases has been limited by the lack of availability of spawners. Table 4.3-2 lists the production capacity of facilities found in the Central Coast area.

4.3.3 Georgia Strait and Johnstone Strait

Most significant Georgia/Johnstone Strait chinook stocks are being enhanced to some extent. A major limiting factor is the lack of availability of spawners, even at hatcheries which have been operating for one or more cycles.

Chinook releases in this area are 90-day smolts, except at Goldstream, Vancouver River and Memekay where releases are pre-migrants and at Sechelt where some fish are reared to the yearling stage in sea pens. Most production is fall-run fish but some summer-run production is conducted in Nanaimo, Puntledge and Squamish River systems. The Big Qualicum stock has been used as a donor for facilities on the Capilano and Little Qualicum. Big Qualicum chinooks were also transplanted to Sechelt Inlet and Vancouver River facilities via Capilano Hatchery. The Qualicum stock has proven to be very adaptable, with good returns to streams in which it has been transplanted. Chemainus chinook production has been accelerated using Cowichan eggs crossed with Chemainus milt.

Production capacity in Georgia/Johnstone Strait is substantial (577,000 returns). For example, the projected Big Qualicum hatchery returns alone are almost equal to the total projected returns for all Fraser River hatcheries combined. Production increased greatly in 1984 due to:

1. Expansion at Quinsam (3 times);

2. Utilization of Big Qualicum and Capilano expansions (associated with EXPO '86 coho production) for chinooks (2 times); and

3. Construction of the Devereux pilot hatchery.

It is becoming evident, however, that projected returns of adults are too optimistic. Recent analyses of time trends in chinook smolt-to-adult survival

rates, based on Capilano and Big Qualicum data (1971-1978 brood years), show that ocean survival was moderately low in 1972 and 1973, high in the mid-1970's, and low in 1978 and 1979 brood years. The crucial, but unanswerable question, is whether rates will decline further, stabilize or increase. In any case, Table 4.3-3 lists the production capacity of facilities found in the Georgia Strait and Johnstone Strait areas.

4.3.4 West Coast Vancouver Island

West Coast Vancouver Island chinook production capacity from eight hatcheries is primarily geared to release of 90-day smolts. Releases from the Sooke and Gold River projects are pre-migrants. As is the case elsewhere on the coast, the availability of brood stock constrains production in many cases (e.g., Tlupana, Kennedy, Marble, Sooke).

Smaller facilities on the West Coast deal primarily with local wild stocks or with threatened stocks further afield (e.g., Kennedy stock). Nitinat eggs were transplanted to Sooke a few years ago, but fish are now taken from local spawning populations. Robertson Creek stock is being released from Thornton Creek to build a run to the Ucluelet area.

The large hatcheries at Nitinat, Robertson and Tlupana were designed for single chinook stock enhancement but are now handling several other stocks. Nitinat and Tlupana are large chum producers and there is potential to convert some chum capacity to chinook.

Robertson Creek hatchery stock was developed from Stamp and Sproat stocks. This facility is the largest chinook hatchery in British Columbia, and has been extremely successful up to and including 1984; however, predictions for 1985 and 1986 are poor. Survival rates for the Robertson stock have declined in recent years, with extremely low rates expected for the 1981 and 1982 broods (see sections 4.3.3 and 4.3.5).

Productivity estimates for hatchery and for wild West Coast chinook stocks should be reviewed. Table 4.3-4 lists the production capacity of facilities found in the West Coast Vancouver Island area.

Table 4.3-3. Production capacity of Georgia Strait and Johnstone Strait chinook enhancement facilities (estimated from SEP bio-standards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
L. Qualicum	1,500,000	45,000	Big Qualicum
B. Qualicum	6,750,000	203,000	Big Qualicum
Puntledge	3,600,000	108,000	Puntledge fall, summer
Quinsam	3,000,000	90,000	Campbell/Quinsam
Chemainus	144,000	4,000	Chemainus
Tenderfoot	1,080,000	32,400	Ashlu, Squamish, Cheakamus, Mamquam
Capilano	2,200,000	67,000	Capilano (Big Qualicum)
Devereux	200,000	6,000	Devereux
Cowichan*	500,000	2,400*	Cowichan
Nanaimo	500,000	15,000	Nanaimo summer and fall
Sechelt	50,000	2,100	Sechelt (Capilano)
Nimpkish**	150,000	4,500	Nimpkish
Vancouver R.	50,000	240	Capilano transplant
Goldstream	36,000	170	Goldstream
Memkay	72,000	2,160	Memekay
Total	19,682,000	581,970	

* Cowichan will be releasing smolts in 1985 (i.e., > 5.0 g); therefore, potential survivals to adult will be 15,000, not 2,400.

** Nimpkish has 149,000 eggs in incubation.

Table 4.3-4. Production capacity of West Coast Vancouver Island chinook enhancement facilities (estimated from SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Nitinat	2,500,000	75,000	Nitinat, Sarita
Tlupana	1,440,000	43,000	Conuma, Sucwoa, Tlupana, Conton
Robertson	9,000,000	272,000	Robertson, Nahmint
San Juan	315,000	9,450	San Juan
Thornton	300,000	9,000	Lower Kennedy, Robertson transplant to Thornton
Gold River	72,000	350	Gold
Marble	216,000	6,480	Marble
Sooke	72,000	350	Rocky
Total	13,915,000	415,630	

4.3.5 Fraser River and Tributaries

4.3.5.1 Upper Fraser River

Two basic approaches are taken in Upper Fraser River enhancement efforts. The first is to out-plant pre-migrant fish which are expected to over-winter either in the release stream or lower in the Fraser drainage. This is the strategy for the Penny facility. The second approach is to release larger fish early enough in the year such that they will migrate to sea soon after release. Releases from Quesnel and Fort St. James are assumed to behave in this manner. Survival is felt to be much greater for the larger migrant releases.

Very little is known about the life history of Upper Fraser chinook stocks. In particular, the relationships between stream-type and ocean-type behaviour; the rearing areas for juveniles (some stocks may utilize several rearing areas sequentially) and migration behaviour are all unknown. Upper Columbia hatchery production, especially in Idaho, might provide insights applicable to Upper Fraser chinook enhancement; however, the Idaho program has produced few returns and useful conclusions cannot be made.

Quesnel was designed as a central hatchery with the capability of enhancing several stocks each year. However, Slim Creek chinook eggs have not been taken during the past two years, since the stock was considered strong. More emphasis has since been placed on the MacGregor stock. Studies at Quensel have included time and size at release, release strategy and the inheritability of flesh colour.

Penny and Fort St. James were both initiated as pilot projects to assess feasibility of fish culture in available water supplies with low temperature and high iron content, respectively. Production has also provided an opportunity to assess post-release survival and homing relative to release characteristics.

No data are yet available with which to assess the contribution of Upper Fraser chinook facilities. Table 4.3-5 lists the production capacity of facilities found in the Upper Fraser area.

Table 4.3-5. Production capacity of Upper Fraser chinook enhancement facilities (estimated from SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Quesnel	1,730,000	38,800	Quesnel, Bowron, Cariboo, Horsefly, Indian Pt., Nazko, Baezaeko, Willow, Cottonwood, MacGregor
Fort St. James	170,000	5,100	Stuart
Penny	150,000	1,125	James
Total	2,050,000	45,025	

Table 4.3-6. Production capacity of Thompson River chinook enhancement facilities (estimated from SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Eagle	1,000,000	13,000	Eagle, Salmon
Clearwater	1,000,000	19,000	Clearwater, Raft, Finn, Lemieux
Spius	800,000	13,000	Spius, Coldwater
Shuswap	80,000	1,800	Shuswap
Loon	150,000	3,300	Bonaparte, Deadman
Kingfisher	70,000	350	Lower Shuswap River
Total	3,100,000	50,450	

4.3.5.2 Thompson River

The basic assumption for chinook enhancement in the Thompson drainage is that the stream rearing area is under-utilized; therefore, all releases are of pre-migrants into selected areas. Eagle, Clearwater, Spius and Shuswap are pilot hatcheries; all except Shuswap were designed to handle several stocks, with target stock eggs imported to the hatchery and fry returned to the source.

Since Thompson chinook life history is poorly understood, the pilot hatcheries' capacities were fixed to produce enough fish to allow statistically valid mark release/recovery studies. Studies are planned to examine survival at different dates and sizes of release (including small yearling smolt releases); survival at different planting densities and sites; and the effect of release strategy on homing. Also, interactions between wild and hatchery fry during freshwater rearing are expected to be examined. Table 4.3-6 lists the production capacity of facilities found in the Thompson River area.

4.3.5.3 Lower Fraser River

Enhancement activities in (Table 4.3-7) the Lower Fraser area have dealt primarily with the production of Harrison River chinook at the Chehalis and Chilliwack hatcheries. The objective of the program was to provide a high-quality freshwater fishery. The current 90-day smolt release strategy has been successful. On the other hand, the same strategy has not been successful when applied to the Birkenhead stocks. As a result, various fish culture and release strategies are now being used at Birkenhead in an attempt to increase post-release survival.

The Little Campbell River flows directly into Georgia Strait. Little Campbell releases are pre-migrants, but most likely smolt as sub-yearlings. One point of interest is that many marked adult chinook captured in the Little Campbell originate from U.S. hatcheries. Little Campbell and Birkenhead hatcheries are limited by low adult escapement. Chilliwack and Stave enhanced production is based in transplanted Harrison stock due to low numbers of native chinooks.

Table 4.3-7. Production capacity of Lower Fraser chinook enhancement facilities (estimated from SEP biostandards).

Facility	Production Capacity		Target Stocks - 1984
	Releases	Returns	
Birkenhead	180,000	4,000	Birkenhead
Chehalis	2,160,000	64,800	Harrison
Chilliwack	1,440,000	43,200	Harrison, Chilliwack
Little Campbell	36,000	170	Little Campbell
Stave	50,000	1,500	Harrison transplant
Total	3,866,000	113,670	

4.4 Fisheries

Chinook salmon are mainly caught by major interception fisheries. The fisheries harvesting on chinook salmon can be partitioned into troll, incidental net, recreation and Indian food fisheries. Each are discussed separately below. Historical chinook catches from British Columbia catch regions by troll and net fisheries are presented in Tables 4.4-1 and 4.4-2, respectively.

4.4.1 Commercial Troll Fisheries

The present troll fleet is composed of 1,700 troll vessels and 1,000 combination boats. The troll fishery has been divided into five areas for management purposes:

1) North Coast (Statistical Areas 1-5);
2) Central Coast (Statistical Areas 6-12, 30);
3) Northwest Vancouver Island (Statistical Areas 25-27);
4) Southwest Vancouver Island (Statistical Areas 21-24); and
5) Georgia Strait (Statistical Areas 13-18, 29).

Vessels operating outside Georgia Strait can fish in any region except Georgia Strait, and Georgia Strait trollers cannot fish outside Georgia Strait.

Since 1982 the troll season outside Georgia Strait has opened on 15 April and closed on 30 September. Chinook and coho are the primary target species; however, some troll fishermen target on pink and sockeye during summer months in response to fish prices and run sizes.

4.4.2 Incidental Net Fisheries

Net fisheries for sockeye, pink and even chum salmon harvest chinook and coho incidentally. These fish are taken as rearing fish (prior to maturity) in migration corridors such as Johnstone Strait, in rearing areas such as Milbanke Sound, and as mature fish during their return migration in terminal fisheries primarily directed at pink and sockeye salmon.

Table 4.4-1 Historical chinook catches by Canadian troll and sport fisheries in British Columbia, 1970-1984 (numbers in thousands).

	Troll									
Year[1]	North (1-5)	North Central (6-8)	South Central (9-11, 30)	Georgia Strait (12-20, 29)	SWVI (21-24)	NWVI (25-27)	U.S. (Wash)	U.S. (AK)	Total Troll	Est.[2] Sport
1970	172	45	19	158	311	43	54	15.5	818	123
1971	204	53	18	304	548	68	69	5.9	1,270	134
1972	231	79	48	246	520	59	40	1.0	1,223	175
1973	182	54	35	157	549	62	45	6.5	1,091	223
1974	213	68	33	190	532	97	43	1.5	1,178	271
1975	228	61	39	196	469	79	29	2.6	1,103	386
1976	191	71	55	230	555	102	44	0	1,249	506
1977	132	55	55	279	507	60	23	0.1	1,111	382
1978	145	53	35	229	444	111	16	0	1,033	486
1979	149	57	39	271	401	80	0	0	997	440
1980	159	47	37	280	385	94	0	0	1,002	414
1981	152	34	33	252	316	82	0	0	868	285
1982	196	39	25	190	439	105	0	0	994	196
1983	165	37	54	132	289	96	0	0	772	228
1984	177	34	35	94	331	130	0	0	802	426

[1] 1970-1972 data from DFO published catch statistics. 1983-1984 data are preliminary: 1984 troll data are from in-season catch monitoring and preliminary sales slip accummulations, and may differ from in-season hail figures; 1984 sport data are projected to end of year.

[2] Sport catch estimates prior to 1 July 1980 are based on projections made by biologists and field staff and are subject to revision. Estimates include a fixed catch of 30,000 for northern sport fisheries and exclude WCVI. Estimates for 1981-1982 adjusted due to re-analysis.

Table 4.4-2 Historical chinook (over 5 lb round weight) catches by Canadian net fisheries and the total by troll, net and sport fisheries in British Columbia, 1970-1984 (numbers in thousands).

	Net										
Year[1]	Dixon E. Q.C.I. (1-2)	Skeena Nass (3-5)	North Central (6-8)	Rivers Smith (9-10)	Johnstone Strait (11-13)	Georgia Strait (14-18)	Fraser River (29)	WCVI (21-27)	Juan de Fuca (20)	Total Net	Total Chinook
1970	2.9	21.4	30.9	5.9	37.6	4.3	105.0	2.1	30.6	241	1,182
1971	3.1	19.2	13.3	6.3	26.2	2.9	112.0	6.1	24.2	213	1,618
1972	2.2	24.9	39.4	8.7	26.1	2.0	111.8	4.0	9.1	228	1,626
1973	0.6	25.8	21.7	9.0	29.7	2.7	81.3	5.0	17.7	194	1,507
1974	2.5	22.0	35.6	5.9	30.1	1.6	61.3	7.6	12.9	180	1,628
1975	6.2	18.8	31.3	9.7	30.3	3.3	63.0	19.3	9.8	192	1,681
1976	3.4	12.4	22.9	9.3	31.4	2.5	69.1	16.4	13.0	181	1,935
1977	22.9	21.6	16.3	15.6	49.1	2.7	81.0	13.1	25.1	247	1,741
1978	10.6	17.2	25.5	9.8	55.2	0.9	49.2	13.9	9.7	192	1,711
1979	23.7	17.0	45.2	5.3	31.2	0.6	47.9	18.3	8.6	198	1,635
1980	15.1	11.1	26.0	12.0	29.6	1.7	28.7	33.7	3.4	150	1,567
1981	19.8	21.9	17.9	9.7	28.6	2.0	18.0	36.4	10.0	156	1,309
1982	11.3	33.8	29.1	3.4	29.6	2.2	20.7	41.1	7.1	178	1,368
1983	5.4	11.7	11.0	1.5	28.3	1.7	15.8	37.6	0.4	113	1,114
1984	11.6	19.5	3.6	0.9	17.7	1.4	16.1	41.8	5.9	119	1,346

[1] 1970-1982 data derived from DFO published catch statistics. Hatchery rack sales of gillnet catch (Stat. Areas 13, 23 and 28) not included in 1978-1979. 1983-1984 data preliminary: 1984 net data from in-season catch monitoring and preliminary sales slip accumulations, and may differ from in-season hail figures.

4.4.2.1 Johnstone Strait

The Johnstone Strait fishery is the major interception fishery for chinook stocks returning from northern coastal waters in B.C. and Alaska. Fraser sockeye and pinks, and chum salmon from Johnstone and Georgia Straits are the primary commercial targets.

A number of management actions have been taken to reduce the catch of chinooks in the Johnstone Strait area. Restrictions in place prior to 1983 were as follows:

1. Closure of Goletus Channel for the complete season for pinks and chinooks;

2. River mouth closures;

3. Closures in most inlets (primarily for trolling); e.g., Knight, Phillips and Bute;

4. Introduction of minimum 10-cm (4-inch) mesh bunt through the summer season to reduce catches of juveniles;

5. The reduction of fishing days from 4 days per week in the mid-1970's to 1 day of fishing in most weeks for seiners throughout the season;

6. Limitations on the early chum season (first 3 weeks of September); and

7. Reductions in the allowed depth of seine nets to 575 meshes or 52 m in depth.

In 1983-1984, further measures were introduced with the objective of reducing the harvest rate for chinooks to 25% less than 1981-1982 levels (15% in 1983 and 10% more in 1984). Chinook adult catches in these years were cut substantially; although there are difficulties in determining harvest rate changes, it is felt the program has been effective. Reductions were accomplished by:

1. Keeping Johnstone Strait closed to all fishing up to the third week of July;

2. Fewer openings;

3. Closures of target chinook areas (e.g., Parsons Bay, Pig Farm);

4. Complete closure of Double Bay through the summer season;

5. Institution of a corridor boundary for seiners (1 km from mainland shore closed) in Areas 12 and 13;

6. Closure of Deep Water Bay to commercial and sports harvests; and

7. Closure of the troll fishery except during net fishing times.

4.4.2.2 Juan de Fuca Strait

The Juan de Fuca fishery is a major interception fishery for Fraser River sockeye and pink salmon. Chinooks are taken incidentally by the sockeye fishery and, to a lesser extent, by the pink fisheries. Chinooks caught are mostly juveniles (1979-1984 average greater than 67%) with some adults; the proportion of adults depends on the timing of the openings. A large portion of the catch of chinooks originates from Puget Sound hatchery stocks; British Columbia stocks comprise only a small portion of the catch.

Catches of chinooks have been reduced since 1978, due to an apparent increase in the proportion of sockeye travelling via the Johnstone Strait approach. Increasing the size of the seine bunt to 10 cm (4 inches) throughout the sockeye season has also substantially reduced the numbers of juvenile chinooks caught. Recent management actions to increase escapements of most early-running Fraser River sockeye stocks have also decreased the overall harvest rates in Juan de Fuca Strait.

4.4.2.3 Fraser River Area

In the Fraser River area, incidental catches of Fraser chinooks occur during summer sockeye fisheries. Catches of late (Harrison) chinooks and coho, are taken during late sockeye, pink and chum fisheries.

Terminal harvests of Fraser River chinooks have been severely restricted in recent years, in an attempt to maintain escapement levels despite increasing ocean harvest rates and declining returns to the river. Commercial and sports terminal fisheries have been most severely restricted. The terminal large-mesh gillnet chinook fishery was eliminated in 1980 and the sockeye and pink gillnet mesh size was reduced from 5-7/8 to 5-/12 inches to reduce the incidental chinook catch. The troll fleet cannot retain chinooks while fishing for sockeye and pinks during net openings in Area 29. These restrictions have reduced the commercial catch of chinooks from an average of 84,461 (1970-1980) to an average of 22,625 (1981-1984), which reduced terminal commercial harvest rates from 46.7% to 21.2%. During the same period, terminal harvest rates in the Indian food fishery have more than doubled, from 9.6% (1970-1980) to 20.1% (1981-1984).

4.4.2.4 North Coast

Incidental harvest of chinook salmon in the North Coast (Areas 1-5) is high, particularly by pink and sockeye fisheries in Statistical Areas 1 and 2. In the Skeena and Nass rivers, chinooks and sockeye have similar timing, and the terminal harvest of sockeye (including major enhanced runs from Babine Lake) continues to be a problem for chinooks.

4.4.2.5 Central Coast

Incidental catch in the Central Coast area net fisheries has long been a problem. However, in 1984, there were significant reductions in by-catch. These were achieved through delayed openings, and moving fisheries inside. For example, the seine fishery at Milbanke Sound was moved to more inside waters in 1983. As a result, the incidental catch of chinooks in the Central Coast was the lowest in the last 15 years.

4.4.3 Recreational Fisheries

The recreational fishery is socially and economically important. In 1983, one in ten adult British Columbia residents was a licensed tidal angler. In addition, 75,000 anglers visited British Columbia in 1983 to fish in tidal waters, and thousands of freshwater anglers fish for salmon in British Columbia rivers. Coho and chinook salmon are the primary species caught in the tidal sport fishery. Catch estimates for the last five years indicate a coastwide tidal sport catch of chinooks ranging from 196,000 - 426,000.

Two kinds of values, or benefits, accrue to society from recreational fishing. One is the direct or primary benefit of doing the activity itself. Where there is no charge or only minimal charge for sport fishing, this primary benefit is captured by the angler, and is relevant only when the anglers are among the people in whose interests the resource is being managed, in this case all Canadians. The unpaid-for benefits therefore accrue to residents of Canada: they exclude unpaid-for recreational enjoyment of non-residents. To the extent that sport fishing benefits are in fact paid for, the amount spent must be included as a primary benefit. Thus, all licence fees are included as primary benefits.

The other category of benefits of recreational fishing is the economic gain Canada derives from non-Canadian anglers' spending on goods and services associated with sport fishing. These benefits are measured by estimating the total amount of non-Canadian spending generated by fishing activity, and subtracting from this the economic cost of providing those goods and services purchased, to yield a measure of net benefit. Expenditures that would still have been made in Canada in the absence of sport fishing opportunities are not included as part of benefits of the sport fishery.

4.4.3.1 North Coast

Tidal sport fisheries are typically developed around population centres. The usual fishery is for mixed-stock assemblages similar to those that the inshore troll fishery exploits, but with higher percentages of local stocks. Chatham Sound, adjacent to Prince Rupert, receives the most fishing pressure;

Portland Canal and McIntyre Bay are important to the nearby communities of Stewart and Masset, respectively. In addition, the numerous inlets and channels that dot the Queen Charlotte Islands and the mainland provide fishing opportunities for tourists and local logging and mining camps. The effort and catch are small compared to those of the South Coast, but there is considerable potential for fisheries expansion if selected stocks can be rebuilt.

4.4.3.2 Central Coast

Recreational fisheries for chinooks on the Central Coast are basically restricted to inside waters. Since the fisheries differ from one another across the large geographical area involved, each Statistical Area is treated separately.

Area 6: The tidal sport fishery occurs mainly in Kitimat Arm and Douglas Channel, which are adjacent to Kitimat, the main population centre and access route to the area. Estimated catch is 3,900 chinooks (1983 statistics). The non-tidal salmon sport fishery takes place mainly on the Kitimat River, with some effort on the Dala, Kildala, Kemano, Kitlope and Quaal rivers. Estimated catch is 570 chinooks (1983 statistics).

Area 7: The tidal sport fishery consists of private boats and one charter boat operating out of Bella Bella, and a new developing charter operation in the St. John Harbour area. Estimated catch is 600 chinooks (1983).

Area 8: The tidal sports fishery is centered in two areas: Hakai Pass, for charter operations; and the areas adjacent to Bella Coola for private fishermen. The main freshwater fisheries are the Bella Coola-Atnarko, and to a lesser extent the Dean River. Estimated catch in tidal and non-tidal waters are 2,328 and 185 chinooks, respectively.

Area 9: The Rivers Inlet sport fishery is a high-profile charter sport fishery specifically for trophy-sized chinooks from the Chuckwalla-Kilbella and Wannock rivers. The nine charter operations in the Rivers Inlet account for 80-90% of the annual effort of 4,000 boat days. The sports fishery in Rivers Inlet in 1984 was similar to that in 1983, with 4,065 boat days and 8,573 fisherman participating in the fishery from 1 June - 2 September 1984.

During this period, 1,535 chinooks, 709 weighing over 9 kg (20 lbs), were caught in Rivers Inlet.

Area 10: The Smith Inlet sport fishery is minor, conducted only by a few loggers, commercial fishermen, and transient sport vessels.

4.4.3.3 Georgia Strait

Sport fishing in British Columbia occurs mainly in Georgia Strait. This sport fishing area is defined as extending from Sheringham Point, near Sooke, to Stuart Island, north of Campbell River. It includes the southern portion of Statistical Area 13 through Area 19 to the eastern portion of Area 20. Areas 28 and 29, excluding the Fraser River, are also included. In 1983, approximately 70% of the coastwide sport catch, 82% of the coho sport catch and 77% of the chinook catch occurred in Georgia Strait.

Management of this fishery is controversial. The main conflicts arise between the desire to protect seriously depleted natural stocks of chinooks and, to a lesser degree, coho, and the desire to maintain opportunities to fish by not restricting sport fishing. The total catch of the sport fishery has not yet been restricted to any meaningful degree, despite restrictions on individual catches.

4.4.3.4 West Coast Vancouver Island

The sport fishery on the west coast of Vancouver Island is not well documented since until recently (the last 8 years) sport fishing was of minor concern. However, the building of Robertson Creek hatchery and a paved highway to Ucluelet has greatly increased sport fishing activity in this area.

Sport fishing occurs mainly in Area 23 or Barkley Sound, although Fair Harbour in Area 26 and other inlets have some angling attention. In Barkley Sound, sport fishing begins in March when chinooks of U.S. origin are caught offshore by guided and local anglers. As the season progresses, this offshore fishery shifts from chinooks to coho, the latter species being caught mainly in the fall. Canadian chinooks from Robertson Creek hatchery stock are caught in early summer in outer Barkley Sound, and these fish are followed by

the sport fleet as the fish migrate into Alberni Inlet. In late August, sport fishing effort peaks at the head of Alberni Inlet, where a thousand boats can be counted fishing. The Robertson Creek hatchery chinooks average 9 kg (20 lbs) in the sport catch and contribute significantly to the local economy.

4.4.3.5 Fraser River

Chinooks and coho harvested by sport fishermen in non-tidal areas of the Fraser River are taken primarily in a bar fishery in the lower reaches below Hope, and in several areas of the middle Fraser and Thompson rivers. From 1980 the fishery has been restricted to jacks (2-year old precocious males). The majority of the catch occurs below Hope near population centres. Fishery Officers compile sport catch statistics but these are incomplete, and the data generally serve only as indicators of the magnitude of total catch.

The estimated annual sport catch of chinooks in the Fraser River from 1969 to 1980 averaged 13,000 fish (range: 7,000 - 23,000). This constitutes about 7% of the mean annual (1969-1980) chinook escapement to the Fraser River. Over 70% of the total sport catch is taken in the lower Fraser River below Hope, with an estimated mean annual catch of 11,000 fish.

4.4.4 Indian Food Fisheries

The Indian food fishery is a traditional fishery that is regulated to meet both the subsistence and ceremonial needs of native communities. Departmental policy recognizes the Indian food fishery as second in priority only to conservation, in acknowledgement of Indian historical dependence on and cultural ties with fisheries resources and salmon in particular.

Food fisheries generally occur in localized terminal areas close to Indian reserve land; however, some fisheries use commercial gear in marine interception areas. More recently, surplus hatchery returns have been provided to local bands for food and commercial purposes. Fishing techniques depend upon the topography and species composition of each area. Dip nets, set gill nets, drifted gill nets, angling, gaffs, spears, harpoons, weirs and traps are used.

The fisheries are regulated through the issuance of food fishing licences, which may specify area, gear, fishing time, and species and quantity of fish that may be taken. The food fisheries are managed in an attempt to meet the "reasonable food fish needs" of native communities. Because native communities are reluctant to define their fish requirements quantitatively, the fisheries are generally managed by restricting fishing time while permitting adequate harvests.

Catch and effort levels in the Indian food fisheries are monitored by local Fishery Officers. Enumeration techniques may include interviews with fishermen, direct observation, or catch subsamples which are extrapolated to estimate total catch. The accuracy of the catch estimates is questionable, and most Fishery Officers believe that catches are underestimated. Coastwide catches of chinooks by Indian food fisheries have averaged approximately 43,000 from 1979 - 1983, and catches have generally increased over the period of record.

4.4.4.1 North Coast

The major North Coast Indian food fisheries occur in the Skeena and Nass stream systems, with smaller fisheries in terminal areas on the mainland and in the Queen Charlotte Islands. Catches of chinooks have averaged 11,000 over the last five years, and have increased substantially since 1970.

The Nass River fishery harvests primarily sockeye, with recent chinook catches averaging 2,200. Set gill nets are the primary gear used on the upper Nass, while commercial gear is used during times when the area is closed to commercial fisheries on the lower Nass. The Skeena River fishery is the largest Indian food fishery in the North Coast, with recent chinook catches averaging 8,900. The fishery in the estuary is conducted with commercial gillnetters during times of closure to commercial fisheries, while set nets, dip nets and gaffs are used in-river.

4.4.4.2 Central Coast

Indian food fisheries in the Central Coast area consist of a large number of small local fisheries. Fisheries are generally conducted with drifted or

set gill nets in the river mouths, with catches from these fisheries supplemented through the use of commercial gear by Indians outside the commercial boundaries during closed periods for commercial fishermen. Recent catches of chinooks have averaged 1,300, with no trend apparent in recent years.

4.4.4.3 Georgia Strait and Johnstone Strait

The Johnstone Strait area Indian food fisheries rely primarily on commercial gear for taking passing stocks in Johnstone Strait. The balance of the catch is taken in small fisheries in river mouths; recent catches of chinook have averaged 90. There are Indian food fisheries in the Georgia Strait area for on a large number of local stocks in rivers throughout the region. Recent catches of chinook averaged 2,800, with the largest single fishery occurring on Qualicum River enhanced stocks.

4.4.4.4 West Coast Vancouver Island

The Indian food fisheries on the west coast of Vancouver Island consist primarily of small, terminal area fisheries; using commercial gear is a comparatively small part of this fishery. Recent catches have averaged 7,800 chinooks.

4.4.4.5 Fraser River

The major Indian food fisheries in the Fraser River area occur in the Fraser, Squamish and Capilano rivers. The Fraser River Indian food fishery is the largest on the coast, occurs from the mouth upstream to the Nechako River system, and uses set nets, drift nets, dip nets, gaffs and spears. Recent chinook catches in the Fraser River have averaged 18,700, with a trend towards increased catches and harvest rates noted over the period of record.

The Squamish River Indian food fishery is an in-river set net fishery; recent chinook catches have averaged 280.

The fishery in the Capilano River has developed in recent years in response to returns of hatchery production; catches of chinooks now average 370. Management of the Capilano River Indian food fishery was removed from DFO control in 1978. Fishing has been generally unrestricted since that time.

4.5 Management Conflicts

Conflicts discussed below include issues related to the allocation of catches, mixed-stock harvests, the effects of stock enhancement, and management responsibilities.

4.5.1 Allocation Conflicts

There are many possibilities for allocation conflicts in the harvest of chinook stocks. Chinook salmon, unlike any other species of Pacific salmon, are taken by fishing gear a few months after entering the ocean, and remain vulnerable to capture until they return to the spawning grounds. Not only are chinooks extremely vulnerable but at maturity they are the largest of all Pacific salmon, command the highest price per pound of any salmon, and are the most prized target for sport fishermen. Chinooks are also the least abundant species of Pacific salmon. All these factors combine to guarantee that there will be conflict in the allocation of the catch from this scarce (and valuable) resource. In addition, chinooks are taken passively during fisheries for abundant stocks of other salmon species. These are valuable and important fisheries, and the ability to curtail them to conserve chinooks is limited.

The harvest of chinooks is a complex problem involving many fisheries, including those directed at other species. On one hand, fisheries for other species need to be able to catch the target species with the least interference. On the other hand, catching chinooks earlier in the maturation cycle can increase the number of fish caught (but not the weight) without affecting the total productivity. This can result in great economic benefit if, as in the sports fishery, benefits are largely a function of total effort or catch per unit effort, regardless of the actual weight (an exception is trophy fisheries where very large fish attract enormous effort).

Interception of returning chinook salmon by nets has been a feature of the harvest of chinooks throughout the history of the Pacific salmon fishery. In fact, the rise of importance of the hook-and-line fisheries - particularly the sport fishery - is a relatively recent phenomenon, having occurred within

the last 20 years. The offshore troll fishery has always been directed primarily at abundant Columbia River stocks, and, more recently, at hatchery stocks from the Columbia River and Puget Sound. In the 1950's, catch by nets accounted for 25 to 30% of the total B.C. chinook catch. At least three-quarters of this total could be assigned to terminal areas such as the Skeena, Nass, Fraser and Bella Coola rivers. From 1980-1984 about 15% of the total British Columbia catch of chinooks has been by nets, and less than 20% of that catch has been from terminal areas (excluding Robertson Creek). Analysis of Fraser River data has shown terminal harvest rates of 60 to 80% in the 1950's and 1960's. These rates are probably too high because of underestimation of escapement in those years; however, they indicate that terminal harvest of chinooks was very high at that time.

Thus, there appears to have been a historical shift in the pattern of chinook harvest. Rebuilding of naturally-spawning chinook stocks may result in a reversal of this trend and would require some reallocation of hook-and-line catch to terminal net and sport gear. The existence of a Canada/U.S. salmon agreement may also require reallocation of some catch of U.S. origin stocks to U.S. fisheries, further reducing the catch of hook-and-line fisheries.

4.5.2 Mixed-Stock Conflicts

Throughout their lives, chinooks tend to migrate northward along the coast, feeding in relatively shallow water (50 fathoms or less). This northward migration lasts for 1 - 3 years, and results in substantial mixing of stocks from different river systems. In these circumstances, it is impossible to manage individual stocks, and identification of catch to stocks of origin is very difficult. Therefore, the relative productivities of individual stocks are unknown. The current approach of treating many chinook stocks as one larger aggregate may be seriously flawed if the most abundant stocks are also the most productive, as is probably the case.

4.5.3 Enhancement Conflicts

The effects of artificial propagation of salmon on fisheries are only beginning to be understood. Although stock enhancement unquestionably

contributes fish to the catch, it is uncertain whether total catch coast-wide is substantially better with an enhancement program than it would be without an enhancement program.

It is easy to point to the positive aspects of enhancement such as the creation of important fisheries (e.g., the Barkley Sound chinook gillnet fishery), the contribution of fish to existing fisheries, and the recovery of tags of hatchery origin in every fishery on the coast. Unfortunately, there are doubts as well. Figure 4.5-1 illustrates one of the primary concerns with regard to SEP from a management perspective. This figure plots the coast-wide (U.S. and Canada) trends in chinook catch, chinook hatchery releases, and escapement to chinook rivers and hatcheries. Without implying that there is a cause-effect relationship, chinook catches and wild escapements are apparently declining, while hatchery releases and escapements are increasing. Nevertheless, although hatchery production on a coast-wide basis has continued to increase, there has not been a corresponding increase in the total return to the fisheries.

These data have been collected only recently, and they may reflect long-term trends in ocean survival and distribution. Figure 4.5-2 shows total survival by time for four chinook hatcheries, three from Canada and one from the Columbia River; the data indicate that there has been a recent trend toward reduced survival in all four of these hatcheries. Possibly, the decline in total catch is the result of decreasing survival of both hatchery and wild chinooks. However, it would be unwise to dismiss the possibility that hatchery productivity may be declining over time with respect to wild productivity.

Enhancement operations are occasionally prone to disaster. For example, in 1975 a chlorine spill at the Capilano hatchery resulted in a significant kill of coho fry. In 1980, poor batches of fish food resulted in widespread blindness of hatchery reared fish in both Canada and the U.S. In 1985 a large proportion of the Chehalis and Spring Creek chinook production has been lost because of disease. These disasters can affect wild stocks if the catch limits are not reduced below those commensurate with the full potential of the enhancement facility. Unfortunately, in the past, catch levels have usually been maintained as if hatcheries were fully functional, despite hatchery disasters.

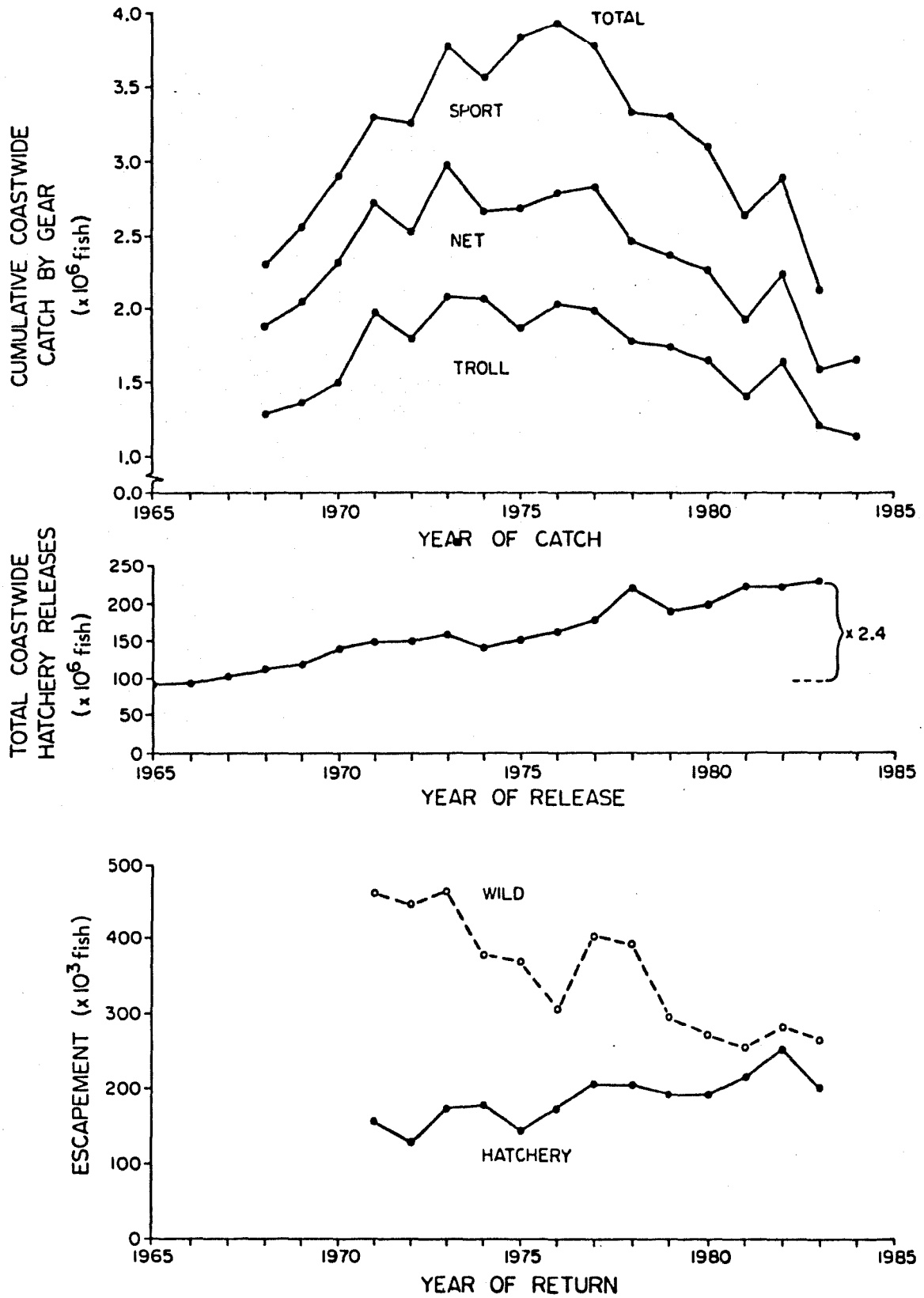


Figure 4.5-1. Coast-wide chinook escapements, hatchery releases and catches.

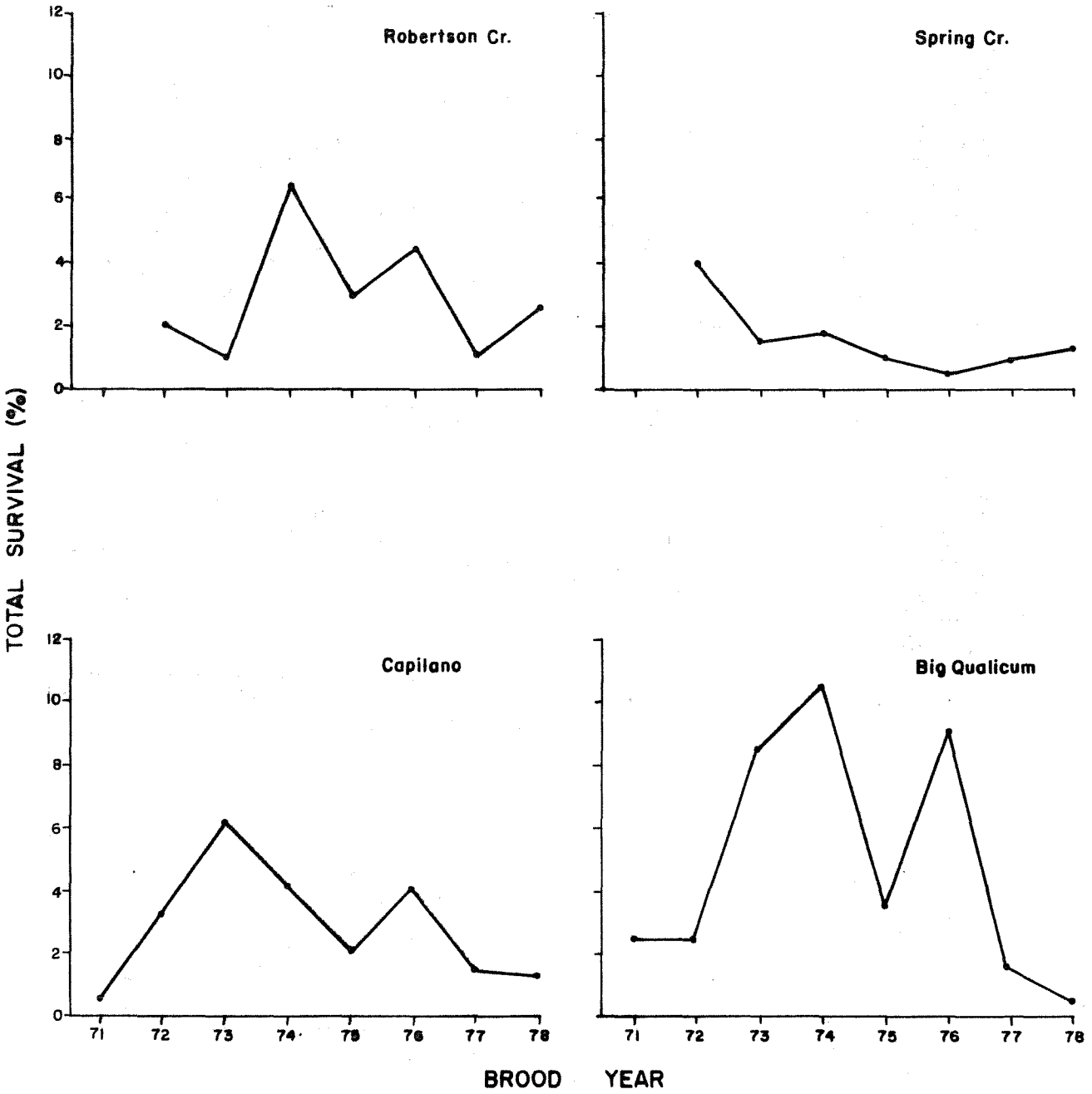


Figure 4.5-2. Time trends of chinook survival for four hatcheries.

Opinions differ on how to manage a terminal mixed-stock fishery for a stock such as Harrison chinooks, one of the most productive wild stocks on the coast, which is also being enhanced (by the Chehalis and Chilliwack hatchery). It is argued that terminal harvests at hatchery production rates will devastate the wild stock and it will be lost forever. Conversely, others regard the loss of the wild stock as acceptable if incremental benefits over the long term are substantial.

Finally, the enhancement of salmon (sockeye, pinks and chums) for net fisheries negatively affects chinooks by increasing the incidental net harvest rates for juvenile and adult chinook salmon. The catch of age 2 chinook salmon in Johnstone Strait and the Central Coast, and the terminal harvest of Harrison chinooks during Weaver Creek sockeye fisheries are two examples.

4.5.4 Management Responsibility Conflicts

Management responsibility for chinook salmon has been fragmented because of the distance that the fish travel. As a result, in the past, management response to declines in chinook abundance has been to reduce the rate of harvest in terminal areas without attempting to deal with the ocean harvest. Furthermore, divisional management has supported the goal of long-term optimization of the catch for all salmon species. Since few gains in chinook abundance can be made through the actions of a single division, management of chinooks has received a lower priority than that of species (sockeye, pinks and chums) that respond to divisional management initiatives.

4.6 Stock Rebuilding Potential

Stock-recruitment analysis of historical catch and escapement data predicts a total catch of approximately 800,000 at optimum escapement, representing an increase of more than 45% over the present catch of naturally-spawning chinooks (about 550,000). The estimated optimum escapement is substantially less than the aggregate chinook escapement targets developed by Fishery Officers from available spawning habitat. However, there is a consensus that optimum escapement estimates are highly uncertain. Nevertheless, both estimates suggest that considerable stock rebuilding is necessary even to approach an optimum escapement level. Therefore, an interim optimum escapement target of doubling the 1979-1982 average escapement has been set. This should create enough change in escapement and subsequent returns to enable the optimum escapement level to be determined more accurately.

4.7 Management Strategies for Stock Rebuilding

The strategies that are used as examples for stock rebuilding and described in the following sections include imposition of catch ceilings for specific areas; reduction or alteration of areas and times open to fishing; and gear restrictions.

4.7.1 Imposition of Area Catch Ceilings

The basic underlying strategy for chinook stock rebuilding with regard to the proposed Canada/U.S. Treaty will be the imposition of ceiling limits that should double escapements over three cycles. The Treaty calls for catch ceilings for chinooks for West Coast Vancouver Island troll fisheries; all North Coast fisheries; Georgia Strait sport and troll fisheries; and S.E. Alaska coast fishery, in 1985 and 1986. Each is discussed separately below, followed by a description of a plan for reallocation of ceilings.

4.7.1.1 North Coast

The North Coast chinook ceiling (263,000) proposed in the Canada/U.S. Treaty applies to all gear types, and is 38,000 less than the 1984 catch. Of the proposed total, 20,000 will be assumed to be caught by the northern sport fishery, 203,000 by the troll fishery and the remaining 40,000 taken incidentally by the North Coast net fisheries. This division of the ceiling represents a reduction in the troll catch of 43,000 compared to the 1984 troll catch (246,000) and no reduction in the net fishery catch (1984 catch = 35,600). It should be noted that the catch and ceiling limits for net gear apply to chinooks over 5 pounds only.

However, two basic options are addressed in this report. In the first, the net and the troll fisheries are managed to permit them to catch exactly 40,000 and 203,000 chinooks, respectively, while the ceiling is in place. In the second option, the net catch is allowed to rise as the abundance of chinooks increases, and the troll catch is permitted to catch the remainder of the fish allowed by the ceiling. Predictions of the effects of selecting these options are provided in Section 4.10.

4.7.1.2 West Coast Vancouver Island Troll Fisheries

In the following discussion, management to permit fisheries to meet the coho catch limit is also treated, because of the important interactions that occur between chinooks and coho when both are being managed not to exceed catch limits in the same fishery. The coho and chinook catch limits will allow fish that escape from more northerly fisheries to reach Washington and Oregon spawning grounds, and will minimize the redirection of effort to coho should the chinook limit be reached before the end of the established season. The chinook limit of 360,000 is 100,000 less than the 1984 catch (which was taken from 15 April to 19 September with a two-week closure during the second half of June), and 97,000 less than the 1979-1983 average catch.

Table 4.7-1 lists possible management actions with their intents, advantages and disadvantages. Table 4.7-2 describes several possible management strategies, which demonstrate how the management actions in Table 4.7-1 can be used in a complementary fashion. These strategies and others can be further refined if the following factors are assessed quantitatively:

1. Expected stock size;
2. Shaker mortality;
3. Transfer of catch between areas and time periods;
4. Effort responses; and
5. Stock distribution.

4.7.1.3 Georgia Strait

A catch ceiling for Georgia Strait troll and sport fisheries was established in order to rebuild Georgia Strait chinook stocks in three cycles. The ceiling of 275,000 is 215,000 less than 1984 catches and 232,000 less than the 1979-1983 average catch. The catch will be divided between sport and troll fisheries; however, at this time, the limits for each have not been defined. Troll and sport fisheries are discussed separately below, followed by a summary of possible management actions.

Troll Fisheries Regulation in the troll fishery will be influenced mostly by the desire to maximize efficiency. Time and area openings should allow

Table 4.7-1. Some management actions which may limit the troll catch in the west coast of Vancouver Island to the Canada/U.S. Treaty imposed ceilings.

Species	Actions	Intent	Advantages	Disadvantages
1) Chinook	Early season closure (e.g., 15 Apr. - 30 June).	Reduce chinook catch by decreasing effort.	Requires in-season adjustment. Might reduce effort on coho. Reduces coho shakers.	Total catch might be well below ceiling. Possibly a chinook-only fishery at the end of the season.
2) Chinook and Coho	Mid-season closure (e.g., 1 June to 15 July).	Reduce chinook and coho catch by decreasing effort.	Increase mean weight of coho. Reduce coho shakers.	Transfer of catch to after 15 July. Coho ceiling may not be achieved.
3) Coho	Late season closure (e.g., September).	Reduce coho catch by decreasing effort.	Reduce harvest of Canadian stocks. Reduces catch of schooling Puget Sound stocks. Reduces late season shakers.	Has no effect on chinook. Less total weight.
4) Chinook and Coho	Specific area closures.	Reduce catch of one species because of: a) approaching ceiling; b) high shaker rate; c) small fish.	Optimizes weight within the ceiling. Allows for more independent management of each species. Reduces harvest rate on Puget Sound stock (by closing Swiftsure).	Very difficult to define these areas. Increases harvest rates on some U.S. stocks (e.g., Washington Coastal).
5) Chinook and Coho	Single species fisheries.	Stop fishing a species once it has reached the ceiling.	Very precise if a shaker rate can be agreed upon. Permits independent management of the two species.	Promotes wastage of fish through shaker mortalities. Might promote high grading of larger fish to remain below ceiling.
6) Chinook	Increase minimum size.	Reduce chinook catch by increasing recruitment size.	Increases total weight within ceiling.	Increases harvest of larger, older, more fecund individuals. May create a shift in the biological characteristics of specific populations since many maturing fish will not be harvested (e.g., lower productivity). Shaker mortality.
7) Coho	Increase minimum size.	Reduce coho catch by increasing recruitment size.	Increase total weight within the ceiling. Reduces the rate of catch early in the season when Washington coastal stocks are present.	Shaker mortality. Effort shift to chinook early in the season.
8) Chinook and Coho	Increase access to other species (e.g., Fraser sockeye and pinks).	Reduce catch by redirecting effort.	Value of catch to fishermen does not decline.	May cause allocation difficulties. Causes management problems for intercepted stocks.
9) Chinook and Coho	Early season closure with test fisheries.	Monitor the strength of the runs and manage acordingly.	Management is based on known run size. Fishermen are participating.	New test fisheries can be misleading. Troll test fisheries are unproven.

Table 4.7-2. Examples of possible management strategies for the west coast of Vancouver Island.

Strategies (Main Actions)	Contingency Actions[1]	Advantages	Disadvantages
Strategy I			
a) Chinook only taken 15 May - 4 June b) All species taken 1 July - 30 Sep. c) Specific area closures e.g., Swiftsure	a) Single species fishery.	Reduces coho shakers in June. Allows for independent management of the two species. Increases weight of catch.	Shaker mortality during single species fishery Alters stock composition of catch.
Strategy II			
a) All species taken 1 July to 30 Sep. b) Troll test fishery: 1 Apr. to 30 June	a) Single species fishery. b) Possible fishery prior to 1 July. c) Possible closures after 1 July.	Bases management on actual run sizes. Increase precision of management.	Bases management on apparent run sizes - unproven in troll fishery. Could result in high harvest rates on low abundance stocks.

[1] Additional actions possible to supplement main actions if necessary.

for the most profitable fishing, measured by weight per boat-day fished. For instance, 100,000 chinooks could probably be harvested in Georgia Strait in two months, half of the amount of time usually allowed to trollers in that region.

Sport Fisheries Unlike the commercial fishery, the sport fishery could be regulated to reduce its efficiency. Reduced efficiency (fish/boat trip) would extend the open season, thereby providing more benefits to anglers. Figure 4.7-1 shows the cumulative sport catch of chinook in Georgia Strait. Depending on the abundance of fish, the open season may range from 6 to 12 months. At the time of publication the Sports Fish Advisory Board and DFO have embarked upon a co-management scheme to address management of chinooks in Georgia Strait to rebuild in 3 cycles. Early reports indicate that the principal method of regulation will be to use time and specific area closures to extend the season to 12 months. This is in support of a desire, on the part of the Minister of Fisheries and Oceans, to permit a sports fishery which will be regulated by the following criteria:

1. Allow a catch of four salmon per person per day;
2. Only two of those four salmon may be chinook;
3. The sports fishery in Georgia Strait will be open 12 months of the year; and
4. An annual chinook bag limit of 20 chinook per year will be enforced.

A variety of regulations concerning closures, bag limits, gear restrictions, size limits, and economic measures, which could be considered as other options, is discussed below.

1. Closure: River mouth closures to protect pre-spawners and spot closures to protect sub-legal fish have been used in Georgia Strait. To date both have had a negligible effect on reducing total catch. It is apparent that closure of specific area will have to be carefully reviewed to ensure that the season is 12 months in duration and that the ceiling of 275,000 chinooks is not exceeded.

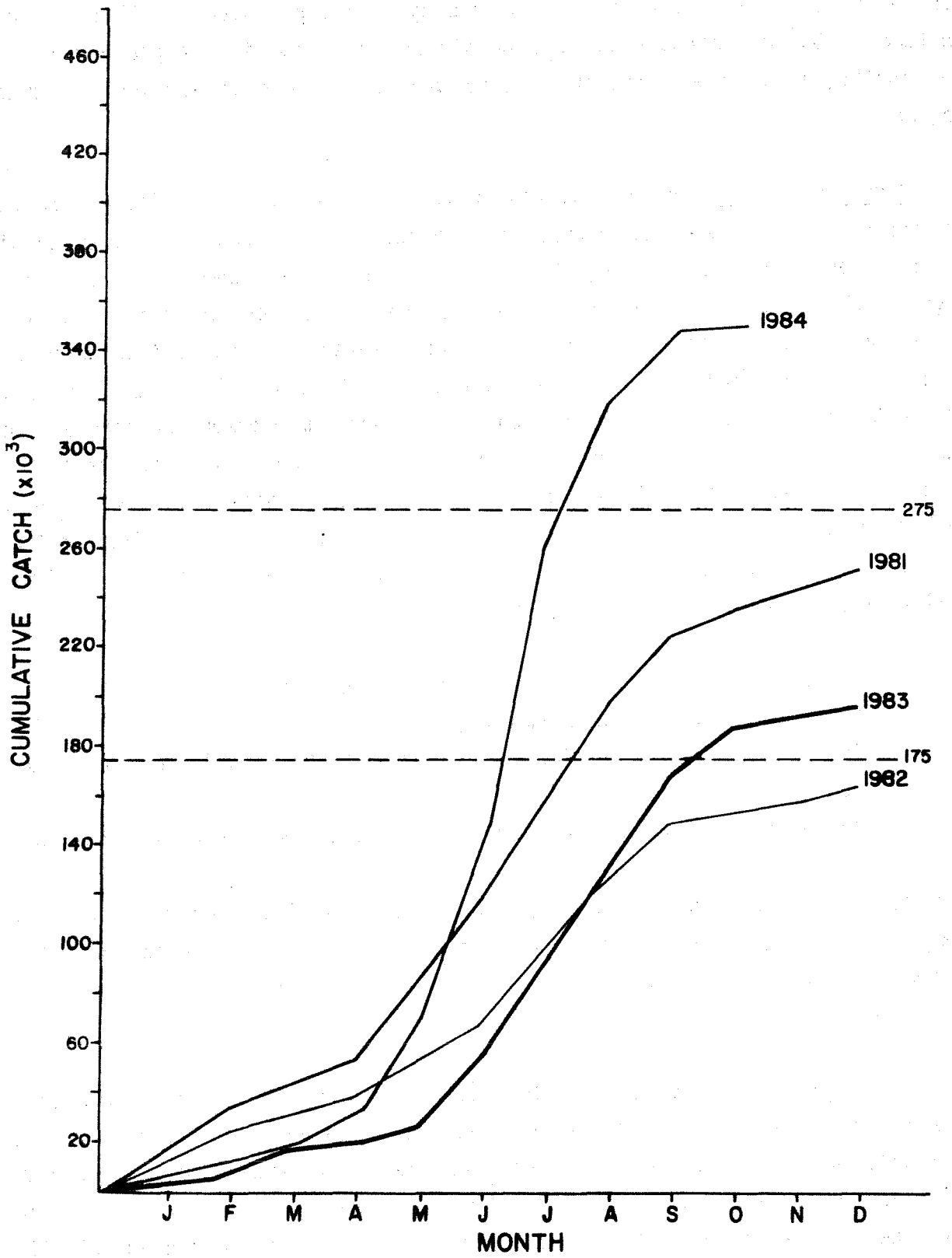


Figure 4.7-1. Cumulative seasonal chinook sport catch in Georgia Strait for 1981-84.

2. Bag Limits: Bag limits, in general, are hard to enforce, and people may start to sort their catch as they approach the limit, releasing (probably dead) fish in favour of "better" ones caught later. Three types of bag limits could be considered: personal daily limits; boat daily limits; and personal season limits. The first two are usually equivalent in practice, since people are liable to continue fishing until the total boat catch is the sum of everyone's personal limit.

At present, there is a daily bag limit of four salmon per licensed fisherman, of which only two may be chinooks. By utilizing a bag limit in isolation, the prediction is that the limit would need to be reduced to one chinook per day to have any significant effect on reducing catch. There is also an annual bag limit of 20 chinooks. This limit has little effect on anglers, since very few catch this number annually. For example, to reduce the actual catch by 15%, an annual personal limit of five per year would be needed.

3. Gear Restrictions: Gear restrictions may be imposed to reduce catches of fish smaller than the legal size limit and to reduce the damage done to released fish and improve their survival. Gear restrictions can also reduce the efficiency and hence the catch of the fishery, and direct the type of "recreational" use of the resource (sports vs. meat). The effects of specific gear restrictions such as banning barbed and/or treble hooks are unknown. However, any reduction in catch per rod would help keep the season open for as long as possible.

4. Size Limits: Adjusting size limits can be an effective way of reducing catch with minimal reductions in effort. However, large chinooks have a higher reproductive value than equal numbers of younger fish. The ceiling proposed in the Canada/U.S. Treaty is based on an assumed age distribution in the catch. Changing the age composition of the catch through size limit restrictions may require an adjustment to the ceiling. Present regulations state that chinooks less than 450 mm fork length must be released. An increase in size limits from 450 to 560 mm, for example, could reduce catch by 30 - 50%, depending on the age composition of the stock in a given year. This action, however, could not be taken without a possible downward adjustment of the assigned ceiling.

5. Economic Measures: Two types of economic measures for regulating sport fisheries can be considered: fixed cost licensing (for instance, the current licensing system), and variable cost licensing. In theory, if the cost of a licence were high enough, participation in the fishery would be discouraged. However, a reduction in participation might not result in a corresponding reduction in catch, since only unsuccessful fishermen are likely to drop out of the fishery. A variable cost system, such as charging a fee for each fish caught, could be implemented through a tag program, where all kept fish must be tagged. Tags could be purchased and associated with an individual's licence. Currently there is little information on how to evaluate this option.

Summary of Management Actions for Georgia Strait Table 4.7-3 describes some combinations of management actions with their intents, advantages and disadvantages. If chinook abundance remains similar to that of 1984, these actions should result in catches that approximately meet the ceiling. This is certainly not an exhaustive list of alternatives; however, it should indicate the range of management actions that could be implemented.

It is critical to assume an arbitrary level of abundance (e.g., 1984 level) when choosing management actions, particularly in the sport fishery, where traditional regulatory options restrict the effectiveness of effort rather than restrict effort per se. As abundance levels increase, management actions will require declining effort in both commercial and sport fisheries in order to obtain the same total catch. For the troll fishery, this means getting the same catch with less effort. For the sport fishery, reductions in effort directly lower the value of the fishery. These strategies can be further refined if the following factors can be quantified.

1. Expected stock size;
2. Shaker mortality;
3. Transfer of catch between areas and time periods;
4. Effort responses;
5. Allocation policy; and
6. Stock distribution.

In this report, two allocation options for this area are considered: first, ceilings for chinooks of 100,000 in the troll fishery and 175,000 in

Table 4.7-3. Some management actions which may limit Georgia Strait troll and sport fisheries to the Canada/U.S. Treaty imposed ceilings.

Actions	Intents	Advantages	Disadvantages
1) 100,000 effective limit on troll catch in an April-June season (accounting for later shaker mortalities during coho fishery). Winter closure for sport fishery, 1 chinook per day, 5 chinook per year.	Reduce troll effort. Reduce number of fish available. Reduce sport effort through closure. Reduce sport effectiveness.	Spreads available sport catch over a longer period, requiring fewer reductions in sport effectiveness.	Requires agreement on shaker mortality rates in the troll fishery. May result in sorting of catch. Directly affects sport fishing effort and lowers the value of the fishery.
2) 100,000 effective limit on troll catch in a July-August season.	Reduce troll effort.	Increase total weight in troll fishery. Can be less concerned about shaker mortalities in the troll fishery.	Directly affects sport fishing effort and lowers the value of the fishery.
3) No Georgia Strait troll fishery. Current sport regulations except 1 chinook per day.	No troll effort. Reduce effectiveness of sport effort.	More coho for the sport fishery.	Requires directed "buy-back" or relocation of troll effort. May result in sport fishermen sorting fish with related shaker mortality.
4) No Georgia Strait troll fishery. Increase minimum sport size limit to 56 cm.	No troll effort. Reduce chinook catch by increasing recruitment size.	Does not reduce sport effort and therefore leaves the value of the fishery basically intact. More coho for the sport fishery.	Requires directed "buy-back" or relocation of troll effort. May alter rebuilding schedule and thus require a lower ceiling. Shaker mortality of under 56 cm chinook.

the sport fishery; and second, no troll fishery in Georgia Strait. Predictions of the effects of selecting either option are provided in Section 4.10.

4.7.1.4 Reallocation of a Portion of the North Coast Ceiling to Georgia Strait

A major feature of the harvest of chinook salmon is their vulnerability to fishing gear for two or three years of ocean life. Also, chinooks tend to migrate northward along the coast as they grow older and larger. Consequently, most chinooks not taken early in their lives are still available one or two years later, although in a different location. A large proportion of the catch could be taken early in their life history if fisheries that harvest the more mature stocks were curtailed. The transfer of chinooks from one fishery to the next over time is complicated by the existence of large coastal net fisheries, which intercept chinooks on their outward and inward migrations while fishing for other species of salmon.

It is possible to construct rebuilding scenarios for the Georgia Strait stock that would affect the North Coast fishery more (and the Georgia Strait fishery less) than would the plan proposed in the Canada/U.S. agreement, without changing the rebuilding period for the Georgia Strait stock. Curtailment of the North Coast fishery affects all other stocks harvested in that fishery. If Georgia Strait stocks make up about one third of the North Coast catch, then for every Georgia Strait fish saved, two fish from other stocks would have to be forgone or caught in clean-up terminal fisheries.

Maintaining the current catch allocation may also be inequitable, because the ocean fisheries have developed at the expense of fisheries taking their catch closer to the streams of origin. Historically (especially before World War II), chinook salmon were taken in British Columbia mostly as fully mature fish by net fisheries near large rivers such as the Fraser or the Skeena. The development of hook-and-line fisheries (sport and troll), which intercept chinooks prior to maturity have substantially (and continuously) changed the allocation of chinook catch between gear types and between regions. The predicted consequences of lowering the North Coast ceiling for chinooks by 100,000 and increasing the Georgia Strait sport fishing ceiling by 100,000 chinooks is evaluated in Section 4.10.

4.7.2 Reductions in Fisheries without Ceiling Limits

Incidental catches of chinook salmon in Johnstone Strait, Juan de Fuca Strait and the Fraser River area are not included in the proposed Canada/U.S. Treaty. Radical steps have been taken in recent years to reduce the incidental catch (see Section 4.4); a number of options may further curtail it, although catch of the target species (sockeye, chum and pink) will have to be forgone at these locations. Moreover, the anticipated increase in abundance of all species (including chinooks) from stock rebuilding and enhancement will increase the effectiveness of the fisheries. Therefore, a short discussion of the available options to control these fisheries without set ceilings is presented below, by area.

4.7.2.1 Johnstone Strait Fisheries

A number of options can be considered to further curtail the Johnstone Strait incidental catch of chinooks, including:

1. Closures from Chatham Point to the mainland side of Johnstone Strait, which would provide a corridor for chinooks saved by the corridor boundaries further north. Only marginal reduction of the incidental chinook catch would be expected from this action;

2. Some seine boats capture an excessive proportion of chinook (i.e., 10% of boats catch over 50% of chinook). Fishing sites used by these boats could be examined and, if necessary, closed to fishing;

3. Chinook salmon are caught primarily by seine boats using fixed anchors on the beach. Restricting fishing to only open sets (no fixed anchor) could be considered. This option would be highly controversial with the affected fishermen and there may be a problem with missing the target species;

4. If each opening lasted only one day and could not be extended for a second day, the incidental catch of chinooks would be reduced. Most chinooks are taken during extensions after sockeye and pink fishing has become less productive. More openings may be required in a week, however, to maintain adequate harvest rates for sockeye and pinks;

5. The most effective way to decrease chinook catches is to further restrict the numbers of days of fishing during July and August. To decrease adult catch by 50% would require a 30-40% decrease in number of days of fishing. In order to accomplish this reduction, sockeye fishing would be restricted to the 2- or 3-week period of maximum sockeye or pink stock abundance. The sockeye catch would be expected to decrease 30% below current levels; however, the anticipated increase of sockeye abundance because of the international agreement may allow for increased harvests over the restricted 2- or 3-week period; and

6. Reduce the available fishing area further between Lewis and Chatham Point.

4.7.2.2 Juan de Fuca Strait Fisheries

If the proportion of sockeye returning through Juan de Fuca Strait returns to previous high levels, the increased rate of sockeye fishing could result in greater incidental catches of chinook. Most of the chinooks would come from Puget Sound stocks. The following options would further reduce catches of chinook in the Juan de Fuca Strait.

1. The overall harvest rate in Juan de Fuca Strait could be reduced by closing the fishery until the beginning of August (probably around 7 August). Adult chinooks migrate through the area primarily during July, and the migration is largely finished by August. This option could eventually reduce adult chinook catch to 50% of the 1983-84 catch. Some of the chinook catch would be transferred to the U.S. Puget Sound fishery. However, the large loss of sockeye catch in the Area 20 fishery would result in pressure to accommodate seiners in Georgia Strait to take the sockeye surplus. Unfortunately, more of the chinook juveniles caught incidentally in Georgia Strait would be of Canadian origin than those caught in Juan de Fuca Strait. In addition, harvest rates in the Fraser River and Johnstone Strait would likely have to increase to take the sockeye surplus, resulting in increasing the numbers of chinooks caught incidentally.

2. All fishing could be prohibited in a corridor 3-4 km from the shoreline, since most adult chinooks are caught near shore. On the other hand, sockeye appear to move away from the shore, depending on weather and tides. The disadvantages to this approach are:

   a) There would be an enforcement problem, which would increase management costs;
   b) Sockeye could be in the nearshore corridor;
   c) The harvest rate of sockeye may have to be increased in order to catch the same number of sockeye; and
   d) The corridor would only marginally decrease the catch of juvenile chinook.

3. The boundary of the Juan de Fuca Strait net fishery could be moved to San Juan Point from Bonilla Point. This would substantially reduce the juvenile chinook catch by moving the fishery away from nursery areas. However, using the new fishing area could increase the proportion of adults in the catch. This measure would also have the advantage of decreasing the harvest rate on local San Juan River chinooks (a small West Coast stock). The primary disadvantage is that major disruptions to fisheries often have unpredictable and undesirable results.

In summary, an approximate 50% reduction in adult chinook catch is possible by adopting one or more of the above options. The success of the regulations is tied to the cyclical nature of Fraser sockeye exploitation. Delayed openings in Juan de Fuca Strait would have little impact on the total Canadian sockeye catch in the years when the run is dominated by the late run stocks (e.g., dominant and sub-dominant Adams River years). In the other two years, when the runs tend to be earlier (especially in the years of Stuart and Horsefly stocks dominance), Canadian catch of sockeye would be severely affected. Much of the catch could be transferred to the Fraser River gillnet fishery, but this would of course require reallocation by gear type.

4.7.2.3 Fraser River Fisheries

The terminal harvest of Fraser River chinook salmon has been severely restricted since 1980 in an attempt to maintain escapement levels in the face

of declining returns to the river. Four fisheries are managed in the Fraser area: the Area 29 gillnet and troll fisheries, the Fraser River Indian food fishery, and the non-tidal sports fishery. They are not managed by controlling ceilings. Possible management actions to reduce the chinook catch by these fisheries are described below.

Fraser Troll and Net There has not been a directed fishery for chinooks by the Fraser River (Area 29) gillnet fleet since 1980, and the troll fleet cannot retain chinooks during sockeye and pink salmon openings. Some minor reductions in the incidental chinooks may be achieved by eliminating some of the less effective openings for late sockeye (such as Weaver Creek sockeye) and pink stocks. In the past, fairly extensive clean-up fisheries for relatively few sockeye and pinks have resulted in significant catches of chinook. Some of these openings can be rescheduled or eliminated to conserve chinook, while minimizing forgone sockeye and pinks. Other than these relatively minor adjustments, there is little opportunity to reduce chinook bycatch in Area 29. If the Johnstone Strait net fishery is curtailed, and if more pink and sockeye are harvested in Area 29, incidental catches of chinooks will increase.

Non-tidal Sport The non-tidal sport fishery for adult chinook has already been eliminated, although jacks can be taken and there are limited openings for hatchery surplus.

Indian Food Fishery As stock rebuilding proceeds, the Indian food fishery will probably catch more chinooks. The major stocks taken are from the upper Fraser, when they migrate with early-run Fraser sockeye stocks. Options for reducing the Indian food fish catch of chinooks are as follows:

1. Reduce the mesh size for set and drift nets to 140 mm (5.5 inches), which should result in a decrease in chinook catch of 5-10%. This regulation change is presently proposed;

2. Where chinooks are the desired catch, redirect effort to areas with a hatchery surplus of chinooks or supply a hatchery surplus of other species as a substitute; and

3. Decrease the catch of chinooks directly by reducing the number of days of fishing. The chinook catch should decrease in direct proportion to a decrease in fishing time. Currently, openings range from 1.5 days per week in the lower Fraser (where nets are used), to 7 days a week in the upper Fraser (where dip nets are used). The main problem with this approach is that the net fishery would lose sockeye.

4.7.3 Enhancement-Assisted Rebuilding Options

The purpose of this section is to illustrate some of the options available for using SEP resources to meet salmon management and rebuilding objectives. In general, enhancement can be used to create or stabilize catch or to conserve depressed stocks simply by increasing their productivity. The enhancement technology is relatively straightforward. However, application of this technology to meet management objectives is complex due to the many interactions among different stocks of a single species, among different species, and among different users of the resource. Each option is described in more detail in the following sections with predicted results based on computer simulations provided in Section 4.10 where possible.

4.7.3.1 Flooding Combined with Catch Ceilings

"Flooding" consists of replacing portions of the catch of wild stocks with enhanced stocks, thus increasing escapement of wild fish. For example, if the Georgia Strait chinook population numbers 1,000,000 fish of which 50% are wild and 50% are of hatchery origin, a catch of 500,000 is expected to consist of 250,000 fish from each origin. If hatchery production is doubled so that the total population is 1,500,000 and the catch is held constant at 500,000, then the harvest of wild fish should drop from 250,000 to 170,000 with the remainder available to spawn. There are two alternative strategies to setting ceilings for such "flooded" stocks:

1. Maintain a low catch ceiling until stocks are rebuilt, followed by an increase in ceilings to sustainable yield of the rebuilt wild stocks; and

2. Set catch ceilings above the low level required for rapid rebuilding but not so high as to prevent rebuilding over the long term.

The first strategy results in fast rebuilding but great short-term fisheries losses, whereas the second strategy lowers rebuilding rates and causes longer-term fisheries losses, albeit not as acutely as in the first case.

From a management perspective, a number of factors tend to make the flooding concept a slower rebuilding process than would be indicated by the Georgia Strait example given above. These factors include the following:

1. Some fish saved in the hook-and-line fisheries may be exploited in terminal net fisheries;

2. Younger fish (specifically chinook up to age 3) may later be available to outside fisheries, and later still to the terminal fisheries;

3. There will be selective harvest by some fishermen with release, and mortality, of smaller fish; and

4. Time (possibly several cycles of chinook) is required to build up hatchery stocks to meet the production potential.

From an SEP perspective, a number of factors tend to constrain production, since massive production of enhanced fish would be required to have a significant impact on chinook stocks. These factors are as follows:

1. Enhancement requires lead time and funds for evaluation and planning;

2. Enhancement facilities require capital and operational expenditures;

3. Brood stock availability limits the rate at which populations can be increased; and

4. Much of the productive capacity of enhancement can not be taken by the traditional fisheries under a catch ceiling system; thus, large returns to the terminal areas are to be expected.

4.7.3.2 "Marked-Only" Fisheries

The eventual presence of marked (i.e., fin-clipped) adult chinook salmon allows the retention of clipped fish only ("marked only") in hook-and-line fisheries. This is a promising method for harvesting wild and hatchery stocks separately. It is especially relevant to the sport fishery, where it has proven difficult to find a management package that effectively protects and rebuilds natural stocks without redistributing benefits or displacing people who depend upon this fishery for livelihood and recreation.

The success of a "marked-only" fishery in terms of rebuilding depends on the mortality of wild fish that are caught and released. The total fishery mortality of wild fish is a function of both the probability of death in a single catch-and-release event (shaker mortality) and the number of times a wild fish is caught. Unfortunately, neither shaker mortality nor the frequency of recapture is known. Therefore, the effectiveness of a "marked-only" fishery is unknown. However, positive benefit may occur at very high shaker mortality rates.

There are two further management implications which should be evaluated carefully before implementation of a "marked-only" fishery. First, the presence of large numbers of fin-clipped chinook in the sport catch could have a significant impact on the Mark Recovery Program for coded wire tags (CWT). Even though those fish not possessing a CWT will have a ventral fin clipped instead of the adipose fin, there will likely be many heads from fish with a ventral clip only (and no CWT) turned in to the voluntary recovery program. An extensive education and advertising program would be necessary to minimize the problem. Second, substantial catches of unclipped hatchery fish from U.S. production and clipped fish which have regenerated the fin (approximately 10 - 20%) will have to be forgone. The co-operation of U.S. fisheries management agencies would be required to take full advantage of the clipped-fish fishery technique. Some of these agencies are already considering this fisheries management tool.

Unfortunately, unlike with the marking of coho smolts, many logistical, cost and mortality problems in the marking of juvenile chinook salmon detract from the viability of the marked-only fisheries option. These problems include the following:

1. Marking 15,000,000 or more chinook juveniles (the existing capacity) is logistically difficult, since the marking must take place during a two- or three-month period (March to June), because chinooks are typically reared for only three months;

2. Marking programs of the magnitude considered (especially for chinook) will necessitate capital expenditures for buildings, sinks, etc.;

3. Large work crews will be required (e.g., to mark 7,500,000 chinook juveniles at Big Qualicum would require 31 people for April and May);

4. Chinook loss prior to release will increase substantially over normally accepted levels due to handling and marking stress; and

5. Chinook post-release survival will decrease by 10-20% due such factors as infection, predator attraction and poor predator avoidance.

4.7.3.3 Augmentation of Native Stocks

There are numerous chinook populations on the coast which are severely depressed, numbering from a few individuals to a few hundred individuals. This section deals with rebuilding such stocks to, but not beyond, their natural capacity. One assumption for stock rebuilding is that more spawning fish will produce a higher return and, over a number of cycles, the population will reach an optimum or maximum level. Enhancement can accelerate this process of rehabilitation. For a stock that is declining towards extinction, enhancement can be used to conserve the stock and push the population to a higher level. It is noteworthy that an effective population size of at least several hundred spawners is necessary to maintain the genetic diversity of a stock over the longer term.

Options for chinook rehabilitation and conservation parallel those described for coho. They include temporary enhancement over one or two cycles for stocks that are productive enough to withstand existing exploitation rates; and long-term, small-scale enhancement for stocks that are not productive enough to withstand existing exploitation. Most chinook released in B.C.

are smolts, with pre-smolt releases most common for some Upper Fraser stream-type stocks. Since the enhancement is intended to increase productivity, and since maximum increase in productivity is achieved through smolt releases, smolt releases are preferred over pre-smolts strategy when the availability of brood stock and reproductive products are limited.

Another approach is stream improvement to increase survival rates for wild fish. Work such as flow control, obstruction removal and spawning ground improvement may increase productivity, although most projects of this type increase escapement by less than 500 fish annually. Improving rearing habitats, incubating eggs and fry in a facility, and subsequent fry release will further increase the yield. Large central hatcheries may serve as incubation and rearing sites for many stocks. Kitimat Hatchery, for example, was designed to enhance chinook stocks; other facilities such as Robertson Creek have started enhancing locally-threatened stocks, although that facility was designed for a single stock. It is not necessary to enhance a chinook stock every year. For example, higher enhancement production once every two or three years could produce long-term results (at a lower cost) equal to those from smaller production increases every year.

The major problems in chinook rehabilitation and conservation enhancement projects are brood stock availability, and uncertainty about release strategies for pre-smolts. The intensity of competitive interactions between fry from wild and enhanced stocks during stream rearing is a function of size of fish, number of fish per unit area and date of release. Studies are required to determine how to minimize competition.

4.7.3.4 Colonization

Colonization and transplant techniques to increase natural production are presently more important approaches for coho (see Section 5.8.5.2) than for chinook due to shortage of chinook spawners. Some chinook transplant opportunities exist using a few of the major hatchery stocks.

4.7.3.5 Creation of New Fisheries for Known Stock

The Alberni Inlet terminal fishery directed at the Robertson Creek Hatchery chinook return has been the recent highlight of chinook production in

British Columbia. It is conceivable that the creation of new fisheries could provide even greater West Coast Vancouver Island chinook production than would the flooding scheme (Section 4.7.3.1).

As an extreme example, consider an inlet which is devoid of any significant stocks due to lack of suitable spawning and rearing habitat. Construction of a large-scale facility with capacity three times that of Robertson Creek could yield terminal catches in excess of 200,000, based on Robertson Creek return rates. There would be no mixed-stock problems in the terminal area, also. Such a large fishery could attract a significant portion of the fleet, and if fishery timing was carefully chosen by selection of a suitable transplant stock, harvest pressure could be deflected from more sensitive areas. Since chinooks in British Columbia run at various times from early spring to late fall, and run timing is an inherited trait; the flexibility should exist to select a stock to best suit management needs.

4.7.3.6 Wild Preserves

Designating a wild chinook refuge on the West Coast Vancouver Island and in other areas of major enhancement activity has been recommended. Major West Coast chinook stocks (greater than 1,000 spawners) are found in the Nitinat, Somass, Burman, Gold and Marble river systems. Of these, only Burman is not being enhanced, although some enhancement projects (particularly Gold and Marble) are small. Smaller populations exist in the 18 streams that have supported 1,000 or more spawners in the past, and some of these are also being enhanced, at least at low levels. Implementation of proposed enhancement projects will result in large-scale chinook production in Nootka, Quatsiko and Barkley sounds, and the Nitinat and San Juan drainages. Small-scale work is already under way in Clayoquot Sound. Kyuquot Sound will be the only remaining area without enhanced chinook. There are two arguments for maintaining the Kyuquot stock as a wild population:

1. While the economic benefits of the current enhancement plans would be great if the Robertson Creek Hatchery-Barkley Sound success were repeated, there are some concerns based primarily on genetic considerations that long-term productivity may be less than anticipated. This may result from changes in the genetic composition of stocks due to

selective pressures exerted by enhancement techniques. All chinook populations face natural selection and fishery selection, but these may have very different genetic results from those produced by hatchery selection. There is a risk that hatchery stocks will be less able to survive new natural selection forces such as diseases, parasites, and physical or chemical conditions in the rivers, estuaries or ocean. A wild stock theoretically will have new genetic material (possibly previously lost from hatchery stocks) which could be introduced into the gene pool of hatchery stocks if declines in productivity occur;

2. Reliable data on escapement of wild stocks are needed for evaluation of the effects of management actions on wild chinook populations. The current chinook key streams such as the Somass are all influenced by hatchery activities, and may not reflect what is happening in wild stocks. For example, hatchery chinooks may mature at a different age than do wild chinooks. Since there are far more wild chinook stocks in British Columbia than enhanced stocks, it seems logical to identify at least one key wild stock in each major geographical region. It will be essential to understand population trends in these stocks, in order to project and verify the impacts of regulation changes.

4.7.4 Enhance Productivity by Habitat Improvement

Very few salmon stocks are presently unaffected by development. Decreases in both quantity and quality of salmon habitats result from a variety of causes, including logging, hydro-electric development, domestic and industrial waste disposal, urban development, diking and agricultural water diversion. Each area has a unique set of problems, but a number of general comments apply to many of them.

Habitat loss is widespread and poses a threat to many salmon stocks; however, it is difficult to assess the extent to which habitat loss has contributed to declining stock productivity for any particular salmon stock. Where escapements have declined significantly, all available spawning and rearing habitat may not be utilized, although harvesting and habitat losses may both have contributed to the decline. Nonetheless, maximum abundance of a stock

depends on habitat availability. Management alone cannot rebuild a stock to historical levels of abundance unless sufficient habitat is available to support the stock as its abundance increases.

The quality and availability of salmon habitat can be improved by a wide variety of available techniques such as low-head headwater storage dams, stream improvement, gravel cleaning, stream fertilization, barrier removal and dike breaching. All these techniques can be cost-effective.

It is an assumption of this rebuilding program that over-harvesting is the primary cause of declining salmon production, and that most (if not all), stocks will benefit from increased escapement. However, habitat loss has almost certainly contributed to the decline of some stocks, and habitat availability will increasingly limit abundance as stocks are rebuilt.

4.8 Information Requirements for Stock Rebuilding

Obtaining the information necessary to plan and execute a stock rebuilding program is difficult. The available data are generally poor and biased, and estimates of the current status of stocks are often inaccurate. There is sufficient information to show that something must be done, but there is not sufficient information to know exactly what to do.

In order to increase escapements of wild chinooks to optimum levels harvests must be restricted. Proposed restrictions are based on quantitative analyses of catch and escapement data. Catch and escapement estimates of known accuracy are required for stock/recruitment analyses. Such estimates are not available for many groups of chinook stocks, in particular for the wild stocks from British Columbia. Therefore, considerable uncertainty exists in the estimates of stock/recruitment parameters. It is not known whether the catch ceilings proposed under the Canada/U.S. Treaty will rebuild stocks, or whether the estimated stock rebuilding time is sufficient.

Catch ceilings for chinooks were set primarily to rebuild weak natural stocks, and secondarily to reallocate interception catches by Canada and the United States. However, there can be large annual variations in numbers of chinooks taken by mixed-stock fisheries, and the information necessary to predict abundance is incomplete, particularly for wild stocks. This will make fishing plans difficult to devise, and there will be times when fishing plans that limit catches of one species will disrupt fishing for other species. Of more concern are situations where poor recruitment of wild stocks goes undetected and subsequent fishing over-harvests the wild stocks because the ceiling is too high for the stock to support.

In summary, management uncertainty will eventually result in large differences between optimum sustained yield and harvests. It is assumed that the benefits derived from an increased understanding of the system will exceed the costs reducing management uncertainty. The real questions are how to proceed, and what information to collect.

The most appropriate action is to create fairly large changes in harvest rates, hoping that the response by certain key stocks will be conclusive

enough to indicate the correct direction of subsequent management actions. The stock rebuilding plan must be managed adaptively by acknowledging the uncertainties in the data sets used, and reducing uncertainties through experimental management integrated with intensive data collection. In addition to improving information with which to manage the rebuilding over the long run, it is also necessary to co-ordinate various short-term management actions which are used (e.g., catch ceilings). The intensive management of fisheries during the season requires a detailed plan for obtaining, processing, and distributing the necessary statistics within very short periods of time.

The information required for stock rebuilding is used to adaptively redesign the approach to rebuilding; and to assess the progress of stock rebuilding. Four types of information are required to address these two objectives:

1. Levels of escapement, which are important indicators of the progress of stock rebuilding;

2. Exploitation rates for stock groups in all fisheries, which are necessary to evaluate the effectiveness of management actions;

3. In-season estimation of catch, which is required for many types of management actions, particularly those based on ceilings; and

4. Pre-season predictions of expected run sizes, which are necessary for the allocation of catch to user groups, and to manage portions of the run with distinct timings.

Each of these information requirements is discussed separately below, followed by a brief review of the value of indicator stocks in the management process.

4.8.1 Estimation of Escapement

It is difficult to estimate escapement for chinook stocks in British Columbia because there are many remote spawning streams. The effort expended to measure escapement of spawning stocks has varied greatly between geographic areas and between years. Estimates have generally been made with little or no

calibration by field staff with varying experience. Enumeration has become more intensive and accurate in recent years due to improved accessibility of streams, and an increased awareness by field staff of the importance of this species. These factors probably bias the data set systematically, and make comparisons over long time periods misleading.

4.8.2 Estimation of Exploitation Rate

Exploitation rates are currently estimated using CWT data for groups of fish. For the data to be useable, a group of fish must be represented by a complete set of release data, recovery data for all fisheries, and estimates of the escapement of tagged fish to the spawning area. The method of estimating exploitation is currently at an early, incomplete stage of development. Future studies of exploitation rates must put a substantial effort into the design process, including carrying out specific tag release experiments to better understand the statistical structure of the estimation methods.

Exploitation rate estimates from CWT returns currently range from 75% to nearly 90%. These estimates are very sensitive to errors in the calculation of the escapement of tagged fish. Nevertheless, these are the best estimates currently available, and they are consistent from hatchery to hatchery. In the future, CWT data from indicator and index stocks should allow more accurate estimates.

4.8.3 Estimation of In-Season Catch

In-season estimation of catch is essential for the implementation of many of the management actions required for stock rebuilding, particularly catch ceilings. There has been an in-season catch estimation program in place for chinooks in British Columbia since 1983. The program is gradually being refined to produce estimates with the required levels of accuracy, precision and timeliness. In order to produce the required estimates, it is essential that these programs receive a high priority for support.

4.8.4 Pre-Season Forecasts

In order to successfully meet allocation guidelines both for user groups and for different stocks which have different timings, it is important to have

the best possible pre-season estimate of the size of runs to various systems. At present the forecasting process is relatively undeveloped for chinooks in British Columbia.

4.8.5 Indicator Stocks

One method to assess the effectiveness of management actions designed to rebuild chinook stocks is to measure exploitation rates, by fishery, for CWT-marked members of indicator stocks. These stocks are assumed to have the same availability and vulnerability to fisheries (the same exploitation pattern) as the stocks in need of rebuilding. The selection of indicator stocks has been based on one or more of the following criteria:

1. Historical presence of a weir or other method of accurate enumeration (e.g., Big Qualicum River);

2. Presence of long-term CWT marking (e.g., Robertson Creek);

3. Importance of a particular river or run (e.g., Bowron River, a headwater Fraser River early summer chinook stock) and;

4. The opportunity to integrate data with information from an existing program which could be augmented to get total counts (e.g., Salmon and Eagle Rivers, late summer runs to the Fraser River).

One outcome of these selection criteria is that most of the indicator stocks chosen (Table 4.8-1) have been enhanced. At present, hatchery stocks are assumed to be indicators of exploitation patterns for natural stocks. Clearly there is a need for more data on the distribution of wild stocks in British Columbia fisheries. It is recommended that high priority be given to design and implementation of a wild stock marking program to establish a network of indicator stocks, in order to assess the effectiveness of management actions.

Table 4.8-1. Chinook indicator stocks.

River	Major River System	Race or Stock Timing	Presence of Enhancement	Presence of CWT Marking	Mean Escapement 1979-1982
Babine	Skeena	early summer	no	no	800
Kitsumkalum	Skeena	early summer	yes	yes	7,000
Atnarko	Bella Coola	spring	yes	yes	6,000
Campbell/Quinsam	Campbell	fall	yes	yes	2,500
B. Qualicum	B. Qualicum	fall	yes	yes	6,000
Stamp/Sproat	Somass	fall	yes	yes	7,500
Bowron	Fraser	early summer	yes	yes	1,600
Eagle	Fraser	late summer	yes	yes	300
Salmon	Fraser	late summer	yes	yes	400
Shuswap	Fraser	late summer	no	no	5,000
Harrison	Fraser	fall	yes	yes	17,00
TOTAL					54,000

4.9 Rebuilding Model

A multi-stock, multi-fishery model was constructed to simulate changes over 20 years in chinook catch, escapement and NPV of fisheries for different stock rebuilding options. This section includes a brief description of the model, input data, model structure, underlying assumptions, and limitations in the comparison of some options. Details of the model are provided in Appendix 3.

4.9.1 Model Overview

The model included 13 fisheries and 11 stocks, defined in Table 4.9-1. The model was designed to evaluate a wide range of management options:

1. Catch ceilings for any or all fisheries;
2. Harvest rate controls for any or all fisheries;
3. Allocation of catch between fisheries; and
4. Changes in productivity rates or production to reflect changes in enhancement or environmental conditions.

Any of these options could be combined with the others and implemented at any time period.

The distribution of enhanced stocks within the fisheries was estimated through a cohort analysis using coded wire tags recovered from several hatchery release groups in each region. Wild stocks were assumed to have the same distribution as the regionally paired hatchery stocks (see Appendix 3). In addition, fishery- and stock-specific harvest rates, initial cohort sizes and maturity rates were estimated from the above analysis. The fishery-specific and stock-specific harvest rates were scaled across all ages and stocks in each fishery to obtain the observed 1984 catch. However, the relative stock composition across all fisheries had to be adjusted (see below) to obtain an acceptable stock composition, stock-specific harvest rates, and subsequent escapement in each fishery. In order to evaluate the behaviour of the model and of management rebuilding options, the following outputs were produced:

Table 4.9-1. Stocks and fisheries used in the model.

Fisheries	Stocks
1. ALSK - Alaska	1. NTH W - North Wild
2. NTH T - North Troll	2. WVI W - West Vancouver Island Wild
3. WVI T - West Vancouver Island Troll	3. GEO W - Georgia Strait Wild
4. GEO T - Georgia Strait Troll	4. FRA W - Fraser Wild
5. NTH N - North Net	5. NTH E - North Enhanced
6. WVI N - West Vancouver Island Net	6. WVI E - West Vancouver Island Enhanced
7. JOH N - Johnstone Strait Net	7. GEO E - Georgia Strait Enhanced
8. JDF N - Juan de Fuca Strait Net	8. FRA E - Fraser Enhanced
9. FRA N - Fraser Net	9. COL R - Columbia River
10. NTH S - North Sports	10. SPR C - Spring Creek
11. WVI S - West Vancouver Island Sports	11. PSD E - Puget Sound Enhanced
12. GEO S - Georgia Strait Sports	
13. WASH - WAshington	

1. Catch by fishery and stock in 1984;
2. Stock-specific harvest rates by year;
3. Catch by ocean and terminal fisheries by year;
4. Catch by clean-up fisheries by year;
5. Catch by stock by year;
6. Escapement by stock by year;
7. NPV by fishery after 20 years; and
8. Total catch by gear, escapement, and NPV by year.

The NPV's are calculated at 5%, 10% and 15% discount rates.

4.9.2 Critical Assumptions

A number of assumptions are discussed in Appendix 3. The critical assumptions follow:

1. The relative production of the modelled stocks were approximately correct;

2. The weights used for the relative size of stock cohorts were approximately correct;

3. The distribution of wild and enhanced stocks from the same region were similar through space and time; and

4. Marked (CWT) and unmarked fish had similar behaviour (vulnerability to fishing gear, ocean survival, maturity rate, etc.).

4.9.3 Limitations of Model Use

The best application of the model is in comparing or contrasting alternative options. The prediction of any one variable (e.g., catch, escapement, present value) is highly uncertain and no attempt has been made to assign confidence levels or error bounds for any of the outputs. Probably the most uncertain quantity is the number of years a stock will take to rebuild, since it is highly dependent on the productivity and production parameters given to each stock. On the other hand, statements such as "Stock A rebuilds faster

than Stock B" or "Stock A has a faster rebuilding period under Option X" should be valid.

Furthermore, the comparison of NPV's in Section 4.10 should be interpreted cautiously. First, the Base Case (which assumed 1984 harvest rates continue into the future) probably overestimated total NPV because the escapement of north wild stocks was assumed to increase over time (which may or may not be true), and enhanced stocks (both Canadian and American) were assumed to produce their full potential year after year, despite the probability that disasters will occur. Second, most rebuilding options probably underestimated the total NPV. Indian food fisheries are not presently economically evaluated, although the Indian food fisheries are the first to make gains under stock rebuilding. The economic gains resulting from a shorter fishing season (e.g., less gas would be needed to catch fish), which will probably occur under a ceiling management regime, also were not evaluated.

Since the model was produced over a short period of time, programming errors or errors in logic undoubtedly exist, although, at the time of publication, none were known. Further, the parameter values given in Appendix Tables A.3-1 and A.3-2 will undoubtedly be adjusted from closer scrutiny by fishery managers and advisor groups.

4.10 Predicted Results

A number of the management options outlined in Section 4.7 were analysed using the model described in the previous section. The outputs of the model include of catch by stock and by fishery through time, escapement by stock, harvest rates by stock, and the NPV of predicted catch by fishery at different discount rates. Because the model is not capable of taking into account natural events such as years of particularly poor abundance, it cannot be said to predict future catches. However, it can be used as a tool to compare management scenarios on the basis of rebuilding times and NPV of the catch minus the costs of implementing that scenario.

4.10.1 Economic Assumptions

In order to evaluate the different chinook rebuilding options in terms of net present value, a number of economic assumptions were made. First, the value of future catches in the commercial fishery is based on forecast wholesale prices by quality, minus marginal processing and harvesting costs. The prices for chinooks used in the analysis (based on an average weight of 6 kg per fish) are given in Table 4.10-1. No allowance was made for reductions in harvesting costs, which may occur if lengths of fishing times are decreased and fish abundance increases.

In the sport fishery, projected catches are translated to expected effort, using a simple historic linear relationship between catch and effort. The estimates of effort are then used to calculate total value, based on an the average assumption that an angler will be willing to pay $37.00 for a day of sport fishing ($92.50 per boat-day). This may tend to overestimate the value of the sport fishery when ceilings are in place, because the underlying assumption is that management of the sport fishery will not directly affect effort even as abundance increases. It is likely, however, that effort will have to be curtailed directly (not just reducing the efficiency of the effort) as abundance increases, if ceilings are still in place.

It was also assumed that there were no direct costs, apart from forgone catch of chinooks, associated with the different ways of imposing ceilings proposed in the Canada/U.S. treaty; however, this assumption may or may not be

Table 4.10-1. Chinook prices by quality (wholesale price per fish less marginal processing and harvesting costs).

Year	Troll 1	Troll 2	Net 1	Net 2	Canned
1984	$ 50.26	$ 40.14	$ 39.89	$ 29.83	$ 10.98
1985	46.27	36.95	36.72	27.45	10.11
1986	47.87	38.23	37.95	28.38	10.45
1987	49.63	39.63	39.36	29.43	10.83
1988	49.63	39.63	39.36	29.43	10.83
1989	47.87	38.23	37.95	28.38	10.45
1990	47.71	38.10	37.78	28.25	10.40
1991	49.79	39.76	39.36	29.43	10.83
1992	49.79	39.76	39.36	29.43	10.83
1993	49.31	39.37	39.01	29.17	10.74
1994	47.71	38.10	37.78	28.25	10.40
1995	50.10	40.01	39.72	29.70	10.93
1996	50.10	40.01	39.72	29.70	10.93
1997	50.10	40.01	39.72	29.70	10.93
1998	50.10	40.01	39.72	29.70	10.93
1999	50.10	40.01	39.72	29.70	10.93
2000	50.10	40.01	39.72	29.70	10.93
2001	50.10	40.01	39.72	29.70	10.93
2002	50.10	40.01	39.72	29.70	10.93
2003	50.10	40.01	39.72	29.70	10.93

correct. In order to stay within the chinook ceilings, loss of catch of other species may have to be accepted. Further work is required to assess the costs associated with reducing net interception fisheries in Juan de Fuca and Johnstone Strait in order to conserve chinooks. The costs and benefits of harvesting sockeye, pinks and chums in more terminal areas are the prime concern in this scenario.

The NPV of costs associated with building and operation of SEP facilities in the enhancement scenarios was subtracted from the NPV of the catch streams, and was calculated at two different real discount rates, 5% and 10%.

4.10.2 Results

The results of the modeling analysis of rebuilding options using ceilings, reducing net fisheries and "flooding" with enhanced stocks are summarized in Tables 4.10-2 and 4.10-3.

An examination of NPV's shows that the status quo option often results in higher values of catch streams than the rebuilding options primarily because of the forgone catch of U.S. fish. As mentioned previously (see 4.9-5 Limitations of Model Use), the NPV for the status quo option is likely an overestimate, while the rebuilding option likely underestimates the NPV. However, the magnitude of any bias should be small (less than 1%). In any case, the status quo option does not allow for the rebuilding of any wild stocks. Also, the NPV's presented here simply evaluate catch streams, and do not include the value of preserving the stability and diversity of salmon stocks by maintaining the existence of wild stocks. It would be unfair, however, to apply all the costs of ceiling scenarios to rebuilding chinook stocks, as the reductions in catch of U.S. chinook stocks are a consequence of trade-offs for benefits elsewhere in the Canada/U.S. treaty.

Option 2 (Table 4.10-2) represents one possibility for the implementation of the Canada/U.S. salmon treaty ceilings for chinooks; with the allocation of 100,000 to the troll fishery and 175,000 to the sport fishery in Georgia Strait, while holding the North Coast catches to 20,000 sport, 40,000 net and 203,000 troll. This scenario is used as a Base Case against which other options can be compared.

Table 4.10-2. Net present values and relative rebuilding times associated with chinook management options.

Options (Catches in Thousands)	Net Present Value of Catch (millions) @ 5%	Net Present Value of Catch (millions) @ 10%	Estimated Rebuilding Time for Wild Stocks (% change from Option 2) N.C.	W.C.V.I.	G.S.	Fraser
1. Status Quo (Maintain 1984 harvest ratio)	$ 1,698	$ 1,086	never	never	never	never
2. International Ceilings (Base Case) (G.S. - 100T, 175S; N.C. - 203T, 40N, 20S)	$ 1,532	$ 940	0	0	0	0
3. International Ceilings (G.S. - 275S; N.S. - 203T, 40N, 20S)	$ 1,662	$ 1,016	-12	0	-22	0
4. Reallocate 100 N.C. to G.S.S. (G.S. - 100T, 275S; N.C. - 103T, 40N, 20S)	$ 1,656	$ 1,010	-22	-83	-12	-17
5. Reallocate 100 N.C. to G.S.S. (G.S. - 375S; N.C. - 103T, 40N, 20S)	$ 1,784	$ 1,085	-22	-83	-33	-17
6. Reduce N. in Johnstone by 25% (rest same as Option 2)	$ 1,554 - costs	$ 951 - costs	-12	0	-12	-8
7. Reduce N. in Juan de Fuca by 25% (rest same as Option 2)	$ 1,532 - costs	$ 940 - costs	0	0	0	0
8. Reduce N. in Johnstone and Juan de Fuca by 25%; increase N. in Fraser by 25% (rest same as Option 2)	$ 1,547	$ 947	-12	0	-12	never

Abbreviations: G.S. = Georgia Strait, N.C. = North Coast, W.C.V.I. = West Coast Vancouver Island, T = troll, N = Net, S = Sport

Table 4.10-3. Net present values and relative rebuilding times associated with enhancement assisted rebuilding options.

Options	Net Present Value of Catch (millions)		Estimated Rebuilding Time for Wild Stocks (% change from Option 2)			
	@ 5%	@ 10%	N.C.	W.C.V.I.	G.S.	Fraser
9. Georgia Strait SEP potential doubles in 1986 (rest same as Option 2)	$ 1,942	$ 1,143	-12	0	-22	-17
10. West Coast Van. Is., SEP potential doubles in 1986 (rest same as Option 2)	$ 1,629	$ 984	-12	-17	-12	-17
11. Georgia Strait and WCVI SEP potential doubles in 1986 (rest same as Option 2)	$ 2,040	$ 1,188	-22	-17	-33	-25

Abbreviations: N.C. = North Coast, W.C.V.I. = West Coast Vancouver Island, G.S. = Georgia Strait, T = troll, N = Net, S = Sport

Options 3, 4 and 5 progressively allocate more fish to the Georgia Strait sport fishery. In Option 3, the entire ceiling in the Georgia Strait is allocated to the sport fishery, resulting in higher NPV's and little change in rebuilding times. Options 4 and 5 assume a reallocation of 100,000 chinook from the North Coast troll fishery to the Georgia Strait. In Option 4, the new Georgia Strait ceiling is split with 100,000 going to the troll fishery and 275,000 to the sport fishery. In Option 5, the whole 375,000 is allocated to the sport fishery. The most striking result of reallocating part of the Northern ceiling to the Strait of Georgia is a substantial decrease in the rebuilding time required for West Coast of Vancouver Island wild chinook stocks.

For Options 6 and 7, the costs of forgone net catches in Johnstone Strait and Juan de Fuca Strait have not yet been calculated, but they must be subtracted from the NPV in each case in order to give an accurate representation of the option. As mentioned in the section on net fishery reduction options, the catch of pinks, sockeye and chum can be shifted to the Fraser River with little forgone catch of these species. However, the interceptions of Canadian chinooks in the Fraser would increase as a consequence. The result of this action is depicted in Option 8, where both Johnstone Strait and Juan de Fuca Strait catches are reduced, and Fraser harvest rates increase. In this scenario, Fraser River wild chinook stocks do not rebuild.

Options for rebuilding with enhancement are presented in Table 4.10-3. Option 9 assumes major Georgia Strait stocks are enhanced, doubling production by 1986. Option 10 represents SEP production doubling by 1986 on the West Coast of Vancouver Island. In Option 11, enhancement potential is doubled in both areas. Each of these scenarios results in improved NPV compared to scenarios without increased enhancement; however, rebuilding times are not significantly reduced by enhancement alone.

5.0 COHO SALMON RESOURCE MANAGEMENT PLAN

5.1 Overview

5.1.1 A Changing Management Perspective

Management of coho salmon in British Columbia has traditionally been largely passive. The major fisheries for coho have been the troll, sport and native food fisheries. The commercial net fisheries have avoided fishing specifically for coho in recent years, although there has been an incidental catch while fishing for sockeye, pink and chum salmon. Escapement levels are not universally set, and there has not been an emphasis on managing the mixed stock ocean fisheries (troll and sport) to achieve optimum escapement. In the past, conservation measures taken for chinook salmon were assumed to benefit coho salmon. Increased coho catches were also seen as a replacement for a declining chinook harvest. This management perspective must be changed because of the accumulation of evidence documenting the decline of coho stocks, and the management commitment made by the Canada/U.S. Salmon Treaty.

The recently developed Canada/U.S. Salmon Treaty presents new challenges for coho management on Canada's Pacific Coast, as well as new requirements for data acquisition and analysis. One key feature of the Treaty is the establishment of a joint Technical Committee that will force more active management of coho stocks to extract more benefits from the Treaty on both sides of the border. A specific feature of the Treaty with respect to coho is a ceiling (maximum harvest level) for coho take by the West Coast of Vancouver Island (WCVI) troll fishery. Ceilings of 1,750,000 coho are set for 1985 and for 1986. The extent to which ceilings may reduce the WCVI troll catch is unclear; historically, coho catches have averaged 1,630,000 while the 1983/84 average was 2,230,000. Whether the latter yield is sustainable, or whether this catch is anomalously high is not known.

Simulation studies (Section 5.10.3) indicate that a 40% cut to all fisheries may be required to rebuild Fraser and Georgia Strait stocks to optimum levels. This level of catch reduction indicates the current state of these coho stocks. With a history of poor data and passive management, it is hardly surprising that the methodology required to manage the resource more actively

is not entirely clear. However, a commitment has been made to manage at least some coho stocks in the future. The purpose of this chapter is to sketch out conceptually some of the management options that are presently available.

5.1.2 Uncertainty of Stock Status

The primary factors that influence the annual abundance levels of wild stocks are:

1. Escapement levels and available rearing habitat;

2. Freshwater flow in streams during the summer residence period of juveniles;

3. Over-winter stream conditions;

4. Stream temperatures; and

5. Ocean survival rates.

The relationships among these factors are not understood for coho. Spawning escapement estimates for coho are the most difficult among salmon species to obtain because:

1. They spawn over a large geographical area in a vast number of small streams;

2. They spawn over a broad temporal range; and

3. Peak spawning occurs during the harshest weather of the year when visibility is frequently impaired by ice and winter flooding.

In practice, the frequency of surveys depends on available manpower and fiscal resources. Many streams are inspected only once or not at all in some years. Furthermore, methods for estimating escapement are not standardized, and generally depend on the personal judgement of individual Fishery Officers.

While escapement estimates are available for many coho stocks from the early 1950's, the data are generally useful only for the evaluation of gross trends. These trends suggest that most coho stocks require rebuilding. Confirmation of the need for stock rebuilding comes from closely monitored stocks in Washington. Unfortunately, the amount of rebuilding required and the extent of management intervention that must take place to achieve rebuilding are both unknown. Clearly, actions taken now must not preclude future changes, and all actions must be based upon a better understanding of the fishery and coho population dynamics.

5.1.3 Implications of Coho Life-History Features

The majority of coho salmon have similar life-history patterns. They spawn in streams and small tributaries and become smolts after one to two years of rearing in fresh water. They then enter the ocean. Nearly all coho harvested in the ocean are taken during their second ocean year. Thus, the success of each fishing year is dependent on the abundance of one age group (three-year-olds, or four-year-olds in some northern areas). Because of a single dominant age group in the catch, coho fisheries primarily affect a single brood.

Coho are highly vulnerable to hook-and-line ocean fisheries throughout their final summer of life; migration to streams starts in July, accelerates through September and ends in December-January. Coho are not limited to shelves and ridges like chinooks and can range far off shore within the coastal zone. The distance north or south travelled by coho from streams of origin tends to be much less than by chinooks, although some coho stocks are found both north and south of their streams of origin, in contrast to the typical northward migration of chinooks.

The implications of these life-history features are that coho not caught in early summer ocean fisheries are still available later in the summer or fall. Similarly, coho not caught in one area may be harvested elsewhere as the fish travel between areas. Fishing success will not only be high early in the season when populations are large and spread out, but also late in the season when the smaller populations concentrate in localized areas on their return migrations to rivers of origin.

Because coho salmon fishing success depends on only one age group in most areas, the yearly catch is much more variable than for other species in which several age groups contribute to the catch (e.g., chinook salmon). As with any salmon species, the productivity of individual stocks may also vary a great deal. Thus, fisheries operating on mixed stocks are simultaneously harvesting coho stocks with different productivities and capacities to support harvest. Enhancement of coho stocks may be aggravating this problem, since attempts to fully harvest hatchery stocks in a mixed stock fishery invariably over-harvests mixed wild stocks. Even though hatchery output of coho has increased from the mid-1960s, there has not yet been a clear increase in coho catches as a result of this enhancement. It is possible that many less productive wild stocks have simply been replaced by a few highly productive hatchery stocks.

The management implications of these considerations are:

1. The management of coho salmon must effectively deal with substantial annual fluctuations in populations of wild and hatchery fish; and

2. Coho salmon in one area or one time period cannot be managed in isolation from other areas and time periods.

5.2 Stock Description

For the purposes of stock description, coho stocks have been organized into the following groups:

1. North Coast (Statistical Areas 1-5);
2. Central Coast (Statistical Areas 6-10);
3. Johnstone Strait (Statistical Areas 11 and 12);
4. Georgia Strait (Statistical Areas 13-19);
5. West Coast Vancouver Island (Statistical Areas 20-27); and
6. Fraser River area (Statistical Areas 28 and 29).

Trends and other characteristics of escapement estimates by Statistical Area group are described in this section. In view of the questionable accuracy of the escapement data (see Section 5.1.2) trends are substantiated with other data sources where available. A summary is presented in Table 5.2-1. A more detailed review of coho stock status can be found in Section 2.0 and 3.0.

Average coho escapements by stream have been designated "large" if they exceed 5,000, "medium" if they are in the 1,000-5,000 range, and "small" if they are less than 1,000.

5.2.1 North Coast (Areas 1 - 5)

Coho salmon are currently reported to spawn in 323 North Coast streams, approximately 30% of the streams in British Columbia that currently support coho. Of these, 11 are large and 24 are medium-sized. The remaining 288 streams have fewer than 1,000 spawners each, but make up the bulk of the total escapement. Major production areas are: the north and east coast of the Queen Charlotte Islands, the Nass River system and the Skeena River system. Of the 11 large systems, seven are located on the Queen Charlotte Islands: the Naden River, Yakoun River, and Davidson Creek located on the north coast of Graham Island; and the Copper River, Tlell River, Deena Creek and Mathers Creek located on the east coast of Graham and Moresby islands. In addition, 11 of the 24 medium-size systems are on the Queen Charlottes. The remaining four large sub-stocks are: the Tseax River on the Nass, the Lakelse and Babine rivers on the Skeena, and Bonilla Arm on Banks Island.

Table 5.2-1. Coastwide coho escapements (numbers of fish) by Statistical Area groups.

	Statistical Area Groups						
YEAR	1 - 5	6 - 10	11 - 12	13 - 19	20 - 27	28 - 29	TOTAL
1953	85455	152075	201350	164000	177025	115207	895112
1954	119141	245575	124800	168650	167719	104375	930260
1955	141275	191825	208300	179825	120000	134169	975394
1956	173425	308725	280150	158950	153925	52690	1127865
1957	156545	220370	139500	203595	95784	105377	921171
1958	214100	136807	150575	203675	130815	101895	937867
1959	103650	193465	83275	164250	107780	53100	705520
1960	115350	88795	47382	123775	71010	64994	511306
1961	173126	166139	91745	240725	130770	122139	924644
1962	121722	179973	130500	129700	130295	168111	860301
1963	148330	260000	76775	205375	99945	119171	909596
1964	221275	281359	112400	298725	244035	152493	1310287
1965	312200	205415	111375	162025	169684	86661	1047360
1966	290862	184375	83300	235221	176425	90036	1060219
1967	151936	78700	65250	129110	155500	54130	634626
1968	231375	200535	68875	151868	151548	59663	863864
1969	115500	69935	22275	110855	100200	68144	486909
1970	158600	147425	97325	234639	290489	106950	1035428
1971	144080	122060	40025	221628	159151	154658	841602
1972	125536	134925	50205	92415	106121	62009	571211
1973	125945	97900	63350	117128	23221	99018	735562
1974	167932	110730	63120	210990	186510	226702	965984
1975	120729	86120	37975	154919	78320	134965	613028
1976	238192	155193	43115	101499	64816	86842	689657
1977	158660	89800	70255	249937	80499	113581	762732
1978	167942	93695	31090	117666	90699	124743	625824
1979	95940	92236	18578	149040	90713	117578	564085
1980	82535	65978	20100	179769	28710	91072	468164
1981	94920	69574	14024	167760	28382	87175	461835
1982	130983	80994	2927	150155	32017	103525	500601
1983	115972	87912	25406	144061	17543	88870	479764

Overall, escapement estimates have been fairly level since the early 1950's, but have shown an erratic decline for this stock group since the mid-1960's (Figure 5.2-1). For the Skeena River, this decline (to about 50% of the 1960's level) has been corroborated by the Skeena test fishery coho index which, although measuring only about 50% of the run, is very closely correlated with the escapement estimates. The Babine coho stock, which has been partially enumerated through a counting fence since 1947, has declined at a rate similar to total escapement. Escapements to the Nass River and the Queen Charlotte Islands have not shown the same decline.

5.2.2 Central Coast (Areas 6 - 10)

Coho spawning has been reported from 260 Central Coast streams, of which 179 still support populations. Only the Atnarko River in the Bella Coola system and the Dean River at the head of North Bentinck Arm have large escapements. Eleven medium-sized stocks are all located in Areas 6 and 8. The current aggregate escapement (1981 - 1983 average) for this stock group is only about one-third to one-half of the pre-1970 level with a decline evident since the mid-1960's (Figure 5.2-2). The central coast gillnet catch has declined to a current level of less than 15% of historical highs (as measured in 5 year averages).

5.2.3 Johnstone Strait (Areas 11 - 12)

The known escapement to Johnstone Strait coho streams has declined from levels averaging 161,000 over the period 1947 to 1960, to 15,000 for the period 1981 to 1983 (Table 5.2-1 and Fig. 5.2-3). During this time the number of streams with reported coho escapements has declined from 74 to 31. Further investigation is required to determine whether these declines are real or whether they are the result of diminished escapement enumeration effort.

5.2.4 Georgia Strait (Areas 13 - 19)

The wild stock escapement trend (Table 5.2-2) as indicated by Fishery Officer estimates appears to be declining, although overall this is masked by hatchery-generated escapements (Figure 5.2-4). Harvest rates of over 80%, estimated from coded wire tag recoveries of hatchery coho, indicate that these



Figure 5.2-1. North coast coho escapements.

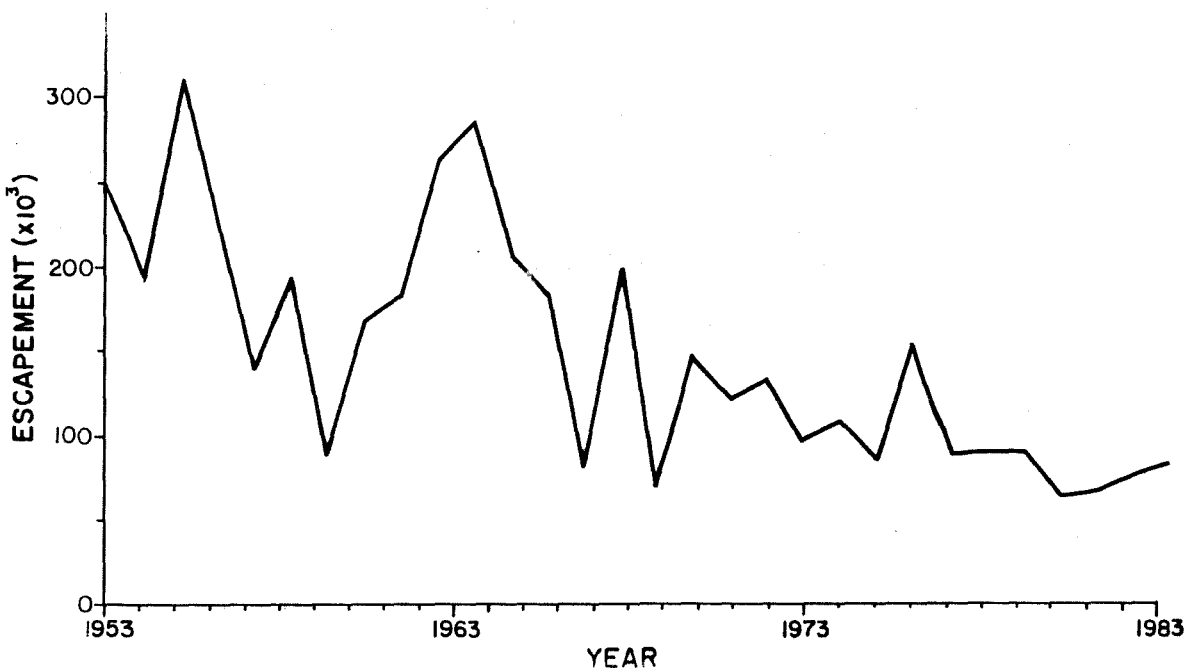


Figure 5.2-2. Central coast coho escapements.

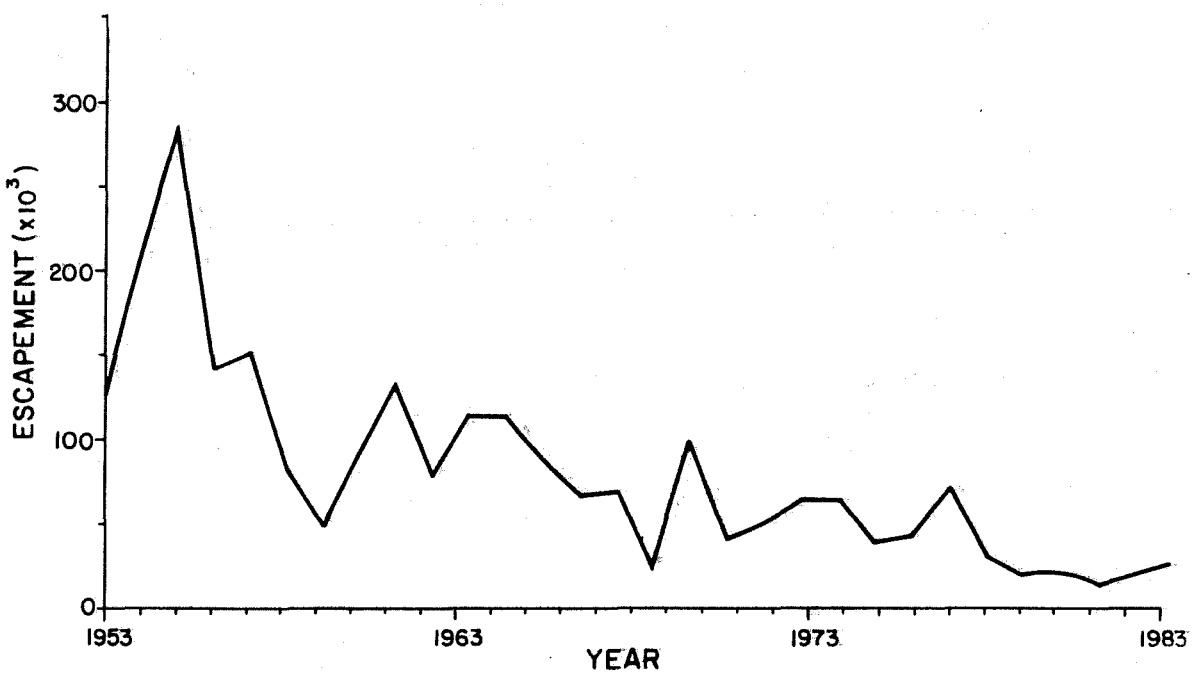


Figure 5.2-3. Johnstone Strait coho escapements.

stocks are being exploited at rates higher than those that would produce maximum sustainable harvests from most wild stocks.

5.2.5 West Coast Vancouver Island (Areas 20 - 27)

Conflicting data prevent any clear conclusion regarding the status of coho stocks on the West Coast of Vancouver Island. Raw escapement data are unreliable, because the effort expended on spawner enumeration each year is highly variable. Therefore, the reported declines in escapement over the past decade may not reflect a real trend. Nevertheless, extensive logging and accompanying road building have increased flows and silt loadings of many coho-producing streams, likely exacerbating the high variability in egg-to-fry survival rates and diminishing carrying capacity. The Somass River is the only stream that currently supports a large spawning population.

5.2.6 Fraser River Area (Areas 28 - 29)

The Fraser River area coho resource is an aggregate of stocks that spawn in the Fraser, Capilano, Seymour and Indian river systems, in the streams of the Boundary Bay drainage, and in a number of other smaller streams. Escapement of the aggregate stock has been erratic but generally trendless since 1951, although declines have been noted over the last five years (Tables 5.2-2 and 5.2-3). Fraser River escapements have been erratic, but show a clear decline, at rates of 1% per year since 1951 and 4% per year since 1970 (Table 5.2-2). A serious decline in the major wild stocks, especially since 1970, is masked by production increases from the Capilano and Seymour hatchery facilities. For this reason, the status of major stocks is discussed individually below.

5.2.6.1 Fraser River

The Fraser River is the largest single coho producer in this area, with recent escapements (1979-1983) averaging 46% of the area total. Until recently, Fraser River coho have been almost entirely wild. However, three major hatcheries and a number of minor hatcheries will reach operational levels of production over the next cycle.

Table 5.2-2. Trends in Georgia Strait and Fraser River wild coho spawning escapements as indicated by Fishery Officer estimates, 1970-1983. The hatchery component has been subtracted from total escapement figures and the results scaled to 1970 escapement = 1.00.

Year	Fraser River (Areas 28-29)	Georgia Strait (Areas 13-19)
1970	1.00	1.00
1971	1.47	0.93
1972	0.64	0.39
1973	0.92	0.48
1974	1.90	0.82
1975	1.23	0.50
1976	0.56	0.35
1977	0.88	0.72
1978	1.12	0.38
1979	0.69	0.37
1980	0.65	0.51
1981	0.65	0.14
1982	0.73	0.35
1983	0.79	0.23

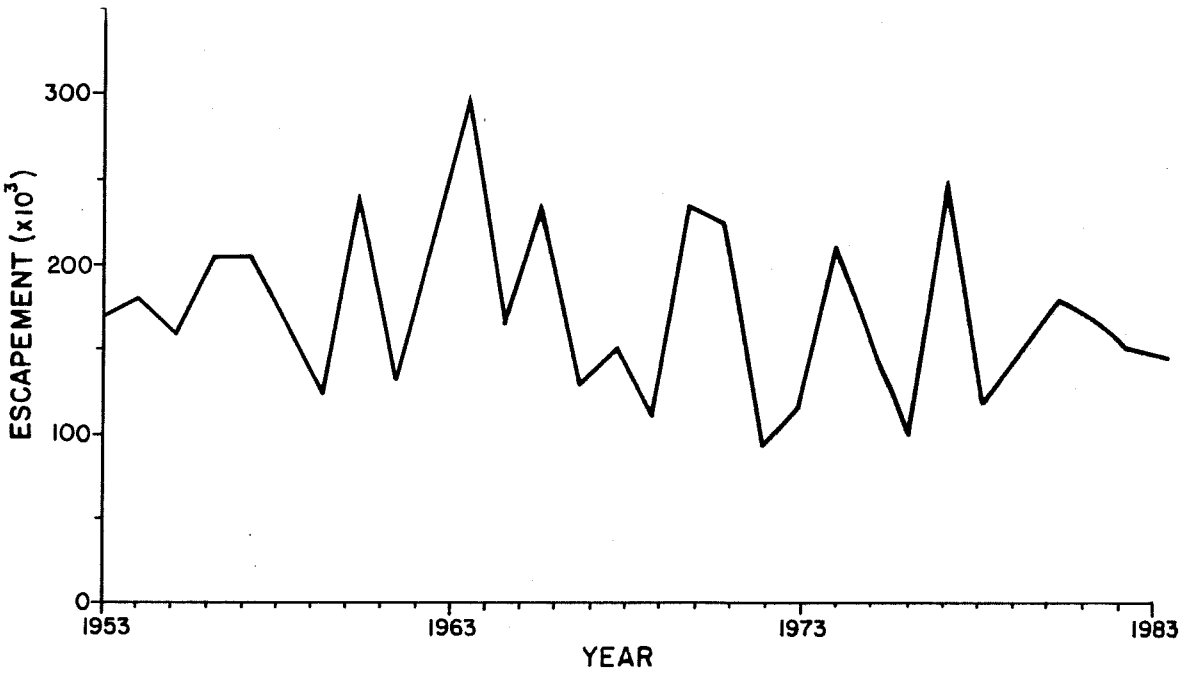


Figure 5.2-4. Georgia Strait coho escapements.

Table 5.2-3. Fraser River region coho escapements.

	Area 29 coho escapements					Area 28 coho escapements							Total
Year	Upper Fraser River	Lower Fraser River	Total Fraser River	Boundary Bay Streams	Area 29 Total	Squamish River	Misc. Howe Sound	Capilano River	Seymour River	Indian River	Misc. Burrard Inlet	Area 29 Total	Area 28 and Area 29
1951	11,375	41,475	52,850	6,500	59,350	87,350	1,375	3,500	1,500	3,500	350	97,575	156,925
1952	29,800	99,375	129,175	6,500	135,675	87,750	950	7,500	3,500	3,500	250	103,450	239,125
1953	28,600	66,925	95,525	6,500	102,025	6,425	200	3,500	1,500	1,500	57	13,182	115,207
1954	16,150	37,525	53,675	5,000	58,675	38,675	400	3,500	1,500	1,500	125	45,700	104,375
1955	63,650	35,871	99,521	2,650	102,171	19,350	400	4,998	3,500	3,500	250	31,998	134,169
1956	11,700	28,700	40,400	3,750	44,150	3,500	75	1,840	1,500	1,500	125	8,540	52,690
1957	14,452	38,075	52,527	1,550	54,077	40,550	400	5,100	3,500	1,500	250	51,300	105,377
1958	20,525	53,650	74,175	1,900	76,075	20,400	400	3,745	400	750	125	25,820	101,895
1959	11,275	32,650	43,925	3,000	46,925	6,100	75	N/R	N/R	N/R	0	6,175	53,100
1960	19,205	26,725	45,930	1,550	47,480	10,800	75	3,614	1,500	1,500	25	17,514	64,994
1961	28,775	38,600	67,375	4,300	71,675	44,400	25	2,114	400	3,500	25	50,464	122,139
1962	37,250	117,125	154,375	800	155,175	8,350	25	2,636	1,500	400	25	12,936	168,111
1963	10,850	92,600	103,450	1,000	104,450	9,550	75	2,071	1,500	1,500	25	14,721	119,171
1964	17,721	68,675	86,396	9,000	95,396	50,000	200	2,622	750	3,500	25	57,097	152,493
1965	34,025	33,086	67,111	800	67,911	17,100	75	750	400	400	25	18,750	86,661
1966	19,300	53,786	73,086	1,200	74,286	9,200	25	3,500	1,500	1,500	25	15,750	90,036
1967	5,180	27,725	32,905	800	33,705	16,950	50	1,500	400	1,500	25	20,425	54,130
1968	14,766	26,272	41,038	600	41,638	14,200	50	1,500	1,500	750	25	18,025	59,663
1969	23,770	29,474	53,244	350	53,594	10,900	50	1,500	1,500	400	200	14,550	68,144
1970	21,050	45,075	66,125	3,000	69,125	30,900	1,100	3,500	1,500	750	75	37,825	106,950
1971	19,031	89,525	108,556	7,750	116,306	29,600	375	4,052	3,500	750	75	38,352	154,658
1972	15,821	23,800	39,621	10,500	50,121	8,350	65	1,173	1,500	400	400	11,888	62,009
1973	16,529	40,375	56,904	8,500	65,404	26,600	825	3,864	1,500	750	75	33,614	99,018
1974	23,394	48,825	72,174	8,000	80,174	100,750	1,075	40,378	3,500	750	75	146,528	226,702
1975	13,224	48,425	61,649	8,500	70,149	56,150	500	6,391	1,500	200	75	64,816	134,965
1976	8,312	29,627	37,939	10,500	48,439	11,500	425	25,248	1,000	200	30	38,403	86,842
1977	19,152	52,589	71,741	7,000	78,741	11,100	225	19,927	3,000	500	88	34,840	113,581
1978	20,037	57,687	77,724	6,600	84,324	9,350	585	25,163	5,000	150	171	40,419	124,743
1979	14,842	41,704	56,546	4,500	61,046	8,625	175	42,788	4,500	280	164	56,532	117,578
1980	9,816	32,287	42,103	4,750	46,853	10,265	200	23,931	9,00	300	523	44,219	91,072
1981	10,806	30,057	40,863	4,000	44,863	9,361	75	23,100	8,500	800	476	42,312	87,175
1982	11,697	37,091	48,788	4,887	53,675	10,980	192	29,266	8,500	450	462	49,850	103,525
1983	10,113	26,698	36,811	4,350	41,161	11,160	75	21,328	14,000	700	446	47,709	88,870
MEAN													
51-60	22,673	46,097	68,770	3,890	72,660	32,090	435	4,144	2,044	2,083	156	40,125	112,786
61-70	21,269	53,242	74,511	2,185	76,696	21,155	168	2,169	1,095	1,420	48	26,054	102,750
71-80	16,011	46,484	62,496	7,660	70,156	27,229	445	19,292	3,400	428	168	50,961	121,117
79-83	11,455	33,567	45,022	4,497	49,520	10,078	143	28,083	8,900	506	414	48,124	97,644

A test fishery intended specifically to index Fraser River coho escapement has not yet been established. Nevertheless, an index of coho abundance has been developed by combining coho data from the International Pacific Salmon Fisheries Commission (IPSFC) sockeye test fishery, which generally ceases operation by mid-October, with coho data from the chum test fishery, which operates from early October through mid-December. This index confirms a significant decline in returns to the Fraser River, at least since 1970. While uncertainties in escapement enumeration and in determination of the escapement required for optimum yield prevent a full analysis of Fraser River stock status, these declining trends are cause for concern, and indicate that current escapements are well below potential.

5.2.6.2 Capilano River

The Capilano River is the second largest coho producer in the Fraser River area, with recent escapements averaging 29% of the area total. Returns have been greatly increased by the construction of the Capilano River hatchery. Recorded escapements, derived primarily from the "trap and truck" operation prior to construction of the hatchery and more recently from hatchery returns, strongly reflect enhancement activities in the watershed; a recent 5-year average is 6 times the level recorded in the early 1950's. Escapement targets are based entirely on hatchery production requirements and generally vary from year to year. Escapements in excess of brood stock requirements have occurred since the hatchery began production.

5.2.6.3 Squamish River

The Squamish River is the third largest coho producer, and the second largest wild coho producer, in the Fraser River area. Recent escapements (1979-1983) have averaged approximately 10% of the area total. Production has been entirely wild to date, but two minor facilities expect enhanced returns in 1985. Coho escapements have shown an erratic but declining trend. Escapements since 1951 have declined at an average rate of 2% per year, with more severe declines of 10% per year since 1970. Although the escapement level required for optimum production is unknown, the accelerated rate of decline since 1970 indicates that Squamish River coho stocks are among the most depressed in the Fraser River area.

5.2.6.4 Seymour River

The Seymour River is the fourth largest coho producer in the Fraser River area, with recent (1979-1983) escapements averaging approximately 9% of the area total. Escapements have increased almost four-fold between 1951 - 1955 and the present. Much of this increase is attributable to a small enhancement facility that has operated in the watershed since 1977.

5.2.6.5 Boundary Bay

Three streams discharging into Boundary Bay support significant runs of coho: Little Campbell, Nicomekl and Serpentine rivers. Current escapements average 4,500 annually. While there have been marked fluctuations since the early 1950's, no trend is apparent.

5.3 Current Enhancement Activities

5.3.1 North Coast (Areas 1 - 5)

Table 5.3-1 lists coho enhancement facilities in the North Coast area. North Coast coho enhancement activities include yearling smolt production (Fort Babine, Kispiox and Masset) and fry plants from all other facilities, including Kispiox and Masset. Pallant Creek coho fry plants yielded returns at projected rates on the basis of coded wire tag recovery data, suggesting that pre-migrant release programs in this area may achieve expected production levels. No data are presently available on the success of yearling smolt releases.

5.3.2 Central Coast (Areas 6 - 10)

Table 5.3-2 lists coho enhancement facilities in the Central Coast area. The most important facility for enhancement of Central Coast coho stocks is at Kitimat. It was designed to produce a single Kitimat system stock, plus Dala, Kildala and Bish stocks. The three remote stocks are currently not receiving attention due to the high costs involved. Kitimat stock production reached full capacity in the first year of operation (1983).

Enhancement at Klemtu, Hartley Bay, and Snootli involves fry releases while coho at Bella Bella are reared in sea pens to the yearling stage.

No data are yet available for assessment of the long-term success of coho enhancement in the Central Coast.

5.3.3 Johnstone Strait (Areas 11 - 12)

Table 5.3-3 lists coho enhancement facilities in the Johnstone Strait area. Johnstone Strait coho production from enhancement facilities is limited to approximately 18,000 adults from four stocks. All hatchery releases are pre-migrant sub-yearlings. The Port Hardy program includes two facilities on the Quatse (East Coast Vancouver Island) and Stephens (West Coast Vancouver Island) rivers. Flow storage works on the Keogh and Quatse are expected to boost natural rearing capacity.

Table 5.3-1. Coho enhancement facilities in the North Coast area (production capacity based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
Pallant	215,000	3,200	Pallant
Ft. Babine	30,000	4,500	Babine
Kispiox	85,000	3,200	Kispiox
Masset*	50,000	7,500	King, Wilson, Ghost, Gold
Skidegate	25,000	750	Slarkedus
Terrace	50,000	750	Copper
Toboggan Ck.	100,000	3,000	Toboggan
Eby St.	567,000	8,500	Lakelse
Sachs Ck.	81,000	1,220	Sachs, Haans
Sewell	81,000	1,220	Sewell Head
TOTALS	1,284,000	33,840	

* Brood stock was not taken in 1984 due to the possibility of moving King Creek Hatchery.

Table 5.3-2. Coho enhancement facilities in the Central Coast area (production capacity based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
Kitimat	405,000	60,700	Kitimat
Snootli	86,000	1,300	Bella Coola
Hartley Bay	160,000	2,400	Hartley Bay Creek
Bella Bella	20,000	3,000	MacGlaughlin, Kajusdis
Klemtu	55,000	1,650	Kitasoo
TOTALS	726,000	69,050	

Table 5.3-3. Coho enhancement facilities in the Johnstone Strait area (production capacity based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
Port Hardy (Quatse)	250,000	7,500	Quatse, Cluxewe
Scott Cove	400,000	6,000	Scott Cove
Nimpkish	150,000	4,500	Nimpkish
TOTALS	800,000	18,000	

5.3.4 Georgia Strait (Areas 13 - 19)

Table 5.3-4 lists coho enhancement facilities in the Georgia Strait area. Georgia Strait coho enhancement activities include: flow storage and improved fish passage (Hemming Lake); pre-migrant fry plants (Cowichan, Chemainus, Nanaimo, Powell River, Sechelt, Seymour, Sliammon, Vancouver River, Courtenay, Goldstream, Hyacinthe, Memekay and Upper Paradise); yearling smolt releases (Qualicum, Puntledge, Quinsam, Tenderfoot, Capilano, Seymour, Noons Creek); and yearling releases from sea pens (False Creek, Sechelt, Sliammon, Deep Cove). Many major hatcheries also plant hatchery fry into local barren streams, sometimes in co-operation with public groups. Further, colonization above the upper limit of adult migration is a routine practice on the Capilano, Puntledge and Quinsam rivers.

Coho production rates vary significantly among facilities and years but overall appear to be close to projections. Smolt release strategies have proven to be successful, and some fry release programs have yielded good returns. It is uncertain whether or not transplant stocks can be established in natural systems.

5.3.5 West Coast Vancouver Island (Areas 20 - 27)

Table 5.3-5 lists coho enhancement facilities in the West Coast Vancouver Island area.Almost 90% of production capacity for salmon enhancement in this area is at the Robertson Creek facility. West Coast coho enhancement is limited to fry plants, except at Robertson Creek and a portion of the Thornton Creek production, where yearling smolts are produced. Many projects have been limited by egg availability, resulting in some transplant of Robertson Creek stock to Thornton, Plastid, Beaver, Lanteman, Sooke and Sandhill.

5.3.6 Fraser River Area (Areas 28 - 29)

Tables 5.3-6 and 5.3-7 list coho enhancement facilities in the Lower Fraser area and the Thompson area, respectively. These areas can be further partitioned into the following major drainage units: Chilliwack, Harrison, Lower Fraser, North Thompson, South Thompson, Upper Fraser and the lower mainland area. Each of these units is discussed in detail in Section 3.7.

Table 5.3-4. Coho enhancement facilities in the Georgia Strait area (production capacity based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
B. Qualicum	2,250,000	337,000	Big Qualicum
Puntledge	3,900,000	149,000	Puntledge, Tsolum
Quinsam	1,600,000	160,000	Quinsam
Chemainus	50,000	1,000	Chemainus
Tenderfoot	270,000	40,500	Cheakamus, Squamish, Mamquam
Capilano	1,400,000	167,000	Capilano
Cowichan	500,000	7,500	Cowichan
False Ck.	20,000	3,000	Seymour
Nanaimo	500,000	15,000	Nanaimo
Powell R.	300,000	5,400	Lang, Kelly
Sechelt	50,000	4,800	Sechelt (Capilano)
Seymour	200,000	9,750	Seymour
Sliammon	100,000	9,000	Sliammon, Okeover
Deep Cove	150,000	22,500	Capilano transplant
Vancouver R.	100,000	3,000	Jitco
Hemming L.	141,000	1,700	Hemming
Courtenay	400,000	6,000	Trent
Goldstream	180,000	2,700	Goldstream
Hyacinthe Ck.	400,000	6,000	Hyancinthe
Memekay R.	160,000	2,400	Memekay
Noons Ck.	34,000	5,100	Noons
Up. Paradise	40,000	600	Cheakamus
TOTALS	12,745,000	958,950	

Table 5.3-5. Coho enhancement facilities in the West Coast Vancouver Island area (production capacity based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
Nitinat	72,000	1,000	Nitinat
Robertson	1,000,000	150,000	Robertson
Tlupana	360,000	5,600	Conuma, Tlupana, Canton
Thornton*	140,000	10,200	Staghorn, Upper Kennedy, Kootowis
Kyuquot	40,000	600	Mckay Cove Ck.
Ahousat	40,000	600	Lower Kennedy
Marble	120,000	1,800	Marble
Robertson	120,000	1,440	Plastid, Beaver, Lanteman
Sooke	320,000	4,800	Rocky
Thornton	100,000	1,520	Sandhill (Robertson Ck. transplant), Lostshoe
Stephens Ck.	350,000	10,500	Stephens, Waukwaas, Wanokana
San Juan**	1,500,000	2,250	San Juan
TOTALS	4,162,000	190,310	

* 90,000 presmolts, 50,000 Robertson Creek transplanted smolts released at 20 g weight.

** district staff authorized the collection of 1,500,000 coho eggs, later released at 1.0 g. Assumed survival 1.5%.

Table 5.3-6. Coho enhancement facilities in the Lower Fraser drainage (production capacity based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
Birkenhead	25,000	3,800	Birkenhead
Chehalis	507,000	75,000	Weaver, Chehalis, Harrison, Coho, Squakum, Evans, Hicks/ Maria
Chilliwack	2,040,000	306,500	Dolly Varden, Post, Salwein
Inch	288,000	43,000	Inch, Nicomen, Siddle, Norrish, Blaney
Alouette	100,000	15,000	Alouette
Brunette	34,000	5,100	Brunette
Centre Creek	100,000	1,500	Chilliwack
Kanaka	97,000	1,455	Kanaka
Little Campbell	81,000	1,215	Little Campbell
TOTALS	3,272,000	452,570	

Table 5.3-7. Coho enhancement facilities in the Thompson drainage (production capacity based on SEP biostandards).

	Production Capacity		Target Stocks
	Releases	Returns	1984
Eagle	750,000	30,000	Eagle, Salmon
Clearwater	500,000	18,000	Lion
Spius	600,000	23,000	Coldwater
Barriere	175,000	4,125	Dunn, Lemieux, Fennel
Louis Creek	200,000	3,000	Louis
Kingfisher	40,000	600	Lower Shuswap
TOTALS	2,265,000	78,725	

5.4 Fisheries

There are few fisheries managed specifically for coho salmon. Historically, coho have been intercepted by major hook-and-line fisheries that target on both chinook and coho salmon. The troll fishery in British Columbia has been the major commercial harvester of coho salmon on Canada's Pacific Coast. Since many coho streams are small and isolated, and coho runs are prolonged, terminal harvesting of many stocks is very inefficient. For many coho stocks (e.g., West Coast Vancouver Island, Johnstone Strait and mainland inlets), a troll fishery remains the only practical means of harvest. The sport fishery concentrated in Georgia Strait is the other major directed fishery on coho. There are incidental and targeted Indian food fisheries. Directed commercial net fisheries for coho no longer exist in British Columbia, although the incidental catch by nets is significant. Since these fisheries have been described in detail previously, only a brief overview is given here. In addition, some information is available from coded wire tag (CWT) data on the catch distribution and exploitation rates for the enhanced coho stocks found in each of these major interception fisheries (see Glossary for a definition of interception fishery). Therefore, a short overview of coho distribution by stock and a summary of each aggregate stock group will also be presented.

5.4.1 Commercial Troll Fishery

Commercial trollers have been the major harvester of coho in British Columbia since the 1920's. Beginning in 1980, vessels were required to commit annually to fishing either within Georgia Strait or outside Georgia Strait, but trollers were permitted in a common area formed by Statistical Areas 12 and 13. In 1984, 263 trollers opted to fish in the Strait of Georgia. These boats are generally smaller and less seaworthy than outside trollers. Vessels opting for an inside troll licence are not permitted to use any other gear type.

Trollers fish all the outside areas; coho are caught generally in the upper 20 fathoms (37 m) of water and up to 30 miles (50 km) offshore. Ice and freezer trollers are highly mobile and can fish many areas in a trip. Each trip ends in a single delivery with a single record of catch.

The troll fishery for coho has been relatively unmanaged, with a set season each year, and few or no in-season changes in response to observed abundances. Regulations covering changes in gear, size limits, gear licensing and area licensing are written under the Fisheries Act. Most of these regulations have been aimed at harvesting maximum-sized fish, recognizing that rapid growth takes place in the final few months of ocean life. Restrictions on gear (e.g., the six gurdie limit, barbless hooks) and nursery area closures are directed at conservation.

Overall, troll catches of coho in 1983 and 1984 are above those of previous years, while catches in net fisheries have decreased. The troll catch of coho in the Strait of Georgia is currently stable but below the level of the 1970's, while the West Coast of Vancouver Island troll catch has shown an increase in 1983 and 1984 compared with the early 1980's. The troll fishery season has been reduced in recent years, with closure of the fishery in October initiated in 1980 and in late September in 1984. In addition, coastwide closures have reduced the proportion of shakers in June, when small fish are most abundant.

5.4.2 Commercial Net Fishery

Net fisheries have been considerably reduced to rebuild stocks of chinook salmon; this measure has also reduced or reallocated the coho catch to some extent. Net fisheries catch substantial numbers of juvenile and adult coho salmon incidentally in directed sockeye, pink and chum fisheries. Juvenile coho have no monetary value and are caught incidentally. An unknown proportion is kept but not recorded in catch statistics. Adult coho are caught while feeding prior to maturity and during their migration back to rivers of origin.

5.4.3 Sport Fisheries

The sport fishery, located primarily in Georgia Strait, targets on coho through June to September and catches have remained relatively stable in recent years. Sport fishing in British Columbia occurs mainly in Georgia Strait, between Sheringham Point (near Sooke) and Stuart Island, north of Campbell River. In 1983, this area produced approximately 82% of the British

Columbia coho tidal (marine and estuarine) sport catch. Estimates for the last five years indicate a Georgia Strait tidal sport catch of coho ranging from 404,000 to 642,000. The Provincial Ministry of the Environment has estimated that there is a substantial non-tidal (freshwater) recreational harvest in addition to the tidal sport catch. Recreational fishing has increased dramatically over the past two decades and is expected to continue to grow in the future. Increased numbers and mobility of fishermen, and increased harvesting efficiency due to improved fishing gear and techniques, have altered the sport fishing catch and effort statistics significantly. Georgia Strait sport fishing is open to anglers year round and involves some 600,000 boat trips annually. Peak fishing activity occurs from June to September, when 80% of the coho are caught. The West Coast of Vancouver Island sport fishery is not well documented, but sport fishing activity in this area has increased in recent years.

5.4.4 Canadian Indian Food Fisheries

The traditional Indian food fishery is regulated to meet both the subsistence and ceremonial needs of Native people. The food fisheries generally occur in localized terminal areas adjacent to or in reserve land. However, some fisheries use commercial gear in marine interception areas and, more recently, surplus hatchery returns have been provided to local Indian bands for food and commercial purposes.

Fisheries are generally managed by restricting fishing time to periods that have permitted adequate harvests in previous years. Catch and effort estimates in the Indian food fisheries are obtained by local Fishery Officers. The accuracy of the catch estimates is questionable, and most Fishery Officers believe that catches are underestimated. Coast-wide catches of coho have averaged approximately 92,000 during the period 1979 to 1983, and catches have generally increased over the period of record.

Recent annual catches of coho in Georgia Strait Indian food fisheries have averaged 37,400. The largest single fishery is for Qualicum River enhanced stocks. The Indian food fisheries on the west coast of Vancouver Island have averaged 1,700 coho and consist primarily of small, terminal area fisheries. The major Indian food fisheries in the Fraser River area are in

the Fraser, Squamish and Capilano rivers. Recent catches have averaged 22,500 coho, with a trend toward increasing catches. The Squamish River Indian food fishery coho catches have averaged 5,000 annually in recent years. The fishery in the Capilano River has developed in response to returns of hatchery production, and catches of coho now average 6,200.

5.4.5 Catch Distribution and Exploitation Rates for Coho Stocks

Analysis of coded wire tag (CWT) data provides information on the distribution of coho catches for various tagged stocks. Since the distribution of tag returns depends on harvest rates in the fisheries, only qualitative information on migration routes can be obtained. Because most tagging efforts have concentrated on southern hatchery and Fraser River wild stocks, results described below for northern and central British Columbia stocks are best considered preliminary.

Table 5.4-1 shows the distribution of CWT recoveries for brood years 1975-1980 by fishery for selected stocks. In general, coho are more confined geographically than are chinook. A large proportion of Georgia Strait and Fraser River stocks stay in inside waters and are harvested heavily by Georgia Strait sport and troll fisheries. The Georgia Strait stock is also vulnerable to Central Coast - North West Vancouver Island (CC-NWVI) troll and inside net fisheries. Significant proportions of Fraser River fish are also caught in South West Vancouver Island (SWVI) troll and in southern British Columbia and northern Puget Sound net fisheries. Robertson Creek coho are confined primarily to the West Coast of Vancouver Island and Central Coast, where more than 90% of tags were recovered by the troll fishery.

Escapement counts for all tag groups are recorded in Big Qualicum, Puntledge, Quinsam, Capilano and Robertson Creek hatcheries. Cohort analysis of "production" tag codes provides information on harvest rates experienced by these groups of fish. Table 5.4-2 shows that harvest rates vary widely from hatchery to hatchery. Robertson Creek and Capilano coho generally experienced lower harvest rates than other hatchery fish in the period 1979-1981. This seems reasonable in light of preliminary evidence showing that:

Table 5.4-1. Distribution of coho coded wire tag recoveries by fishery.

	Fishery										
	Troll						Net			Sport	
Release	Alaska	North-ern	Central NWVI	SWVI	Georgia Strait	Wash/ Ore.	North Central	SWVI	Georgia Strait	Georgia Strait	Others*
Pallant	20.4	76.8	2.7	0	0	0	0	0	0	0	0
Kitimat	31.7	26.7	16.7	1.0	0	0	16.9	0	0	1.0	6.2
Atnarko	8.1	13.6	30.1	3.0	0	0	42.6	0	1.4	0	1.2
Keogh	0	3.9	55.4	18.2	2.0	0	3.1	0	14.7	0.8	1.9
Robertson	0	1.2	48.6	43.2	0.02	1.3	2.1	2.0	0.8	0.3	0.8
Georgia Strait	0	0.5	16.2	8.6	11.1	0.5	1.0	0.04	22.2	39.1	0.7
Fraser River	0	0.01	4.4	16.0	22.8	3.7	0.2	0.02	8.8	33.7	10.4

* includes U.S. net fisheries, particularly for Fraser River stocks.

Table 5.4-2. Harvest rates of age three coho.

Canadian Stocks	1979-81 Total Harvest Rate
Quinsam Hatchery	83.0
Puntledge hatchery	84.0
Big Qualicum Hatchery	74.6
Capilano Hatchery	67.0
Robertson Creek Hatchery	55.0
U.S. Stocks	
Lummi-Nooksack	89.3
Skagit River	78.1
Snohomish and Stillaguamish R.	81.0
South Sound Normal	80.8
South Sound Delayed Release	89.2
Hood Canal	77.2
Juan de Fuca Strait	81.8
Quillayute Summer Run	79.6
Quillayute and Hoh Rivers	77.2
Queets-Quinault Rivers	83.0
Grays Harbor	84.4
Willapa Bay	85.8
Columbia River Late	88.9
Columbia River Early	87.1

1. Capilano coho begin their spawning migration earlier than other hatchery coho, thus decreasing their vulnerability to troll, sport and net fisheries; and

2. Robertson Creek coho are vulnerable primarily to West Coast Vancouver Island fisheries while fish from Big Qualicum, Puntledge and Quinsam are also vulnerable to Georgia Strait sport, troll and net fisheries.

Harvest rates of over 70% determined for some stocks in 1980 and 1981 (brood years 1977 - 1978) are generally believed to exceed maximum sustainable harvest rates for natural coho stocks. A brief summary of the fisheries specifically taking or incidentally harvesting each of the stock aggregates follows.

5.4.5.1 Georgia Strait Stocks

As indicated by CWT analysis, the harvest rate of Georgia Strait hatchery coho stocks appears to be between 70 and 85%. This is higher than is thought to be sustainable by wild coho. The majority of the catch from these hatcheries is taken in Georgia Strait by the sport fishery. Net fisheries in Juan de Fuca Strait and the West Coast of Vancouver Island also harvest substantial numbers. In contrast to more northerly hatchery stocks, CWT recoveries for wild Cowichan River coho from the 1973 brood year indicate that about one-half of the catch was taken by Washington State fisheries, with another 30% taken by the West Coast Vancouver Island troll fishery. With recent reductions in the Washington State ocean fishery effort, this component of the harvest rate has almost been eliminated.

These patterns of exploitation combined with the distribution of the Koegh River catch (see below) would seem to indicate a substantial outmigration from Georgia Strait of northern and southern Vancouver Island stocks. In contrast, a significant proportion of mid-Vancouver Island stocks stay resident within Georgia Strait.

5.4.5.2 Johnstone Strait Stocks

Coded wire tag data from the wild Keogh River coho stock indicate a substantial harvest by the West Coast of Vancouver Island and Central Coast troll

fisheries. The Johnstone Strait net fishery and the north coast troll fishery also harvest some of these fish. There are few fish harvested in Georgia Strait and no fish taken by Washington fisheries.

It is not possible to calculate exploitation rates for these stocks, since tags were not systematically recovered in the escapement, and escapements are not known with confidence.

5.4.5.3 West Coast Vancouver Island Stocks

Robertson Creek hatchery tag recoveries indicate a 50 to 60% total exploitation rate of this stock. This is thought to be within the acceptable range for wild coho stocks. Robertson Creek coho are caught almost exclusively by the West Coast of Vancouver Island troll fishery.

5.4.5.4 Fraser Area Stocks

According to lower Fraser River CWT recoveries, these stocks contribute very heavily to Georgia Strait hook-and-line fisheries. In addition, the Juan de Fuca net and Fraser River gillnet fisheries, Washington State fisheries, and the West Coast Vancouver Island troll fishery harvest these stocks. The net fishery catch of Fraser River coho is taken incidentally in fisheries for pink, sockeye and chum salmon. The Indian food fishery in the Fraser River is thought to catch significant numbers of coho, but the catch is not sampled for coded wire tags. Data for coho stocks in the upper Fraser River are not currently available.

5.4.5.5 Central Coast Stocks

CWT recoveries from Kitimat and Atnarko River coho indicate significantly different harvest patterns for these two stocks. The more northerly Kitimat stock is harvested primarily by the Alaskan and northern British Columbia troll fisheries. The Atnarko stock is located in the heart of the mixed stock Bella Bella - Bella Coola fishery area, and is harvested primarily by the Central Coast - North West Vancouver Island troll fishery and the Central Coast net fishery.

5.4.5.6 North Coast Stocks

There are currently no CWT data for the Nass and Skeena rivers. Local fishery managers believe that these coho stocks are harvested extensively in Alaskan and northern British Columbia troll fisheries, and incidentally in terminal net fisheries for pink, sockeye and chum salmon. In addition, there is a small tidal and non-tidal sport fishery and significant Indian food fisheries on these stocks.

The Pallant Creek hatchery stock on the east coast of Moresby Island (Queen Charlotte Islands) is the only stock with useful CWT data. Since escapements are sampled for marks and counted through a fence, exploitation rate estimates can be made. For the 1980 brood, a harvest rate of only 32% was calculated with over 95% of the harvest being taken by the northern British Columbia and Alaskan troll fisheries. There is currently no terminal fishery on this stock. If this stock can be used as an indicator, overharvesting should not be a problem for other coho stocks in the area.

5.5 Habitat Interactions

The young of coho salmon spend at least one year growing in small "rearing" tributaries. Therefore, spawning success and juvenile survival is highly dependent on environmental conditions found in these streams and environmental degradation can reduce coho abundance more than that of other salmon species. Unfortunately, the relationship between environmental conditions and habitat productivity is not known except for extreme cases (e.g., if there is little habitat few fish will be produced).

5.7 Stock Rebuilding Potential

The rebuilding potential for coho salmon stocks is unknown. However, the decline in coho stocks, especially those found in Georgia Strait and the Fraser area, is well documented. A fundamental (but unsubstantiated) assumption is that increased escapement of depressed stocks will yield long-term benefits from increased production. In other words, coho stocks need rebuilding but the question of how much is unanswered.

5.8 Management Strategies for Stock Rebuilding

With a history of poor data and passive management, it is not surprising that the proper approach to managing coho more actively is not obvious. Some of the many possible management options that could be applied are briefly presented below.

5.8.1 Management to Escapement Goal

In theory, escapement goals are used in the management of coho salmon stocks. In practice, the relationship between these goals and observed escapement is unclear. Escapement goals are derived from Fishery Officers' estimates of available spawning area and are not necessarily "optimal" in the sense of producing maximum sustainable harvests. Since the goals take theoretical spawning capacity into account, they must be compared to observed escapements to determine the relationship between these observations and actual escapements. This has rarely been done.

The usefulness of such habitat-based escapement goals in determining current stock status and the potential for rebuilding is therefore questionable. For example, if the escapement goal on a given river system is the maximum population that can reasonably fit in the system, and if Fishery Officers' escapement counts include only 50% of the actual spawning stock, the coho population may be at its optimum even though escapements are counted to be only half of the stated goal. Unfortunately, the proportion of spawners that is observed or estimated varies widely between streams, years and Fishery Officers, so that "blow up" factors cannot be applied with any confidence. Habitat-based escapement goals are therefore not generally suitable for use in coho stock rebuilding without the expenditure of large sums of money for accurate escapement enumeration. However, the setting of escapement goals for "key streams" and the careful monitoring of these systems can be used as an escapement-based approach to rebuilding.

5.8.2 Management to Catch Ceilings

Catch ceilings, if implemented over a number of years, could rebuild stocks by an initial reduction in harvest rate and, subsequently, a continuous

reduction as stocks rebuild. For example, by implementing a catch ceiling for the Georgia Strait sport and troll fishery and for the WCVI troll fishery (already in place) and by increasing enhanced production to these areas, wild stocks should be rebuilt. Enhancement could speed up the rebuilding process if ceilings are maintained at relatively low levels. In addition, altering season length or flexible ceilings must be an integral part of the strategy, since fishing until a fixed ceiling is reached cannot be permitted in years of low abundance.

A commitment to a catch ceiling strategy on the WCVI troll fishery has been made through the Canada/U.S. Salmon Treaty. This strategy is described in Section 5.1.1 and will not be repeated here. The Treaty may or may not force a reduction in the WCVI troll harvest rate. If this reduction does occur, it would have the following effects:

1. Georgia Strait and Fraser River coho stocks may rebuild, assuming that the relatively small fraction of these stocks that moves to the WCVI is not exploited more heavily than it is currently in the inside fisheries: and

2. WCVI coho stocks may benefit from increased escapements remaining after the troll fishery.

5.8.3 Management to Harvest Rates

In order to rebuild stocks, a manager must achieve a harvest rate reduction. The calculation of harvest rates on a stock-specific basis provides a tool or strategy for determining the direction and magnitude of any management actions. The impact of management actions taken can only be assessed (through harvest rate calculation) after the season has been completed.

In the case of Georgia Strait and Fraser River, coho harvest rates as determined by CWT analysis are currently between 70 - 80%. Wild coho stocks may not be sustainable at these rates. Work done in the U.S. suggests that 65 to 70% is the optimal harvest rate for wild coho. Since these two stock groups are harvested in similar fisheries, harvest rate calculations dictate that fisheries must be limited to obtain the optimal harvest rate for wild stocks.

Harvest rates can only be calculated for stocks that have been properly tagged and where escapements are measured with accuracy. Many wild stocks will have to be tagged and assessed, and work on optimal harvest rates will have to be conducted before this approach can be widely used.

5.8.4 Net Fishing Reductions

Coho salmon are caught in significant numbers as incidental harvest by the Johnstone Strait, Juan de Fuca Strait and Fraser River net fisheries for pink, sockeye and chum salmon. In general, a substantial catch of pink or chum salmon must be forgone to obtain reductions in the incidental catch of coho salmon. These trade-offs are explored in more detail below.

5.8.4.1 Johnstone Strait

The Johnstone Strait fishery is the major interception fishery for sockeye, chum and pink salmon from the Fraser River, Georgia Strait and Johnstone Strait. Coho are caught incidentally in net fisheries through the late summer; and in mid- to late September, when their abundance peaks. It is estimated that 20 to 40% of coho caught in this area are hatchery fish. Enhanced contributions appear to have been increasing substantially in recent years. Three-quarters of the hatchery fish are of Canadian origin.

Restrictions on early chum fisheries have reduced coho catch, but, in general, no direct attempts have been made to reduce coho catch. Restrictions on chinook catch (about a 25% reduction) have reduced the coho catch, particularly when enforced until mid-October. Further coho catch reductions can be achieved only by curtailing Fraser odd year pink harvests, and by maintaining chum restrictions. To restrict pink harvest may mean losses of up to 3 to 5 million pinks in Johnstone Strait which would then have to be harvested off the Fraser River. This is not possible with gillnetters under current regulations. Restricting the chum fishery would mean a reduction in catches of up to 500,000 to 1 million chum salmon. A closure of upper Statistical Area 12 and lower Statistical Area 13 during the peak coho migration period may be a viable compromise, since coho move quickly (1 week) through those areas.

5.8.4.2 Juan de Fuca Strait

In Juan de Fuca Strait there is a major interception fishery for Fraser River sockeye and pinks. In general, hatchery coho are dominant in the incidental coho catch, with the proportion of the hatchery contribution growing in combination with declining catches. CWT data suggest that the average hatchery contribution to coho catch for 1973 to 1980 was approximately 30%. Data for 1981 indicate almost 60% of the catch was of hatchery origin; 90% of hatchery fish came from Washington State. About 5% of the total Juan de Fuca coho catch was Canadian hatchery stocks. The shift in hatchery contribution may be due to the timing of the fisheries, or from increased hatchery production.

The separate fall fishery for coho has been curtailed since 1980 with the exception of 1982. The primary action was to eliminate the fall coho fisheries in Statistical Area 20 after sockeye and pink stocks have passed through the area. Most incidental coho catches now occur during the pink fishery from early to mid-September.

Further reductions in the incidental coho catch (primarily U.S. stocks) can only be achieved by restricting pink harvests. Potentially, the later run of pinks could be reallocated to fisheries in U.S. waters.

5.8.4.3 Fraser River

Some minor reductions in the incidental catch of coho may be achieved by eliminating the less effective openings for late sockeye (e.g., Weaver Creek) and pink stocks. The forgone catch of sockeye or pink salmon should be small. Other than this relatively minor adjustment, there is little opportunity to reduce coho incidental catch from commercial operations.

The development of management options to conserve coho salmon in the Indian Food Fishery have been hampered by the approach taken in marine fisheries management. Departmental policy dictates that fulfilling the seasonal food fishery needs of native communities is second in priority only to resource conservation. Since substantive conservation methods specific to coho salmon have yet to be implemented in the marine harvest sector, none has been

implemented in the Indian Food Fishery (other than standard gear and time restrictions which address general conservation and among band allocation concerns). Conservation measures in the Indian Food Fishery can play a major role in the stock rebuilding process, especially in even years when gear saturation does not constrain coho harvest rates; however, implementation of such measures is contingent upon the development of a regional coho conservation package for all user groups.

The non-tidal (freshwater) sports coho fishery currently has a bag limit of four fish per day. Reductions in the limit may significantly increase escapements, although a quantitative evaluation has not been conducted. Furthermore, increased sports effort could be directed to hatchery chinook and coho stocks throughout the Fraser and Thompson rivers.

5.8.5 Enhancement-Assisted Rebuilding Options

The purpose of this section is to illustrate some of the options available for using the Salmonid Enhancement Program (SEP) to aid in the rebuilding process. In general, SEP can be used to augment native stocks through increasing productivity, or to colonize barren or severely depleted areas. Enhancement can also be used in conjunction with other management options such as fisheries for marked (hatchery) fish only, catch ceilings, and creation of new discreet fisheries to assist in the rebuilding of natural stocks. Each of these options is described below.

5.8.5.1 Augmentation of Native Stocks

On the British Columbia coast, there are numerous small coho populations that are severely depressed, numbering from a few individuals to a few hundred individuals. This section deals with rebuilding such stocks. One assumption in stock rebuilding is that more spawning fish will produce a higher return and that over a number of cycles the population will reach an optimum or maximum level. Enhancement can accelerate this process of rehabilitation. For a stock that is declining towards extinction, enhancement can be used to conserve the stock and push the population to a higher level. It is believed that an effective population size of at least several hundred spawners is necessary to maintain the genetic diversity of a stock over the long term.

Options for coho rehabilitation and conservation parallel those described for chinook. They include:

1. Temporary enhancement over one or two cycles for stocks that are productive enough to withstand existing exploitation rates; and

2. Long-term, small-scale enhancement for stocks that are not productive enough to withstand existing exploitation rates.

The benefits of coho enhancement, are usually realized faster than the benefits of chinook enhancement. In particular, if coho are reared to smolts, a very small spawning population can be increased 25 times in one generation (i.e., 10 spawners yield 250 spawners) because of high post-release survival, even at exploitation rates of 75%.

Enhancement technology for coho rehabilitation and conservation includes the following strategies:

1. Stream improvements such as increased accessibility, improved incubation (e.g., flow control, gravel work), improved rearing (e.g., flow storage, in-stream structures);

2. Incubation facilities with fry releases to normally accessible rearing areas or to rearing areas above obstructions; and

3. Incubation and rearing facilities with fed fry or smolt release.

The major problems encountered in coho enhancement projects are brood stock shortages, and uncertainty about release strategies for pre-smolts (i.e., fish that will remain in the rivers for a substantial period of time before migrating to sea). The intensity of competitive interactions between wild and enhanced fry during stream rearing is a function of factors such as size of fish, number of fish per unit area and date of release. Studies are required to determine the effects of competition on production.

5.8.5.2 Colonization

Colonization of inaccessible areas using the stock native to the watershed (e.g., upper Quinsam from Quinsam Hatchery) is a technique for expansion of natural rearing capacity. Some of the potential capacity of inaccessible stream sections in the province has been documented through biophysical surveys and aerial photograph interpretation done by DFO and B.C. Fish and Wildlife (BCFW) staff, but much remains to be done. Colonization has proven to be a successful technique on the Puntledge, Quinsam and Pallant watersheds. There have been no documented failures in British Columbia.

The primary issues that arise when using native fish to stock inaccessible areas are how to determine manageable production levels (e.g., too many returning fish will be viewed as a problem in some streams due to generation of increased fishing pressure and impacts on other stocks), and the interaction between rearing coho and resident cutthroat trout. The interaction problem has, to a large degree, been resolved through site-specific negotiation with BCMOE, based on identification of preferred cutthroat habitat, but firm guidelines have yet to be developed. An additional concern is the distribution of escaping adults. Accumulation of these fish immediately below an obstruction will occasionally arouse public concern. In order to continue the colonization program, the adults can be captured and released upstream, or their eggs can be taken and incubated.

Transplants of coho stocks to different watersheds to utilize available habitat (e.g., streams with depressed stocks, inaccessible habitat) is the least desirable option for rebuilding natural production levels. Although augmenting native stocks is the preferred option, there is often pressure on fishery management biologists from public groups to accelerate production increases by introduction of other stocks and, in particular, by introduction of hatchery stocks because of their availability. This is an issue in all areas of the coast but is especially prevalent in Georgia and Johnstone straits.

When a transplant is approved, an important issue is choice of a donor stock. Geographical, ecological and morphological characteristics should be considered, but proximity and convenience are often the dominant factors.

There is controversy over whether the best approach is introduction of a single, "best-fit" stock or of a number of stocks with a broader genetic base. The best-fit approach would utilize a stock most similar to the native stock, based on measured criteria. The problem is that the criteria used, such as timing, stream type, body size, etc., may overlook other, often unmeasurable traits essential to survival in a new environment. The best-fit approach has been used at Scott Cove Creek on Gilford Island. From a genetic point of view, the multi-stock approach will increase the probability of successful reproduction of the transplant stock in subsequent generations.

Transplants might be introduced as fry or smolts. While there are many examples of returning spawners from releases of these types, evidence of successful reproduction is lacking. Recent studies in Oregon demonstrate poor reproduction by transplanted coho stock but this may be due to significantly different spawning timing between the native and transplanted stocks.

Step-wise selection guidelines for augmenting native stocks or colonizing from other water sheds have been developed by DFO. These guidelines are as follows in order of decreasing desirability:

1. Use remnant indigenous stock from within the river systems, incubate/rear (eggs or fry) in existing facilities and then transplant back into the original system;

2. Use indigenous stocks as above; however, incubate and/or rear in a new facility built within the stream system. This is less desirable than option one since it requires time and resources to carry out, and has higher short-term risk at an unproven site;

3. Wait at least one year prior to transplanting. The stock may recover naturally or through future management actions. This option particularly applies to cases where disruptions such as flooding have affected a brood year;

4. Where there is no prospect for the natural stock to increase and donors from the system are demonstratably unavailable, a combination of suitable wild donor stocks should be transplanted;

5. If a sufficient combination of wild stocks is unavailable, a combination of suitable wild and hatchery stocks may be transplanted;

6. If no wild stocks are available, a combination of suitable hatchery stocks can be transplanted; and

7. Finally, if none of the above mentioned options is possible, a single hatchery stock may be used as a donor.

5.8.5.3 "Marked-Only" Fisheries

Hatchery produced coho smolts can be marked by a ventral fin clip at a cost of 2.5 cents per smolt. Since the current production in British Columbia is approximately 8.7 million smolts, the total cost ($217,500) of such a marking program is not exorbitant. Furthermore, the marking of many coho smolts is logistically feasible because the work can be spread over a period of at least six months (October to March).

The eventual presence of marked adult coho salmon would allow regulations to be formulated for the retention of clipped fish only ("marked only") in hook-and-line fisheries. This is a promising method for harvesting wild and hatchery stocks separately. It is especially relevant to the sports fishery, where it has proven difficult to find a management package that effectively protects and rebuilds natural stocks, without redistributing benefits or interfering with recreation.

The success of a "marked-only" fishery in terms of stock rebuilding depends on the mortality of wild fish that are caught and released. The total fishery mortality of wild fish is a function of both the probability of death in a single catch-and-release event (shaker mortality) and the number of times a wild fish is caught. Unfortunately, neither shaker mortality nor the frequency of recapture is known. Therefore, the effectiveness of a "marked-only" fishery is unknown.

There are two further management implications that should be evaluated carefully before the implementation of a "marked-only" fishery. First, the presence of large numbers of fin-clipped coho in the sport catch could have a

significant impact on the Mark Recovery Program for coded wire tags (CWT). Even though the fish not possessing a CWT will have a ventral fin clipped instead of the adipose fin there will likely be many heads turned in to the voluntary recovery program from fish with a ventral clip only (and no CWT). An extensive education and advertising program would be necessary to minimize the problem.

Second, substantial catches of unclipped hatchery fish from U.S. production and clipped fish that have regenerated the fin (approximately 10-20%) will have to be forgone. To take full advantage of the marked-only fishery technique would require the co-operation of U.S. fishery management agencies. Some of these agencies are already considering this fisheries management tool.

In the fall of 1983, coho production from Georgia Strait hatcheries was increased to provide fishing opportunities for the visitors to EXPO '86. There are now five to six million additional coho fry at the hatcheries. Increased fishing effort from EXPO '86 visitors and from local fishermen responding to an increased abundance of fish has generated concerns over conservation of wild coho stocks. DFO has made a recommendation to clip all fish produced from the 1983 brood that will contribute to the Georgia Strait fishery in order to test the marked-only fishery management tool and to substantially decrease the anticipated harvest rate on wild stocks.

5.9 Information Requirements

Lack of understanding of basic biological production parameters for coho makes the setting of harvest goals, the forecasting of returns and the evaluation of fishing strategies difficult. Although there has been a considerable amount of research into the freshwater portion of coho life history, the relationships between this and other life-cycle stages are not fully understood. Because of extended freshwater rearing, coho production may be more dependent upon local environmental conditions, particularly during summer and overwintering periods, than other species. It appears that coho production is likely to be highly dependent upon other factors in addition to the number of spawning adults, in contrast to other salmon species where production is largely dependent upon numbers of spawning adults. To compound the problems in determining the production parameters for coho, accurate escapement estimates for coho are probably the most difficult to obtain of all salmon species, because of the protracted nature of their migration timing, their dark colour during spawning, adverse environmental conditions (heavy rain, ice, etc.) during their spawning period and the large number of streams that support coho.

An active management plan with biologically sound objectives must be developed to rebuild wild coho stocks. Many of the information requirements for this management program have been described above, and require either systematic collection of verifiable data, or research activities into population dynamics.

The following list of data and research needs highlights major gaps in our current understanding of fishery management requirements for coho.

5.9.1 Escapement Data

In many cases, current escapement data for coho are of questionable quality. If stock and recruitment analyses are to be carried out, escapements will have to be known more accurately. More research will be required on improving and standardizing methods for estimating escapement. A continuous commitment will be required so that a meaningful time series of data can be collected. Methods of calibrating historical escapements with this new time series should also be explored.

5.9.2 Catch Statistics

Due to the mobility and long-term storage capabilities of the troll freezer boat fleet, it has become difficult to obtain accurate catch data by time and area through the normal sales slip process. Without this information, total catch within a certain area cannot be accurately determined. Some means (perhaps a compulsory logbook) must be implemented to remedy this situation.

5.9.3 Stock Identification

Advances have recently been made in the use of biological markers as stock identification tools for salmon management. Electrophoretic enzyme analysis has shown significant differences in chinook, chum and sockeye stocks. Parasites have been successfully used to identify stocks in the management of sockeye and pink salmon, and scales have been used for decades to separate sub-stocks of Fraser River sockeye. For coho, these tools are still in their developmental stage and should be explored.

5.9.4 Expanded Marking Program

The tagging and recovery of coded-wire tagged coho has become an integral part of the management of coho stocks and the analysis of management actions. The CWT program has continued for the past five years with no formal Canada-U.S. agreement. There is need for a Canada-U.S. agreement that sets out standards for marking hatchery production and wild coho. There is a need to formalize the present recovery program, and to set a minimum sampling effort in all areas of concern.

5.9.5 Management Information System for Hatcheries

Hatcheries provide an excellent opportunity to collect valuable stock information for coho. Very precise marked:unmarked ratios and escapement estimates can be collected at hatcheries at a relatively low cost. In addition, time and size of release should be manipulated to more closely approximate wild stocks for management tag groups. Biological sampling for age

composition, sex ratios, fecundity, and CWT incidence should be routinely performed for all hatchery stocks.

5.9.6 Effects of Oceanographic Conditions on Productivity and Migration

Recent poor returns from large hatchery releases of Columbia River coho have been poor. Possible causes, ranging from localized limitations to ocean carrying capacity, should be investigated. Coho are typically at sea for a little over a year. They are not as far ranging as most other salmon species, and hence may be subject to density-dependent mortality if a large number of fish are released from a certain area at the same time. Hatchery releases may encourage this, but such mechanisms are poorly understood at best.

5.9.7 Stock Dispersal Patterns

Although coho are primarily available to ocean fisheries for one fishing season only, past tagging studies have shown that individual fish may be available to fisheries over a broad geographic range within a season. Management actions for too small an area might therefore be ineffective. Ocean tagging could be used to assess stock dispersal patterns.

5.9.8 Run Size Prediction

It is necessary to develop methods of predicting annual abundance if stocks are to be managed to produce the maximum sustainable harvest. Efforts should be made to improve stock specific and population index forecasting techniques as part of an overall coho management plan.

5.10 Predicted Results

Given the poor quality of coho escapement data, the uncertainty regarding coho population dynamics, and the lack of experience in active coho management within the Pacific Region, it must be emphasized that any "predicted results" are highly dependent on the assumptions and data used in predictive models. In this section a relatively simple simulation model is used to estimate the effects of various coho harvest rate reductions based on the "most probable" assumption that some level of stock rebuilding is possible. It is conceivable, in fact, that increases in escapements may not increase long run coho harvests, but this is not considered a highly probable situation and will not be examined further in this section. It is a point worth noting, since there is a risk involved in harvest rate reductions, namely that catches may be sacrificed without corresponding future gains.

5.10.1 Stock Groups

Due to a lack of major coho tagging effort throughout the coast of British Columbia, only two stock groups have been considered here. These two aggregations, "Georgia Strait" and "Fraser River", are rather better understood than others on the coast, but are nevertheless subject to considerable uncertainties.

Three hatcheries on the east coast of Vancouver Island have been combined to represent the harvest pattern for Georgia Strait wild coho production. The Quinsam River stock is a northern Georgia Strait stock that represents a northward migratory component, while the Puntledge and Big Qualicum stocks represent progressively more southern resident type stocks.

Recoveries of coded wire tags from various Fraser River wild stocks were used to determine the distribution of catch for all Fraser River stocks. Since the associated escapement data are poor, harvest rates cannot be calculated. Based on a comparison of the distributions of the Fraser River and Georgia Strait stocks, it was estimated that the Fraser River harvest rate was probably slightly lower than that for Georgia Strait. This harvest rate was subsequently partitioned as per the Fraser catch distribution for coded wire tags.

5.10.2 Modelling Methods and Assumptions

A relatively simple two-stage procedure has been followed to evaluate the effects of changes in harvest rates. First, cohort analysis of several coded-wire tagged coho stocks (primarily of hatchery origin) was used to determine the overall harvest rate by stock, and the distribution of the catch of each stock between fisheries. Second, this information was incorporated into a simulation model in which harvest rates in the fisheries could be adjusted so as to examine the magnitude of management measures required to rebuild broad stock groups at various rates. The simulation model was similar to that used to analyse chinook stocks; its primary inputs were:

1. The harvest rate and catch distribution information;
2. Initial escapement levels; and
3. Stock-recruitment parameters that determine the natural productivity and optimal escapement for each stock.

The initial escapement inputs generated coho stocks three years hence (for southern British Columbia coho), using the relevant biological growth parameters. The stocks were then subjected to fishery harvest rates as determined by the cohort analysis, but modified to reflect any harvest management actions.

Unfortunately, uncertainties in biological parameters and initial stock sizes, together with the fact that the cohort analysis results are based on historical, possibly out-of-date fishing patterns, make the analysis suspect. To reflect these uncertainties, the model was run using a range of possible biological conditions, and the results were expressed not as absolute catch levels but rather in terms of rebuilding times and ratios of potential to current stock sizes.

5.10.2.1 Stock Productivity Assumptions

For the Fraser River stock grouping, a lower bound on productivity was chosen to produce a fairly rapid decline in status quo escapement levels (reflecting the trend presented above) while an upper bound was determined to produce a slightly declining wild stock under current conditions.

For the Georgia Strait coho stock, only one productivity value was used, to produce a status quo escapement trend that reflected current behaviour of the stock.

5.10.2.2 Optimal Escapement Assumptions

An estimate of optimal escapement (i.e., the spawning stock that produces maximum sustainable yield) is required for each stock group in order to fit a stock-recruitment relationship. For each of the Fraser River and Georgia Strait stocks, a lower bound on optimal escapement was set arbitrarily at 25% above current average spawner levels. For the Fraser River stock, an upper bound was set at the current published escapement target, a figure representing habitat spawning capacity, while the Georgia Strait upper bound was set arbitrarily at 4 times the current average escapement level. Note that it is an assumption in the model that these stocks are below optimal escapement levels.

5.10.2.3 Harvest Rates by Fishery Assumptions

The following harvest rates were derived using a cohort analysis of 1976-1979 brood years (1979-1981 catch years) for hatchery-generated coho stocks:

Fishery	Fraser River	Georgia Strait
Outside Troll	15%	19%
Inside Troll	16%	9%
Sport	34%	31%
Net	21%	48%

Note that net harvest rates are calculated based on the stock size after hook-and-line fisheries have taken place.

5.10.3 Simulation Results

A number of scenarios were generated, using a variety of harvest rate combinations, including:

1. A status quo situation in which current harvest rate patterns are continued indefinitely;

2. 20%, 30% or 40% reductions in Georgia Strait troll and sport fisheries;

3. 20%, 30% or 40% reductions in all troll and sport fisheries; and

4. 20%, 30% or 40% reductions in all fisheries (including net fisheries).

Table 5.10-1 displays the tentative results for Fraser River and Georgia Strait stocks, summarized into (a) the fraction or multiple of the initial (1981-1983) escapement level that was eventually achieved, and (b) the number of cycles required to rebuild the stock from initial levels to optimum. In many cases, the rebuilding strategy increased stocks, but not sufficiently to achieve the optimal escapement target. In Table 5.10-1, the scenarios are arranged in approximate order of severity of cutbacks in the harvest rates. For a given harvest rate reduction (20%, 30% or 40%), more rebuilding occurred as the cutback was applied to more fisheries. For equivalent fisheries, a 40% reduction clearly had more impact than one of 20%.

Based on the assumptions of the model, and particularly the assumption that escapements are currently below optimum, the analysis suggests the following:

1. Depending on biological parameters, a 20% reduction in harvest rates of all fisheries may produce a range of responses, from a further 20% decline in escapements (for a low productivity Fraser River stock) to a tripling of escapements under optimal conditions. This level of cuts does not appear sufficient, however, to reach optimum escapement levels.

Table 5.10-1 Coho simulation results for the Fraser River and Georgia Strait stock groupings based on the assumption that current escapement levels are below optimum. The ranges in the ratio of eventual to initial escapement and in the rebuilding time reflect biological uncertainties (X = does not reach optimum).

	Stock			
	Fraser River		Georgia Strait	
Scenario	Fraction or multiple of initial esc. eventually achieved	# of cycles to rebuild to optimum	Fraction or multiple of initial esc. eventually achieved	# of cycles to rebuild to optimum
Status quo	0 - 1.1	X	0.3 - 0.9	X
20% cut to inside hook-and-line	0.5 - 2.8	X	0.6 - 2.0	X
20% cut to all hook-and-line	0.7 - 3.2	X	0.8 - 2.5	X
20% cut to all fisheries	0.8 - 3.4	X	1.0 - 3.3	X
30% cut to inside hook-and-line	0.8 - 3.5	X	0.8 - 2.5	X
30% cut to all hook-and-line	1.0 - 4.0	1 - X	1.0 - 3.2	X
30% cut to all fisheries	1.1 - 4.4	1 - X	1.4 - 4.4	1 - 4
40% cut to inside hook-and-line	1.0 - 4.1	1 - X	0.9 - 3.0	1 - X
40% cut to all hook-and-line	1.3 - 4.8	1 - 6	1.2 - 3.9	3 - 7
40% cut to all fisheries	1.4 - 5.3	1 - 4	1.7 - 5.4	1 - 3

2. A 30% harvest rate reduction in all fisheries will likely be sufficient to rebuild both stocks to optimum, but will not achieve this as rapidly as a 40% reduction, which rebuilds in 1 to 4 cycles.

3. With the harvest rate pattern used in the model, a 20% cut in all fisheries is equivalent to a 30% cut in Georgia Strait hook-and-line fisheries. Similarly, a 30% reduction in all hook-and-line fisheries is equivalent to a 40% reduction in only Georgia Strait troll and sport fisheries.

These results are preliminary, and are based on the assumption that there is potential for stock rebuilding. Nonetheless, the indication is that fairly stringent harvest rate reductions would be necessary in order to attempt rebuilding. In particular, major cuts to hook-and-line fisheries may be required if net fisheries are not reduced, while lesser cuts may be sufficient if these are spread throughout the fisheries.

6.0 GLOSSARY

Backplanting - returning artificially-propagated fry/smolt to site of origin (see "satelliting").

Bar fishery - a fishery from a sand bar in a river.

Beach tie-off - controlling the movement of the end of a seine net by tying the end to a tree or rock on a beach while the net is fed out from the seine boat.

Boat-day - one boat involved in fishing for one day.

Bunt mesh - the bottom mesh in a seine net. The size of the bunt mesh is controlled to allow small fish to escape as the seine is pursed.

Buy-back program - a publicly-funded purchase of existing fishing licences and associated boats with the intent to retire the fishing capacity of the boat. It is assumed that the total number of licences and boats remains fixed.

By-catch - catch of non-target species.

Carcass weir - device, usually a fence, across a stream or channel where drifting or spent fish accumulate and can be enumerated and removed.

Cassette incubator - container consisting of numerous compartments, each large enough for one or a few salmonid eggs, enclosed with a porous cover to permit water flow. Used for incubating eggs in a river or lake environment.

Catch per drift - catch during one drift of a gillnet.

Catchability coefficient (q) - the fraction of a fish stock caught by a defined unit of fishing effort.

CEDP - Community Economic Development Project.

Ceiling - a regulatory constraint on the maximum number of fish which can be caught by a particular fishery.

Clean-up fisheries - usually terminal, single-stock fishery intended to take surplus fish at the end of the run.

Closures - refers to fishery being terminated by DFO.

Counting weir - device, usually a fence, used to temporarily stop migrating adult salmonids to enable enumeration to take place.

Cycle - refers to life cycle of salmon from egg to spawning adult.

Cyclic dominance - the tendency for each sockeye spawning area to produce larger numbers of fish in some years (of a four-year cycle) than others. The dominant cycle years are repeated every four years.

Dead pitching - pitching salmon carcasses onto stream banks to count them and/or recover tags.

Directed fishery - commercial fishery directed at a specific stock by time or space.

Discount rate or **social discount rate** - a factor that is used like an interest rate to reduce values occurring in the future to their equivalent value in the present. Discount rates are used in the calculation of net present values.

Diversion rate - the proportion of returning salmon (generally referring to sockeye salmon) that returns to the Fraser via Johnstone Strait.

Donor stocks - particular population of salmonids from which eggs and/or milt are taken for the purpose of enhancing the same population or for transplanting to other streams.

Drifted gillnet - a gillnet fished without anchors or shorelines.

Effort response - a numerical response of fishing effort to changed catch per effort.

Emergence - stage in salmonid's life when incubation is complete and young fish begin to swim actively in search of food.

Enhancement - techniques used to increase the production of salmonid stocks through intervention by man. May pertain to fisheries management practices, fish culture techniques, stream improvements, etc.

Enumeration fence - See "counting weir".

Environmental loss - loss of potential escapement causing failure to meet target escapement, because of environmental variability (ocean processes, flooding, freezing, etc.).

Escapement - actual number of fish which survive all fisheries and are estimated to be on the spawning grounds.

Exploitation rate - the probability that a fish will die from fishing during a specified period.

EXPO '86 - transportation and communications exposition to be held in Vancouver in 1986. It is expected to attract large numbers of tourists to British Columbia.

Fishery - a fish harvesting activity that is defined by some combination of gear, area, time and/or target species.

Fixed catch approach - management strategy used in a mixed-stock fishery. The catch is held to a fixed amount. The underlying assumption is that stock abundance is increasing or not varying, or the ceiling has to be adjusted. (The latter strategy then resembles the fixed harvest rate approach.)

Fixed harvest rate approach - management strategy used in mixed-stock fishery. It is assumed that harvest rate can be fixed at a constant level by constraining time spent fishing or the amount of fishing gear used in a given area for a given time.

Flow storage works - dam or works to store water during high-flow periods for release during low-flow periods.

Forgone catch - fish in excess of those expected to return to spawn in a given stock, and therefore not caught, resulting in overescapement.

Fry - a stage in the life of a fish from the time it starts actively swimming and feeding to age 14 days.

Gurdie - a winch that is used to raise and lower trollers' lines.

Hails on the grounds - counts made by Fishery Officers on patrol vessels hailing commercial fishermen while on fishing grounds.

Hanging lakes - lakes formed by glacial scour, frequently above valley bottom.

Harvest rate - the harvest proportion of a particular group of fish in a specified area over a specified time (also defined by species, sex, cohort, harvesting fishery, etc.).

Incidental catch - catch of fish other than the target species.

Incubator - a unit constructed to hold fertilized eggs until hatch or emerge.

Index stock - salmon stock deemed to be related to adjacent salmon stock. High quality data are usually gathered for this stock.

Indicator stock - see "index stock".

Inside/Outside - refers to inside (e.g., Johnstone Strait) and outside (West Coast and Juan de Fuca Strait) of Vancouver Island).

Interception fishery - a fishery which captures (intercepts) fish from a number of stocks (i.e., is not stock-specific). This term is often used to refer to international interceptions, but in this report it is defined synonymously with mixed-stock fishery.

IPSFC - International Pacific Salmon Fisheries Commission.

Key stock - a large or otherwise important salmon stock for which better quality data are available or will be obtained in the future.

Keystream - a stream in which one or more key salmon stocks spawn.

Known-stock fishery - commercial fishery targeted on a specific stock of salmon.

Mainstem - principal course of river.

Management to escapement - management of fisheries in a manner that ensures (within technical limits) that the target escapement reaches the spawning area.

Management uncertainty loss - loss of potential escapement causing failure to meet target escapement, because of inaccurate estimation of run size or escapement.

Mean return rate - average yield (yield may be in juvenile fish/adult fish/ catch pieces, etc.) per spawner, or some other measure of spawning yield.

Migrant releases - pertains to release from hatchery of salmonids that are smolted and will migrate downstream.

Mixed harvest loss-failure - loss of potential escapement causing failure to meet target escapement, because of incidental harvest in a mixed-stock fishery.

Net present value - shorthand form for "present value of net economic benefits". Future streams of project benefits and costs are estimated and the difference is the future stream of net economic benefits. This stream is translated into a present value by discounting future values by the social discount rate. The resulting figure is called the "net present value".

Objective - a statement of intent about resource use that is specific with respect to species, area, fishery, or resource uses.

Odd/Even - refers to discrete pink runs which occur in either odd or even years.

Open sets - refers to seine sets where a skiff brings the end of the net back to the boat rather than tying off at the shore.

Opening - date set by DFO for the commencement of a specific fishery.

Optimum escapement - an estimate of the numbers of spawners that will meet (but not exceed) the capacity of available spawning habitat.

Outplanting - see "transplanting".

Pieces - individual fish (in a commercial catch).

Pink corridor - this is a boundary regulation in Johnstone Strait to conserve Johnstone Strait and Georgia Strait pink stocks while fishing for Fraser River sockeye. A ribbon boundary closes the shore on the mainland side of the strait in a half mile wide strip from tidewater. The ribbon strip switches to the Vancouver Island side of the Strait at Chatham Point, and continues to end of fishing area. This regulation is usually in place during the first three weeks in August.

PIP - Public Involvement Project.

Policy - a statement of intent about resource use that has a national or regional scale.

Pre-migrant - young salmon prior to migration downstream to marine environment.

Presmolt - usually pertains to salmonid species that rear for extended periods of time (one year or more) in fresh water; the stage during which the fish is a yearling but has not yet smolted.

Production - the number of fish produced, often used in a stock-specific sense or for a particular enhancement project.

Production release - release of salmonids, usually high numbers, from an enhancement facility, that have been raised using standard fish culture techniques (as opposed to experimental releases).

Productivity - the rate of production, usually in terms of returning adults per spawner (stock specific).

Qualla - refers to chum colour (and therefore quality). Falls between brights (high quality) and darks (low quality).

Raceways - rectangular fish-rearing containers with high exchange rates and vertical walls.

Rack fisheries - commercial fishery targeted on excess hatchery stock (at the hatchery).

Satelliting - an enhancement strategy whereby eggs and milt from a particular salmonid stock are incubated and reared in a central facility or different stream, then returned to donor stream.

Scale pattern analysis - analysis of the patterns on scales of fish to distinguish between stocks.

Sea pen - net enclosures suspended in sheltered bays containing salmon for rearing purposes.

SEP biostandard - criteria used to estimate production of salmonid reproduction in the wild or in various types of enhancement facility. Includes estimates of fecundity and survival during each life stage for each species.

Shaker abundance - numbers of undersized salmon available for capture by sport and commercial fishermen.

Shaker catch - numbers of undersized salmon caught by sport and commercial fishermen (which regulations state must be released).

Shaker mortality - shakers which do not survive the catch and release process.

Silver bright - type of mature chum which has a silvery appearance, and is classified as top quality in the fishing industry.

Smolts - a juvenile salmon that has undergone or is undergoing physiological and behavioural changes in preparation for migration to sea water.

Spawning channel - artificial channels constructed for returning adults to spawn in, with ideal gravel and flow conditions.

Squishers - Undersized fish caught by commercial seine fishermen which are "squished" in the net.

Stock - fish of a single species that spawn in a geographical area of interest at the same time.

Strategy - a collection of management actions for meeting an objective.

Straying - returning adults which stray from normal migration route and spawn in an area different from the one in which they originated.

Stream box boundaries - boundaries of an area around the mouth of a river within which fishing is not permitted, to protect pre-spawning adult fish.

Subdominant year - the second highest production year of a sockeye stock (see "cyclic dominance").

Subyearling - stage in salmonid's life during the first year of rearing prior to the end of the calendar year (see "yearling").

Surplus to escapement - the allowable catch.

Target - refers to the level of escapement at which management plans are aimed.

Terminal fisheries - stock-specific fishery (just prior to entering fresh water).

Test harvest loss - loss of potential escapement causing failure to meet target escapement, because of test fishery operation to estimate run size.

Transplanting - releasing hatchery-raised juveniles in a stream other than the one in which the parent stock originated.

Upwelling gravel box - box filled with gravel, with water flowing through from bottom to top for incubating salmonid eggs.

Voluntary emergence - pertains to incubation of fish eggs in an artificial container where fry swim out of incubation media of their own volition. In known voluntary systems, fry are manually transferred from incubating container.

Window - a period of time during which an activity occurs.

Yearling - a stage in a salmonid's life reached when a new calendar year begins during juvenile rearing period (a subyearling become a yearling on January 1st).