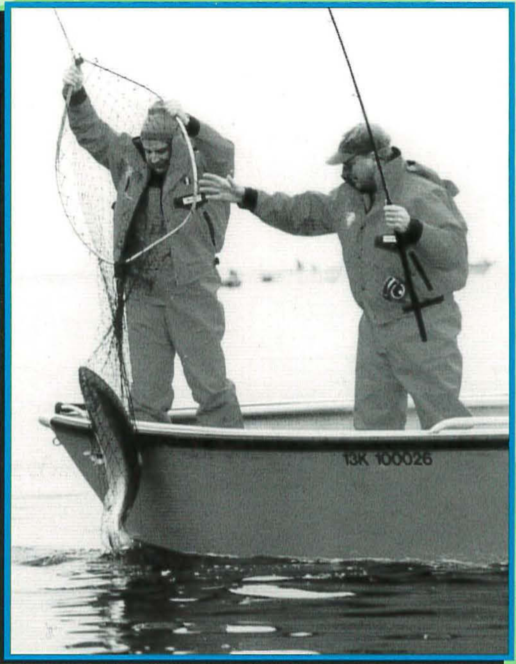
Skeena-Kitimat Sustainable Fisheries Program

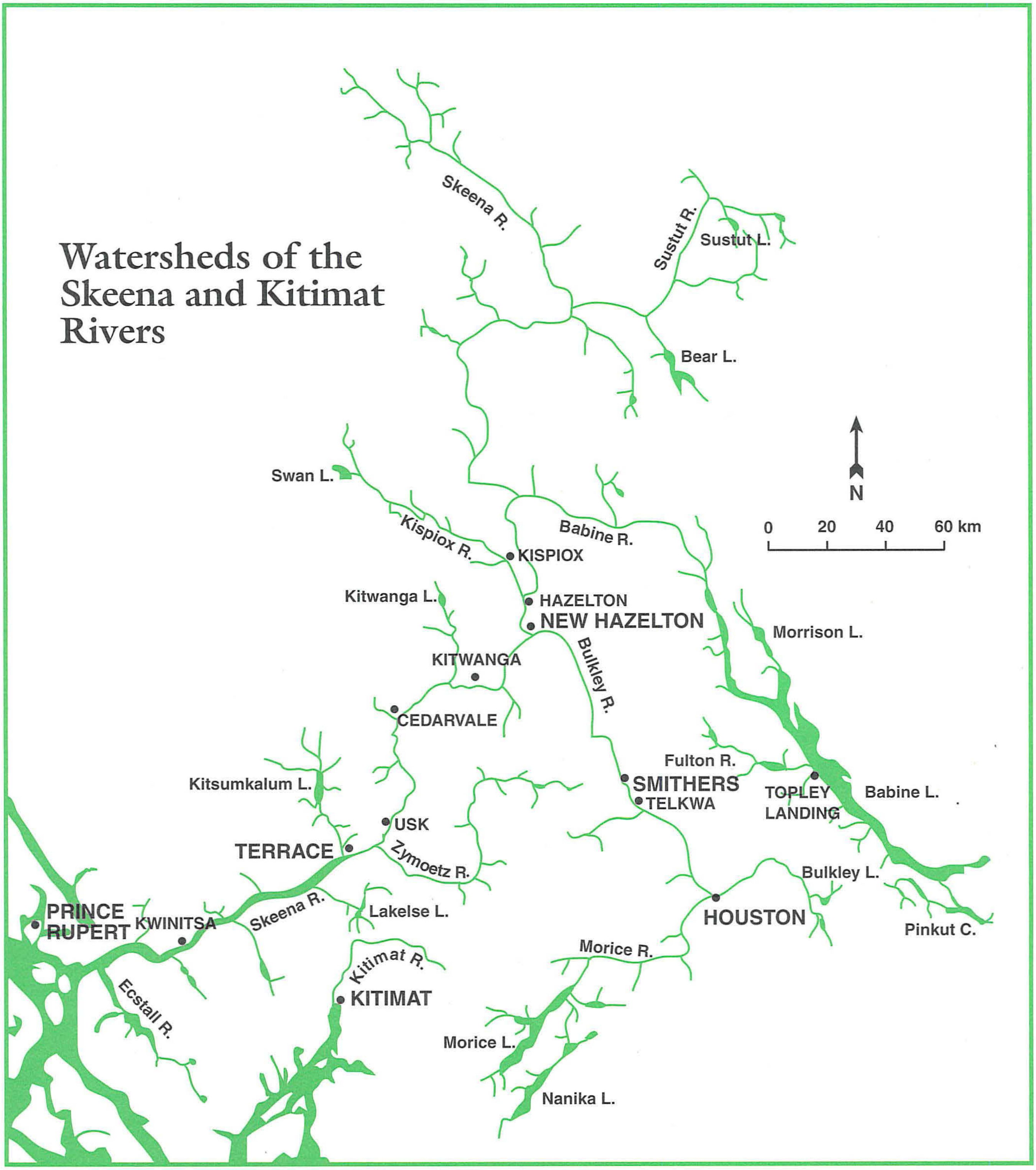
Final Report 1993 – 1997



Fisheries and Oceans Canada Pêches et Océans Canada

Canada

Contents


Watersheds of the Skeena and Kitimat Rivers
Skeena R.
Sustut R.
Sustut L.
Bear L.
N
0
20
40
60 km
Swan L.
Babine R.
Kispiox R.
KISPIOX
HAZELTON
NEW HAZELTON
Kitwanga L.
Morrison L.
KITWANGA
Bulkley R.
CEDARVALE
Fulton R.
SMITHERS
TELKWA
TOPLEY LANDING
Babine L.
Kitsumkalum L.
USK
TERRACE
Zymoetz R.
Bulkley L.
PRINCE RUPERT
KWINITSA
Skeena R.
Lakelse L.
HOUSTON
Pinkut C.
Morice R.
Kitimat R.
KITIMAT
Ecstall R.
Morice L.
Nanika L.

The Skeena-Kitimat Sustainable Fisheries Program

Final Report, 1993 – 1997

The Skeena Watershed

The Skeena watershed is a vital resource producing millions of adult salmon each year which support commercial, recreational and Aboriginal fisheries. In recent years, salmon and non-salmon fish resources resulted in more than 2,500 person-years of harvesting and processing employment within the region, in addition to recreational fishing benefits. Although these numbers are impressive, they do little to convey the fragility of the fisheries resource.

For years we have looked to the resource as a endless and resilient supplier of incomes and sustenance only to realize that its bounty is in fact limited and precious. This awareness has motivated governments and some resource users to consider stock-specific management, increased habitat restoration and more selective harvesting methods in the Skeena and Kitimat River systems. These have been the primary objectives of the Skeena-Kitimat Sustainable Fisheries Program, a four-year, $14 million program introduced in 1993 by Fisheries and Oceans Canada (DFO). The intent of this funding was to contribute to the information base from which management decisions would be made to sustain the resource over the long term.

Although the program has now ended, DFO's accomplishments and legacies continue in significant areas: through the people it influenced and partnerships forged to move the watershed toward sustainability; and through the practical tools and scientific information it produced to improve management and stewardship of the Skeena watershed's resources and ecosystems.

The Goals of the Sustainable Fisheries Program

The goal of the fisheries program is to develop management strategies to protect weaker stocks while achieving sustainable fisheries. It encompasses a broad range of activities to achieve its objectives:

- To develop a fully integrated short-term model fishery project to move the salmon fishery based in the Skeena River watershed towards a sustainable basis.
- To ensure that planning for development in the Kitimat estuary meets the needs of fish and their habitats.
- To develop cooperative sustainable management programs in partnership with all orders of government and stakeholders to foster environmentally sustainable development.
- To restore and enhance the environmental quality and natural productive capacity of fisheries stocks of concern and their habitats and to put in place the required management measures which will ensure long-term sustainability.
- To pilot-test and then implement fundamental changes in fisheries management practices to ensure economic sustainability and the commitment of the public to the preservation of the resource and its habitats.
- To produce new stock assessment, habitat protection, and harvest plans and regulations based on the applied research and pilot projects.
- To involve Aboriginal people in all aspects of resource management.

Simply put, the intent is two-fold: to gather technical data on salmon stocks, which in turn enables all the partners to make harvesting and other decisions that put conservation of the fisheries first.

The following report highlights the current status of salmon populations, summarizes the many projects and initiatives carried out under the sustainable fisheries program, outlines partnership initiatives, and describes the effects and benefits of the research undertaken to manage and conserve Pacific stocks.

Salmon Stocks in the Skeena – A Population Overview

The Skeena River originates in the high mountain valleys of the Skeena Range in northwestern British Columbia and flows for approximately 560 kilometres, draining an area of 39,000 square kilometres before entering the Pacific Ocean just south of Prince Rupert.

The Skeena watershed is well known for its wild salmon populations. Tributaries of the Skeena produce all major species of wild Pacific salmon including pink, sockeye, chinook, chum and coho. Canadian commercial fisheries targeting Skeena-bound pink and sockeye salmon occur between British Columbia's border with Alaska and the mouth of the Skeena. First Nation's fisheries harvest all species from the Skeena's approach waters to its upper reaches. Recreational fisheries occur in tidal waters adjacent to the Skeena and in non-tidal Skeena waters for chinook and coho. In recent years, pilot scale non-tidal recreational fisheries for sockeye and pink salmon also have taken place in the Skeena.

Pacific salmon are renowned for their precise homing ability. This trait leads to reproductive isolation of spawning sites over a relatively small area. Fisheries scientists refer to these isolated groups as populations when they are completely isolated and subpopulations when they are only partially isolated. Under isolated or partially isolated conditions, populations and subpopulations may become adapted to local conditions through a process of natural selection. The stock's ability to adapt locally contributes directly to its productivity and capacity to support a fishery. Once a wild population becomes extinct, it could take hundreds or even thousands of years to achieve local adaptation again.

Although Pacific salmon populations in Canada have evolved since the height of the last glaciation some 15,000 years ago, attempts to transplant Pacific salmon have only rarely been successful. Accordingly, scientists are not very optimistic about the potential to re-establish self-sustaining populations within a human lifetime. The long-term adaptability and persistence of a given salmon species depends directly on the number of healthy populations. This is because the total genetic diversity of each salmon species is subdivided among many populations.

The following tables summarize what is known about the population structure of Pacific salmon in the Skeena watershed:

	COHO		PINK		SOCKEYE	
SUB AREA	Escapement survey sites	Known populations	Escapement survey sites	Known populations	Escapement survey sites	Known populations
Lakelse	14		7	1	7	2
Kitsumkalum	11		5		5	1
Other Lwr. Skeena	15		18	1	4	1
Kispiox	21		12	1	5	1
Bulkely/Morice	15	1	10	1	3	1
Other Mid Skeena	13		15	1	5	1
Babine	6		5	1	23	1
Bear	4		2		8	4
Total Surveyed	99	1	74	6	60	12
Number Screened	1	10			22	

7 from odd years

* Pink salmon spawning in even years are always genetically distinct from those spawning in the same site in odd years because they always mature at age two.

	CHINOOK		CHUM	
SUB AREA	Escapement survey sites	Known populations	Escapement survey sites	Known populations
Lakelse	3		1	
Kitsumkalum	5	2	3	
Other Lwr. Skeena	11		13	1
Kispiox	8	1	6	
Bulkely/Morice	8	2	0	
Other Mid Skeena	8	1	7	
Babine	3	1	1	
Bear	4	1	0	
Total Surveyed	50	> 8	31	> 1
Number Screened 7 from odd years	8	10	1	

The first column for each species indicates the number of distinct spawning sites recorded during spawning escapement surveys within each sub area. Escapements are recorded for most, but not all spawning sites. Some spawning sites are known to be distinct populations, while often neighbouring sites are connected by straying or successful interbreeding (a process referred to as gene flow) so that one population includes a number of spawning sites. The second column indicates the number of populations that have been identified by genetic surveys. This number should be regarded as a minimum estimate because of the limited extent of genetic surveys to date for species other than sockeye (note the relatively low number of sites screened).

Sockeye and pink production and subsequent catches in the Skeena have been at high levels for the better part of the last ten years. The higher harvest rates targeting these increased abundances have significantly affected the ability of fisheries managers to protect less productive, non-targeted stocks. These vulnerable stocks include non-Babine sockeye, early timing upper Skeena coho and summer-run upper Skeena steelhead.

Skeena coho have been a threatened species for some time. Their vulnerability has been attributed to low survival rates related to flooding and freezing, poor ocean survival and of course, overharvesting. Consequently, since 1990, they have been the focus of a number of strict conservation measures, including curtailments to fisheries in all three sectors. Despite these efforts, stock assessment data for the upper Skeena early coho stocks suggests that more conservation efforts are necessary. Coho conservation is further affected by the inability of Pacific Salmon Treaty arrangements to limit the impacts of Alaskan fisheries on Skeena-bound coho stocks. Some estimates have suggested that up to half of the harvest of these stocks occurs in Alaskan commercial fisheries.

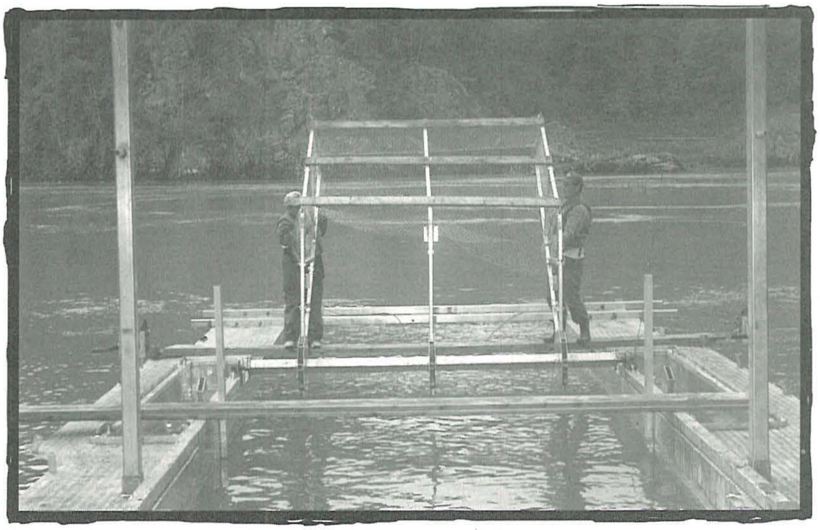
Minimizing Bycatch

Minimizing the interception of bycatch, or non-targeted species, is one of the major challenges in the Skeena watershed. The following outlines the challenges of fisheries management in the Skeena:

For the past several decades, management of the Skeena commercial fishery has concentrated on providing sufficient spawning escapement for specific stocks. This is called managing to an escapement target. It is generally suitable for single stock or slightly mixed stock fisheries where the escapement can be estimated in sufficient time to adjust the fishery. It is usually not feasible to manage fisheries to meet escapement objectives for many small stocks in a mixed stock circumstance such as the Skeena River mouth. Moreover, it is virtually impossible to manage to escapement objectives for coho and steelhead.

An alternative method is to manage harvest rates. Reduced harvest rates on weaker stocks and species (i.e. stocks and species with lower reproductive rates) will conserve those stocks, independent of stock size. Surpluses from more productive stocks would be available for harvest in discrete new fisheries or more selective existing fisheries.

The consequences of reducing the harvest rates in the existing fisheries are mixed. On one hand there will be more production from the less productive stocks. However, if there is no ability to make current fisheries more selective, total ocean catches will drop as protection is afforded the weaker stocks, and an increased surplus of strong stocks will be created upstream.



The inability of Skeena River coho and steelhead stocks to sustain harvest rates in the 1980s and early 90s during the conduct of the commercial sockeye and pink fisheries resulted in significant allocation and conservation concerns.

During the past decade, and particularly, in the last few years, Skeena management has moved from a fishery managed primarily for aggregate sockeye or pink abundance to more stock-specific management that includes numerous aggregate and stock specific abundance concerns for all species. This trend is expected to continue.

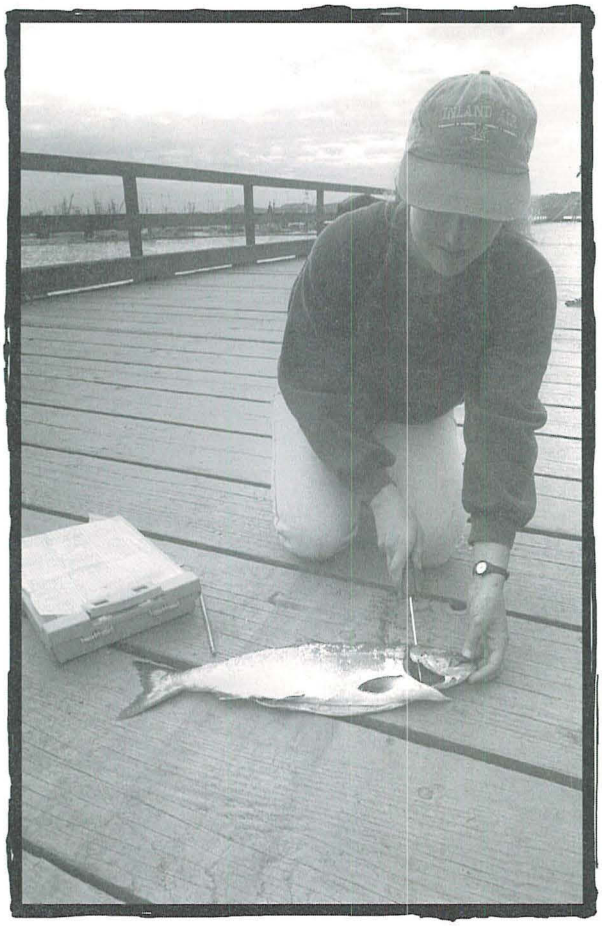
The current approach aimed at minimizing the interception of non-targeted species focuses on fishery time and area adjustments. It also involves various selective gear initiatives which are intended to minimize the ratio of incidental to target catches.

First Nations groups have introduced a number of innovations to minimize the interception of non-target species. These have occurred primarily in the Excess to Spawning Salmon Requirement (ESSR) fisheries and to a lesser extent, in some fisheries for food, social and ceremonial purposes. Aboriginal fishers have used fishwheels, beach seines, dipnets and traps to harvest sockeye and pink salmon in ESSR fisheries throughout the Skeena watershed.

In addition to the use of selective gear, time and area management have steered the ESSR fisheries away from the wild stocks to the enhanced sockeye. The proportion of food, social and ceremonial fish harvested by selective means has increased, and there are strong local initiatives to move the Moricetown gaff/jig fishery towards a more selective harvest.

In the Skeena's commercial gillnet fishery, management initiatives to minimize the harvest of non-targeted species have concentrated on the timing separation of sockeye, coho and steelhead stocks. The current fishing plan reflects this approach and has achieved a significant reduction in incidental harvests. A series of initiatives to improve the selectivity of gillnets are ongoing, but have yet to result in an approach that can be implemented in the fleet.

Other commercial as well as recreational fisheries have also undertaken measures to curtail the harvest of non-targeted species. For instance, seine fisheries have reduced incidental catches through selective harvesting via catch-and-release. These methods continue to be refined. Meanwhile, the management approach in the commercial troll fishery has been to close areas adjacent to the Skeena where the highest proportion of coho stocks are present. Area closures and catch-and-release fishing have been the major management tactics to minimize incidental catches in the Skeena's recreational fisheries.



Current approaches only deal with species as aggregates. Time and area closures often become less effective as management becomes more stock-specific and stock complexity and timing overlaps increase. Successful stock identification programs are essential to better understand the potential for further progress involving adjustments in time or area.

Selective harvesting opportunities will continue to be explored on a number of fronts. The challenge will be to balance technical progress with social and political considerations. In order to do this effectively, issues relating to conservation rather than allocation must be further examined and clarified.

Research efforts have focused on two major areas. First, researchers have evaluated the stock status and productive potential of Skeena stocks. Second, efforts have been directed at improving and/or creating existing management tools and harvesting techniques. Almost all of the sustainable fisheries research programs are in some way linked to determining the most effective ways in which to minimize the interception of non-targeted species.

Stock Status – Distinguishing Skeena Stocks in Season

Stock identification techniques are used to define population units for fisheries conservation and management. They also are used as a tool to identify stock components in mixed-stock fisheries and in mixed escapements. A number of stock identification initiatives took place under the auspices of the sustainable fisheries program for steelhead, coho, chinook and sockeye species.

For steelhead, a method known as laser ablation has been used. This technique compares the chemical isotope content of scales and has demonstrated some promise as an effective means to distinguish steelhead stocks in the Skeena. The provincial Ministry of Environment, Lands and Parks conducted an initial experiment using samples from the Babine, Morice, Sustut and Zymoetz and achieved almost perfect separation of stocks. The next step involves ensuring that the characteristics being measured are consistent among years as well as looking at a broader range of steelhead stocks in order to determine how many can be separated.

One of the more positive features of the laser ablation (and a new approach called micro-satellite DNA) is its ability to analyze historical scale collections from the test fishery or commercial sampling collections. Fisheries researchers have also examined other identification techniques including protein electrophoresis in which genetic variation is inferred among enzymes (proteins) and DNA analysis. Their research has shown that although these methods demonstrate some capacity to separate Skeena stocks, some major steelhead stock groupings cannot be separated.

Skeena coho studies have evaluated protein electrophoretic, DNA and laser ablation techniques. During the past four years, adult and juvenile baseline samples have been collected from a wide variety of sites throughout the Skeena watershed. As yet, the potential for any of these techniques to distinguish coho stocks is uncertain. From a coast-wide perspective, stock identification methods for coho have been the most difficult to develop.

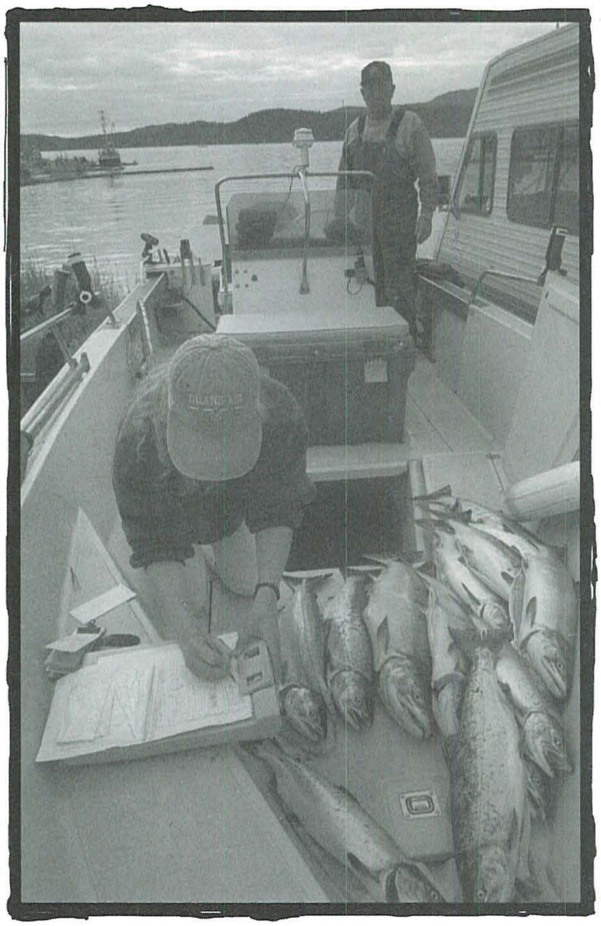
Previous indications from chinook protein electrophoretic studies show significant differences among chinook populations. Extensive samples were collected in 1995 to undergo protein electrophoretic, DNA and laser ablation testing in 1996. Researchers believe that if the DNA and laser ablation techniques work as expected, analysis of historical scale collections of Skeena chinook will be possible.

Protein electrophoretic and DNA methodologies have been effective tools for sockeye stock identification. Protein electrophoretic techniques have been used for a number of years to provide a more stock-specific breakdown of sockeye escapement past the test fishery. Further evaluation is required on the use of available techniques for sockeye stock separation in the more complex stock mix in outside fisheries.

Management models also are used to separate stocks in-season. This approach involves using the accumulated knowledge of stock-specific timing and migration pathways of salmon to make assumptions about how they will return. Examples of how this method is currently used include:

- early steelhead stock separation in the Skeena based on historic tag recoveries;
- Upper Skeena coho stock separation using a September 1 cutoff in ocean fisheries based on tagging recovery patterns; and,
- management consideration for early Skeena sockeye and late Babine River stocks based on historic timing separation from enhanced runs.

The Skeena run reconstruction of sockeye and pink salmon was based on the results from an international tagging program that took place from 1982 to 1985. This reconstruction will serve as the basis for a North Coast management model. The model is intended to evaluate the impacts of Alaskan and all Canadian fisheries on Skeena and Nass sockeye stocks. The reconstruction also may lead to a detailed in-season management model used to evaluate sockeye management scenarios all user groups as well as for Nisga'a and any other land claim commitments.



The ideal scenario for distinguishing the Skeena's stocks in-season would involve a collaborative use of stock identification techniques and management models. Within this scenario, stock identification data gathered in-season would be applied to management models in order to make effective decisions about stocks. Research programs are intended to provide the tools to realize such a scenario for Skeena salmon stocks.

Stock Identification - Coho

Within the Skeena River, further study of genetic variation was needed to delineate population units for coho salmon conservation and management.

A hierarchical design was used to examine population structuring and patterns of genetic diversity within the Skeena drainage. Special efforts were made to determine the number and geographic scale of populations within the Bulkley River (representing upper river coho) and tributaries to the lower Skeena River. Samples were compared to determine their distinctiveness across a range of geographic distances, from sites within the same stream separated by only a few kilometres, to sites in different drainages separated by hundreds of kilometres. Delineating population units is a necessary first step in the application of DNA techniques for stock composition analysis.

Baseline samples of more than 600 adult and 3,000 juvenile coho from more than 50 sites were screened for nuclear DNA variation. Juvenile coho samples are much easier to collect than adult coho samples, and consequently, juvenile collections to date are more extensive than adult collections. Analyses in 1996 confirmed that juvenile samples can be used instead of adult samples to construct baseline data sets for inferring population structure and the composition of mixed-stock samples.

DNA data analysis reveals that coho populations are typically delineated by major tributaries, although distinct subpopulations do occur within some tributaries. Coho spawning in the upper watershed (above Terrace) are reproductively isolated from those in the lower watershed. Within the upper Skeena, persistent differences in allele frequencies occur among all major tributaries, indicating separate lineages within the Morice-Upper Bulkley, the lower Bulkley, Kispiox, Babine, and upper Skeena rivers. Similarly, separate lineages exist within all major tributaries examined in the lower Skeena, including the Cedar, Lakelse, Gitnadoix, and Green rivers. Lachmach River (Work Channel) coho are genetically very distinct from Skeena coho and appear most related to Green River coho which inhabit an adjacent watershed. Persistent genetic differences were also detected among juveniles rearing in different sites within the Lachmach (upstream site versus other downstream sites) and within the Gitnadoix (inlet versus outlet tributaries to Alastair Lake).

Genetic differentiation among coho populations in the Skeena is sufficient to develop practical stock identification procedures. However, the differences in microsatellite DNA loci observed among coho populations in the Skeena River are quantitative, not qualitative — the same alleles occur in most populations but at different frequencies. This means that individual fish cannot be classified reliably to specific populations and, as with other stock identification techniques, statistical procedures and relatively large samples are required to estimate stock composition of mixed-stock catches. Even so, microsatellite DNA procedures can improve estimates of stock composition estimates and greatly simplify sampling protocols, in part by avoiding the necessity of killing fish.

DNA Methods for Selective Harvest of Enhanced Babine Sockeye

The objective of this research was to develop DNA techniques that would allow DFO to monitor the stock composition of catches by terminal or selective fisheries in the Babine River. Intensive selective harvesting of enhanced (Fulton and Pinkut) sockeye based on run timing could threaten unenhanced sockeye Babine Lake subpopulations because their run timing distributions overlap considerably. Stock identification research to date (scales, parasites, allozymes, mtDNA) has not identified a practical technique for monitoring the relative abundance of these closely-related subpopulations.

Microsatellite DNA variation in samples previously collected from seven subpopulations in Babine Lake was examined. These include two early wild subpopulations (Pierre and Twain), three middle-timing populations (Pinkut, Morrison and Fulton), and two late wild subpopulations (Upper and lower Babine River). Samples from some of the same populations collected in different years were also compared to demonstrate temporal stability.

Ten microsatellite loci known to be useful in other salmon species were examined in Babine sockeye; six were found to be polymorphic and interpretable, and potentially very useful for sockeye stock identification. Unfortunately for the objective of this project, no significant differences were detected between any of the subpopulations examined in Babine Lake. Allele frequency distributions at all six loci were found to be very similar across samples and years. These results imply that there has been sufficient gene flow (successful straying) among subpopulations to prevent genetic differentiation at these genes which are not affected by natural selection. Thus, any conventional genetic stock identification technique that focuses on selectively-neutral traits is unlikely to achieve the original purpose of this study. Scientists have recommended that further work to distinguish subpopulations in Babine Lake focus on selected traits such as run timing, homing behaviour, morphology, or DNA coding for selected traits.

Skeena and Nass Sockeye Stock Identification

The purpose of this project was to develop and test stock identification techniques for sockeye salmon populations likely to be caught in Area 3 and 4 fisheries. The long-term goal is to implement marine catch sampling programs to improve Skeena/Nass sockeye management.

Simulation studies for stock identification problems involving mixtures of Skeena and Nass sockeye populations indicate genetic/parasite baseline data have remained stable since the last sampling period in the mid-late 1980s. Sockeye from each of the nine principal lake systems in the Skeena are sufficiently distinct from one another and from the six principal Nass sockeye populations to estimate their proportionate contributions to simulated mixed-stock fishery samples of 150 fish with a bias of less than 10 per cent; for most Skeena stocks (including the three largest stocks), the bias is less than five per cent.

Getting a Count on Coho

Skeena River Juvenile Coho Survey.

The status of a population of Pacific salmon is usually determined by counting the number of adults that return to spawn, and by comparing those numbers to historic numbers and to expected numbers that come from mathematical models that describe the productivity of the population. This approach works well for species such as sockeye and pink salmon where there are only a small number of populations and where spawners can be easily enumerated on the spawning grounds. Adult coho salmon however, are extremely difficult to count due to their late spawning time, the large number of small populations occurring throughout river basins, and their preference for small streams with lots of cover in which they hide. Because juvenile coho spend one or more years in freshwater, an alternative method of determining the status of coho salmon populations is to measure the densities of juveniles rearing in freshwater in late summer.

The objective of this project was to provide a cost effective overview of coho juvenile density and distribution and to conduct detailed habitat evaluation at sites throughout the Skeena River watershed.

This project involved the sampling of juvenile coho and other fish species in up to 60 sites throughout the Skeena River watershed in August, 1994, 1995 and 1996. Site selection was conducted in June 1994 and included sites where juvenile coho would be expected, mostly low gradient small stream type sites. Some lake sites were also included for comparison purposes. In addition to fish distribution and densities, detailed habitat measurements were taken at each site. The habitat measurements included stream cover, volume of wood debris, bottom composition, wetted area measurements including depths and pool, riffle, glide dimensions, bank angles and a measurement of sun penetration referred to as sun arc.

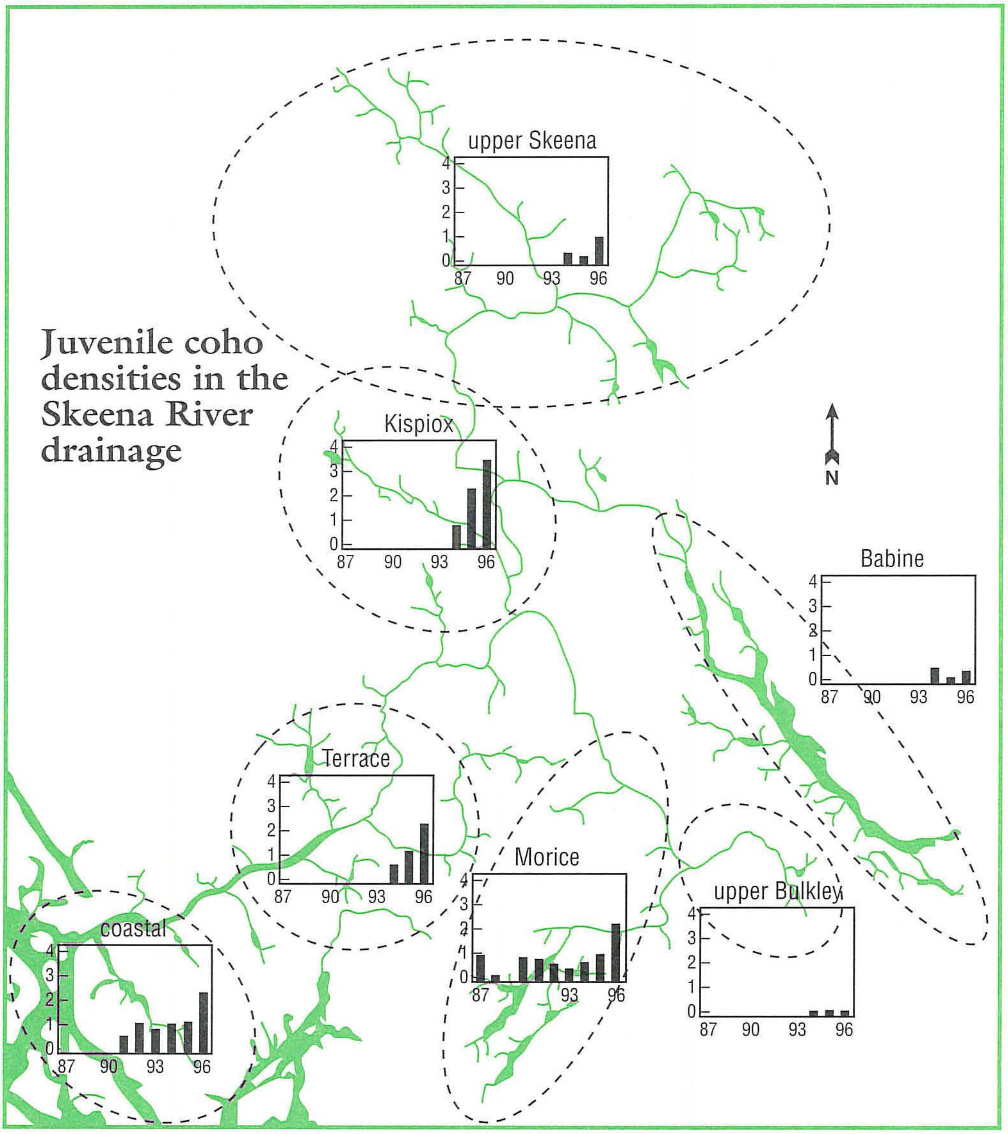


Figure 1. Coho densities (number per square meter) over time are shown for the regions of the Skeena watershed indicated by the dotted lines. The coastal zone includes the Lachmach River, at the head of Work Channel. All of the graphs are to the same scale to emphasize the differences in density between regions. In the coastal area and in the Morice data collected under the Skeena Green Plan in 1994, 1995 and 1996 were augmented with similar data collected in earlier years.

The status of coho populations as indicated by juvenile densities varies widely across the Skeena River watershed (Figure 1). Coho stocks in lower Skeena River systems, those from Terrace downstream, are stable and the available habitats sampled are well seeded with juveniles. The Kitwanga River below Kitwanga Lake is well seeded with juvenile coho and the main tributary, Moonlit Creek also appears to have a healthy coho stock. Areas upstream of Kitwanga Lake held no coho and water quality appears to be a problem in late summer. The Kispiox River system including its major tributaries and mainstem side-channels also had good densities of juvenile coho. Toboggan Creek, an enhanced upper Bulkley River stock, had good densities of juvenile coho. From this point upstream on the Bulkley River the picture is much less encouraging.

Despite reasonable densities of juvenile coho in the mainstem Morice River side-channels all other areas of the upper Bulkley River above Houston, and all of the Morice River tributaries sampled, including Gosnell, Shea, Thautil, McBride and Owen Creek had very low or no juvenile coho present. The upper Zymoetz (Copper) River also had very low densities of juvenile coho. This is a marked decline over historic coho distribution is this area.

The situation in Babine Lake and its tributaries is also of concern. Some sampling problems were encountered due to high water and difficult access, however, juvenile densities in tributary streams were very low. The low juvenile densities were consistent with the recent low adult escapement counts into Babine Lake. Sampling conducted in Nilkitkwa Lake confirmed this as a major juvenile coho rearing area.

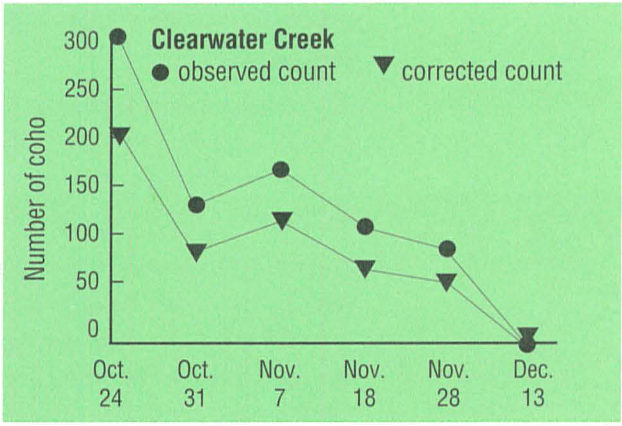
Other upper Skeena areas were also sampled. Slamgeese River was found to have lower than expected juvenile numbers though this may have been confounded by juveniles rearing in Slamgeese Lake. The glacial inlet to Motasse Lake was found to have good densities of juvenile coho, which was surprising given its apparently poor quality due to the cold, turbid glacial water. Another stock of interest was found in the tributary to Kluatantan Lake near the northern most limit of the Skeena watershed. Good numbers of small but healthy juvenile coho were found to be rearing in the cold, clear-water inlet to Kluatantan Lake. Coho were also found to be present in the tributary to Johanson Lake in the upper Sustut River watershed. No coho were found in the tributaries to or in Bear Lake which historically held good numbers of coho.

Habitat quality and quantity was found to be good throughout the Skeena River watershed. There are localized areas of concern from such factors as agricultural runoff, water extraction and beaver activity. However, when compared with other areas of British Columbia, coho habitat on the Skeena is for the most part in good condition. Escapement of adult coho into upper river areas, particularly into south eastern portions of the watershed, is of most concern at the present time.

The juvenile sampling conducted in this project will provide a valuable baseline for measuring changes to coho stock status within the Skeena River watershed. Data collected by this project will be vital to the assessment of future coho stock rebuilding efforts. The extensive habitat data collected also serves as a baseline for future work and as a record of current habitat status.

Lower Skeena Adult Coho Escapement Surveys

Adult coho escapement counts from the Skeena River watershed have in the past been based on fishery officer counts of the number of fish present during what was often only a single survey of a given stream. This approach provided some information on coho presence or absence, coho adult distribution and stream conditions, but it provided no estimate of the total coho escapement. This project surveyed several systems in the lower Skeena River as candidates for estimating total adult coho escapement using a method called area under the curve (AUC). The AUC method of escapement estimation relies on regular, often once per week, counts of the number of adult coho present in an entire stream or some subsection of that stream. By conducting weekly stream surveys to count adult coho and by determining observer efficiency and survey life, or how long any given fish stays in the stream area being surveyed, it is possible to generate an estimate of total escapement.



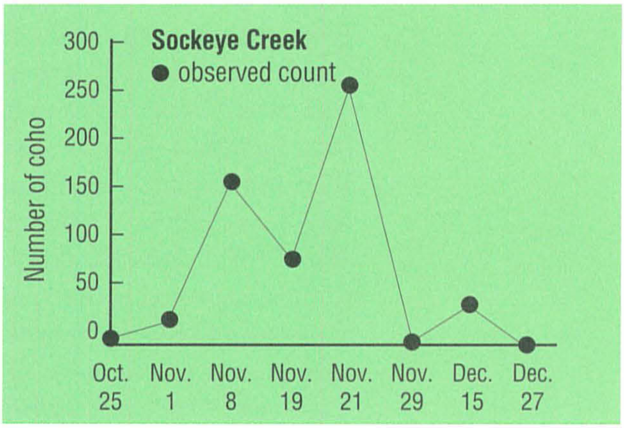


Figure 2. Adult coho counts at three lower Skeena River sites, Fall 1995.

The streams chosen for this project were McNeil (Green) River near Prince Rupert, Clearwater Creek and Sockeye Creek which are tributaries to Lakelse Lake, and lower Cedar River and Hadenschild Creek which are upstream of Kitsumkalum Lake. These sites were chosen based on access and past adult coho surveys.

In addition to conducting adult counts samples were collected for DNA analysis. Samples of fin or operculum were collected from adult coho. Samples of 100 whole juvenile coho were also collected from each system.

The results showed that Clearwater Creek was the best candidate for estimating escapement using AUC. Sockeye creek proved to be too large and viewing conditions were frequently poor. Tributaries to Green Lake in the McNeil River system showed some promise, however frequent high water followed by snow hampered access. A total of 515 adult coho were observed in Clearwater Creek between October 24 and December 13, 1995. Residence time was found to be nine to 12 days. Observer efficiency, or how many of the adult coho present were actually observed, was found to be 64.7 per cent. From this an estimate of escapement of between 454 and 605 was calculated. Figure 2 shows the adult coho counts for the three survey sites including counts corrected for observer efficiency in Clearwater Creek. Samples for DNA analysis were successfully collected from all sites.

Data collected for this project will provide a valuable base for future work. It will now be possible to produce statistically valid estimates of escapements for Clearwater Creek, a lower Skeena River tributary. This will be useful for monitoring stock status and for comparing late summer juvenile coho densities with adult escapement numbers.

Toboggan Creek Smolt Enumeration

The number of coho salmon smolts produced by a stream or stream system is a measure of that system's habitat productivity. Coho smolt production is related to the quality and quantity of available suitable habitat. The determination of total smolt production from a stream can provide valuable data on stock status and stream productivity.

The purpose of this project was to estimate the total smolt production from Toboggan Creek, a tributary of the Bulkley River near Smithers. The project involved a mark recapture estimate of smolt production using the adipose clipped smolts released by Toboggan Creek Hatchery as the known mark group.

A floating Fyke net trap was used to trap outmigrating smolts. The trap was installed in late April and fished until late June in the spring of 1995 and 1996. The trap was fished for two to three days per week. Captured coho smolts were sorted and counted as wild or hatchery origin. Hatchery smolts were then released downstream while wild smolts were weighed, measured and subsampled for scales.

This project was extremely successful in both years of operation. Total wild smolt production in both 1995 and 1996 was estimated to be 32,000, approximately equal to the production of hatchery smolts. Wild smolts were found to be of three age classes with 50 per cent two year olds, 48 per cent one year olds and two per cent three year olds. Length at age was variable in both years reflecting a wide range of habitat types. Wild and hatchery outmigration was found to occur at the same time in late May and early June (Figure 1). Figure 2 shows the length frequency of wild coho captured in 1996. Wild coho captured at Toboggan Creek are similar in size and age composition to those captured at the Lachmach River near Prince Rupert. This suggests that Toboggan Creek is productive for a northern interior site. There was no correlation between stream discharge or temperature and smolt migration. Migration from Toboggan Creek as in other systems is related to photo period or day length. The Fyke trap that was designed for this project worked well at low to moderate stream levels, but was somewhat less effective during peak discharge periods.

There is about 19 kilometres of available habitat upstream of the trapping site on Toboggan Creek. Therefore, Toboggan Creek produced 1,684 smolts per kilometre of stream in 1995 and 1996. From this it can be said that Toboggan Creek is very productive for a northern interior type system.

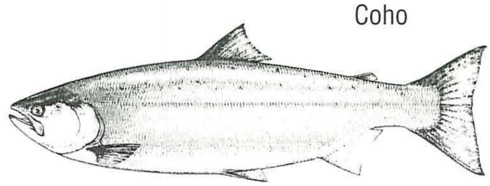
This project has also provided valuable data on the survival of wild coho from Toboggan Creek. Given that all of the hatchery production of coho from Toboggan Creek is adipose clipped and tagged, the survival of wild coho can be inferred by comparing the ratio of wild and hatchery fish on return as adults. The ratio of wild to hatchery fish on migration is approximately 1:1, and on return as adults is 1:4. Smolt to adult survival for hatchery fish averages two per cent, therefore the survival of wild smolts to adults can be estimated as eight per cent. This smolt to adult survival is surprisingly high for a northern interior system and is very similar to survivals seen from northern coastal systems.

This project provided valuable data on production, age composition and survival of wild coho salmon from a northern interior system. This data will be useful in determining potential smolt production from other northern interior systems and will serve as a valuable baseline for future work in Toboggan Creek and surrounding systems.

Upper Bulkley Adult Coho Surveys

Aerial counts of adult salmon in freshwater, particularly counts using helicopters, are frequently used to provide some estimate of adult escapement in areas where ground access is not possible. Counting coho from the air in interior systems can be difficult due to late spawning times and coho salmon's preference for small streams. These problems aside, aerial counts of adult coho can provide valuable information on numbers and distribution.

The purpose of this project was to conduct aerial surveys of adult coho numbers and distribution in the Telkwa River, Gosnell Creek, and Zymoetz River near McDonell Lake. In addition an attempt would be made to verify numbers observed from the air with swim surveys.


Coho

The 1994 surveys were successful. The peak survey in the Telkwa River was on November 1 where 605 adult coho were observed. The November 14 survey on the Telkwa River counted 173 from the air and 228 using a single swimmer. The peak aerial count in Gosnell Creek was 14 coho on November 1. The November 18 survey of Gosnell Creek counted three from the air and 18 by snorkel survey. The October 26 survey on the Zymoetz River above McDonell Lake counted 171 coho. The November 8 survey on the Zymoetz River counted 52 coho from the air and 88 by swim survey.

In addition to these surveys a single aerial survey of Toboggan Creek was conducted on October 28. This survey was intended to compare aerial, ground and fence counts of coho salmon. The escapement through the Toboggan Creek adult fence was close to 2,000 adult coho, aerial surveys counted 261, while ground surveys counted 420.

The 1995 surveys were much less successful. The October 31 count in the Telkwa River observed 178 coho. Flights on November 1 counted zero in Owen Creek, 54 in the mainstem Morice River, 3 in Gosnell Creek and 77 in Toboggan Creek. Unfortunately cold weather beginning on November 7 followed by snow prevented any further surveys from being conducted. One late attempt was made on Gosnell Creek on November 14 however ice on the creek and blowing snow prevented any useful counts.

These surveys provided valuable data on coho adult numbers and distribution in the upper Bulkley and Morice River watersheds. By using swim surveys in conjunction with aerial surveys it is possible to calibrate aerial observer efficiency. These counts show that aerial surveys of coho distribution can be of value but that the numbers counted must not be taken as a total escapement. Timing information provided by these surveys suggest that counts should be conducted in areas such as the upper Telkwa earlier than expected. Surveys in the past have been conducted throughout November. Results of this survey show that mid October may be a more accurate start time.

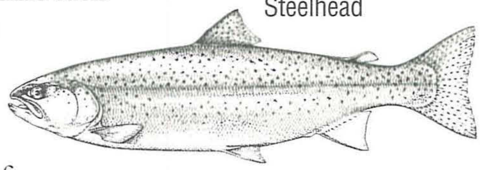
These surveys further confirmed data gathered during juvenile coho surveys that show very low numbers of coho particularly in the upper Morice River tributaries. While numbers of coho in the Telkwa River were similar to historic counts, the almost complete lack of adult coho in areas such as Gosnell Creek is of major concern.

Restoring Steelhead

The Skeena River watershed is world renown for its wild steelhead trout. Tributaries of the Skeena contain many of the last major runs of wild summer-run steelhead in the world. These steelhead stocks are characterized by varied run times, large size and resilience. While not the focus of a directed commercial fishery, steelhead trout are incidentally intercepted by salmon harvesters in a gauntlet of mixed-stock fisheries (mainly sockeye and pink and to a lesser extent chinook and coho) operating from Alaska to the Nass River and the Skeena River systems.

For management purposes, ten major steelhead stocks have been identified as indigenous to the Skeena's tributaries. As it is impossible to accurately measure steelhead escapements, these stocks are managed by harvest rates. Accordingly, fisheries scientists have estimated that under ideal habitat conditions and with no fishing activity, the Skeena watershed would produce between 80,000 to 120,000 steelhead. In theory, under current conditions, if each stock was harvested at its sustained yield level, 23,000 spawners would be required for the Skeena. However, in practice, the number of fish necessary for escapement is estimated at between 30,000 to 40,000.

Although there are no effective means through which to accurately determine whether the target has been achieved in the watershed as a whole or in individual tributaries, it is important to note that these increased escapement estimates result from several major factors.



First, given that steelhead stocks are part of a mixed-stock fishery and that each steelhead stock has its own timing and productivity, it is impossible to harvest each stock separately. What this means is that some stocks will be underharvested in order to protect less productive stocks. Second, the escapement of steelhead past the commercial fishery must be increased in order to provide for the food fish requirements of the First Nations. Finally, there also are a number of other incidental sources of mortality including losses resulting from hooking mortality in the recreational fishery, losses from in-river selective fisheries conducted under the Aboriginal Fisheries Strategy, predation and poaching.

During the past several years, some concern has been raised about the health of summer-run steelhead stocks. In large part, this concern has stemmed from increased fishing pressure in Alaska, the development of enhancement facilities at Babine Lake and greater Native participation as part of the Aboriginal Fisheries Strategy. Historically, early-run steelhead stocks (e.g., Sustut and Morice) have been particularly hard hit as they tend to overlap most with peak sockeye runs.

In 1991, the federal Minister of Fisheries and Oceans committed to reducing steelhead harvest rates in net fisheries by 50 per cent over a three-year period. Although ongoing difficulties surrounding Pacific Salmon Treaty arrangements have resulted in an inability to limit the impact of Alaskan fisheries on Skeena-bound steelhead stocks, some degree of success has been achieved in Canadian waters. An example is a project that was developed in cooperation with the commercial fishing industry and was intended to reduce steelhead mortality in the gillnet fishery. Live capture steelhead were held on board gillnet boats, transferred to a large barge storage facility and then released following the end of commercial openings.

Under the stewardship of the federal and provincial fisheries departments and the Skeena Watershed Committee, the program is intended to develop management strategies to protect weaker stocks while achieving sustainable fisheries within the Skeena. Through the consensus-based SWC, a fishing plan agreed to in 1994 targetted average harvest rates of 33 per cent on early-run timing steelhead and 21 per cent on the aggregate of all summer steelhead. This fishing plan continued for three years.

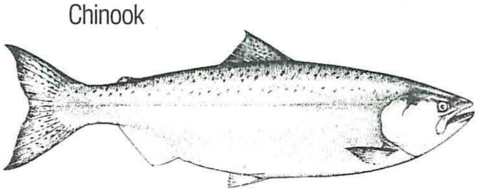
Steelhead stocks have benefitted from initiatives carried out under this program. For example, a 1994 radio tagging project was able to provide estimates of stock specific abundance and migration timing. This enabled researchers to find out more about steelhead populations throughout the Skeena system as well as how many fish enter each tributary to spawn. Other efforts also include the continuing search for more selective gillnets, traps and other harvesting techniques.

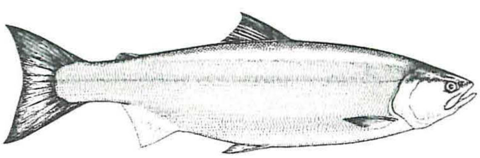
Current indicators for steelhead stocks in the Skeena River watershed are positive. For two consecutive years, the catch index has shown improvement in steelhead numbers. This increase also has been evidenced at the counting fence in the Sustut. In part, this may be due to the cyclical nature of steelhead stocks. However, credit is also attributable to changes in management of the fishery and increased commitment by all user groups to the conservation of this valuable resource.

Chinook, Steelhead and Sockeye Enumeration

The objective of this research was to enumerate chinook, sockeye and steelhead trout spawning in the Sustut River upstream of the Moosevale Creek confluence in 1996.

Chinook





Sockeye

One worker conducted the counts from Aug. 1 to Aug. 31, 1996. One fish counting fence located 500 metres upstream of the Moosevale Creek confluence was used to count all fish from Aug. 1 to Aug. 31. An "upstream" fence used in previous years was not used. Chinook salmon passing the mainstream fence were counted and sexed; sockeye salmon and steelhead trout passing the mainstream fence were counted. A random subsample of steelhead were measured for fork length.

Physical variables of water temperature and river height were measured for the Sustut river mainstem 500 metres upstream of the Moosevale Creek confluence. Dead chinook salmon recovered from the mainstem counting fence were measured for length, sexed, and examined internally for egg retention or testis condition.

Fifty sockeye salmon were sampled through August for the presence or absence of Philonema oncorhynchi as part of the Pacific Salmon Commission's responsibility to estimate catches of Fraser River sockeye.

In 1996 escapement to the upper Sustut River (upstream of the Moosevale Creek confluence) was 1,188 chinook, 466 steelhead, 3,470 sockeye (to both Johansen and Sustut lakes), and 33 coho. These escapement counts are believed to be totally accurate for the period of sampling (Aug.1- Oct. 1) and complete for the entire run of chinook, steelhead, and sockeye salmon. The count of coho is also believed to be accurate but incomplete because the coho run is thought to continue past Oct. 1.

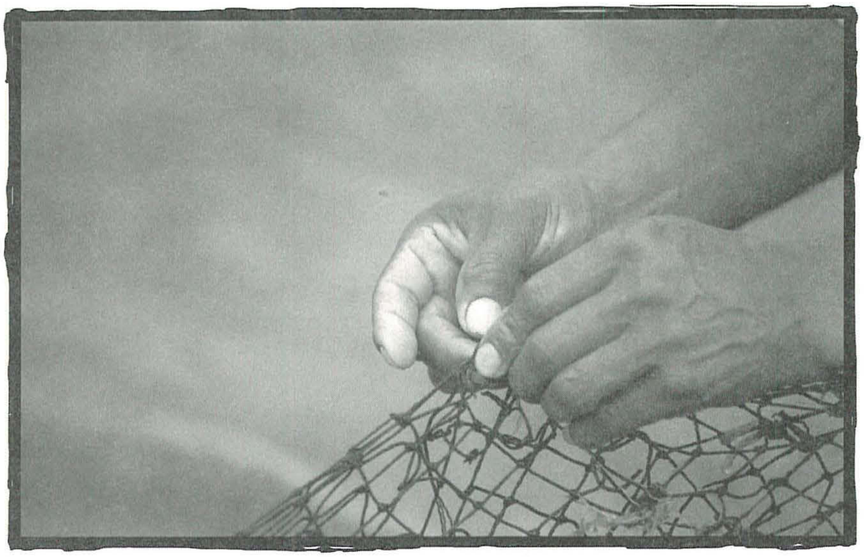
Sockeye infestation rate with Philonema sp. was 82 per cent, although identification of all parasites as Philonema is uncertain. For those sockeye with parasites, the mean infestation rate was 7.6 parasites per fish. The sex ratio of sampled sockeye was 1.63:1 males to females.

Two hundred and thirty nine chinook were subsampled at the counting fence during the migration period for sex, size, and fork length. The sex ratio of males to females was 1.2 males:females. The females averaged 88.9 cm and 8.4 kg (n = 108) and the males averaged 88.6 cm and 8.3 kg.

Two hundred and fifty five chinook carcasses were examined at the counting fence as the chinook died and washed up against the fence. Their "spawning lifetime" (the time in days between their passage through the fence onto the spawning grounds and their death and recovery at the fence) was 7.9 days for females (n = 32) and 8.8 days for males (n = 38).

All steelhead passing through the fence from August 4-31 were sexed and measured for length. Twenty five steelhead (15 females; 10 males) passed through the counting fence during August 1996. The mean fork length of the females and males was 74.6 cm and 80.8 cm respectively.

Sustut Juvenile Steelhead, Sockeye, Chinook



The purpose of this project was to estimate the freshwater production of juvenile salmonids produced by assumed low-productivity salmonid populations at high elevations in the Skeena watershed in 1996.

Two workers operated an eight-foot Rotary screw trap in the mainstem Sustut River 500 metres upstream of the Moosevale Creek confluence from mid-May to June 30. Based on results from a 1994 study, downstream movements of juvenile salmonids in the upper Sustut River begin before road access to the sample site is available. To avoid the use of helicopter as in previous years, the rotary trap and associated hardware was stored on the left river bank over winter. In 1996 road access was possible due the road to the sampling location being plowed for a mine operating in the area. A tent camp was constructed on the right river bank 500 metres upstream of the Moosevale Creek confluence. The rotary trap was assembled and tested for two days before routine sampling began. A pulley and cradle system suspended off a cable across the river was used to move the trap laterally into the required sampling position. The rotary trap was operated continuously from mid-May to June 29. Trap catches were emptied at four hour intervals; juvenile salmonids were identified to species and counted. The proportion of the total downstream migrants caught by the trap in each 24 hour sample period was calculated by dying a known number of chinook fry and fin clipping a known number of sockeye smolts, transporting them upstream, releasing them, and then recapturing them along with unmarked fry and smolts in the trap. The proportion of the marked juveniles recaptured of the total number of marked juveniles released was used as an estimate of the proportion of the total number of downstream emigrants the trap was catching. The fork length, wet weight, and scales were sampled from all chinook, coho, and steelhead smolts and from a subsample of chinook and steelhead fry. River surface height, water velocity at the entrance to the trap, and water temperature were measured and recorded daily.

The results shows that from May 20 to June 30, 1996, 63,000 sockeye smolts, 1,200 chinook smolts, 84 steelhead smolts, and 12,600 coho smolts migrated downstream from the upper Sustut River past the Moosevale Creek confluence. In addition, 198,000 chinook fry, and 81 coho fry migrated downstream from the upper Sustut River. Because of cold weather in May 1996 the period of downstream juvenile salmon migration was delayed and extended from previous years. Also, sampling stopped on June 30 and from sampling in previous years it is known that juvenile salmon would have continued to emigrate after this date. The weather and the short sampling period together resulted in less than all juvenile salmon and steelhead being counted. The estimated production numbers for 1996 are therefore underestimates of the juvenile salmon and steelhead production that actually occurred from the upper Sustut River.

The beginning of the sockeye smolt emigration from the upper Sustut River began on May 22, 1996. The start of the downstream emigration of chinook, coho and steelhead smolts occurred before sampling began on May 22. Sockeye smolts averaged 76 mm fork length (fl), and 3.5 g. Chinook smolts averaged 76 mm fl and 4.6 g. Coho smolts averaged 97 mm fl and 9.7 g. Steelhead parr (possibly smolts) averaged 91 mm fl and 8.9 g.

River discharge at the sample location increased over the sample period from 8 $m3.s^{-1}$ on May 20 to 32 $m3.s^{-1}$ on June 30. Peak discharge of 35 $m3.s^{-1}$ occurred in the first week of June.

Water temperature increased from 2 C on June 01 to 7 C on June 30. Maximum water temperature of 12 C occurred on July 29.

Morrison Creek Sockeye Project

For the fall of 1995 and 1996, an adult counting fence was installed and operated near the mouth of Morrison Creek, a tributary of Babine Lake. The objective of the program was to determine the duration and the size of sockeye returns into the watershed. The presence of the fence allowed for tagging activities that would determine possible differences in migration timing of two separate stocks, Tahlo Creek and Morrison Creek. Field staff also documented adult distribution and the initiation, peak, and conclusion of spawning activities in both systems.

Given their similar lake fed natures, adult run timing for Morrison watershed sockeye overlaps extensively with Babine's two enhanced stocks, Fulton and Pinkut. Concerns have been raised over the impact that elevated exploitation rates targeting enhanced production might be having on Morrison escapements. Given this concern, the project also allowed for a review of any current limitations to the productive capacity of the Morrison system.

For both years, movement into the watershed took place over a two month period from late July to late September. Extensive tagging and recovery throughout this period showed no clear separation of migration timing. The total escapement for the fall of 1995 was 5,300, and for the fall of 1996 was 5,900. Previous total brood year returns for these cycle years were 20,500 for 1995 and 7,300 for 1996. Given that the target escapement for the system had been set at 20,000 spawners, two consecutive years of less than 6,000 returning adults must be considered disappointing.

During the two seasons of field work in the Morrison and Tahlo systems, the major concern that has arisen is the presence throughout the watershed of numerous impassable beaver dams. Low flow conditions experienced throughout the duration of the sockeye return mean that beaver dams can seriously limit adult access to both the system of origin and the streams' prime spawning locations. Although some hand removal/breaching has been performed, dams are quickly reconstructed. This then results in backwatering of areas were eggs have recently been laid, slowing velocity, increasing sedimentation and decreasing flow through the gravel. Egg survival in these areas is expected to be minimal.

In conclusion, two seasons of fence operation have confirmed that current escapements are well below target levels. A major factor contributing to this situation is the presence of numerous beaver dams. Although some effort has been expended to reduce the impacts of these dams, current techniques and level of effort are insufficient to ensure optimal production. With no access for machinery, properly timed (mid summer) and sized blasting of the major dam sites should be considered as a method of guaranteeing spawner access throughout the system.

Creel Surveys

Creel surveys of the salmon sport fishery were undertaken to sample as many sport caught fish as possible for genetic stock identification, and to obtain information on angling, catch and species composition. One such survey involved the chinook salmon sport fishery covering the mouth of the Kitsumkalum River to Polymar Bar, a distance of about 85 kilometres.

The project began April 25, 1996, with the field component of the project completed on July 8, 1996. The Skeena River was divided into two zones, with a randomly generated schedule of trips for each zone. The technician conducting the creel survey within each zone counted the number of anglers, asked anglers a series of standard questions, recorded the number and species of fish caught and obtained biological samples of each chinook when permitted by anglers.

The first portion of the survey was conducted with a river boat and the remainder of the survey was conducted by truck. The survey effort was concentrated at the Lakelse River bridge, the mouth of the Kasiks River and the mouth of the Exchamsiks River.

A total of 1,357 anglers were interviewed and catch totalled 537 chinook, 142 steelhead and 172 trout. A total of 99 chinook biological samples were taken, and 102 scale samples were obtained from anglers during the study. Researchers also noted that very few fishing infractions occurred.

Rearing Capacity of Skeena River Sockeye Nursery Lakes

This project had three main objectives: first, to determine the current numbers, diet, and condition of juvenile sockeye stocks in Skeena River system lakes; second, to determine the lakes' productivity; and third, to estimate their rearing capacity for juvenile sockeye and the escapements needed to maximize sockeye production from the lakes.

Fall Sockeye Fry: Escapements (thousands)

LAKE	Surface area (km^2)	Mean PR ($mg\ C{,}m^{-2}{,}d^{-1}$)	(#/ha)	Mean wt. (g)	Maximum observed	Mean of last 10 years	Predicted optimum
Alastair	6.7	202	874	1.7	11	7.0	
Babine	475.0	138	788	3.6	1,226	872	
Bear	19.0	174	99	3.9	5	2.4	111
Johanson	1.4	66	321	0.9	2.6	0.9	3.1
Kitsumkalum	18.5	33	125	1.6	5.5	2.6	20
Kitwanga	7.8	150	67	2.4	2.2	1.4	39
Lakelse	13.2	77	311	6.1	16.8	5.3	34
Morice	96.1	86	68	0.8	40	12.3	278
Morrison	13.2	108	337	4.3	12	5.0	48
Sustut	2.5	88	1,564	1.0	2.6	1.4	7.4
Swan	17.5	117	388	1.3	13	8.4	69

Table 1. Productivity and status of juvenile sockeye in Skeena lakes. Mean PR is seasonal average photosynthetic rate. Predicted optimum escapements (P_{opt}) were derived from a productivity-based rearing capacity model. P_{opt} to Alastair Lake is not given because stickleback numbers in the lake are so high that its rearing capacity is reached or exceeded at even very low sockeye escapements. P_{opt} to Babine Lake is not given because most model estimates are not applicable to the higher egg-fry survivals which occur in spawning channels. Juvenile sockeye data from Johanson and Sustut lakes were collected in summer, so numbers are higher and size is smaller than if data had been collected in the fall.

Data collection in this study was carried out from 1993-1995 and had two major components. The first consisted of summer and/or fall hydroacoustic and trawl surveys where the data needed to accomplish the first objective were collected. Surveys were carried out on 11 lakes (Alastair, Babine, Bear, Johanson, Kitsumkalum, Kitwanga, Lakelse, Morice, Morrison, Sustut, and Swan). The second component was a series of limnological surveys (carried out monthly from May-October) on Babine, Johanson, Kitsumkalum, Kitwanga, Lakelse, Morrison, and Sustut lakes (appropriate limnological data was already available on Alastair, Bear, Morice, and Swan lakes). These surveys provided data necessary to meet the last two objectives.

There was a six-fold variation in the productivity of Skeena system sockeye nursery lakes and a >300-fold variation in lake area. Kitsumkalum Lake was the least productive (mean daily photosynthetic rate was 33 mg C/m^2) and Alastair Lake was the most productive (202 mg C/m^2). Babine Lake makes up 71 per cent of the total Skeena sockeye nursery area. Data from this and previous studies indicate that productivity of Babine Lake has increased in the last 20 years, most likely because of higher sockeye escapements (more nutrients from carcasses) since channel construction. The data indicate that current sockeye escapements to most Skeena lakes are below what is needed for maximum production. With the exception of Alastair Lake, adult sockeye returns would increase if escapements increased. To enhance Alastair sockeye, some form of control of the stickleback population is required. Morice Lake sockeye fry were extremely small despite low densities, which is indicative of the lake's ultra-oligotrophic status. Increasing productivity by whole-lake fertilization would facilitate rehabilitation of Morice sockeye.

Enhancement in the Skeena

Determining and quantifying the enhancement potential of a watershed system is a complex task. Ideally, detailed information is required on the capacity of the habitat to support each life stage for a stock in order to estimate its potential production. The enhancement potential can then be calculated as the difference between current and potential production. Such data are expensive to obtain and assume that researchers fully understand the relationship between fish and habitat, which is seldom the case. A more commonly used approach to determine enhancement potential is to estimate the differences between historical and current production.

Enhancement potential for Skeena salmon is largely unknown for species other than sockeye. For sockeye, there has been a systematic survey of most of the lakes which support this species. Analyses of these systems' productive potential have shown that in all cases the potential exceeds current stock size. To date, enhancement efforts have been directed mainly to Babine sockeye. The productivity model used for sockeye assumes that lake rearing capacity is greater than spawning ground capacity and uses lake area, photosynthetic rate and a modified version of the Alaskan euphotic volume model to predict optimum escapements to, and maximum smolt output from, Skeena sockeye lakes. The model will be used in conjunction with other factors to determine the enhancement potential of 11 lakes: Babine, Alastair, Bear, Morice, Swan, Johanson, Kitsumkalum, Lakelse, Sustut, Morrison and Kitwanga.

Surveys of other Skeena species - coho and chinook - indicate some stocks are at consistently low levels. Due to a lack of data on production capacity, the enhancement potential of these stocks has been difficult to determine. There is some consensus among fisheries managers and scientists that opportunities exist to increase the abundance of these stocks, particularly some chum, chinook and coho stocks. However, discussion continues on whether the best way to achieve this is through enhancement or more effective harvest management.

Methods Used to Enhance Stocks

Enhancement can be defined as any human intervention intended to sustain a stock and/or increase its productivity. Enhancement includes everything from habitat restoration to small-scale volunteer hatcheries to large-scale spawning channel and fish culture operations. The differences among enhancement techniques lie in the degree of intervention in or substitution for natural physical and biological processes and in the effect they have on stock productivity. Once enhancement has been decided upon as an option, techniques which are most appropriate to the situation can be used. For example, fish culture has the potential to greatly increase stock productivity by increasing the numbers and survival of juveniles. Habitat improvement cannot improve productivity to the same degree, but acts on both naturally and artificially produced juveniles, and maintains a greater degree of natural selection.

Habitat restoration include fishways and other access improvements, groundwater and surface-fed side channels, major spawning channels for spawning and rearing. Spawning channels promote the growth and abundance of stocks with a lower degree of artificial intervention than hatcheries. Lake enrichment refers to fertilization of lakes in order to increase the food supply for the sockeye fry which will inhabit the lakes for a year or two prior to entering the ocean. Hatchery technology calls for the greatest amount of human intervention as fish are reared in an entirely controlled setting until juveniles are released at any stage up to that of smolts.

Four main factors are considered in determining whether to enhance or restore habitat. These include: the species' life history and stock status; exploitation rate; natural stock productivity; and habitat status (on which productivity depends). Water supply/flow and topographical considerations are also factors.

Enhancement Projects in the Skeena

There are some 20 enhancement projects producing more than 2.5 million adult salmon (predominantly sockeye) in the Skeena. Virtually all of the enhancement efforts in the Skeena are undertaken in natal areas of the stocks which are being enhanced. The following chart provides a breakdown and illustrates the production potential of enhancement initiatives.

Species	Enhancement Strategy	Current No. of Projects	Adult Production	Increase in Production – Enhanced vs. Wild
COHO	Hatchery Fry	3	1,026	6 :1
	Side Channel Smolt (Habitat Improvement)	5	378	3 :1
	Hatchery Smolt	7	5,030	38 :1
CHINOOK	Hatchery Fry	1	527	3 :1
	Side Channel Yearling	1	65	2 :1
	Hatchery Yearling	3	3,082	9 :1
SOCKEYE	Spawning Channel	3	2,576,221	3 :1
PINK	Spawning Channel	0	0	4 :1 *
	Hatchery Unfed Fry	1	84	6 :1 *
	Sea Pen Fed Fry	0	0	16 :1*
CHUM	Spawning Channel	0	0	6 :1*
	Side Channel Fry	1	3,360	2 :1*
	Hatchery Unfed Fry	0	0	10 :1*
	Hatchery Fed Fry	0	0	20 :1*

[* Based on standard ratios determined through enhancement efforts in other areas.]

There are also 46 classroom incubator projects at regional schools that are supported by the Salmonid Enhancement Program. Although technically not on the Skeena, two enhancement projects, Oldfield Creek and Oona, are included in the above chart because of their proximity to Prince Rupert.

Risks of Enhancement

Risks associated with enhancement methodologies can be categorized into two major classes. First, there is a general risk of any type of failure in the project's production system. This may include a minor interruption in the water supply or a physical breakdown of technology. The second class of risks are biological interactions. Biological interactions can be further broken down into four general areas.

First, enhanced stocks may be threatened by disease which could be harmful to a population and potentially, contaminate wild stocks. The reverse (i.e., diseased wild stocks contaminating enhanced stocks) also is possible and considered by some to pose a much greater risk. Second, enhanced stocks could compete with wild stocks for food or space to the detriment of one or both. Third, some believe that despite strict hatchery guidelines issued by the Department of Fisheries and Oceans, genetics may vary between hatchery and wild stocks, possibly resulting in less adaptable future generations. Finally, wild stocks could be overfished when harvested with the more productive hatchery stocks if harvest is not carefully managed.

Can Enhancement Be Used to Maintain Current Fishing Patterns in the Skeena?

The response is a complex one and there is no clear answer. Harvest rate reductions and habitat protection are integral to ensure that all stocks of all species can maintain themselves at sustainable levels. Three scenarios illustrate the difficulties.

Reduced Harvest

If existing fisheries are reduced to levels sustainable by least productive stocks, all stocks should be sustainable assuming that there is no further habitat degradation. In this scenario, enhancement may be useful to increase the speed at which previously overharvested stocks rebuild. Catch levels would decline. Where possible, strong stocks could be fully exploited in more terminal areas where less productive stocks are not present if that is possible. This often means harvesting closer to spawning grounds.

Maintain Harvest

If existing fishing patterns and harvest rates are maintained, the stocks that are overharvested would eventually disappear without enhancement efforts. Stocks would disappear over time at a rate based on their level of productivity and habitat degradation. Enhancement could maintain some such stocks. Enhancement beyond natural productivity levels could maintain current catch levels of some stocks and allow reduced harvest rates on other weaker productivity stocks to allow them to recover where this harvest management plan is feasible. However, it is likely that some stocks, perhaps many, would be lost and this scenario would likely be undesirable in the long-term.

Increased Harvest and Enhancement

If existing fishing patterns are maintained and harvest rates are increased, many stocks would be subject to overexploitation which would render most of them at unsustainable levels. In this case, broad enhancement efforts would be necessary to maintain stocks. However, this is not a desirable option as it would likely fail in the long term.

Each of these scenarios has a number of outcomes. What is reinforced is that enhancement by itself cannot maintain current catch levels on the Skeena. A comprehensive plan involving harvest management, enhancement, stakeholder involvement, and research is necessary to maintain sustainable fishing levels on the Skeena.

Habitat Restoration

The Skeena River system's habitat is considered to be relatively pristine. Current estimates suggest that less than 10 per cent of the productive capacity of the Skeena is compromised by habitat degradation. The adjacent Kitimat Valley has been heavily logged during the past 25 years, and is comparatively heavily industrialized at the estuary. Approximately 174 tributary streams have been estimated as supporting anadromous species in the Skeena.

Throughout the stream system which makes up the Skeena, there also are natural events occurring which may cause change to the habitat in certain tributaries, but may not affect the overall productive capacity. These include: landslides, windthrow, bank erosion and channel changes. While a few drainages have lost productive capacity, the relatively unmarred condition of most others suggest that a significant amount of habitat is still available. Nevertheless, habitat problems are still considered to be limiting both production and use of many species in the Skeena watershed.

DFO's focus is on the impacts of human actions on the watershed's habitat. The department is addressing concerns related to forestry and agriculture in the Kispiox, Kalum and Bulkley drainages, problems associated with urbanization in the Lakelse drainage as well as the effects of highway, railway, urban sprawl and other linear (infrastructure) development on the main part of the Skeena River.

Habitat restoration in West Coast fisheries encompasses a broader definition which also includes enhancement. For the most part, habitat restoration often employs "softer" enhancement technologies in order to help maintain fish habitat. However, there is some risk of restoration efforts being ineffective as restoration is based on human assumptions of what the habitat needs. As the saying goes about stepping in the same river twice, the dynamism of a given river system and its habitat inherently limits human ability to precisely determine the effective potential of habitat restoration efforts. Nonetheless, if successful, habitat restoration initiatives can help sustain the natural limits of the resource.

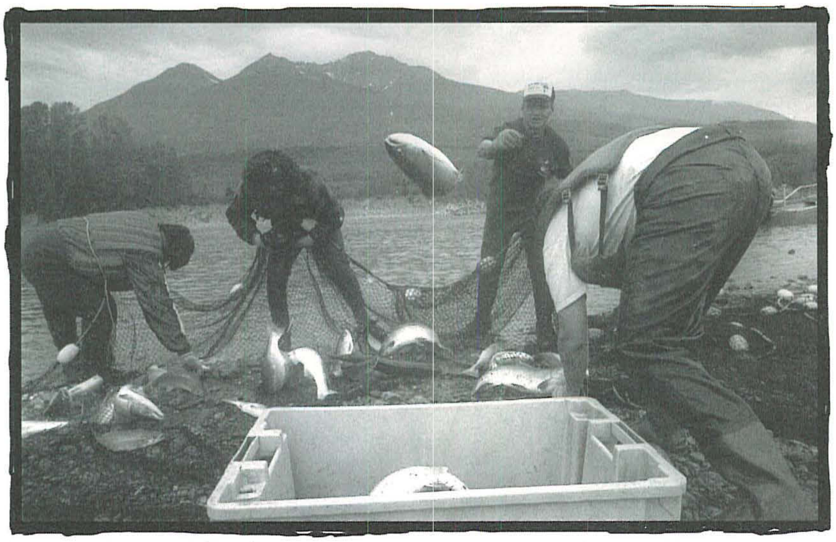
Habitat reconnaissance efforts under way in the Skeena watershed are aimed at finding suitable candidates for habitat restoration. In 1994 and 1995, investigations took place on the Morice, Telkwa, Bulkley, Zymoetz, Lizard and Georgetown systems. Some of the findings are:

- Owen Creek and some areas on the Morice have shown potential for off-channel rearing with construction to begin in 1996/97 following completion of monitoring and final surveys;
- Three areas have been recommended for further assessment and survey work following land-based inspections and aerial flights over the Telkwa River;
- Biologists believe that there is potential for deepening a former side-channel to the Bulkley River (opposite Smithers) and improving its connection to the river in order to promote off-channel rearing;
- Improvement recommended on a passage of Lizard Creek where an obstruction was found to be hampering extensive stable spawning and rearing habitat for coho and pink populations; and,
- The Georgetown system was examined for its potential for sockeye or coho fry planting, as well as its feasibility for providing a passageway above some falls. While the passage at the falls was deemed unsafe, biologists have recommended further assessment of the lake's potential for rearing fry.

People and Partnerships

The Role of the Skeena Watershed Committee

Throughout most of the sustainable fisheries program, the Skeena Watershed Committee's role has been key: to bring all the players to the table to operate in a consensus-based decision making process.



Since coming together in 1992, the members of the Skeena Watershed Committee have used a community-based, cooperative approach to forge strong links with one another. The goal was to come up with northern solutions to northern problems. One of the most important tasks for the committee was the integration of fishing plans between the sectors. Each sector was responsible for developing their own fishing plan. These plans must then be brought to the committee to ensure consistency with conservation goals (e.g.. target harvest rates) and integration with the other sectors' plans.

In 1994 a consensus was reached by the Skeena Watershed Committee regarding the commercial salmon net fishery, a significant accomplishment in light of past acrimony which always greeted annual fishing plans. A key component of this agreement was the Skeena-Kitimat Program and the resultant research and enhancement opportunities that would be developed using program funds. Consensus was also reached on the evolution of the Skeena Watershed Committee into a senior planning body on fisheries-related issues affecting the Skeena River.

In the interim, the committee was fully integrated into the Skeena-Kitimat Sustainable Fisheries Program. Committee members became full members of the Skeena-Kitimat Technical Committee, thereby actively participating in the development of projects.

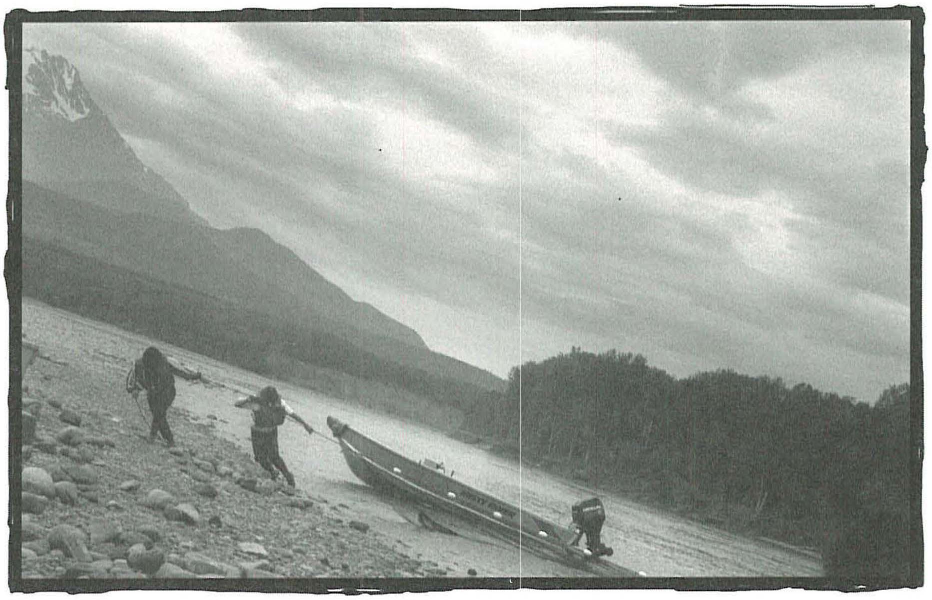
The Skeena Watershed Committee stakeholders have had direct input into the planning process of the Skeena/Kitimat Program through the Skeena Technical Committee.

Sustainable resource management has focused on:

- selective harvest
- in-season management
- catch monitoring
- escapement
- radio tagging

On the habitat side, research has focused on:

- productive capacity
- habitat protection, restoration and enhancement



To involve the public more fully, the Skeena Watershed Committee held three key workshops. These workshops covered habitat restoration and enhancement, selective harvesting and the socio-economic status of the Skeena watershed. The intent of the workshops was to inform the Skeena Watershed Committee and the general public of the issues within each of the topics as well as to seek input from the public through discussion groups.

It is clear that the Skeena Watershed Committee has broken new ground in the way we think about and address the challenges of fisheries management. Governmental participation in the Skeena Watershed Committee is significantly different from the historical consultative process. As part of the Skeena Watershed Committee, the department's role was that of stakeholder. Many of the issues surrounding allocations have been left to the non-government stakeholders. The department retained fiduciary responsibilities for First Nations. However, the department's primary role at the table was to ensure that conservation objectives were met.

The SWC's accomplishments over a five-year period are:

- significant trust among all stakeholders
- commercial, recreational and aboriginal sectors are now highly attuned to the intricacies and needs each fishery
- development of a true partnership - the users, and the community have a direct say in the management and the future of the fishery
- the use and maturing of a consensus based process by the SWC provides a model for community-based management elsewhere
- an increased knowledge base on which to make future management decisions
- the management plan for the commercial fishery has resulted in the achievement of harvest rate targets and provided protection to coho and steelhead stocks, and
- through regular meetings and public workshops, members of the public has been involved as never before in resource issues that affect them and the communities in which they live.

Achieving consensus is often difficult, and time consuming. Despite the impressive gains made by the committee, in 1997 the commercial sector dropped out of the process. Of course, having the freedom to opt out is an integral part of any consensus process. Participants must be willing to sit down and resolve differences, or have the ability to exit the process at any given moment should they feel that their interests or needs are not being met.

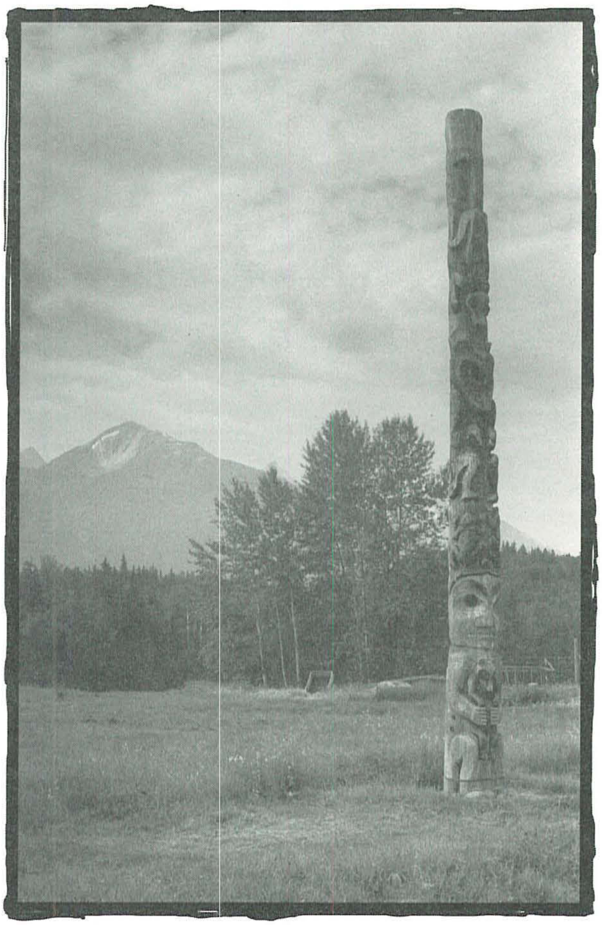
Whether the commercial fishing sector will decide to rejoin the process remains to be seen. Nevertheless, the work carried out to date under the auspices of the Skeena-Kitimat Program will serve as the foundation for the future management of the Skeena River. Stakeholders have been empowered by the approach taken, and their participation in fisheries management has significantly increasing their stewardship role at the community level. These activities carry with them significant responsibilities as stakeholders attempt to gauge the desires and aspirations of the public they represent. Ultimately, the key to sustaining the fisheries resource for future generations depends on responsible fisheries resource management and an informed and motivated population.

Partnerships with First Nations

First Nations have played an important role in a variety of projects that contribute to the overall objectives of the Skeena-Kitimat Sustainable Fisheries Program.

The principal efforts of the Ned'ut'en fisheries staff have been in carrying out stream work in the natural spawning stream tributary to Babine Lake. This work has included all spawning ground enumerations and reporting, as well as ensuring that the streams are accessible to spawning salmon.

Fisheries management work carried out by the Ned'ut'en has included monitoring of their communal fisheries. These communal fisheries include harvest for sale of sockeye salmon that have been declared surplus to spawning requirements, as well as the traditional harvest to address the social, ceremonial and food needs of the Ned'ut'en people. The program has funded the development of selective harvesting techniques. These selective harvesting techniques, which include dip nets and beach seines, allow the harvesters to focus on target species and to release non-target species.

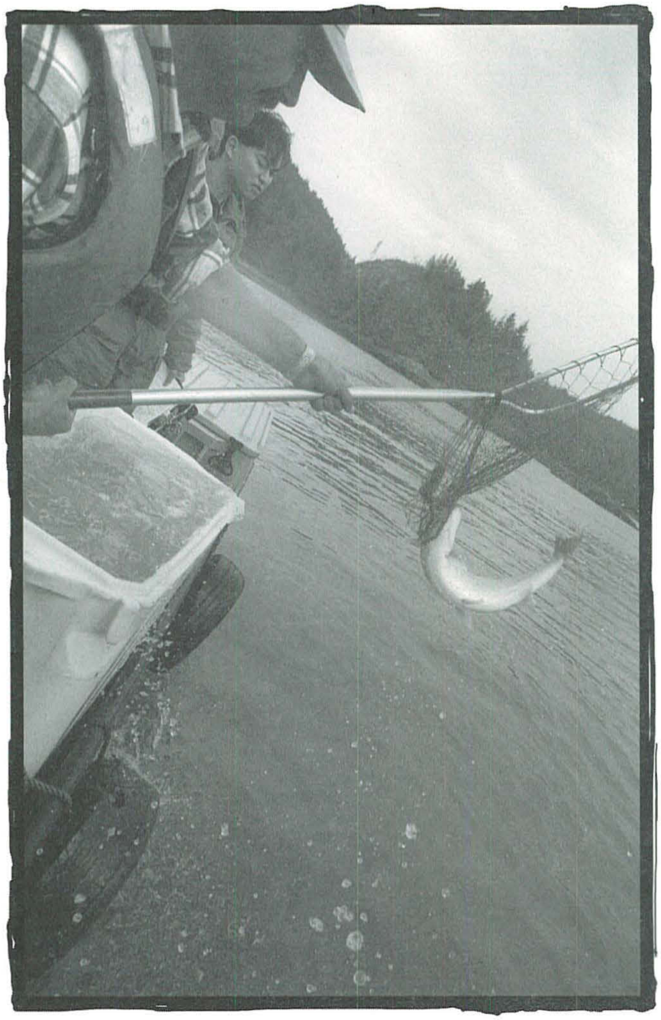


Another First Nations fishing group in the Skeena - The Gitksan Wet'suwet'en - has focused on habitat assessment in the spawning streams as well as on fisheries management issues. The fisheries management issues include monitoring and enforcement of both the inland commercial fishery and the communal fishery for food, social and ceremonial purposes. The development of the selective inland commercial fishery has been of interest both from the perspective of the economic development opportunities it affords, and from the perspective of experimentation with innovative selective harvesting techniques, including weirs, fish wheels, dip nets and beach seines. The efforts of the Gitksan to develop selective harvesting techniques have resulted in a virtual elimination of less desirable gillnet technology from the lower Babine River food, social and ceremonial fishery. This shift is strongly supported and encouraged because of the non-selective way that gillnets impact all stocks and species, including those for which there are recognised conservation concerns.

In addition to selective harvesting, the Gitksan selective fishing techniques have played an active role in ongoing experimental tagging programs designed to illuminate issues related to salmon timing and migration routes.

The Tsimshian Tribal Council has also been involved in the development of selective methods of harvesting salmon. These efforts have focused on beach seine and purse seine techniques in the lower Skeena, as well as on fish wheels. The fish wheels operated by the Tsimshian have played important roles in tagging studies similar to those noted above, and have also contributed to the collective knowledge regarding selective harvesting methodologies.

In addition to these selective harvesting experiments operating as part of the inland commercial fishery, the Tsimshian have also been active in the monitoring and enforcement of all Aboriginal fisheries carried out in the lower Skeena and its approach waters.



The Way Ahead

After four years, DFO's role in the Skeena-Kitimat Sustainable Fisheries Program has ended. The department will continue to have a major role in the Skeena system as part of its mandate to manage and conserve Pacific salmon stocks. Research on salmon populations, habitat restoration, forging new partnerships and managing fisheries into the future will continue in the watershed as lasting legacies of the sustainable fisheries program.

Partnerships

Sustainable fisheries cannot be achieved in isolation. New ties have been forged among all levels of government as well as among commercial, First Nations and recreational stakeholders to encourage environmental sustainable development. One of the lasting legacies of the Skeena-Kitimat Sustainable Fisheries Program is the cooperation that has taken place among those who use and depend on the resource. Watershed residents are now tasked with demonstrating a greater commitment to changing the manner in which they treat not only the fisheries resource, but the way in which they treat the environment as a whole. The crises in global fisheries have shown all too clearly that the world's marine and aquatic resources are finite. These resource can no longer be regarded as mere commodities intended only for profit and gain. Rather, they must be respected for their environmental, social and cultural as well as economic value.

Science and Knowledge of Skeena Salmon Stocks

Researchers have accumulated an impressive store of knowledge of evaluating the stock status and productive potential of Skeena stocks. This information is vital to improve and create management tools and harvesting techniques to determine the most effective ways to minimize the interception of non-targeted species.

Maintaining species diversity is key to sustainable fisheries. There has been notable success in rebuilding depressed stocks in both the Skeena and Kitimat rivers. Chinook, for example, have been subject to a successful conservation and rebuilding program over the past 10 years. As well, Babine Lake sockeye stocks have expanded to record-high levels today from record-low levels in the 1950s through a program of harvest management and enhancement.

Stock specific fisheries management, or reducing the commercial harvest rate of steelhead and protecting weak stocks such as coho, is a major goal. To date, stock assessment information has improved significantly, which in turn allows fishery managers to better determine optimal harvest rates. The harvest rate on steelhead has been reduced, and much work has also been done in the areas of catch monitoring and stock identification. More stock-specific management will also increase as gains are made in river escapement counts and escapement monitoring of index stocks.

As pointed out earlier in this report, Skeena coho continue to be at risk. Their vulnerability has been attributed to low survival rates related to flooding and freezing, poor ocean survival and of course, overharvesting. Consequently, since 1990, they have been the focus of a number of strict conservation measures, including curtailments to fisheries in all three sectors. Despite these efforts, stock assessment data for the upper Skeena early coho stocks suggests that more conservation efforts are necessary. Coho conservation is further affected by the inability of Pacific Salmon Treaty arrangements to limit the impacts of Alaskan fisheries on Skeena-bound coho stocks. More stringent management measures are warranted in the future to assure their survival.

Restoring Habitat

Progress has been made in protecting and restoring habitats on which fish depend. Habitat protection is a major focus in the Kitimat River system and its estuary. Ensuring that planning for development meets the needs of fish and their habitat is a long-term commitment that will continue in partnership with various groups.

If you would like to find out more about the Skeena-Kitimat Sustainable Fisheries Program, contact:

North Coast Division
Fisheries and Oceans
417 2nd Avenue West
Prince Rupert, B.C. V8J 1G8
Phone: (250) 627-3499 Fax:(250) 627-3495

Communications Officer
Fisheries and Oceans
Suite 412
555 West Hastings St.
Vancouver, B.C. V6B 5G3
Phone (604) 666-2872 Fax: (604) 666-1847

Catalogue No. Fs 23-280/1998E
ISBN 0-662-26761-3

Printed in Canada on recycled paper