Nechako Fisheries Conservation Program

Technical Data Review 1988—2002
Summary

BRITISH COLUMBIA | Ministry of Environment

ALCAN

Fisheries and Oceans Canada | Pêches et Océans Canada

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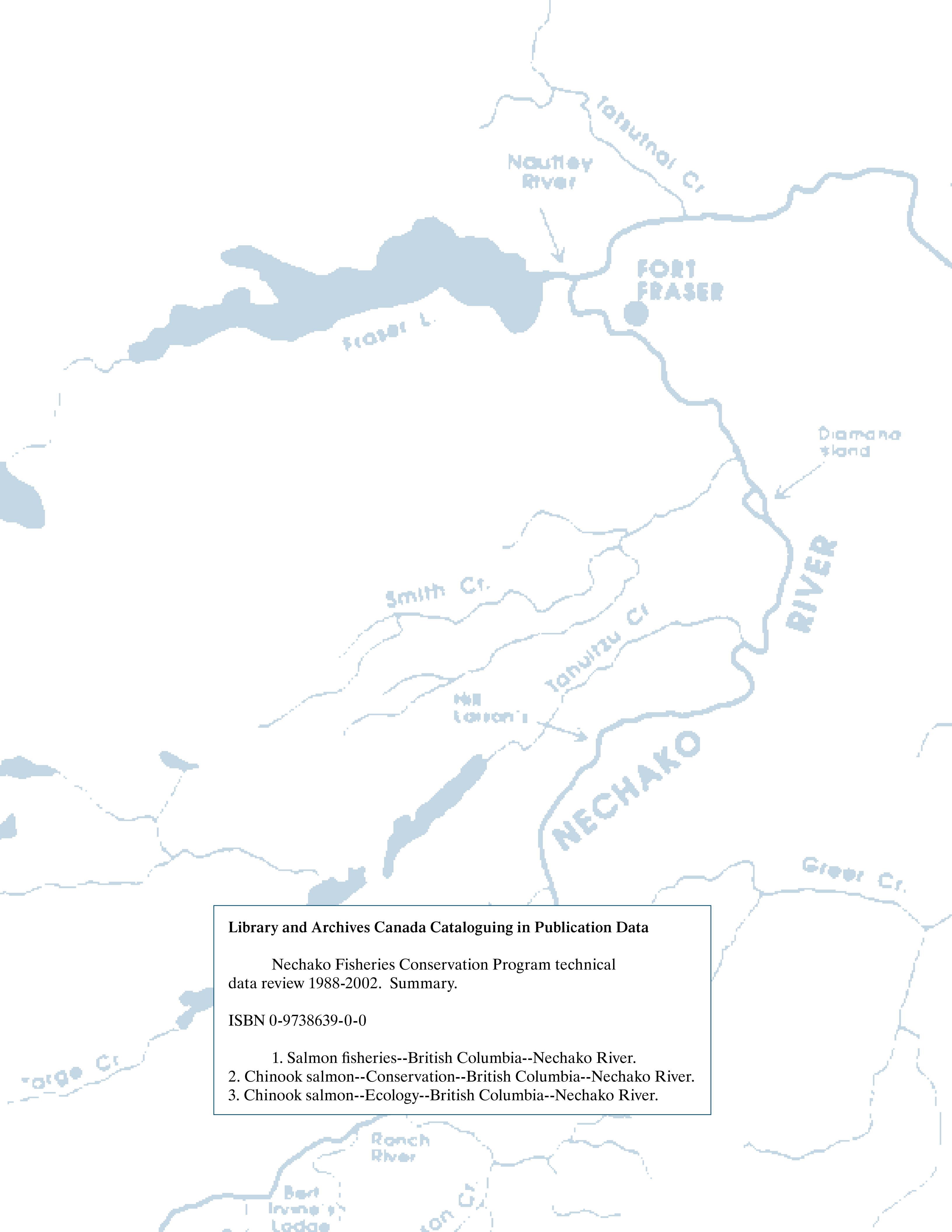

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INTRODUCTION

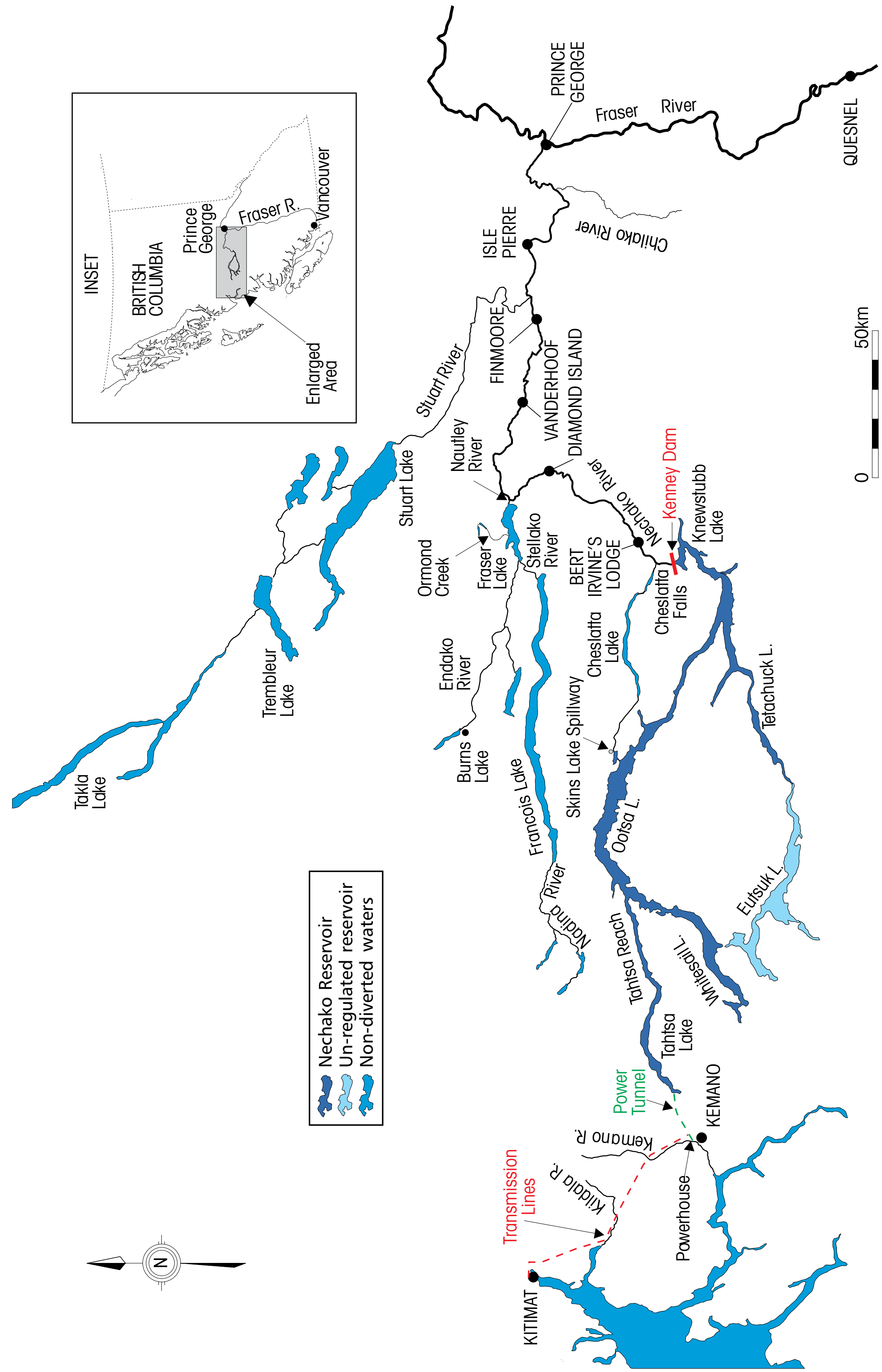
SINCE 1987, THE NECHAKO FISHERIES Conservation Program (NFCP) has collected biological and physical data on the Nechako River basin (**Figure 1**). The data, spanning almost three complete life cycles of chinook salmon (1987 to 1998 with selected data to 2002), have been regularly documented in project reports, as well as in a major report entitled *Nechako Fisheries Conservation Program: Technical Data Review.* That report:

- summarizes and integrates the data collected by the NCFP's Technical Committee;
- discusses the outcomes of the various projects undertaken by the NCFP's Technical Committee;
- provides a scientific basis for deciding the future direction of the NFCP;
- makes suggestions for further analytical work; and,
- reaches conclusions on the status of Nechako River chinook salmon and their habitat.

This report is a companion document to the much larger *Technical Data Review.* Serving as an executive summary, this report provides background information on the work of the NFCP Technical Committee, including a summary of its significant research results. The full report can be found at www.nfcp.org.

Cheslatta Falls is the upstream limit of salmon migration in the mainstem of the Nechako River.

Figure 1 **The Nechako River watershed and Kemano power production system**



BACKGROUND

Origins of the Kemano Completion Project

The Kemano Power Project originated in 1941 when the British Columbia government invited the Aluminium Company of Canada Limited (now Alcan Inc.) to establish an aluminum industry on Canada's West Coast. Alcan carried out preliminary engineering studies in 1948 and 1949 and proposed a project that would include (among other things) a dam in the Nechako River's Grand Canyon, a spillway at Skins Lake, a power plant at Kemano, two new communities (Kitimat and Kemano), and an aluminum smelter and deep-water port at Kitimat (**Figure 1**). The agreement to implement the project, including a conditional water licence for power generation, was signed in 1950.

Kenney Dam and Nechako Reservoir

Construction began in 1951, ending in 1954; river flow was diverted in 1952 and the reservoir took four years to fill. In the interim, Nechako River water levels were regulated using a temporary weir in the Murray-Cheslatta system. Water releases from the reservoir began in 1956 with water entering the Cheslatta River through the Skins Lake Spillway.

The Kemano powerhouse was completed in stages paralleling the construction of the aluminum smelter; installation of the last of the powerhouse's eight generators was completed in 1967. The powerhouse supplied power to the Kitimat aluminum smelter and the neighbouring communities of Kitimat, Terrace and Prince Rupert until 1978 when British Columbia Hydro and Power Authority's (B.C. Hydro) inter-tie reached Terrace from Prince George. The inter-tie linked Kemano to the provincial power grid, allowing Alcan to sell power to B.C. Hydro. Alcan continued to investigate ways to use all of the water rights granted in the conditional water licence, including diverting additional water from the river to an expanded powerhouse at Kemano, a project known as the Kemano Completion Project.

Court Challenges and the Origins of the 1987 Settlement Agreement

In June 1980 the Department of Fisheries and Oceans[1] (DFO) expressed concern over the volume of water released from the Nechako Reservoir. The department anticipated sockeye salmon (*Oncorhynchus nerka*) migrating through the Nechako River system would be exposed to high summer water temperatures resulting from low water flows and that low spring, fall and winter flows could possibly affect chinook salmon rearing in the river. Consequently, DFO sought, and received, an interim injunction from the B.C. Supreme Court setting out the flows to be released until the issues could be resolved.

A series of studies carried out between 1980 and 1984 failed to resolve the issue. Alcan voluntarily agreed to renew the 1980 injunction throughout these years; however, by 1985, with consensus still out of reach, Alcan returned to court to seek resolution.

While the parties prepared for court, a task force (the Nechako River Working Group) comprised of scientists from DFO, the provincial environment ministry and environmental consultants from Alcan was asked if there was a technical basis for reaching an out-of-court settlement that could, with an acceptable level of certainty, conserve the chinook salmon *(O. tshawytscha)* that spawn in the Nechako River.

The Working Group's *Summary Report* (1987) became the basis for the *1987 Settlement Agreement* between Alcan and the federal and provincial governments. The Working Group's *Summary Report* was appended to the Agreement.

The 1987 Settlement Agreement and the NFCP

The *1987 Settlement Agreement* defined a program of measures intended to conserve Nechako River chinook and protect migrating sockeye populations. It also established the Nechako Fisheries Conservation Program (NFCP) to carry out remedial measures, monitoring, and applied research projects, as deemed necessary.

The NFCP is administered by a Steering Committee made up of senior representatives of the three parties to the Agreement, and is implemented by a Technical Committee. The Technical Committee includes one independent member plus one technical representative and one alternate from the federal government (Fisheries and Oceans Canada), the provincial government (the Ministry of Water, Land and Air Protection) and Alcan Inc.

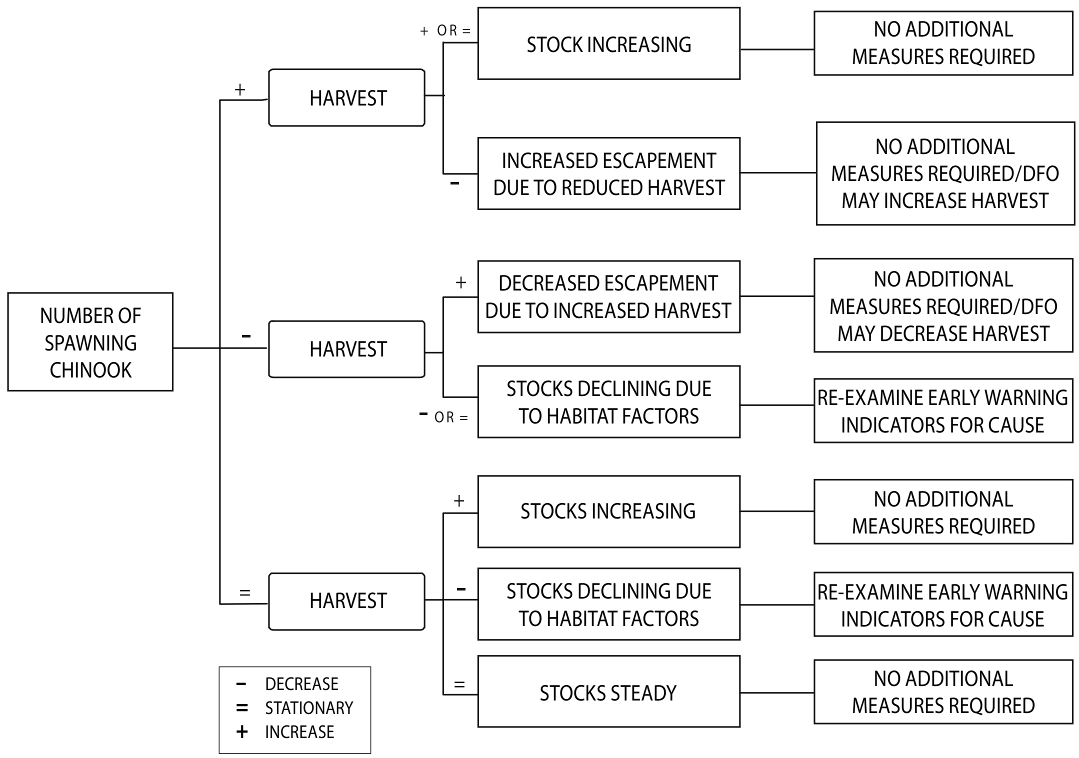
To meet its mandate, the Technical Committee began to:

- develop a program of activities to collect baseline data; and
- develop and test a suite of remedial measures in anticipation of lower flows resulting from the Kemano Completion Project.

Following the recommendations of the Nechako River Working Group's *Summary Report,* the Technical Committee designed and implemented a number of programs to monitor different fresh water life-history phases of chinook, as well as physical variables that could influence habitat conditions. An assessment framework (**Figure 2**),

[1] Now Fisheries and Oceans Canada

Figure 2 **Conservation Goal: assessment framework**

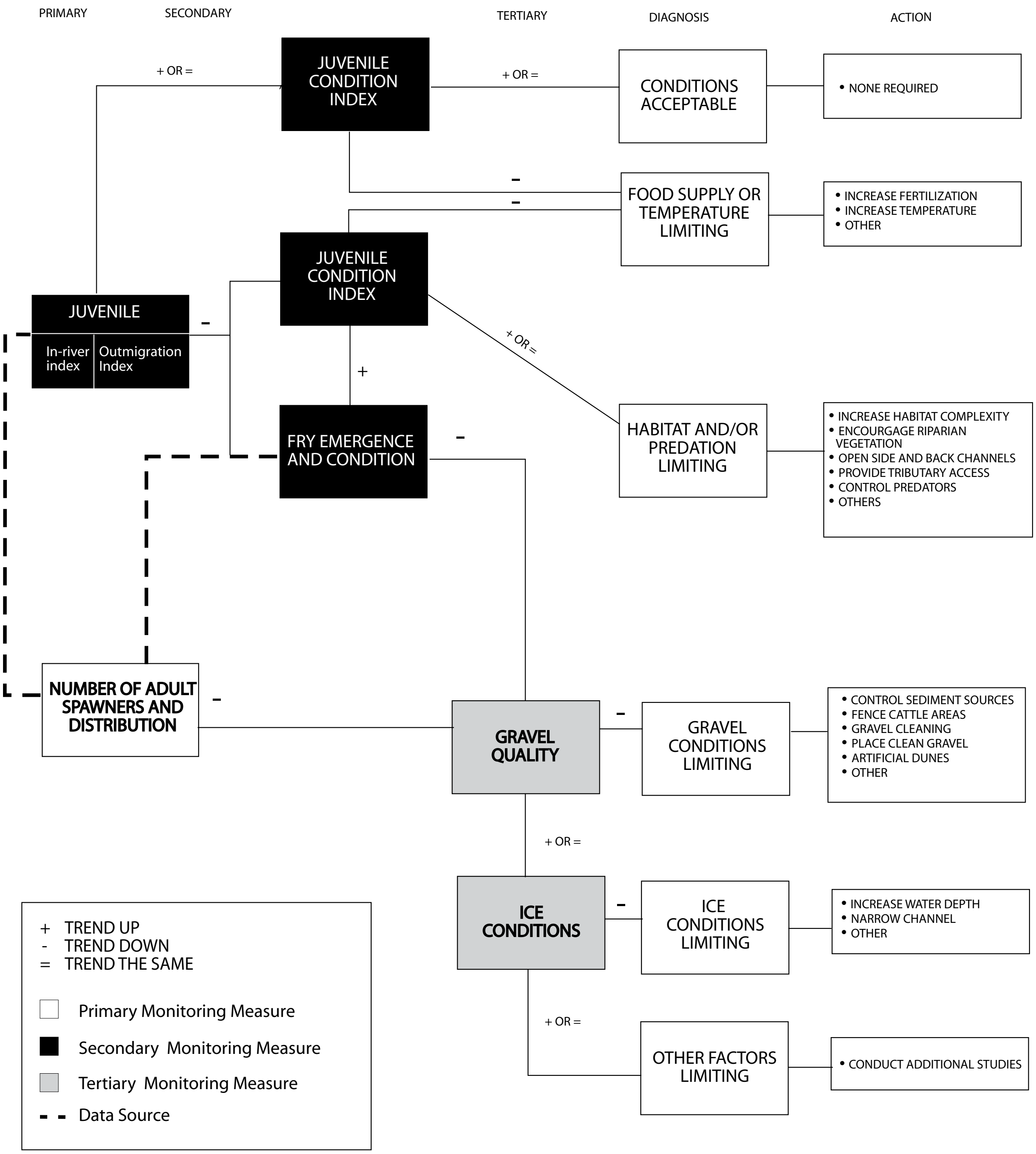


developed between 1987 and 1990, established the rationale for the various components of the monitoring program, identified key parameters and data requirements and provided a framework for presenting data and reaching decisions. A number of applied research projects to fill gaps in the data identified by the *Summary Report* were also begun.

An Early Warning Monitoring Program (**Figure 3**) was also implemented in anticipation of the lower flows that would have resulted from the proposed Kemano Completion Project. The program used data from annual juvenile chinook monitoring projects to assess trends and would be used to trigger remedial activities post-Kemano if those trends suggested that adult chinook returns four to five years later would be significantly lower.

In fact, with the exception of the Summer Temperature Management Program — which was instituted for the benefit of migrating sockeye — all of the committee's projects were directed at assessing factors that could affect chinook in the Nechako River; conditions downstream of the Nechako River basin were outside of the research mandate.

Figure 3 Early Warning Monitoring Program



Events Affecting the NFCP, 1991 to 1997

Anticipating construction of the Kemano Completion Project, the Technical Committee envisioned collecting baseline data before completion of the project and before the flow released to the Nechako River was replaced by lower post-project flows (referred to as the Long-Term flows). These data would then be compared to data collected following the project completion to determine the effect of lower flows on fish using the river. However, following the signing of the *1987 Settlement Agreement,* a number of unforeseen events occurred that had a direct effect on the Technical Committee's activities.

Events affecting NFCP activities – 1991 to 1997	
May 1991	Federal Court Trial Division decision requires further environmental review of the Kemano Completion Project under federal guidelines.
May 1992	Federal Court of Appeal reverses lower court decision.
January 1993	Province issues terms of reference for a review of the Kemano Completion Project by the B.C. Utilities Commission (BCUC).
February 1993	Supreme Court of Canada refuses Kemano Completion Project opponents leave to appeal the Court of Appeal's May, 1992 decision.
November 1993	BCUC public hearings begin.
December 1994	BCUC panel submits report to provincial Cabinet.
January 1995	Province releases BCUC report.
	Province rejects recommendations of the BCUC report and rejects Kemano Completion Project.
August 1997	Alcan and the province reach a settlement on issues arising from the rejection of Kemano Completion Project. The B.C.-Alcan Agreement affirms the terms of the *1987 Settlement Agreement.* The Short-term flows are now the permanent Annual Water Allocation.

Following the rejection of the Kemano Completion Project (1995) and the signing of the *B.C.-Alcan Agreement* (1997), DFO, the Government of British Columbia and Alcan agreed to continue with the NFCP's annual program. The Technical Committee recognized the need to summarize its activities and conclusions in a comprehensive report before it could consider what might come next for the NFCP. In compiling that report, the Technical Committee brought together much of the data it had collected in a background report entitled *Nechako Fisheries Conservation Program, 10-Year Review Background Report* (1997).

This was followed in February 1998 by a two-day workshop in which 25 participants from DFO, the provincial Ministry of Environment, Lands and Parks, Alcan, academia and the private sector reviewed the data and recommended further analyses to summarize the results. The product of the workshop is reported in *Nechako Fisheries Conservation Program (NFCP): The Last 10 Years and the Next 10 Years.*

Since 1998, the Technical Committee has been completing the data analysis and review based on the recommendations in the workshop report. The committee has also continued its responsibilities under the *1987 Settlement Agreement*.

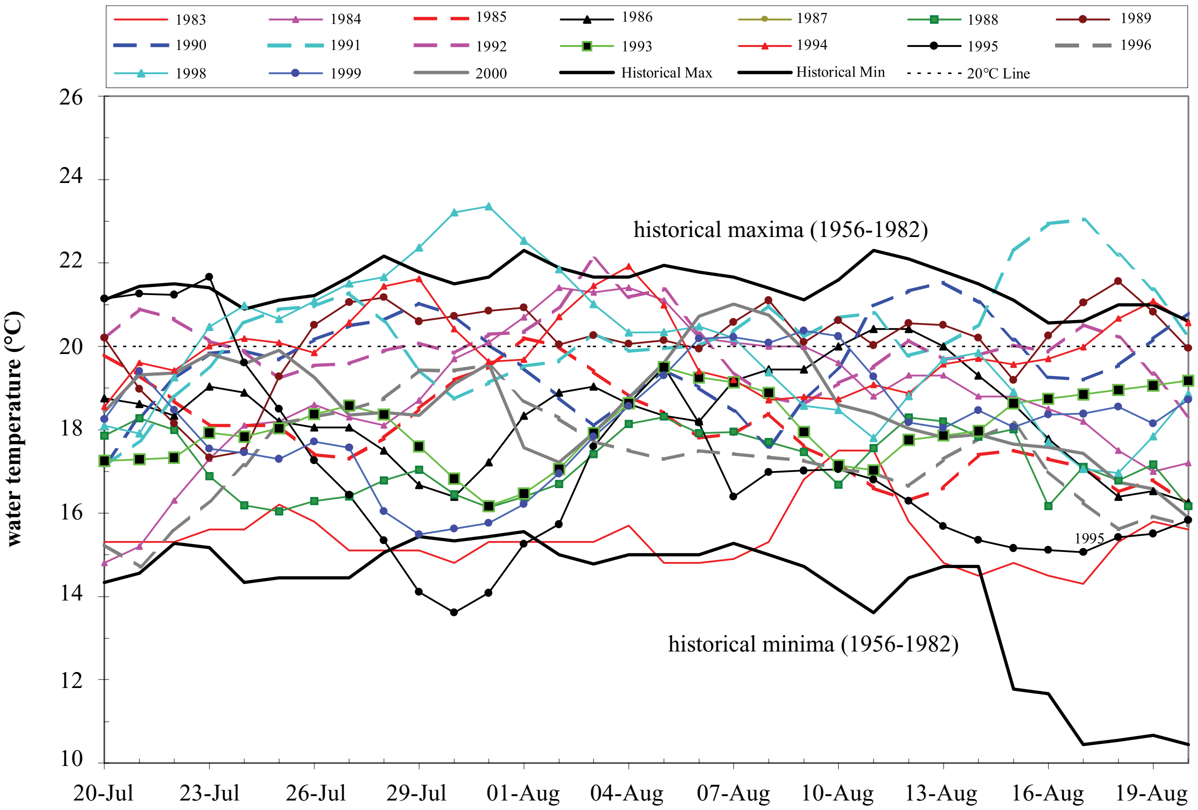
Spawning sockeye salmon

PROTECTING SOCKEYE: THE SUMMER TEMPERATURE MANAGEMENT PROGRAM

The Summer Temperature Management Program (STMP) is the only NFCP program designed to benefit sockeye salmon. The intent of the program is to moderate the effect of high water temperatures during sockeye migration. This is done by manipulating the timing and volume of water releases from the Nechako Reservoir via the Skins Lake Spillway to the Nechako River to reduce the frequency of water temperatures >20°C at Finmoore, located upstream of the confluence of the Nechako and Stuart Rivers (**Figure 1**).

The STMP operating protocols were developed in the early 1980's and were referenced in the *1987 Settlement Agreement.* The protocols direct the Technical Committee to use flow and water temperature prediction models (with water temperature, stream flow and meteorological data) to predict changes in Nechako River water temperature up to five days into the future.

Figure 4 **Nechako River: mean daily water temperature recorded above the Suart River confluence, July 20 to August 20, 1983 to 2000**



The ability to achieve the STMP's objective is restricted by the current infrastructure and the limit placed on the maximum flow permitted in the Nechako River to avoid flooding lands adjacent to the river. Consequently, water temperatures can exceed 20°C, because meteorological conditions can warm the river above the target temperature even in cases where the maximum release has been made, or when increased releases from the reservoir were delayed due to weather forecasts that subsequently turned out to be incorrect.

However, since the STMP was implemented in its current form in 1983, Nechako River temperatures have rarely exceeded 20°C, even though meteorological conditions have warmed over the study period. In fact, the frequency of occurrence of Nechako River water temperatures exceeding 20°C during this warmer period is similar to that recorded in a cooler period prior to the STMP being implemented (**Figure 4**).

CONSERVING CHINOOK

The *1987 Settlement Agreement* mandated the NFCP to conserve:

> *…on a sustained basis [the] target population of Nechako River chinook salmon including both the spawning escapement and the harvest….*

The approach adopted by the Technical Committee to meet this "Conservation Goal" was based on the philosophy expressed in the Nechako River Working Group's *Summary Report,* that it is necessary to maintain sufficient habitat quantity and quality to provide an acceptable level of certainty that chinook salmon will be conserved and protected in the Nechako River.

The committee's projects relating to the Nechako River chinook and its habitat fall into three main areas:

1. Collecting information to identify trends in Nechako River chinook, including life-history events and stock performance.
2. Collecting information on the status of in-river habitat and the use of natural and artificial habitats by juvenile chinook.
3. Filling previously identified gaps in knowledge on Nechako River chinook ecology.

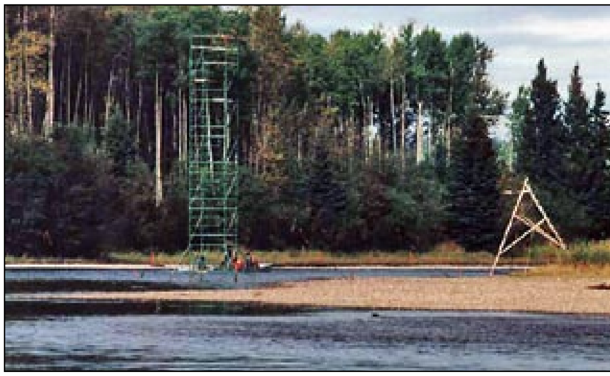
The Technical Committee recognized early in this process that physical and biological parameters vary both spatially and temporally and that not all of the possible parameters could be monitored with the same degree of rigour and precision. Consequently, the committee decided to measure primary biological parameters that allow assessment of the Conservation Goal with the greatest degree of rigour, and secondary biological and tertiary physical parameters with less rigour (**Figure 3**).

Monitoring Life-History: Primary Monitoring

Adult Returns

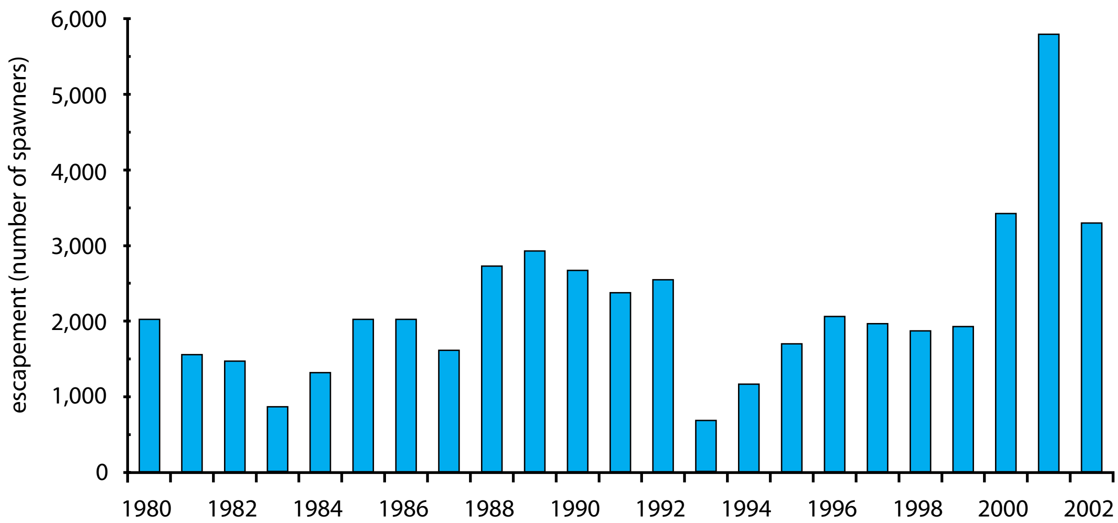
According to the *1987 Settlement Agreement,* a key measure of the Conservation Goal is whether the annual abundance of chinook spawners is within the described target population of 1,700 to 4,000 spawners. This measure led the Technical Committee to use the "area-under-the-curve" method (AUC) to estimate each year the number of chinook returning to spawn in the mainstem of the Nechako River above Vanderhoof (**Figure 5**). This method provides more accurate estimates of spawner abundance than other common enumeration techniques.

The number of spawners returning to the Stuart River was also estimated each year. The Stuart River shares the same hydrological basin and biogeoclimatic influences as the Nechako River but its flow is not regulated. The geographic proximity of the two rivers means that chinook returning to the Stuart River most likely experience similar migration timing, as well as ocean conditions and harvest rates as Nechako River chinook. The Technical Committee therefore decided to use the Stuart River returns as a reference against which to measure Nechako River returns. A mark-recapture method was used to estimate returning spawners in the Stuart River, because the AUC method



Observation towers used in chinook residence time study

Figure 5 **Nechako River: escapements of chinook to the mainstem, 1980 to 2002**



cannot be used in its turbid water. Although the methodologies differ, the separate indices are suitable for assessing trends in both systems.

Until 1992, the number of chinook that returned to the Nechako River was greater than the number of spawners that produced them. There was a significant downturn in the ratio of returns to spawners from 1993 to 1995. Although a direct comparison of trends between the Nechako and Stuart Rivers needs to be approached cautiously, data indicate that the declines occurred within both the Nechako and Stuart River stocks, suggesting that they were the result of "extrinsic" factors — they occurred outside of the natal streams. Since 1998, approximately as many fish came back as there were parents and there was a significant increase in the ratio of returning fish to spawners in 1998 and 2000. The Nechako River escapement trends were also compared to escapements to other unregulated rivers in the upper Fraser River basin and the comparison supported the conclusion that the effect observed on the Nechako was related to extrinsic factors.

Carcass Recovery

An annual Carcass Recovery project was conducted on both the Nechako and Stuart Rivers. This project gathered biological data on age distribution, sex ratio, body size, fecundity, and egg retention of spawners in Nechako and Stuart River chinook populations in order to identify possible effects of river flows on population biology.

Comparing the two populations showed no notable differences in adult characteristics. Additionally, characteristics of fish from the Nechako River and those from the unregulated streams of the upper Fraser River basin are similar. For example, the age structure of Nechako River chinook closely resembled the age structure found on the unregulated Stuart River and was not markedly different from the age structure of combined Fraser River basin stream-type chinook. The sex ratios of the Nechako and Stuart River chinook populations were skewed towards females, but that may be the result of a bias towards sampling female carcasses, compounded by sex-related differences in age at sexual maturation.

The fact that the Nechako and Stuart River populations have a similar range of sex ratios and age structure indicates that the observed ratios in the Nechako River were not related to regulating the river.

Monitoring Life-History: Secondary Monitoring

Fry Emergence Monitoring and Juvenile Out-migration

The numbers of chinook salmon returning to the Nechako River annually are affected by both intrinsic (Nechako River) and extrinsic (Fraser River, Pacific Ocean) factors. This means that the abundance of returning adult salmon alone cannot be relied on to indicate or detect changes in the quality of Nechako River habitat. Consequently, in order to provide a reliable indication of changes in the habitat, the Technical Committee implemented two projects—the Fry Emergence Project and the Juvenile Chinook Out-migration Project—designed to monitor components of chinook freshwater life-history and provide an early warning of changes in stock status or habitat variables (**Figure 3**).

Juvenile chinook salmon

The Fry Emergence Project is a key element of the Early Warning Monitoring Program. The objectives were to acquire baseline information on the biological characteristics of emergent chinook fry in the upper Nechako River, and develop an index of emergence success to monitor the quality of the chinook incubation environment after the completion of the Kemano Completion Project. Specific tasks included monitoring changes in the quality of the incubation environment in the upper Nechako River by:

- developing an index for fry emergence timing and abundance;
- estimating egg-to-fry survival per spawner; and
- monitoring the average size and condition of emerging chinook fry.

Fry Index sampling was done using downstream Inclined Plane Traps at Bert Irvine's Lodge (**Figure 1**). Indices were developed using alternate flow expansion and mark-recapture techniques.

In 1997 and 1998 higher than normal flows were released to the Nechako River. With the exception of these two years, there was a strong correlation between the emergent fry index and the number of spawners above Bert Irvine's Lodge (the trap site) the previous fall. However the second index, developed through the mark-recapture estimates did not show a similar increase in emergence success in 1997 and 1998, indicating that it may be the more robust methodology to employ.

Based on the stable relationship of emergent fry per spawner using both indices, the quality of the incubation environment in the upper Nechako River has not shown any degradation over the

Rotary Screw Trap near Diamond Island

study years, appears to be stable, and does not appear to be limiting within the range of spawner escapements observed. Data collected over the project period showed that there has been little variation from year to year in the mean length, weight or condition factor of fry.

Like the Fry Emergence Project, the Juvenile Chinook Out-migration Project is part of the Early Warning Monitoring Program (**Figure 3**). As juvenile chinook spend a portion of their first year in the Nechako River before migrating downstream, information on the condition and relative abundance of juveniles over time is presumed to reflect changes in rearing habitat. In this case, the project was designed to monitor key components of juvenile chinook population biology, including relative abundance, average size and spatial distribution.

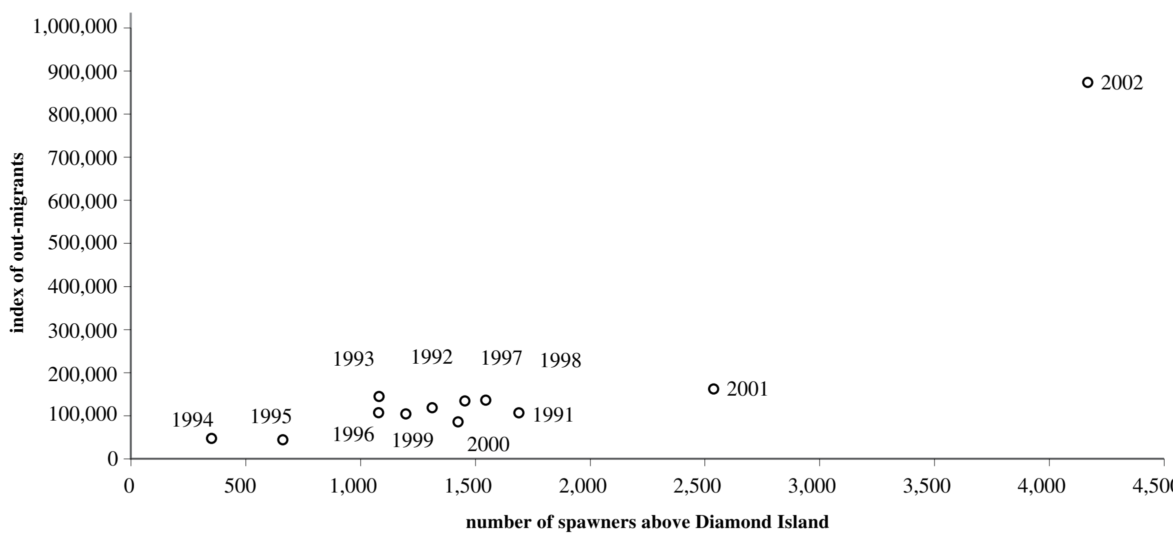
Juvenile chinook migrating out of the Nechako River were trapped using Rotary Screw Traps near Diamond Island (**Figure 6**), while rearing chinook were assessed using electrofishing techniques at numerous sites on the river.

The specific objectives were to:

- monitor temporal and spatial changes in juvenile chinook abundance, from spring to autumn, within the upper 90 km of the Nechako River;
- monitor juvenile chinook body size, growth and condition;
- develop a standardized index of the number of juvenile chinook leaving the upper Nechako River;
- measure the timing of juvenile chinook out-migration; and
- assess changes in out-migrant number and timing, spatial distribution within the upper river, body size, growth and condition as an early warning of habitat changes in the upper Nechako River that may be related to changes in flow regime.

Between 1988 and 2000, both the number of juvenile fry rearing in the upper Nechako River and leaving the system increased linearly with higher spawner numbers. The length, weight and condition of juvenile chinook were similar in most years with differences in size related to timing of emergence and water temperature regimes.

Figure 6 **Nechako River: index of chinook 0+ out-migrants calculated from rotary screw traps vs. the number of spawners above Diamond Island the previous year, 1991 to 2002**



Freeze core sampler pulled from substrate and lifted onboard a boat for sample extraction

In 2001, the number of spawners returning to the river exceeded the upper bounds of the Conservation Goal's target population by almost 40%. In 2002, more fry per spawner left the river than usual while the rearing index did not increase beyond maximum values seen previously, indicating a possible density dependence.

Based on the consistency of the two relationships (rearing fry per spawner and juvenile out-migration per spawner), the capacity of the available rearing habitat in the upper Nechako River appears to be adequate for the number of spawners identified in the Conservation Goal.

Monitoring Life-History: Tertiary Monitoring

If a change in secondary monitoring indices (e.g., the index for fry emergence timing and abundance) was detected, then results from tertiary monitoring could be examined to help isolate the cause for the change and, if needed, help identify the most appropriate remedial activity. Consequently, through the program years the Technical Committee has collected baseline data on winter conditions, gravel quality and temperatures at several locations along the Nechako River and worked to develop techniques to measure inter-gravel dissolved oxygen levels.

Physical Factors

A number of physical factors are important influences on successful chinook production during the fish's various freshwater life-history stages. These include winter physical conditions, physical data (e.g., air and water temperatures; discharge), dissolved oxygen, and substrate quality and composition. Changes in these factors have the potential to explain changes or trends seen in primary or secondary monitoring parameters, such as egg-to-fry survival, fry condition and the out-migration index.

Pilot substrate sampling studies using freeze core techniques were carried out in 1990 and 1991; full-scale studies on grain size composition of

Upper Nechako River Valley

gravel beds were undertaken in 1992 and 2000. The findings of the full-scale studies were that, generally, the percentage of fine sediments (i.e., clays, silts and sands) in the Nechako River spawning gravel in both 1992 and 2000 ranged between 8% and 11% in the surface layers and 16% and 18% in the lower layers. This is typical of good spawning gravels.

Remedial Measures

Clause 3.4 of the *1987 Settlement Agreement* requires that, in anticipation of lower flows associated with the Kemano Completion Project, the NFCP "establish a comprehensive body of decision making criteria" for designing and implementing remedial measures, including determining the extent of implementation. The Agreement further stipulates that the measures be:

- biologically sound with demonstrated use;
- reasonable, based on practical and proven techniques, and consistent with good science and engineering and fiscal responsibility;
- cost effective compared to alternative means of achieving the same biological objective within the same stage, taking into consideration initial capital and maintenance costs relative to other measures of equal benefit; and,
- implemented according to the hierarchy of preferences for successive remedial alternatives contained in the Department of Fisheries and Oceans' *Policy for the Management of Fish Habitat.*

Remedial measures set out in the Agreement included flow control, instream manipulation, instream fertilization and off-channel improvements. Initial measures were to be in place to offset loss of habitat due to flow changes associated with the Kemano Completion Project; additional measures were to be implemented if a negative trend was detected in any of the life-history parameters for Nechako River chinook that the NFCP was assessing.

The studies undertaken by the committee included inventorying existing habitat values, developing tools for implementing instream habitat remediation, and pilot testing habitat structures. The habitat inventories included:

- **existing cover habitat -** to provide guidance in determining the amount of artificial habitat to apply following the reduction in flows;
- **sediment sources -** to assess the risks associated with changes in sediment resulting from changes in streamflows and to identify sources that might require remedial activity; and
- **sand mapping -** to determine the size and location of existing sand deposits and provide a baseline to assess whether conditions change after the flow changes.

The planning tools included:

- a HEC-2 model to assist in siting habitat complexes and provide information on stream depth and average velocities at different streamflows; and
- snow course and water level data from within the Bird Creek sub-basin of the Murray/Cheslatta drainage system to predict inflows to the Murray/Cheslatta basin from snow melt.

Annual Water Allocation

The *1987 Settlement Agreement* established the Technical Committee's responsibility in reaching decisions on the release of the Annual Water Allocation (AWA) from the Nechako Reservoir.

Skins Lake Spillway

Prototype instream fertilization applicators

The AWA is a mean annual release of 36.8 m^3/s of water at Skins Lake Spillway. The objective of the AWA is to best allocate flows for chinook in the Nechako River below Cheslatta Falls. The mean annual release at Skins Lake Spillway is combined with the average estimated inflows from the Murray/Cheslatta drainage.

The flow release protocol between the Technical Committee and Alcan has worked well. The AWA released through the spillway has exceeded 36.8 m^3/s every year.

Inorganic Fertilization

Adding nutrients (i.e., instream fertilization) was first proposed by the Nechako River Working Group. The Group recognized that introducing cool water from the proposed Kenney Dam Release Facility (one of the components of the Kemano Completion Project) might reduce the growth of both juvenile chinook and their prey and that stream fertilization was one method of mitigating some of the possible ecological effects of the releases.

Although fertilization had been shown to increase the growth of some species of salmonids, its effect on chinook had not been demonstrated. Consequently, a series of experiments were conducted in the upper Nechako River between 1988 and 1991 to test the effect of fertilization on periphyton and benthic invertebrate production and on the abundance and growth of juvenile chinook.

Four years of research showed that introducing inorganic fertilizer to the upper Nechako River resulted in an increase in nutrients, periphyton and insect abundance. A full river fertilization trial and an assessment of its effect on juvenile chinook was not conducted due to the cancellation of the Kemano Completion Project.

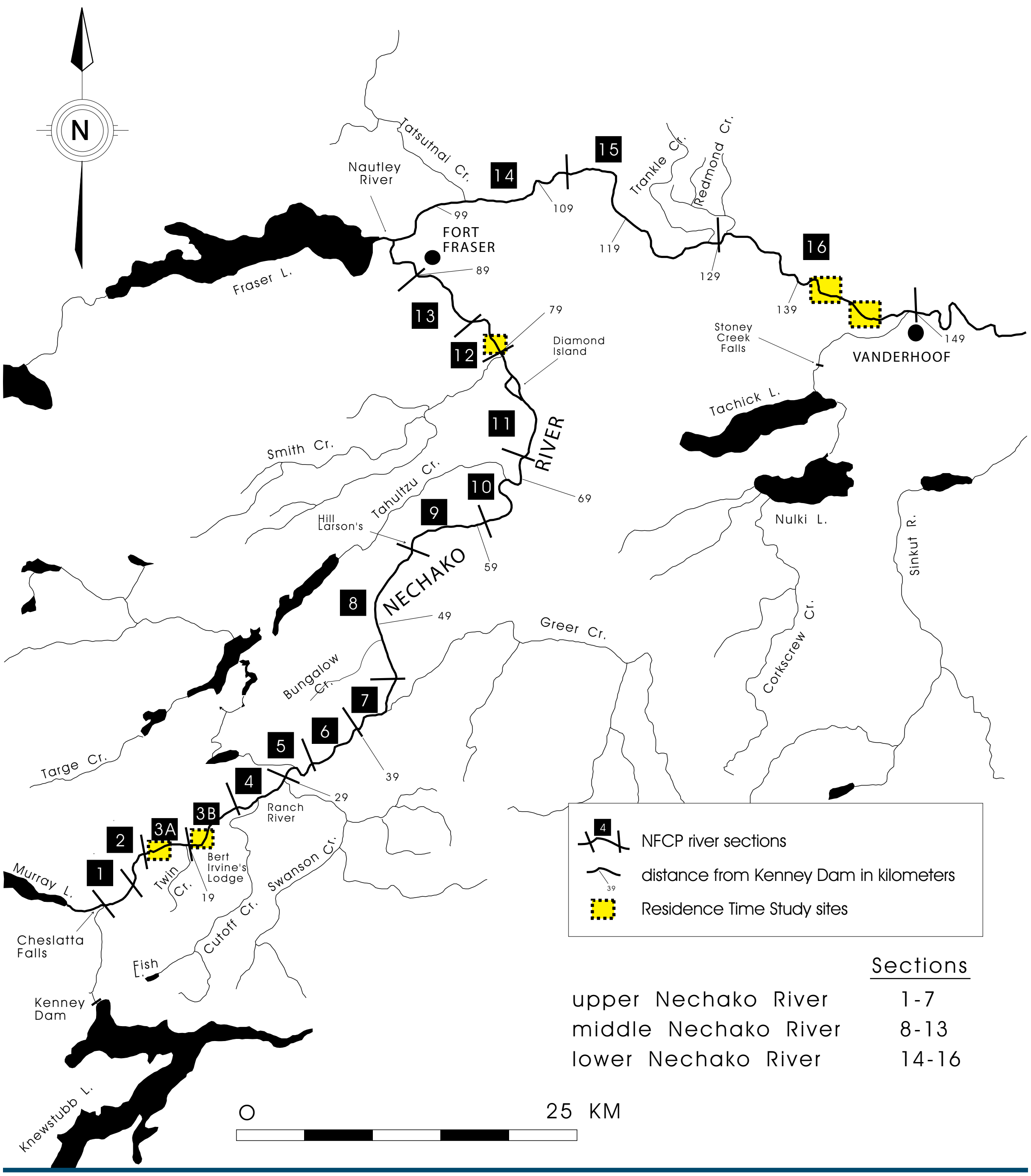
Instream Structures

The Technical Committee's instream habitat modification pilot project to test habitat complexes and assess their use by Nechako River juvenile chinook began in 1988. From 1988 to 1991, 82 structures covering 14 different habitat complex designs were constructed in Reaches 2 (km 15 to km 40), and 4 (km 72 to km 89) of the river. (**Figure 7**). The majority of these structures were constructed between 1988 and 1991.

While some designs were rejected due to structural failure, or because they produced less than optimal habitat, some complexes continue to function well at present. Snorkeling and electrofishing surveys demonstrated high-use of the structures by juvenile chinook. In fact, in most cases, usage was comparable to, or better than that found in naturally complex habitat while the structure of the fish community was similar to that found in high quality natural complex habitats. The project's original objective—designing and placing habitat complexes in the Nechako River suitable for rearing chinook—was achieved.

Electrofishing to document fish useage at a typical instream structure

Figure 7 Nechako River: chinook spawning study area



Riparian Bank Stabilization

The Technical Committee explored using vegetative techniques to control sediment inputs at failing banks as an alternative to using hard engineering techniques (e.g., rip rap) to stabilize streambanks. The pilot study showed that the banks of smaller tributary streams were suitable for riparian bank stabilization techniques, but not larger mainstem river banks.

Applied Research

Recognizing that overall chinook production is affected by all life-history stages—including factors such as freshwater rearing outside of the Nechako River, ocean survival, ocean and in-river harvesting and upstream migration survival—the Technical Committee intended to develop a Nechako River chinook life-history model. However, as the study progressed it became apparent that critically important extrinsic information was unavailable and will likely remain so indefinitely. That said, research projects were undertaken to provide additional information on both in-river life-history factors for Nechako River chinook, as well as to identify life-history factors outside of the river that could affect the population.

Work by the committee has shown that a minority of juvenile chinook overwinter in the Nechako River and the majority migrate out of the upper Nechako River by late spring or early summer. Department of Fisheries and Oceans DNA analyses indicate that these fish move into rearing areas in the mainstem of the Fraser River where their distribution is similar to that for Stuart River juvenile chinook.

Research projects have also provided data on predators that could pose a threat to chinook rearing on the river. While preyed on by both fish and birds, chinook do not appear to be preferentially selected under the current flow regime.

ASSESSING THE PROGRAM'S SUCCESS

During its initial work, the Technical Committee recognized that sufficient time would need to elapse after the implementation of the Kemano Completion Project before it could assess whether the Conservation Goal had been achieved. The time frame identified by the committee to ensure that the Nechako River chinook population was stable and within the target value established by the 1987 Settlement Agreement was 20 to 25 years, or four to five complete chinook life cycles. However, with the cancellation of the Kemano Completion Project (and, consequently, no change in reservoir releases) and the completion of three spawning cycles, the Technical Committee believes that it is now possible to interpret the success of the program in achieving the Conservation Goal.

The Conservation Goal is:

> *… the conservation on a sustained basis of the target population of Nechako River chinook salmon including both the spawning escapement and the harvest as referred to in paragraph 3.1 of the Summary Report…. [Nechako River Working Group]*

Paragraph 3.1 of the Summary Report states that:

> *The total population of chinook salmon to be conserved is that represented by the average escapement to the river plus the average harvest during the period 1980-1986. DFO escapement records during this period averaged 1,550 with a range of 850-2,000. In view of the known inaccuracies in spawner count data the working group recognizes that the estimated escapement is on average 3,100 spawning chinook but ranges from 1,700 to 4,000. This number is referred to as the target population.*

Early in its deliberations, the committee recognized the need for more clarity in defining the number of chinook to be conserved:

- both "total population" and "target population" are used in the same directive;
- both the average "3,100" and the range "1,700 to 4,000" are referred to as the "target population"; and
- the number of returning adults recorded for the period 1980 to 1986 was based on various counting methods, each with a different level of precision and accuracy. Recognizing this uncertainty, the authors of the *Summary Report* multiplied the escapement estimates by a factor of two to better reflect what was, in the Working Group's opinion, a more likely range of returning adults for the 1980-86 period.

To overcome some of the uncertainty in the definition of the "target population," and recognizing the potential for extrinsic factors to result in significant annual and multi-year variations in the number of chinook returning to spawn in the Nechako River, the Technical Committee has assessed the annual escapements against the range of "1,700 to 4,000" spawners per year. The "total population" of Nechako River chinook is made up of two groups, the adults that return to the Nechako River to spawn and those fish harvested in the ocean or in fresh water on their way to the Nechako River. It has not been possible to develop accurate data on the harvested group of salmon.

The returns to the Nechako River have been generally within the range for the target population set out in the *1987 Settlement Agreement.* Supported by similar trends in the Stuart River chinook stock, the exceptions are thought to result from factors not related to the Nechako River.

MONITORING HABITAT QUALITY AS A SURROGATE FOR THE CONSERVATION GOAL

In 1986, the Department of Fisheries and Oceans adopted *Policy for the Management of Fish Habitat.* This policy, which includes a hierarchy of preferences for protecting or replacing the productive capacity of fish habitat, helped establish the context of the *1987 Settlement Agreement.*

One of the objectives of the NFCP has been to use indirect indicators to evaluate the capacity of Nechako River fish habitat (or habitat quality) in the context of the Conservation Goal. Changes in these indicators provide an early warning of possible changes in habitat capacity or productivity, thereby signaling the need to implement remedial measures. Estimating fry emergence and juvenile out-migration are two examples of this approach. While the expected changes in flow contemplated as part of the proposed Kemano Completion Project have not occurred, the indices developed to evaluate the effects of flow changes can be used as a means of assessing the stability of the habitat of this regulated river. The relationships developed over the program period serve this purpose.

Analysis of the indices indicates that from incubation through rearing to the returning adult spawners, in-river conditions since the inception of the NFCP in 1987 have been consistent. For example:

1) Egg-to-fry survival
   - emergent fry indices increase proportionately with the number of spawners upstream of the trapping site (there is no density dependence) indicating that the spawning habitat does not appear limiting within the range of escapements observed;
   - based on hatching time, size at emergence and condition, chinook life-history parameters appear normal; and
   - based on the relationship between spawner numbers and emergent fry, and the gravel quality results, the quality of the incubation environment in the upper Nechako River has not shown any degradation over the study years and appears to be stable.

2) Egg-to-juvenile survival
   - the timing of juvenile chinook out-migration has been consistent over the duration of the program;
   - the number of fry leaving the system is directly and positively related to the number of spawners the previous year;
   - the number of fry rearing in the river as reflected by catch-per-unit effort values is directly and positively related to the number of spawners the previous year; and,
   - the number of fry produced in the Nechako River have generally resulted in numbers of return spawners within the values identified in the Conservation Goal.

This report presents the results of intensive sampling and monitoring of Nechako River chinook salmon for almost three complete life cycles; it represents one of the most extensive data sets of its kind. The Nechako Fisheries Conservation Program's mandate to protect and conserve chinook salmon was implemented, and its mandate to achieve the Conservation Goal defined, in anticipation of the significantly reduced Long-Term Flows that were expected to be released into the Nechako River as part of the Kemano Completion Project. However, that project was effectively cancelled in January 1995, and flows to the Nechako River will not be reduced to the level of the long-term regime. Regardless, monitoring should be considered as part of any future program, as the possibility exists that in-river conditions could change over time.

In spite of uncertainties associated with the considerable variability that exists external to the Nechako River (i.e., ocean conditions and harvest rates), the habitat capacity of the upper Nechako River as measured through various indices has been shown to support reproduction and the early life stages of chinook salmon at numbers that result in the return of chinook salmon at the levels of abundance identified in the *1987 Settlement Agreement.* Consequently, it is the opinion of the Nechako Fisheries Conservation Program Technical Committee that the in-river conditions examined by the committee are sufficient to sustain a population of chinook salmon that fluctuates generally within the target population range identified by the Conservation Goal.

Given that a defined schedule of water releases into the Nechako River has been established since 1987, and given the results of the work described in this report, the Nechako Fisheries Conservation Program Technical Committee concludes that the intent and spirit of the Conservation Goal has been met.

The Nechako Fisheries Conservation Plan Steering and Technical Committees continue to function in their respective roles, managing the annual water allocation, implementing the Summer Temperature Management Program, enumerating chinook salmon returns to the river, and, as needed, continuing to evaluate the capacity of Nechako River fish habitat through fry emergence and out-migration projects in the context of the Conservation Goal. This work will continue until an alternate agreement, organizational structure or mandate is established.

The Nechako River at Vanderhoof.

Tatsutnai Cr
Redmond Cr
FORT FRASER
Diamond Island
Stoney Creek Falls
VANDERHOOF
Tachick L
RIVER
NECHAKO
Nulki L.
Sinkut R.
Greer Cr.
Corkscrew Cr.


FORT FRASER
Fraser L.
Smith Cr.
RIVER



FORT FRASER
Fraser L.
Smith Cr.
NECHAKO
RIVER