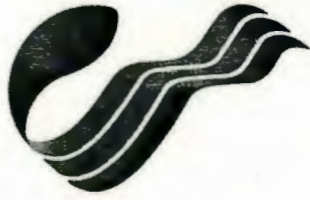


DRAFT



**Salmonid
Habitat
Management
Plan
for the**



**CANADA'S GREEN PLAN
LE PLAN VERT DU CANADA**

**Stuart/Takla Habitat
Management Area**

Lander,
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STUART/TAKLA FISH HABITAT MANAGEMENT PLAN

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FOREWORD

The Government of Canada and the Department of Fisheries and Oceans have made commitments towards achieving sustainable development of the fisheries resources. The principles that will guide DFO are those popularized by the 1987 World Commission on the Environment and Development - Our Common Future. However, it is difficult to take global concepts and apply them effectively in smaller geographic areas. This is our first attempt to establish a relevant fisheries data base to better allow multi-disciplined sustainable development discussions to take place in the Fraser River Basin.

In 1990, DFO established a small Task Force to address this challenge. The initial task of this group was to devise and complete a habitat management plan for the Fraser River. It was recognized that salmon habitat has been significantly degraded in the Fraser River Basin over the past 100 years. Despite that, the salmon stocks are being actively rebuilt towards historic levels. Obviously a link between the capability of the habitat to produce fish and stock rebuilding goals had to be established. Also, we must begin the process of better protecting existing habitat and to restore and enhance what is desirable within a plan involving more than DFO habitat and harvest managers.

To address this overall task a Habitat Planning Unit divided the Fraser River Basin into 15 Habitat Management Areas. This division was based on major river systems and salmon stocks. The Stuart/Takla report is the first of 15 Fish Habitat Management Plans. It is DFO's attempt to define salmon habitat status, stock status and habitat restoration and protection priorities. It is a first step towards establishing a data base for long-term environmental sustainable development discussions with other stakeholders in the basin.

Although the stock rebuilding initiative began several decades ago, it received greater priority after the 1985 Canada-U.S.A. International Agreement. Serious attempts to include habitat considerations into the process began in late 1988. In 1990, the initiative was incorporated into the National Green Plan's Fraser River initiative. It is now called the Fraser River Action Plan and is under the general guidance of the newly formed (Canada/B.C./Municipal/aboriginal/public) Fraser Basin Management Board.

As part of our commitment to sustainable development and Canada's Green Plan we have defined specific goals for sustainable fisheries development. The Fish Habitat Management Plan and associated DFO decisions and activities are guided by the goals of sustainable development. The two basic principles of sustainable development are:

- to maintain ecological diversity of the basin; and
- to maximize the net economic benefits that can be derived from the resource.

DFO has defined the following seven measurable and achievable goals for sustainable fisheries development. They are as follows:

1. **Avoiding irreversible man made changes to fish producing habitats.**
Alterations to fish habitat that reduce its capacity to produce valuable fish populations and cannot be reversed within a human generation will be avoided.
2. **Maintaining the genetic diversity of fish stocks.**
No fish stock, however small, will be arbitrarily written off and, where possible, efforts to conserve and rebuild small and remnant stocks will be made.
3. **Maintaining the physical and biological diversity of fish habitats.**
Physical and biological diversity of habitat provides fish with an opportunity to adopt alternative life history strategies, hence providing protection from natural variation.
4. **Providing a net gain in productive capacity by habitat management.**
Ecological limits control productive capacity. Natural and self-sustaining production systems are preferred over semi-natural and artificial or non-self-sustaining systems.
5. **Maximizing the value of commercial, sport, and aboriginal fisheries.**
Consideration of both tangible and intangible market and extra-market values measured in a way to permit comparison of competing users of the fisheries resources.
6. **Maximizing the non-consumptive values of fishery resources.**
Intangible and cultural values associated with fishery resources must be given due consideration in decision making.
7. **Distributing fishery net benefits in a fair and equitable manner.**
Local communities must be involved in the decision-making process with respect to habitat conservation, enhancement, and restoration, and particularly to who benefits and who pays.

It is hoped that this report will provide the basis for discussion resulting in the development of a more effective land use planning process that will better protect aquatic environments. The end product should be the application of this HMA plan. The end product will be the application of a higher level of environmentally sustainable development.

OTTO E. LANGER
Head, Habitat Planning
Fraser River ESD Task Force
June 25, 1992

PREFACE

DFO PLANNING ACTIVITIES LEADING TOWARD A PLAN FOR ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT IN THE FRASER BASIN.

Fish Habitat Management Plan

The FHMPs are currently being prepared by DFO as a first step to documenting the status for fish and fish habitat salmon resources in each designated Habitat Management Area (HMA) within the Fraser Basin. These plans provide a comprehensive documentation of salmon species life histories, stock abundance and status, as well as information on spawning and rearing habitats. The HMA is described in geomorphological terms, including physiography, soil landscapes, hydrology and stream channel stability. Other land and water uses are described and projected into the future and impacts of the salmon resource are documented.

The most important component of the FHMP is the plan for action which includes a habitat management strategy encompassing research direction and plans for monitoring and evaluation. Habitat restoration and enhancement plans are part of the habitat plan (Figure 1).

Salmon Production Plans

DFO is currently developing plans to increase the production of five species of salmon in the Fraser River Watershed. The Fraser River Sockeye Production Plan has progressed the furthest and includes the following components:

- Stock Status including information of life histories, catch and escapement figure, and exploitation rates.
- Rebuilding Potential, incorporates data on historical catch levels, habitat capacity estimates and resulting rebuilding goals.
- Fisheries Management, a section describing the fisheries employed in catching a particular species and the current management practices.
- Future Management Options, details the recommended management options and provides information on the impacts to other species.

- **Enhancement Options**, is a presentation of preferred strategies for enhancement runs and stocks to augment the recommended management approaches.
- **An Evaluation and Consultation Process** will also be described.

Harvest Management Plan

Fisheries are managed on a yearly cycle which documents last years escapements, catches, run sizes and exploitation rates and an evaluation of management strategies (e.g., openings, restrictions, etc.) based on this analysis and stock assessment information, expectations are set for the next fishing season and discussed with various fishing advisory groups. This process results in a fishing plan to harvest the allowable catch.

Fraser River Salmon Management Plan

It is at this stage that all the DFO planning activities will come together, including incorporation of estimates of habitat capacity, stock management options, harvest strategies and stock enhancement approaches. The Fraser River Salmon Management Plan will be DFO's contribution towards the preparation of a truly Environmentally Sustainable Development Plan for the Fraser Basin, which will result from integration with other federal and provincial agencies, municipalities, aboriginal and other public groups.

With the release of the Stuart/Takla Fish Habitat Management Plan, DFO has embarked on the evolving process towards truly integrated ESD Planning. Over the next few years, the Task Force will continue to develop FHMPs for the remaining HMAs integrating these with the Production Plans, currently under development, for the other five species of salmon.

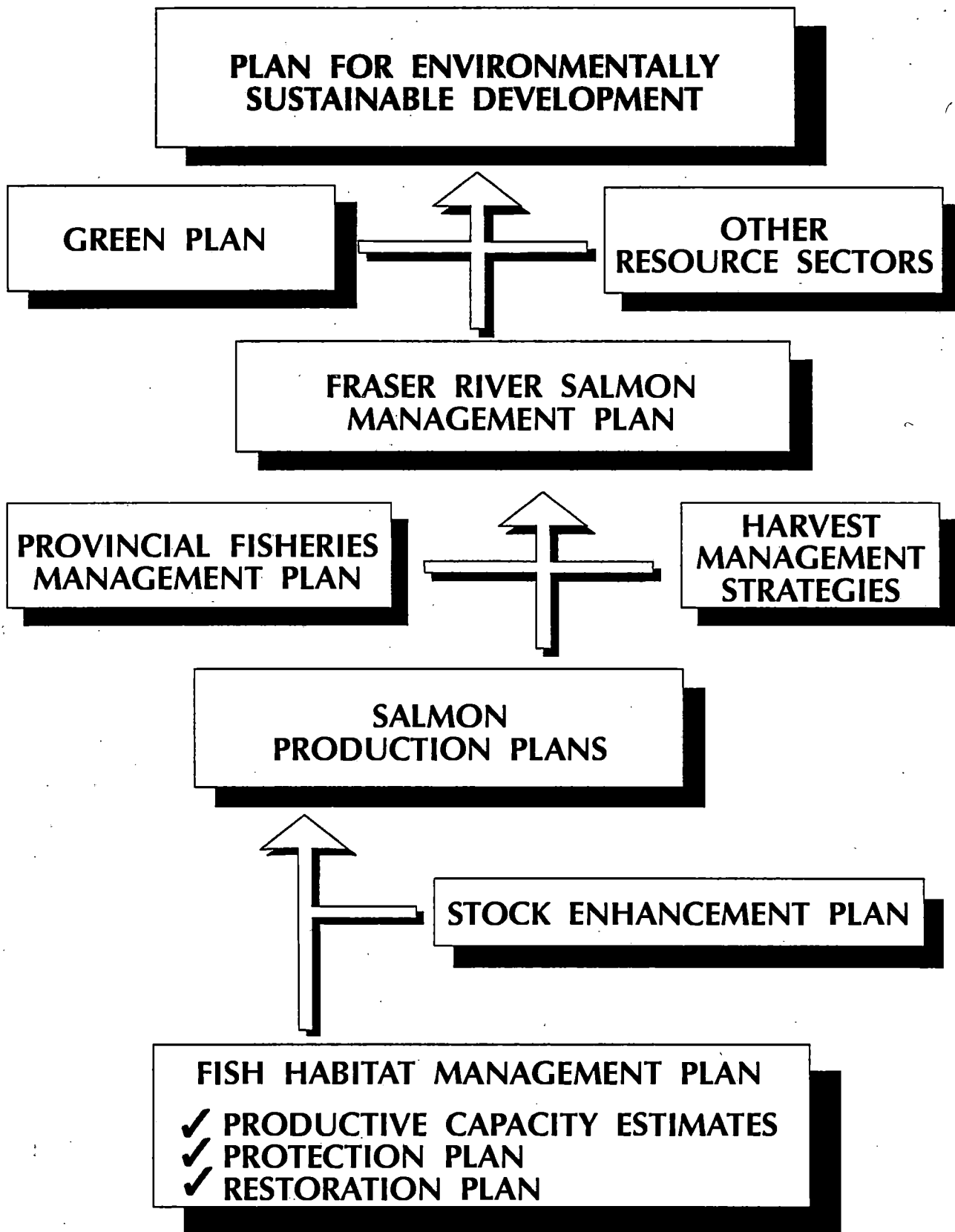


Figure 1. Outline of the Fraser River Sustainable Development Plan.

The overall task of developing a comprehensive Fraser River Salmon Habitat and Production Management Plan, to be eventually incorporated into a Environmentally Sustainable Development (ESD) plan, will require that the initial task be subdivided into a number of component parts. They can be summarized as follows:

1. Subdivide the Fraser River watershed into manageable geographic areas (HMAs).
2. Determine the status of the various stocks and habitat base within each HMA.
3. Determine the productive capacities of the various habitats and determine escapement targets using habitat capacities, historical catch and escapement records and, for some species, stock recruitment analysis.
4. List the various habitat restoration and development options that exist in a particular watershed.
5. Establish a comprehensive habitat protection plan for a particular watershed.
6. Develop a final production strategy for each area, including protection, restoration and enhancement.
7. Develop a management support package for each HMA.
8. Evaluate the completed pilot HMA plans and modify and upgrade as required.

In 1988 the Department of Fisheries and Oceans initiated the development of salmon habitat and production management plans for the Fraser River. Central to the procedure was the subdivision of the Fraser River into 15 manageable geographic salmon production units called Habitat Management Areas (HMA). The boundaries for these areas were largely determined by the salmon stock management realities that govern how the department must manage the fisheries resources. In this context, watershed and physiographic boundaries rather than administrative ones have greater use and significance.

The 15 Habitat Management Areas, shown in Figure 2., are as follows:

Upper Basin

1. Upper Fraser
2. Stuart/Takla
3. Nechako
4. West Road

Middle Basin

5. Quesnel
6. Chilcotin
7. North Thompson
8. Seton-Bridge
9. Thompson-Nicola
10. Shuswap-South Thompson
11. Middle Fraser
12. Harrison

Lower Basin

13. Chilliwack
14. Pitt-Stave
15. Greater Vancouver

In January 1989 work on the habitat management plan for the Stuart/Takla was initiated. This report presents that plan.

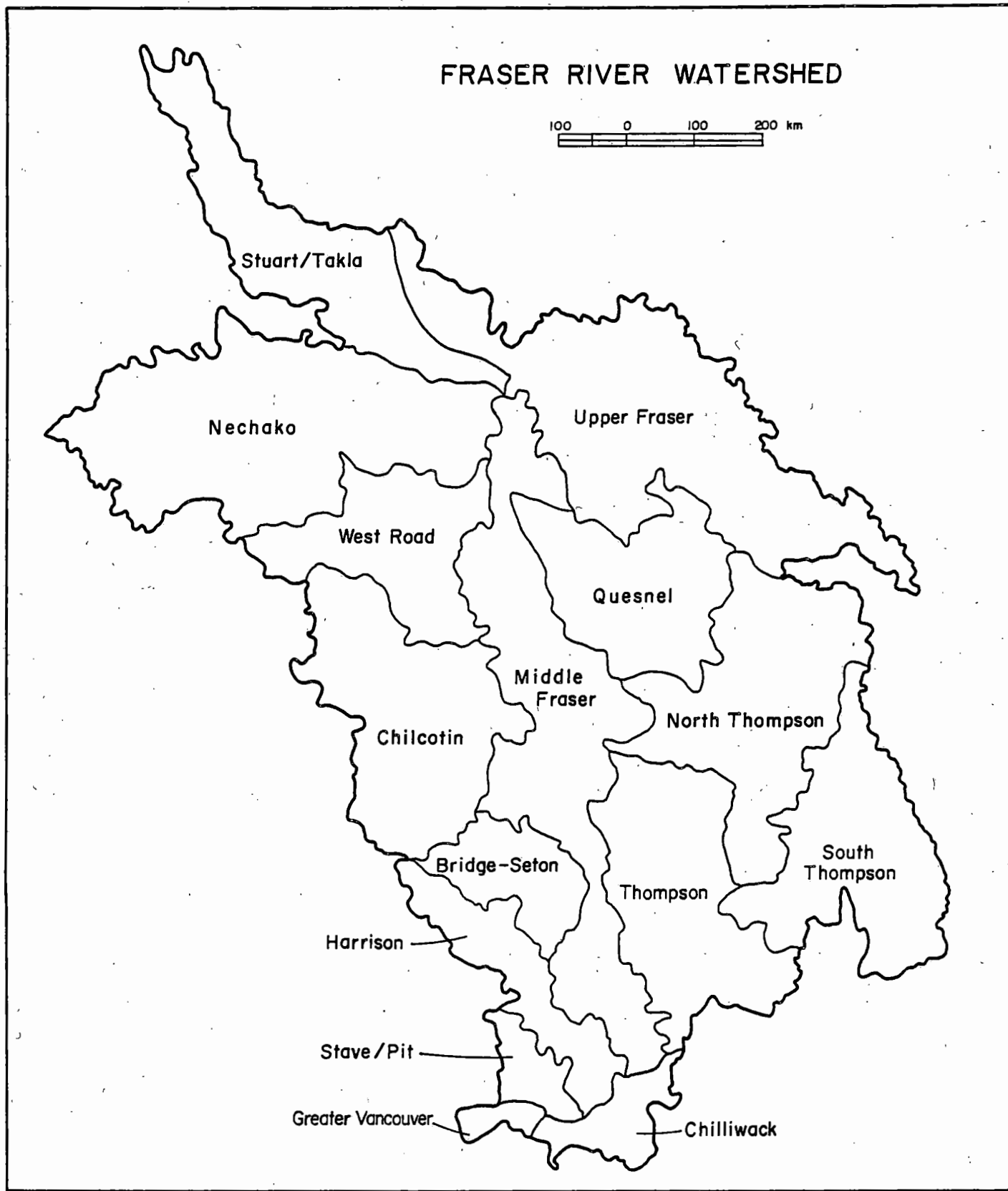


Figure 2.- Fraser River Habitat Management Areas.

ACKNOWLEDGEMENTS

The planning of this report began three years ago. The completion of the Stuart/Takla Fish Habitat Management Plan (HMP) has been a long and difficult process. As with the Quesnel and Thompson River HMPs that were initiated in October 1990, the initial HMP had to define what we really wanted to accomplish, determine what was possible with the resources available, and establish a framework for the completion of the remaining habitat plans.

Bill Schouwenburg carried the initial burden of editor and writer. Consultants Paul Harder, Ted Harding, Mike Miles, and Mark Walmsley originally compiled and authored the biophysical description of the Stuart/Takla HMA. They also reviewed the resource interactions in this HMA. Bruce MacDonald authored sections related to habitat status and stream sensitivity. John Patterson in addition to writing, assisted in collating and organizing the report while managing the contract for the completion of the HMP.

We are particularly indebted to those who took the time for critical reviews of early drafts of the report. Special thanks are in order for Bruce MacDonald, John Patterson, Lidia Jaremovic, and Gordon Kosakoski. Final editing of this report was completed by Ted Harding through a DFO-Aboriginal Co-management contract with the Lheit Lit'en Nation.

(REVIEWER CREDIT)

I did my best to review all drafts, write select sections and, above all, acquire the resources and cooperation necessary to put this plan together. I thank all others that provided their assistance despite their other work demands.

Otto E. Langer

1. INTRODUCTION

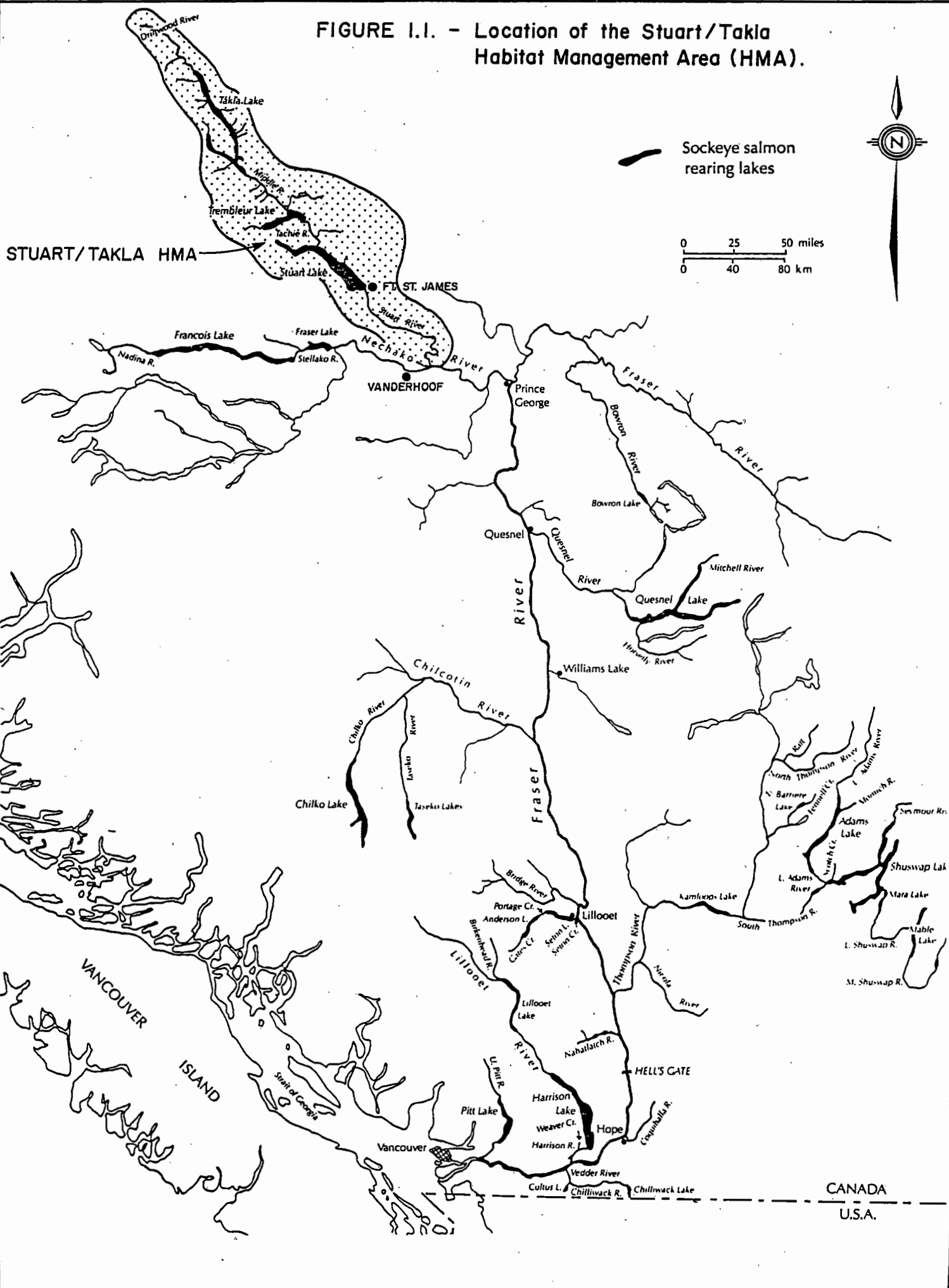
The Stuart/Takla Habitat Management Area (HMA) covers approximately 18,000 km² or about 7% of the Fraser River basin. The HMA consists of a major river system draining from the north through the three major lakes (Takla, Trembleur and Stuart) and entering Nechako River near Vanderhoof (Figure 1.1). The upper watershed consists of Driftwood River, which drains into Takla Lake and includes approximately 32 tributaries to the river and lake. Takla Lake, approximately 85 km long and 2 to 3 km wide, is connected to Trembleur Lake by the Middle River, which flows southward from Takla Lake for approximately 23 km and is fed by six tributaries. Trembleur Lake is approximately 31 km long with an average width of 4 km and is fed by five major tributary systems. Trembleur Lake is connected to Stuart Lake by the Tachie River, which is approximately 25 km long. The only tributary is the Kuzkwa River. Stuart Lake has four major tributaries and is approximately 75 km long by 4 km wide. Stuart Lake drains into the Nechako River via Stuart River. Stuart River flows for approximately 112 km between Fort St. James and the Nechako River confluence near Vanderhoof.

The Stuart/Takla HMA is known to produce sockeye salmon (*Oncorhynchus nerka* (Walbaum)) and chinook salmon (*Oncorhynchus tshawytscha* (Walbaum)). Despite consisting of only 7% of the overall Fraser River Basin area, sockeye salmon escapement from this HMA accounts for 24% of the entire Fraser River Basin spawning population, and both species are harvested in commercial fisheries along the Pacific Coast from Washington to Alaska. The dominant resident fish species found in the HMA include: rainbow trout (*Oncorhynchus mykiss*), which is divided into two distinct populations, a very large race of up to 10 kg, and a smaller race; lake trout (*Salvelinus namaycush* (Walbaum)); kokanee salmon (*Oncorhynchus nerka*); lake whitefish (*Coregonus clupeaformis* (Mitchill)); and Dolly Varden char (*Salvelinus malma* (Walbaum)).

The major fish habitat types in this HMA are the spawning streams and associated lake rearing areas for sockeye salmon, kokanee, rainbow trout, lake trout and lake whitefish, and the streams that serve in a dual spawning/rearing facility for chinook salmon, rainbow trout and some Dolly Varden char.

The Stuart/Takla HMA consists of watersheds that are largely covered by light to heavy forests and wetland areas. The area was exposed to logging throughout the HMA with the development of B.C. Rail in the early 1970s. Due to massive cost overruns, changing world-wide resource markets and declining revenues, the provincial government decided to abandon this project in the mid-1970s. With abandonment of the railway, several small-scale forest sector initiatives were also suspended. However, during the late 1980s it became apparent that the forests within this HMA were one of the prime timber supply areas remaining in the

FIGURE I.I. - Location of the Stuart/Takla Habitat Management Area (HMA).



central interior. Other than logging, associated road construction and the reactivation of the B.C. rail extension north of Fort St. James, other local developmental threats to fisheries habitat appear minimal. However, watershed changes outside of the HMA do pose a long-term threat to fish stocks. These include the diversion of the Nechako River, water quality due to proposed and existing pulp mills, other industrial and domestic discharges, and climate change. All these concerns have complex interrelationships and can have far reaching implications for salmon production.

Report Organization

This HMP report is organized as a quick reference document addressing issues of direct concern to continuing fisheries production in the HMA; however, more detailed information is also provided.

Section 2 is the actual Habitat Management Plan, which provides an overview of the fisheries resource and resource development issues in the HMA. Summary recommendations are provided for the implementation of fisheries production and habitat management plans. Section 2 also provides descriptions of seven sub-units, which comprise biophysically discrete sections of the HMA, and in which specific habitat protection and management prescriptions apply.

More detailed information on all aspects of the resources and physical conditions found in the HMA are provided in the following sections:

- Section 3 is a complete discussion of all the fisheries resources,
- Section 4 describes the existing physiographic features,
- Section 5 defines the hydrologic and climatic conditions,
- Section 6 provides an overview of interacting land and water uses,
- Appendix I is a stream-by-stream summary detailing fish production (chinook and sockeye), resource use status and resource use conflicts, and
- Appendix II is a table providing sensitivity ratings for all the known sockeye and chinook salmon spawning and rearing streams.

This overview provides a variety of perspectives of the fisheries resources of the Stuart/Takla HMA to the various managers and habitat biologists as a tool for further developing the fisheries resources of the HMA.

2. FISH HABITAT MANAGEMENT PLAN

The Fish Habitat Management Plan (HMP) is a fish production and fish habitat protection plan created from specific information gathered from various management and habitat biologists and Fisheries Officers. Much of the detailed information used in the Habitat Management Plan is presented in Sections 3, 4, 5, and 6 of this report. The Habitat Management Plan is organized in the following manner.

- Section 2.1 provides a summary and assessment of the fisheries production plans and recommendations for fish and fish habitat protection for proposed logging developments; it also outlines other significant land use issues and briefly discusses some concerns about possible changes in climate.
- The standard in-stream construction timing requirements are outlined in Section 2.2.
- Water extraction approval requirements are outlined in Section 2.3.
- The majority of the HMP is a detailed assessment of fisheries and land management issues discussed in terms of seven sub-units (Section 2.4). These sub-unit plans are condensed overviews of all the resources and pertinent issues in regard to the sub-unit. For each sub-unit, physical conditions such as precipitation, run-off, water temperatures, geology, terrain stability and stream channel stability are homogenous. Hence, in most cases one management prescription can apply to all streams in the sub-unit.

2.1 Fish Habitat Management Plan Summary

2.1.1 Fish production plans

The Stuart/Takla Habitat Management Area (HMA) is known to produce sockeye salmon (*Oncorhynchus nerka*) and chinook salmon (*Oncorhynchus tshawytscha*). Of the two species the sockeye, with total stock size numbering up to 4.3 million (1989), are by far the most abundant. Both species are harvested in commercial fisheries along the Pacific Coast from Washington to Alaska. The dominate resident fish species found in the HMA include: rainbow trout (*Oncorhynchus mykiss*), which is divided into two distinct populations, a very large race of up to 10 kg, and a smaller race; lake trout (*Salvelinus namaycush*); kokanee salmon (*Oncorhynchus nerka*); lake whitefish (*Coregonus clupeaformis*); and Dolly Varden char (*Salvelinus malma*).

Sockeye Salmon

The catch of Early and Late Stuart sockeye during the period 1952 to 1990 has ranged from a low of 14,000 in 1963 to a high of 3.3 million in 1989. Escapements of early and late sockeye to the HMA range from a low of 7,829 in 1963 to a high of 960,496 in 1989.

The key habitat management considerations are:

- that there is sufficient spawning area available to support approximately 2 million sockeye spawners, to date the largest escapement recorded was 1 million (1989), and no stream was at its spawning capacity, and
- Stuart, Takla and Trembleur lakes are collectively capable of supporting fry produced from approximately 11 million sockeye spawners.

The present Department of Fisheries and Oceans (DFO) management strategy is to develop increasing interim escapement goals for all cycle-years by reducing the exploitation rate of the commercial fisheries. Interim escapement goals of 1.0 million-fish on a dominant year to 250,000 fish on the lowest off-cycle year were to be achieved by 1995; they were achieved in 1989. These improvements ensure that there can be a less restrictive approach to managing the aboriginal fisheries and to providing a commercial opening for the Early Stuart. At the same time, DFO biologists are monitoring fry emigrations and adult returns (fence counts) on several streams to assess egg and fry survivals. These data will be used to help set escapement levels and desired spawning densities.

Enhancement of Early and Late Stuart stocks is under consideration. A spawning channel proposed for the Tachie River will not be required until the total escapement is increased by an additional one million fish. However, because it is estimated that the three large lakes (Stuart, Takla and Trembleur) could support the fry from 11 million spawners, there is renewed interest in developing a pilot hatchery on Takla Lake. Two other possible enhancement options are to increase lake productivity by fertilization, most likely in conjunction with a hatchery program, and to improve spawning conditions in the Kazchek and Kuzkwa systems by water storage and timely water releases.

Chinook Salmon

The majority of the chinook salmon escapement and spawning occurs in the Stuart River. Escapements for the entire HMA have ranged from a low 10-year average of 509 fish (1961-70) to a high of 2,447 fish (1981-90). From 1986 to 1990 the average escapement increased to 3,864 fish. These increases are a direct result of the imposition of catch quotas on chinook for all fisheries from southeast Alaska to Puget Sound.

Since 1982 the enhancement facility at Fort St. James has provided for the introduction of 100,000 chinook presmolts each year. However, the actual contribution of these fish to overall chinook production appears minimal with the hatchery survival rate estimated at 0.2%. This reflects a concern that stocking strategies for stream rearing chinook populations are generally not effective, and that more research on stream stocking methodology is required.

Rainbow Trout

There are two distinct races of rainbow trout in the HMA. The large (10 kg average) race is found in Stuart and Trembleur lakes and is a much sought after sports fish. As reflected through the sports catch the abundance and size of these fish is declining. At present there are no estimates of the size of the spawning population or the life history; hence, management targets are not available.

The smaller rainbow race, found throughout the HMA, are abundant and no stocks are presently at risk. However, when fishing pressure on a previously unexploited rainbow stock increases -- usually due to improved access -- the largest fish are usually harvested immediately, resulting in a drop in the overall size.

Lake Trout

Lake Trout are present in the three major lakes (Stuart, Trembleur, Takla) and in many of the smaller lakes throughout the HMA. Lake Trout up to 23 kg have been caught, but based on sports catches, most fish average from 7 to 11 kg and the overall population is exhibiting a downward trend. At present there are no population estimates and knowledge of spawning areas and specific life histories are lacking; hence, management targets are not available.

Kokanee

Kokanee are present in the three large lakes and in most of the smaller lakes throughout the HMA. These fish are smaller than the kokanee found in adjacent systems such as the Babine. Although this reduces their desirability as a sport fishing species, kokanee are the major food item for the large rainbow trout and lake trout. Recent work has suggested that the adult population of kokanee in Takla Lake could range from 100,000 to 500,00 fish. However, there are no estimates of the total population for the HMA or the size of the individual stream spawning populations; hence, management targets are not available.

Lake Whitefish

Lake Whitefish are present throughout the HMA and an important species in aboriginal fisheries. Again there are no population estimates and spawning sizes are not known.

FISH PRODUCTION ISSUES

Sockeye salmon enhancement and resident species interactions

The potential exists for a significant increase in both early and late sockeye salmon production in this HMA by both hatchery introductions and continued management of commercial interception. However, to date these proposed enhancements have not been considered in the light of possible interactions between sockeye and the resident fish populations.

- **Kokanee and sockeye lake rearing competition**

Production estimates for sockeye lake rearing capability have not considered the present or potential levels of kokanee populations. A recent study suggests that Kokanee comprise 30% of the salmon population in Takla Lake. However, the size of the kokanee population in the rest of HMA is not known. Hence, it is not known if kokanee levels will curtail projected sockeye production levels, or if increased sockeye densities could adversely affect kokanee production.

- **Kokanee production influence on rainbow and lake trout production**

If sockeye production could, in fact, curtail kokanee production, then there are ramifications on the large race of rainbow trout and lake trout populations. The larger kokanee in the three large lakes are the main food supply for these two sports fishing species.

- **Sockeye, lake trout and rainbow trout production**

Concerns have been expressed in the sockeye production plan about the effects of rainbow and lake trout predation on sockeye salmon fry, and predator control plans have been suggested.

Kazchek and Kuzkwa water storage proposals

The proposals to improve sockeye spawning in the Kazchek and Kuzkwa systems by water storage could have impacts on the existing resident fish populations in these systems. As well, it has not yet been shown that additional water storage can aid in increasing winter flows or controlling summer water temperatures.

RECOMMENDATIONS

- Estimates of the size of the kokanee spawning population and the resultant lake rearing populations are required for areas where increased sockeye production could affect kokanee production.
- Research on the interaction of lake rearing populations of kokanee and sockeye fry is required.
- Work by Wood and Foote (1991) suggest that adult kokanee are smaller in Takla lake than Babine lake, suggesting some sort of production constraint. It is suggested that sockeye carrying capacity of these lakes be re-assessed in light of this work.
- Research is required to assess the feeding patterns and diets of lake trout and large rainbow in the sockeye lakes to determine the impacts of increased sockeye production.
- Estimates of population size and location of spawning areas for lake trout and large rainbow trout are required.
- Additional inventory of available and useable spawning area for sockeye is needed for the Driftwood River because at present it is known that the amount of spawning gravel in the Driftwood has been underestimated, due to concerns over dewatering during the winter.
- For both production and habitat management purposes, the location of all existing and potential sockeye and chinook spawning areas should be mapped.
- The proposed use of Kazchek and Kuzkwa lakes for water storage for enhancement of sockeye spawning downstream requires inventory of the fisheries resources in these systems and analysis of the actual benefits to sockeye production. Included in a cost benefit analysis must be an analysis of additional available water and the potential for stream temperature modification.
- There are known barriers on Sakeniche, Kuzkwa, Kazchek and Pinchi rivers. These barriers should be re-assessed for possible sockeye enhancement opportunities, and cost benefits compared to hatchery and spawning channel production.
- Additional work is required on stream stocking strategies for chinook salmon, and net contribution to the chinook fishery.

2.1.2 Forestry development

In the past 10 years forestry development has spread throughout the entire HMA, and many new areas are under initial development plans. Forest harvesting and road construction can have a major impact on fish producing streams, but impacts can vary greatly as the stability of hillslopes, valley walls and stream channels vary. A series of seven habitat sub-units for the HMA were created, based mainly on terrain and channel stability factors. An analysis of these sub-units is presented in Section 2.3. However, several key forestry concerns arise as a consequence of this sub-unit analysis.

- The Lower Takla/Middle Mountains sub-unit (Figure 2.3) is the most unstable of the seven units. Stream channels are steep and laterally unstable, valley walls and hillslopes are unstable, and landslides deposit materials directly into fish bearing streams. This sub-unit supports 40% of the total sockeye escapement for the HMA and contains 51% of the total spawning area in the HMA. It is apparent that, due to the significant stability problems in the sub-unit, logging could have a serious impact on sockeye production within the entire HMA.
- The Takla/Driftwood Uplands (Figure 2.3) supports 30% of the sockeye run for the HMA and will in the next 10 years be developed for logging. Lateral channel stability and valley wall stability are of great concern.

RECOMMENDATIONS

- It is strongly suggested that logging be deferred from the Lower Takla/Middle Mountains sub-unit. At present the risks to the Early Stuart run and Late Middle River run are too high to allow logging to continue.
- In the Takla/Driftwood Uplands and Mountains units logging and road construction should be set back from valley walls and floodplains. This is not a simple prescription to adopt since there are extensive floodplain areas with high timber values throughout the Driftwood River.
- Generally, one should avoid logging on fans of fish bearing and, in particular, sockeye spawning streams. As well, logging should not occur on valley walls adjacent to fish bearing streams, since, for the most part, they are unstable, and materials from landslides can move directly into stream channels.

- If logging is to occur in drainages where instability may be a problem, an inventory is required to map areas of streams where logging unstable channels, valley walls and hillslopes could impact on fisheries resources.
- Detailed mapping of actual spawning areas is also required throughout the HMA in order to create detailed logging plans.

2.1.3 Other land-use issues

- Upgrading of the B.C.Rail through the Driftwood River valley will require a great deal of attention by fisheries managers, due to the potential impacts of construction on important spawning and rearing streams.
- Acid mine and heavy metal runoff into Pinchi Lake from the Cinnabar Mine is still an issue, since the fish in Pinchi Lake are considered unsafe to eat.
- Recreational property and village development are of general concern. In particular, sewage and waste disposal in Fort St. James should be monitored.

2.1.4 Climate change

Long-term climate analysis shows that there have been increases in annual precipitation, annual snowfall, average mean temperature and average August temperature over the period of record (Section 4.2). Concerns have been expressed over water temperature increases in the Fraser system which could affect sockeye migration. It is recommended that these climate changes be considered as how they may relate to the enhancement strategy. For instance, the potential for continuing temperature increases in the Kazchek and Kuzkwa systems could negate proposed water storage proposals for this system.

2.2 Timing of In-stream Construction

The time period permitted for work in and around streams, the in-stream construction timing requirements, are shown in Figure 2.1. The general timing for in-stream work is from July 1 to September 1. However, timing in or around an Early Stuart spawning stream is from June 7 to July 15, and work around a Late Stuart Sockeye stream is from June 7 to between June 30 and July 31. Specific timings and project approvals must be obtained from DFO for work on Stuart, Takla and Trembleur lakes.

2.3 Water Extraction Approval Requirements

Water extraction restrictions are summarized in Figure 2.2 and the stream classification definitions are as follows:

1. Water Extraction Prohibited

These watersheds have high salmon values and are already constrained in some way (beaver dams, dewatering, obstructions, low winter flows/survival concerns, temperature, etc.) by existing flow regime. Water extraction may not be permitted by DFO on these watersheds. Timing constraints may apply.

2. Limited Water Extraction

Limited extraction of water may be permitted, but each request will be assessed on both an individual and a cumulative basis. Cumulative extractions may result in a deterioration in fish habitat. Consequently, DFO may reject a request by an individual if the amount proposed for extraction is deemed to cause cumulative concerns. In addition, water extraction requests will be assessed on a site-specific basis. Requests for water removal from a headwater lake may be less of a concern than removal from a tributary adjacent to a spawning area. Timing constraints may apply.

STUART - TAKLA HABITAT MANAGEMENT AREA



General timing (unless otherwise noted)
July 1 - September 1

Site specific = Must obtain a specific timing approval from the Fisheries Agencies for work in Stuart, Takla and Trembleur lakes.

S = Specific timing for early sockeye spawning streams June 7 - July 15

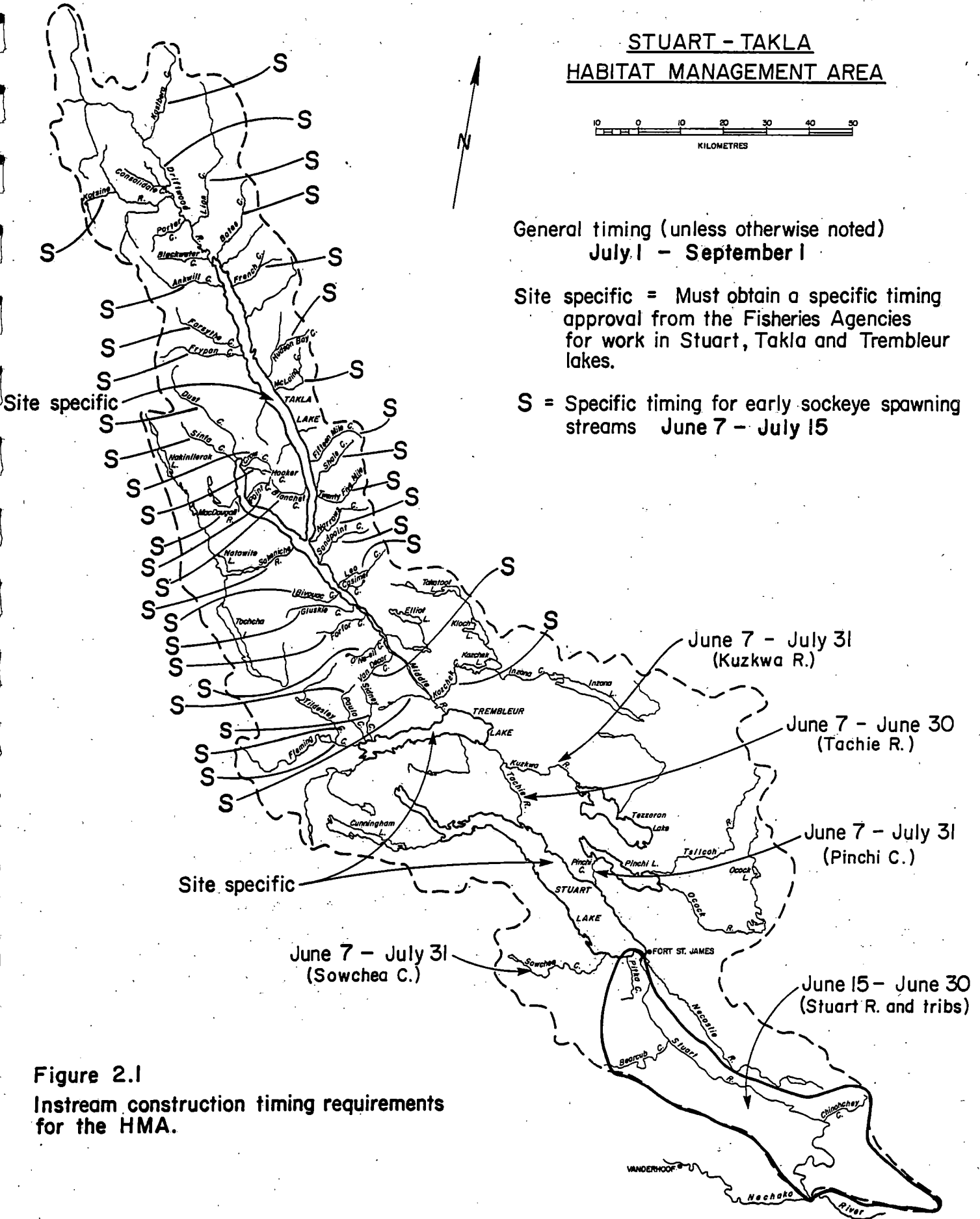
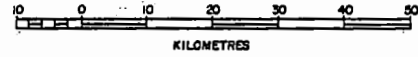


Figure 2.1
Instream construction timing requirements for the HMA.

STUART - TAKLA HABITAT MANAGEMENT AREA



All water extractions require a water licence approval from B.C. Environment. However additional restrictions are applied to specific streams in the HMA.

P = Prohibited: water extraction may not be approved due to existing low flow conditions.

L = Limited: water extraction may be subject to limitations.

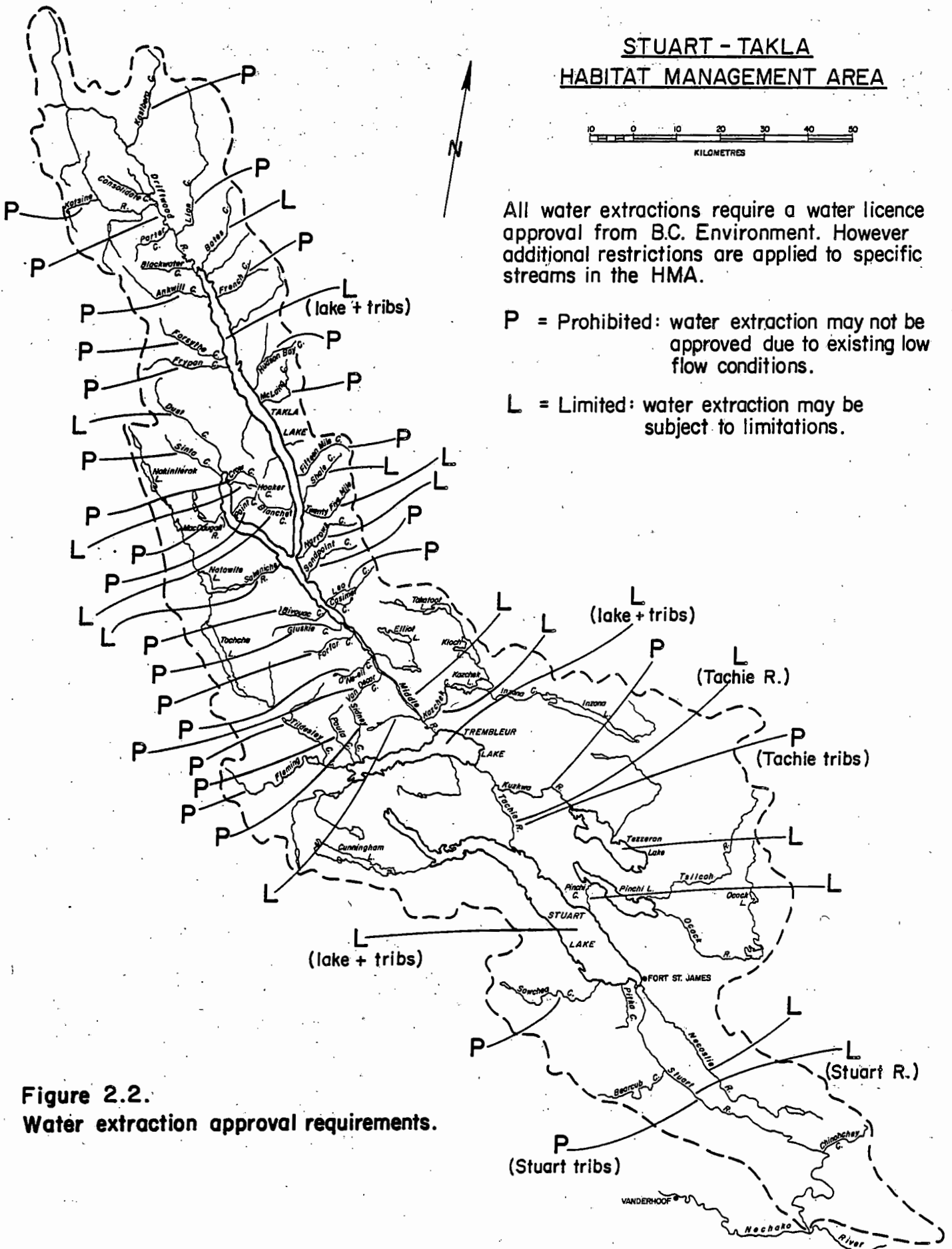


Figure 2.2.
Water extraction approval requirements.

2.4 Habitat Sub-units

The Stuart/Takla HMA (Figure 2.3) contains a wide range of physiographic conditions (Section 4) in which lakes and streams are subject to a variety of terrain and stability conditions, depending on the system's location in the HMA. The habitat sub-unit classification is described in Section 4.5, and the sub-units are shown in Figure 2.3.

The creation of the sub-units was based on lumping together streams that were controlled by, or exposed to, similar physical conditions, such as:

- all streams within similar terrain units, (i.e., plains, plateaus, foothills or mountains),
- all streams exposed to similar levels of terrain stability, (i.e., landslides, no landslides, extensive bedrock, or predominately unstable fine grained materials),
- all stream channels of similar channel morphology, (i.e., steep and confined, meandering with wide floodplains, or extensive fans at stream mouths), and
- all streams having similar water supplies, although usually taken into account within similar terrain units, (i.e., no lakes, numerous lakes, wetlands, glaciers and or differences in snow-pack).

Because terrain, water sources and terrain stability factors are similar for each sub-unit, micro-climates, water temperatures, periods of run-off, and fish population life histories are also similar. Hence, it is possible to apply specific habitat protection or fisheries production prescriptions to each sub-unit. These prescriptions can deal with forestry and land development concerns, and provide a suitable base for analysis of fisheries production issues and conflicts.

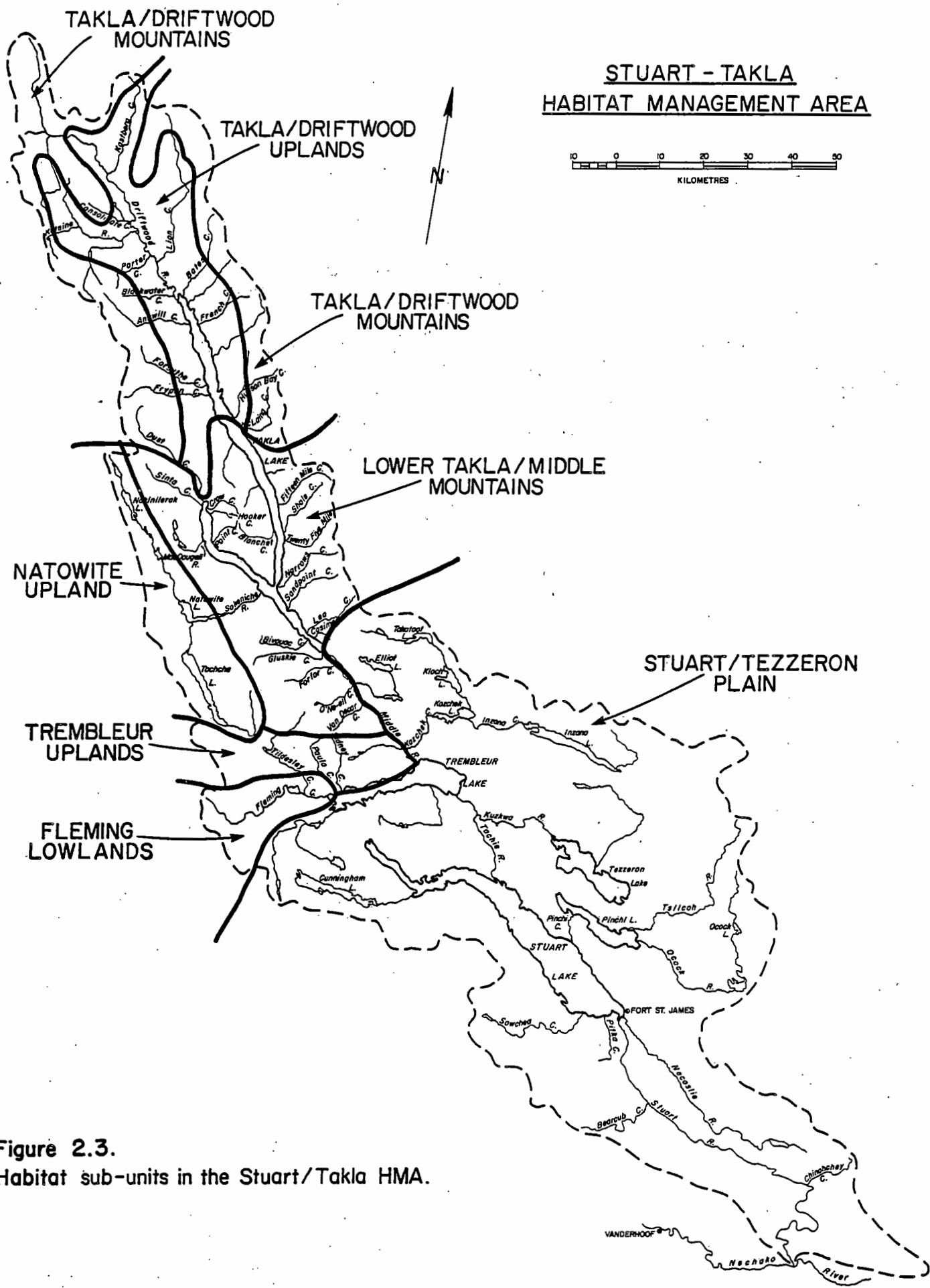


Figure 2.3.
Habitat sub-units in the Stuart/Takla HMA.

For each habitat sub-unit the following issues are discussed.

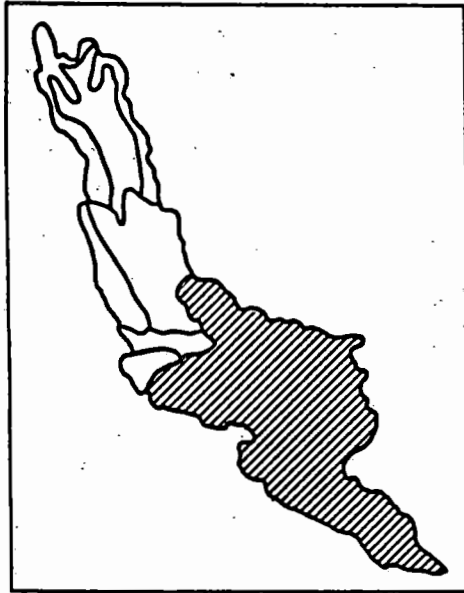
General Description	The location of the sub-unit, streams present and main physiographic features are described.
Fish Production	The status and management objectives for sockeye, chinook and kokanee salmon, and lake trout, rainbow trout and lake whitefish.
Watershed Sensitivity	The land and channel stability of each unit is discussed as well as concerns, if any, over water temperatures.
Present and Proposed Land Use	The known plans and objectives for forestry, mining, and B. C. Rail.
Fish Production Objectives	Based on the Fisheries Production Plan (Section 3) the key fish production objectives for the sub-unit are described.
Habitat Management	Fisheries management is discussed in terms of land use issues as well as in terms of competing fisheries species management objectives. Basic working requirements such as water withdrawal and timing of in-stream construction are also outlined.
Action Required	This is a series of recommendations for action based on an analysis of fisheries values and proposed land uses for the sub-unit, that will protect existing fisheries resources or advance fisheries management objectives.

Site-specific information is available for all the known salmon spawning streams.

Appendix I provides a summary of the values and concerns for each stream, and Appendix II provides a summary of stream sensitivities.

HABITAT SUB-UNITS

STUART/TEZZERON PLAIN



General Description

Stuart-Tezzeron Plain (Figure 2.3), which covers half of the HMA from the southern shore of Trembleur Lake to the Stuart-Nechako confluence, is a broad, low lying area characterized by low gradient, relatively stable streams. The large streams in this sub-unit include the Stuart and Tachie rivers. The Middle River has been included in the "Middle River Lower Takla Mountains Sub-unit" because land-use in that sub-unit will have a more significant effect on the Middle River. The other major systems include the Kazchek, Kuzkwa, and Pinchi river systems. Stream reaches adjacent to Stuart Lake are down-cut, leaving unstable valley walls as the primary source of sediment to streams. Hillslope stability is not a major factor. The Stuart and Tachie rivers are the largest

streams in the sub-unit, and most of the salmon streams in this sub-unit are lake fed and have stable hydrographs. The larger streams, Stuart and Tachie rivers, have relatively low susceptibility to land use impacts. Land use -- forestry, placer mining and linear development -- have affected the Tachie River, Middle River, Kuzkwa River and Kazchek Creek, but the impacts have been minor and restricted to site-specific locations.

Fish Production (See Section 3 for greater detail.)

Sockeye Salmon

Tachie River supports the main late Stuart sockeye run, but significant runs are also found in Kazchek and Kuzkwa rivers, with minor runs present in Pinchi and Sowchea rivers.

Total sockeye escapement for the dominant cycle-years for all streams in the Stuart/Tezzeron Plain Sub-unit.										
Total escapements for dominant cycle-years, late runs for Kazchek, Kuzkwa, Pinchi, Tachie and Sowchea Rivers.										
	1953	1957	1961	1965	1969	1973	1977	1981	1985	1989
Late	124,196	194,237	232,377	75,746	95,723	121,811	65,621	122,736	160,220	299,566
Average escapement for the 1953 to 1989 period: 149,223									Total HMA: 29.3%	
Average escapement for the 1973 to 1989 period: 153,991									Total HMA: 29.2%	
Number of sockeye spawning streams in the Sub-unit: 5									Total HMA: 10.0%	
Total available spawning area in the Sub-unit (m ²): 271,800									Total HMA: 26.4%	
Estimated total spawning capacity (# of fish): 502,500									Total HMA: 25.9%	

Chinook Salmon

The Stuart River, below Stuart Lake, supports the main chinook population in the HMA, with small populations in Pinchi Creek, Kuzkwa River, Kazchek Creek, and Tachie River. From 1981 to 1988 this sub-unit had an average run size of 2,078 chinook, most of which are concentrated in the Stuart River downstream of the Stuart Lake outlet. In 1991 an escapement of 7,000 chinook was recorded in the Stuart River, the maximum recorded for this stream.

Lake Trout

Significant populations of lake trout are found in Stuart and Trembleur lakes and as well as in a number of the smaller lakes. Of the smaller lakes, Cunningham Lake is of particular note as a significant producer of larger, trophy sized lake trout. Most of the other middle sized lakes, such as Pinchi, Tezzeron, Inzana and Kazchek, also have populations of lake trout.

Rainbow Trout

All of the lakes and most of the streams within this sub-unit have substantial populations of rainbow trout, and most of the larger lakes, such as Pinchi, Tezzeron, Kazchek and Inzana, are popular rainbow fishing lakes. Stuart and Trembleur lakes also have sports fisheries for rainbow, but in Stuart Lake there is a race of large rainbow (up to 10 - 15 kg) which provides a prized trout fishery.

Kokanee

Kokanee are found in all of the large and moderate sized lakes, and provide not only an important sports fishery, but also the main food source for lake trout and rainbow trout. Kazchek Creek supports an extremely large spawning run of kokanee. Other major kokanee spawning streams include Pinchi, Tachie and Kuzkwa rivers.

Lake Whitefish

In some lakes, such as Inzana, the lake whitefish provide an important aboriginal food fishery.

Watershed Sensitivity

Lateral stream channel stability

The streams are low gradient and meandering, with little evidence of lateral instability. The streams are generally low energy and are not capable of flows that would cause significant lateral instability. Generally, the most unstable areas within this region are the fans, which also show relatively little evidence of lateral channel shifting.

Valley wall stability

Where streams have down-cut, the valley walls are unstable. Numerous old revegetated and some recent slope failures indicate that the valley walls are unstable throughout this sub-unit. If slope failures occur in the Sowchea or Pinchi Creek valleys it is very likely that material would enter the creeks. Lacustrine deposits are up to 30 m thick in this sub-unit and create a general hazard due to the high erosion potential.

Hillslope stability

Hillslopes are not a significant feature in this sub-unit.

Water temperature concerns

The streams in this sub-unit are subject to significant increases in temperature during the summer, due to the early loss of snow pack, the large number of lakes and wetlands in the headwaters, and the low gradient nature of the stream channels. This is particularly true in the larger systems such as the Kuzkwa, Kazchek and Pinchi rivers.

Present and Proposed Land Use

Forestry

A large proportion of this area has been logged, and emphasis is now on the Upper Kazchek drainage area, particularly the Kloch, Kazchek and Inzana lakes area. Also of concern is proposed logging in the Lower Stuart River Drainage in areas adjacent to known chinook spawning and rearing areas.

Mining

New mining activity is not has not been proposed. However, effects of mining in the Pinchi drainage are still of concern. Placer mining is permitted within the three designated placer mining areas in this sub-unit (Figure 6.7).

B.C. Rail

This section of the railway is operational, and no significant additional upgrading is expected.

Fish Production Objectives

Salmon production

Based on the sockeye production plan (Section 3.1), the present spawning capacity is under-utilized for sockeye salmon. Long-term plans for water storage on the Kazchek and

Kuzkwa have been developed to improve their spawning capability, and a spawning channel is also proposed for the Tachie River.

Resident species

Maintenance of rainbow and lake trout production in Stuart and Trembleur lakes is of the utmost importance. As well, the health of these stocks depends on the health of the kokanee population. For the numerous lakes in this section, the management objective is to maintain existing stocks in order to support the growing sports fishery.

Habitat Management

Forestry management

Due to the structure of the terrain adjacent to streams, it is possible to identify areas of potentially high impact and to mitigate potential effects. At fish bearing streams, logging should not be permitted within stream floodplains, on stream fans, and on or adjacent to the valley walls of the streams. If logging is set back from the edge of valley walls, impacts to streams from mass wasting and erosion will be minimized. These concerns are particularly important in the Kazchek, Kuzkwa, Pinchi and Sowchea rivers.

Water temperatures are also of concern, particularly in lake headed systems, and stream-side vegetation management is required to mitigate temperature concerns. This issue is related to the rate of cut, which is most likely the key to mitigating this concern.

Fisheries management

Studies are required to determine the impacts and benefits of sockeye enhancement on the productivity of Stuart and Trembleur Lake and in particular impacts or benefits to kokanee, lake trout and rainbow trout production in these lakes. As well, the effects and impacts of proposed water storage on lakes in the upper Kuzkwa and Kazchek systems, suggested for sockeye spawning enhancement, must be evaluated.

Timing of in-stream work

In an attempt protect fisheries resources from the direct effects of development, it is expected that all in-stream work be done from July 1 to September 1. However, for the Tachie and Stuart rivers, the timing is from June 7 to June 30, and for Kuzkwa, Kazchek, Pinchi and Sowchea the timing is from June 7 to July 31. The only other exception is for Stuart and Trembleur lakes, where timing is site-specific and must be negotiated with the Department of Fisheries and Oceans and B.C. Ministry of Environment, Lands and Parks.

Water extraction prohibited

Due to high fisheries values and limited water supply, the Department of Fisheries and Oceans may not permit water extraction from the Sowchea River, Stuart River tributaries and Tachie River tributaries.

Limited water extraction

Due to high fish values, the Department of Fisheries and Oceans requires that their approval be obtained, and limitations set before water extraction proceeds on the Stuart River and Stuart Lake tributaries, Trembleur Lake and south side Trembleur Lake tributaries, Necoslie River, Pinchi River, Kazchek River, and Trembleur Lake.

Action Required

Inventory

Due to the proposed logging and water storage development in the Kazchek and Kuzkwa drainages, inventory of the fisheries resources should be conducted in order to address these specific concerns. Stability analysis of stream channels and valley wall slopes and the present fisheries value of streams (spawning and rearing) and lakes that could be affected by water storage should be considered. The engineering requirements for such a water storage project must, therefore, be provided.

Monitoring

It is important to monitor the effects of logging in the Kazchek and Kuzkwa drainages to determine whether logging is having a marked effect on stream temperatures.

Due to the extensive area open to placer mining and concern about the effects of placer operations on Sowchea and Stuart rivers, the effects of placer developments should be monitored.

An assessment of the residual impacts as a result of the construction of the B.C. Rail should also be compiled, to aid in future development projects with the company.

Research requirements

Studies are required on enhancement of sockeye stocks in Trembleur and Stuart lakes, specifically the effects this will have on rainbow trout, lake trout and kokanee production and the effects these species could have on sockeye production.

The potential benefits to sockeye production from the water storage proposal on Kazchek and Kuzkwa rivers must be analyzed, particularly in terms of temperature concerns, increased production and the benefit-cost.

FLEMING LOWLANDS



General Description

Fleming Lowlands (Figure 2.3), which drains into Trembleur Lake, contains only Fleming Creek and the lower end of its main tributary, Tildesley Creek. Fleming Creek has relatively little lateral instability due to the swampy, meandering nature of the stream. Unstable valley walls are set back from the stream and present little danger to the watercourse. The Fleming Creek drainage is presently in an undeveloped state.

Fish Production (See Section 3 for greater detail.)

Sockeye Salmon

Fleming Creek supports an early sockeye run; however, most of the spawning occurs in its tributary, Tildesley Creek.

Total sockeye escapement for the dominant cycle-years for all streams in the Fleming Lowlands Sub-unit.										
Total escapements for dominant cycle-years, early runs for Fleming Creek.										
	1953	1957	1961	1965	1969	1973	1977	1981	1985	1989
Early	20	0	14	9	598	3,211	616	343	1,687	8,699
Average escapement for the 1953 to 1989 period: 1,520									Total HMA: 0.3%	
Average escapement for the 1973 to 1989 period: 2,911									Total HMA: 0.6%	
Number of sockeye spawning streams in the Sub-unit: 1									Total HMA: 2.5%	
Total available spawning area in the Sub-unit (m ²): 5,000									Total HMA: 0.5%	
Estimated total spawning capacity (# of fish): 9,500									Total HMA: 0.5%	

Chinook Salmon

Chinook salmon are not present in this area.

Lake Trout

Lake trout are present in Trembleur Lake.

Rainbow Trout

It is suspected that rainbow spawn and rear in Fleming Creek, and it is known that Trembleur Lake supports a race of large rainbow trout.

Kokanee

Kokanee are present in Trembleur Lake, but spawning has not been identified in this sub-unit. The key spawning stream is in the Kazchek River.

Lake Whitefish

Whitefish are present in Trembleur Lake.

Watershed Sensitivity

Lateral stream channel stability

Fleming Creek and the lower sections of the tributary stream meander through swamps and meadows in the valley bottom. Channels are relatively stable, with the exception of lower Fleming Creek below Tildesley Creek. Channel instability in this area is the result of sediment input from Tildesley Creek.

Valley wall stability

Old instability features are evident along the valley walls throughout this sub-unit. However, since the valley walls are generally set back from the streams, risk of a landslide entering the stream is low.

Hillslope stability

Hillslopes are not present in this unit.

Water temperature concerns

Removal of vegetation from the stream channel and wetlands could affect the water temperature regime of Fleming Creek, particularly upstream of the Tildesley confluence.

Present and Proposed Land Use

Forestry

Fleming Creek, upstream of Fleming Lake, has been logged extensively, but the lower end is unlogged. No logging has been proposed for this lower area, but there is a joint proposal by the B.C. Ministry of Forests and the B.C. Ministry of Environment, Lands and Parks to establish a wilderness area over the lower end of this drainage.

Mining

Mineral claims are present, but there are no active developments. This area is in a "No Staking Placer Reserve".

Fish Production Objectives

Salmon production

It is intended to increase sockeye production by management of escapement levels to effect greater utilization of available spawning and rearing areas.

Resident species

It is intended to maintain existing stocks and populations to support the existing sports fisheries.

Habitat Management

Forestry management

The key to protection of fisheries resources is to avoid road and logging development on the floodplain, wetlands, or valley walls of Fleming Creek. Tildesley Creek has the potential to be affected by present standard rates of cut.

Fisheries management

Studies to examine the impacts and the benefits of sockeye enhancement on the productivity of Trembleur Lake and, in particular, the relationship to kokanee, lake trout and rainbow trout production are required.

Timing of in-stream work

In an attempt to protect fisheries resources from the direct effects of development it is expected that all in-stream work be done from July 1 to September 1. However, time for Fleming Creek is specified as June 7 to July 15. If work is to be done on Trembleur Lake,

an appropriate work period must be negotiated with the Department of Fisheries and Oceans and B.C. Ministry of Environment, Lands and Parks.

Water extraction prohibited

Due to high fisheries values and limited water supply, the Department of Fisheries and Oceans may not permit water extraction from Fleming and Tildesley creeks.

Limited water extraction

Streams are not specified for this sub-unit.

Action Required

Inventory

Assessment should be made of the relative importance of Fleming and its tributary Tildesley creeks to sockeye spawning. There is some indication that Tildesley Creek is the main spawning stream.

Monitoring

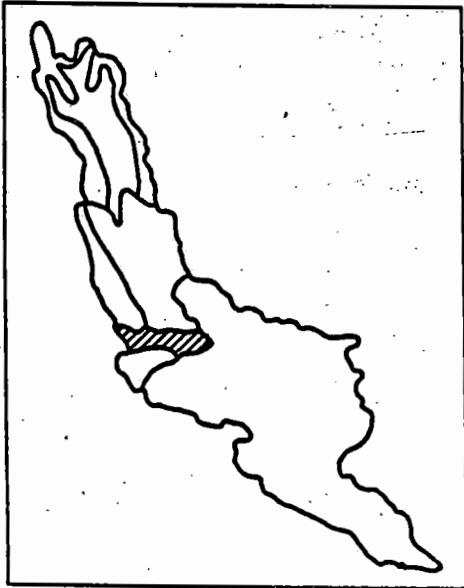
Water temperature conditions should be monitored in Fleming Creek, producing baseline information, to ensure that logging does not dramatically alter downstream water temperatures.

Research requirements

In the Trembleur Lake system, the effects of the proposed sockeye enhancement on kokanee, lake trout and the larger race of rainbow trout should be studied.

A rate-of-cut analysis may be required for Tildesley Creek, and the reasons for such concerns should be further analyzed. At present this area has been included in a proposed wilderness area and, hence, such studies may not be required if the area is protected.

TREMBLEUR UPLANDS



General Description

Trembleur Uplands (Figure 2.3) encompasses a transition between the plateau and mountainous zones located on the north side of Trembleur Lake. This sub-unit includes all the streams on the north slope of Trembleur Lake, west of the Middle River, and includes Tildesley Creek (Fleming Creek tributary), Paula Creek, Sidney Creek and Baptiste Creek. Streams in this sub-unit are actively downcutting and have steep slopes and unstable valley walls. Laterally unstable fans emphasize the extremely sensitive nature of these watercourses.

Fish Production (See Section 3 for greater detail.)

Sockeye Salmon

Early run sockeye are present in Tildesley, Paula and Sidney creeks. Tildesley Creek totals are included in Fleming Lowlands.

Total sockeye escapement for the dominant cycle-years for all streams in the Trembleur Uplands Sub-unit.										
Total escapements for dominant cycle-years, early runs for Paula and Sidney creeks.										
	1953	1957	1961	1965	1969	1973	1977	1981	1985	1989
Early	2,211	14,999	4,497	1,483	6,673	10,215	3,016	7,818	23,825	22,986
Average escapement for the 1953 to 1989 period: 9,772									Total HMA: 1.9%	
Average escapement for the 1973 to 1989 period: 13,572									Total HMA: 2.6%	
Number of sockeye spawning streams in the Sub-unit: 2									Total HMA: 5.9%	
Total available spawning area in the Sub-unit (m ²): 15,000									Total HMA: 1.5%	
Estimated total spawning capacity (# of fish): 32,300									Total HMA: 1.7%	

Chinook Salmon

Chinook salmon are not present in this area.

Lake Trout

A significant lake trout population is present in Trembleur Lake.

Rainbow Trout

A significant rainbow trout population is present in Trembleur Lake, including a race of large rainbow, and it is expected that most streams in this sub-unit support spawning and rearing for rainbow.

Kokanee

A kokanee population is found in Trembleur Lake and it is known that spawning occurs in Paula and Sidney creeks.

Lake Whitefish

Whitefish are present in Trembleur Lake.

Watershed Sensitivity

Stream channel stability

Paula and Sidney creeks have formed large fans in their lower 4 km that display features indicating lateral instability within the active channel. There are no indications of old channels across the historic fans, suggesting that the channels have shown relative stability in recent times.

Valley wall stability

Valley walls are unstable, with numerous old and recent failures evident. Failures on the valley walls will result in direct input of material to the stream channels.

Hillslope stability

Hillslopes are not adjacent to the stream channels in this sub-unit, and adequate buffering between streams and hillslopes is present.

Water temperature concerns

There are no known water temperature concerns in this sub-unit.

Present and Proposed Land Use

Forestry

A forestry access road to Baptiste Lake exists, and there is active logging in the Baptiste Creek watershed. Logging has not yet occurred in Sidney or Paula creeks; however, 5 cutblocks are proposed in Sidney Creek from 1994 to 1996.

Mining

Mineral claims are present. However, there are no development plans. This area is within a "No Staking Placer Reserve".

Fish Production Objectives

Salmon production

At present, the only objective within this sub-unit is to increase present production through management of escapements of the Early Stuart run. If the 1985 and 1989 sockeye escapement figures (Table 3.3, Section 3) are any indication, this management approach has been successful.

Resident species

The present objective of the B.C. Ministry of Environment, Lands and Parks is to maintain present production levels for the existing sports fisheries in Trembleur Lake.

Habitat Management

Forestry management

There is high potential for major impacts to the high capability sockeye spawning streams in this sub-unit due to logging of the floodplains, in particular the fans and valley walls of these stream channels. These unstable features should be delineated, and proposed logging examined and possibly deferred in areas of high risk.

Fisheries management

Studies to examine the impacts and the benefits of sockeye enhancement on the productivity of Trembleur Lake and, in particular, the relationship to kokanee, lake trout and rainbow trout production are required.

Timing in-stream work

In an attempt to protect fisheries resources from the direct effects of development, it is expected that all in-stream work be done from July 1 to September 1. However, a specific regulation of June 7 to July 15 is in place for early sockeye streams (Paula and Sidney). Trembleur Lake timing is site-specific and must be negotiated with the federal and provincial fisheries agencies.

Water extraction prohibited

Due to high fisheries values and limited water supply, the Department of Fisheries and Oceans may not permit water extraction from Tildesley, Paula, Sidney and Fleming creeks.

Limited water extraction

No streams are present in this class.

Action Required

Inventory

It is suggested that a stability inventory of the hillslopes, valley walls and stream channels of Sidney and Paula creeks be undertaken, in order to develop a logging protection plan for this system.

Monitoring

Some monitoring of the effects of logging on Baptiste Creek should be undertaken, in order to prepare for possible logging in Paula and Sidney creeks.

LOWER TAKLA/MIDDLE MOUNTAINS



General Description

The Lower Takla/Middle Mountains sub-unit (Figure 2.3) includes the Middle River and all the tributaries to Takla Lake found in the lower two-thirds of the system. The known fish producing Takla Lake tributaries range in size from 13 km² to 250 km², with Sakeniche River the exception. Streams in this subdivision are steep and the entire drainage system is influenced by mountainous terrain. The streams are high energy systems capable of moving significant volumes of sediment. These water courses have large unstable fans at their mouths, particularly those along the west side of Middle River and all of Takla Lake. Valley walls and hillslopes are highly unstable and provide significant volumes of sediment to stream channels. All streams in this subdivision are small

and extremely sensitive to damage from naturally occurring terrain instability. Middle River has been included in this sub-unit because of its susceptibility to the downstream impacts of terrain instability on the tributaries on its west side.

Fish Production (See Section 3 for greater detail.)

Sockeye Salmon

This sub-unit contains 53% of the sockeye spawning streams, and 50% of the total spawning capacity of the HMA. Middle River, which has been included in this HMA, has a Late Stuart sockeye run. The Early Stuart sockeye salmon spawning streams in this unit include Middle River, Van Decar, O'Ne-ell, Bivouac, Sakeniche, MacDougall, Sinta, Crow, Hooker, Point, Blanchet, Fifteen Mile, Shale, Twenty Five Mile, Narrows, Sand Point, and Leo creeks.

Total sockeye escapement for the dominant cycle-years for all streams in the Lower Takla and Middle River Mountains Sub-unit.

Total escapements for dominant cycle-years, early and late runs.

	1953	1957	1961	1965	1969	1973	1977	1981	1985	1989
Early	107,668	134,169	65,742	12,074	39,120	93,115	26,384	55,134	89,493	68,410
Late	244,334	336,279	177,416	139,186	111,291	91,862	80,381	126,439	114,115	276,131
Total	352,002	470,448	243,158	151,260	150,411	184,977	106,765	181,573	203,608	344,541

Average escapement and percentage for the 1953 to 1989 period: early = 69,131 (13.6%), late = 169,743 (33.4%), total = 238,874 (47%).

Average escapement and percentage for the 1973 to 1989 period: early = 66,507 (12.6%), late = 137,786 (26.1%), total = 204,293 (38.8%).

Number of sockeye spawning streams in the Sub-unit: 18 Total HMA: 52.9%

Total available spawning area in the Sub-unit (m²): 530,900 Total HMA: 51.5%

Estimated total spawning capacity (# of fish): 973,300 Total HMA: 50.2%

Chinook Salmon

A small run of chinook salmon (maximum escapement of 25) is found in Middle River.

Lake Trout

Lake trout in Takla Lake provides the primary sports fishing species in this sub-unit.

Rainbow Trout

Rainbow trout present in Takla Lake are a component of the sports fishery, although the race of large rainbows found in Stuart and Trembleur lakes are not found in Takla Lake. Rainbow are present in most of the streams, but usually not in sufficient numbers or size to have sports fishery value. The exceptions are the Middle and Sakeniche rivers.

Kokanee

There is a large kokanee population in Takla Lake and the majority spawn in the Driftwood River. Kokanee spawning populations are found in the majority of the sockeye spawning streams.

Lake Whitefish

Lake whitefish are present in Takla Lake.

Watershed Sensitivity

Stream channel stability

The presence of large fans at the mouths of these streams indicates a high energy nature capable of moving large volumes of material. The largest fans are evident on the streams

along the west side of Middle River and Takla Lake. These fans appear particularly unstable, and in many instances relic channels are still visible on the fans, indicating that major shifts in channel locations are still occurring.

Valley wall stability

All valley walls throughout this sub-unit are very unstable, with numerous revegetated and more recent failures evident on most of the slopes. Due to the close proximity of the stream channel to the valley wall, slope failures on the valley walls will likely result in direct input of material into the stream channel.

Hillslope stability

Hillslopes within this sub-unit exhibit instability features such as old slides and gulying, suggesting extremely unstable conditions. In many instances the hillslopes are adjacent to the stream channel, so that material may enter directly into the streams.

Water temperature concerns

Due to the mountainous terrain, which provides a longer snow pack, heavy stream vegetation cover, and streams shaded by the terrain, increases in water temperature are not a significant issue.

Present and Proposed Land Use

Forestry

Limited forest harvesting took place along some streams in the early 1980s (Leo Creek, Rosette Creek, Bivouac Creek, Sakeniche River, MacDougall Creek). Most areas have revegetated. Up to 1991 harvesting occurred in Dust Creek and Narrows Creek, and the forestry access road on the west side of Middle River has been extended to Baptiste Creek. The original logging schedule for Bivouac, Gluskie and Forfar creeks was deferred, in order to conduct an effects-of-logging study on these watersheds. Forest harvest plans for 1993 to 1996 call for some forest harvesting in the area between MacDougal and Bivouac creeks. Some harvesting will be done in the O'Ne-ell and Van Decar watersheds in 1994 to 1995. These cuts are done in conjunction with the effects of logging research study.

Mining

Numerous mineral claims are found scattered throughout the sub-unit, and there has been active mineral exploration on the west side of the Middle River. This sub-unit is in a "No Staking Placer Reserve".

B.C. Rail

This section of the B.C. Rail, along the east side of the sub-unit, is operational; minimal additional upgrading is anticipated.

Fish Production Objectives

Salmon production

The streams in this sub-unit support 40% of the entire sockeye run for the HMA and have 50% of the total available spawning area. The maintenance of this area for the production of the Early Stuart run is critical.

A pilot sockeye hatchery has been proposed for either Gluskie or Leo creeks.

An effects-of-logging study has been initiated on Bivouac, Gluskie and Forfar creeks.

Resident species

At present, the objective of B.C. Ministry of Environment, Lands and Parks is to maintain existing stock levels in streams and, in particular, Takla Lake, in order to maintain the existing sports fisheries.

Habitat Management

Forestry management

The stream channels, valley walls and hillslopes are very unstable throughout most of this area. In the majority of situations, hillslope and valley wall failures will result in direct input of sediment into these streams. Because of the value of these streams and the sensitivity of the entire area, all areas to be logged require a detailed review of stability issues and, where required, logging should be deferred.

Fisheries management

Studies to examine the impact of sockeye enhancement on the productivity of Takla and Trembleur lakes and, in particular, the inter-relationship of sockeye production to kokanee, lake trout and rainbow trout production are required.

Timing of in-stream work

To protect fisheries resources from the direct effects of development, it is expected that all in-stream work be done from July 1 to September 1. However, all sockeye spawning

streams have a specific timing of June 7 to July 15. In-stream work in Takla Lake requires special approval from both the Department of Fisheries and Oceans and the B.C. Ministry of Environment, Lands and Parks.

Water extraction prohibited

Due to high fisheries values and limited water supply, the Department of Fisheries and Oceans may not permit water extraction from Bivouac, Crow, Fifteen Mile, McLaing, Forfar, Gluskie, O'Ne-ell, Leo, MacDougall, Sinta, Van Decar, Sandpoint and Point creeks.

Limited water extraction

Due to high fish values, permission of the Department of Fisheries and Oceans is required before water extraction proceeds on Dust, Hooker, Twenty-five Mile, Narrows and Shale creeks.

Action Required

Inventory

Slope and stream channel and streambank stability mapping is required to identify the potential impact of logging on streams and fish habitat.

Monitoring

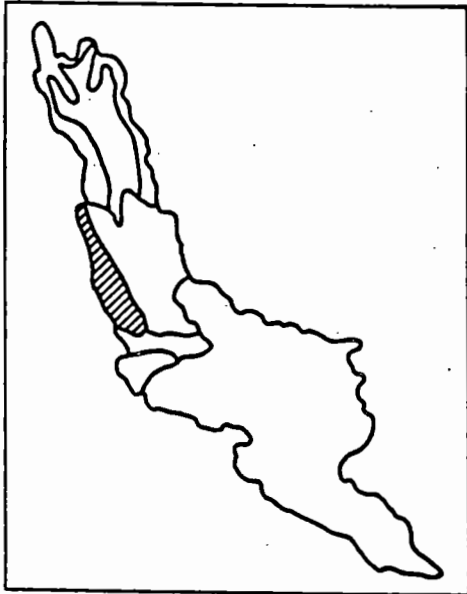
Impact assessments logged should be conducted on areas already logged.

Research requirements

An effects-of-logging study has been proposed for Bivouac, Gluskie and Forfar creeks. This study includes biological and physical data collection, including gravel sampling, large organic debris surveys, suspended sediment, spawning and fish production studies of resident and salmon species. These sorts of studies should be approached with caution because of the relative value of the streams and the potential for major loss of fish habitat, as has occurred as a result of the forest harvesting that occurred during the 15 year study at Carnation Creek.

Impact assessments usually have not considered what should be done if a landslide or major bank erosion occurs. Development of a set of contingency plans, including an immediate halt to logging and stabilization and clean up requirements, should be included in the research proposed for this sub-unit.

NATOWITE UPLANDS



General Description

The Natowite Uplands sub-unit (Figure 2.3) encompasses the upper Sakeniche drainage, including Natowite, Tochcha, and Nakinilerak lakes. Streams in this sub-unit are laterally stable, but unstable valley walls could result in significant input of sediment into stream channels.

Fish Production (See Section 3 for greater detail.)

Sockeye Salmon

Sockeye salmon are not present in this sub-unit, but are found in the Sakeniche River in the Lower Takla/Middle Mountains sub-unit.

Chinook Salmon

Chinook salmon are not present in this sub-unit.

Lake Trout

Lake trout are known to be present in Nakinilerak and Friday lakes.

Rainbow Trout

Rainbow trout are abundant throughout the lakes and streams in this sub-unit, providing a large and valuable sports fishing resource.

Kokanee

Kokanee are present in the lakes of this sub-unit.

Lake Whitefish

Lake whitefish are present.

Watershed Sensitivity

Stream channel stability

Streams in the lowland areas are stable, although the meandering nature of some stream channels suggests that over time the channels will move. In the upland section the streams are well entrenched, and hence, stable.

Valley wall stability

In the upland areas the valley walls are unstable, and failures from the valley walls will likely result in the direct input of materials to the stream channel.

Hillslope stability

Hillslope concerns are not an issue in this sub-unit.

Water temperature concerns

Due to the amount of lake and wetland area in this sub-unit, warmer summer water temperatures already exist. Additional vegetation removal could create an additional increase in water temperatures, causing some concern with management of the Early Stuart sockeye run in lower Sakeniche River.

Present and Proposed Land Use

Forestry

Extensive logging has occurred in the upper watershed, in particular, in the Natowite and Tochcha lake area. Logging has commenced and will continue in the lower Sakeniche drainage for the period from 1992 to 1996.

Mining

The lower watershed is in a "No Staking Placer Reserve" and numerous mineral claims are found throughout the sub-unit. The upper watershed is in a designated placer mining area (Figure 6.7).

Fish Production Objectives

Salmon production

No salmon production actually occurs within this sub-unit. The primary objective for the lower Sakeniche River is to maintain existing production levels, and to increase them by control of habitat quality and maintenance of the early run escapements into the HMA.

Resident species

Because of the significant amount of trout production for sports fisheries, maintenance of existing stocks is a key management objective.

Habitat Management

Forestry management

Sakeniche River has one of the few favourable incubation/flow ratios (Section 3.1.4). All logging development should be assessed as to its effect on stream flows and water temperature as it relates to sockeye production. Generally, logging should be deferred from steep slope areas and from unstable fans, in order to protect the rainbow spawning and rearing streams.

Fisheries management

Additional inventory for this area is required in order to determine the use and value of the various streams for rainbow spawning and rearing. A few streams could be responsible for much of the trout production in the area.

Timing of in-stream work

In an attempt to protect fisheries resources from the direct effects of development, it is expected that all in-stream work be done from July 1 to September 1. However, for the Sakeniche River, downstream of Natowite Lake, the timing restriction is from June 7 to July 15.

Water extraction

No streams are listed under this category.

Limited water extraction

Due to high fish values, the Department of Fisheries and Oceans' specific approval is required before water extraction proceeds in Sakeniche River and tributaries.

Action Required

Inventory

It is suggested that a hazards inventory of hillslope, valley wall, and stream channel and banks be undertaken in order to assess potential fisheries impacts of logging.

Monitoring

Extensive logging has occurred in the upper part of this watershed. The effects of such logging should be examined, with particular emphasis on the impacts on water temperatures, and channel and bank stability.

TAKLA/DRIFTWOOD UPLANDS



General Description

The Takla/Driftwood Uplands (Figure 2.3) sub-unit includes all the streams draining into the upper third of Takla Lake, as well as the Driftwood River and all tributaries to it. The extreme upper ends of the Driftwood tributaries and the mid and upper reaches of the Takla Tributaries are found in the Takla/Driftwood Mountains Sub-unit. The lower Driftwood River exhibits a moderate degree of lateral instability but the fans of Driftwood River tributaries and Takla Lake tributaries exhibit a very high degree of lateral instability. Valley walls are also very unstable and potentially can contribute large volumes of sediment to streams.

Fish Production (See Section 3 for greater detail.)

Sockeye Salmon

Driftwood River, which supports the largest portion of the Early Stuart sockeye run, and six small but productive tributaries which support Early Stuart sockeye runs are found in this sub-unit.

Total sockeye escapement for dominant cycle-years for all streams in the Takla/Driftwood Uplands Sub-unit.										
Total escapements for dominant cycle-years, early runs for Driftwood, Hudson Bay, Frypan, Forsythe, Ankwil, French and Bates creeks.										
	1953	1957	1961	1965	1969	1973	1977	1981	1985	1989
Early	40,562	79,610	125,926	9,439	62,120	189,598	86,239	65,462	118,441	267,926
Average escapement for the 1953 to 1989 period: 104,532									Total HMA: 20.6%	
Average escapement for the 1973 to 1989 period: 145,533									Total HMA: 27.6%	
Number of sockeye spawning streams in the sub-unit: 7*									Total HMA: 20.6%	
* Does not include Driftwood River tributaries									Total HMA: 20.6%	
Total available spawning area in the sub-unit (m ²): 207,600.									% of total HMA: 20.2	
Estimated total spawning capacity (# of fish): 420,300									% of total HMA: 21.7	

Chinook Salmon

A small run (average escapement of 20 fish) of chinook salmon is found in the Driftwood River.

Lake Trout / Dolly Varden Char

A significant sports fishing population of lake trout is present in Takla Lake, and Dolly Varden char are known to be present in Driftwood River.

Rainbow Trout

Rainbow trout are known to be present in Driftwood River, which includes a large resident population in Leo Creek.

Kokanee

Driftwood River has an extremely large escapement of spawning kokanee, and it is estimated that the majority of the kokanee production for Takla Lake comes from the Driftwood.

Lake Whitefish

Lake whitefish are present in Takla Lake.

Watershed Sensitivity

Stream channel stability

Meander patterns in Driftwood River indicate a gradual lateral shifting in the lower reaches with a moderate degree of instability. Lateral instability is substantially higher in the fans of the tributaries to Driftwood River and upper Takla Lake. The fan of Kotsine River, tributary to the Driftwood, exhibits a very high degree of lateral instability and is heavily utilized by sockeye for spawning.

Valley wall stability

Valley walls within this sub-unit show numerous old revegetated slope failures and, in many cases, numerous recent failures. Slope failures from the valley walls in this section will likely result in direct input of material into the stream channel. Valley wall instability was most noticeable in the Kastberg Creek valley in the upper Driftwood system. This also appears to be a major source of sediment for the upper Driftwood River.

Hillslope stability

Because the upper mountainous areas have been classified in the Upper Takla/Driftwood Mountains sub-unit, hillslope stability is not applicable to this sub-unit.

Water temperature concerns

None have been reported.

Present and Proposed Land Use

Forestry

Limited forest harvesting has taken place in French, Hudson Bay and Ankwil creeks, and in the Driftwood River valley. The majority of the sub-unit remains unlogged, although significant forestry activity is planned in the upper Driftwood River (above Lion Creek), Hudson Bay, Frypan, Forsythe and Ankwil creeks for the period 1992 to 1997.

Mining

There are a few mineral claims in this area, but at present no potential developments. This area is within a "No Staking Placer Reserve".

B.C. Rail

B.C. Rail is proposing to re-open this area by 1993, or earlier if required for forest harvesting. To make this section of the rail line operational will require re-construction of several bridges and extensive work on floodplains at Azukoltz and Bird creeks.

Development of mitigation for these proposed developments is of prime importance.

Fish Production Objectives

Salmon production

Driftwood River, as a single stream, has the largest run of Early Stuart sockeye, and is key to the maintenance of the early run. The overall sub-unit accounts for 27% of total sockeye production in the HMA and 21% of the total spawning capacity. At present, the key objective is to increase production by control of the downstream fisheries.

Resident species

The Driftwood is the key kokanee spawning stream in Takla Lake and maintenance of this stock is essential for the overall kokanee production in Takla Lake.

Habitat Management

Forestry management

To protect fisheries resources, logging of flood plains, streambanks and valley walls should be carefully considered. If long-term impacts are predicted, logging should be deferred.

B.C. Rail

Re-opening of the rail line through the Driftwood Valley will require the development of specifications for design and the creation of construction mitigation procedures.

Fisheries management

Key to sockeye management is the maintenance of existing runs and increased control of escapements into the HMA. If sockeye stocks are to be enhanced the effect on kokanee stocks must be considered.

Timing of in-stream work

In an attempt to protect fisheries resources from the direct effects of development, it is expected that all in-stream work be done from July 1 to September 1. However, for most of the streams in this sub-unit the dates specified are from June 7 to July 15, since most of the streams are either sockeye spawning streams or drain into Driftwood River.

Water extraction prohibited

Due to high fisheries values and limited water supply, the Department of Fisheries and Oceans may not permit water extraction from the Driftwood, Kotsine, Katsberg, Lion, French, Ankwil, Forsythe, Frypan, Hudson Bay and McLaing rivers.

Limited water extraction

Due to high fish values, the approval of the Department of Fisheries and Oceans is required before water extraction proceeds on Dust, Bates and Takla lakes.

Action Required

Inventory

Identification of unstable stream channels and banks, valley walls and hillslopes is critical to developing a logging management plan to protect the fisheries in this sub-unit.

An inventory should be conducted of the present status of impacts, as a result of the original B.C. Rail construction on the streams in this sub-unit. Thus, past impacts may be mitigated by proposed new construction, and potential new impacts can be identified.

The amount of useable spawning gravel for the Driftwood has been under-estimated due to the dewatering problem, and a true estimate of the spawning potential should be undertaken.

The size of the kokanee population spawning in Driftwood River and Dust Creek should be estimated, to provide input into the sockeye management plan.

Research Requirements

Much has been said about the dewatering problems in the Driftwood and research should be applied to this problem. In particular, the actual amount of stream habitat that is dewatered and the estimated survival rates in these dewatered areas should be examined.

TAKLA/DRIFTWOOD MOUNTAINS



General Description

The Takla/Driftwood mountains (Figure 2.3) surround the Takla/Driftwood Uplands. The headwaters of all streams in the Uplands sub-unit originate from this area. The stream channels are confined, and valley walls and hillslopes are generally unstable.

Fish Production (See Section 3 for greater detail.)

Sockeye Salmon

The only stream containing sockeye and found entirely in this sub-unit is McLaing Creek. The sockeye production in all other streams is accounted for in the Uplands sub-unit.

Total sockeye escapement for dominant cycle-years for all streams in the Takla/Driftwood Mountains sub-unit.										
Total escapements for dominant cycle-years, early runs for McLaing Creek.										
	1953	1959	1961	1965	1969	1973	1977	1981	1985	1989
Early	2,632	3,821	731	40	902	2,393	907	369	638	604
Average escapement for the 1953 to 1989 period: 1,304								Total HMA: 0.3%		
Average escapement for the 1973 to 1989 period: 982								Total HMA: 0.2%		
Number of sockeye spawning stream in the sub-unit: 1								Total HMA: 2.9%		
Total available spawning area in the sub-unit (m ²): 100								Total HMA: .01%		
Estimated total spawning capacity (# of fish): 200								% of total HMA: .01		

Chinook Salmon

Chinook salmon are not present in this sub-unit.

Lake Trout

Lake trout are not present in this sub-unit.

Rainbow Trout

Some headwater rainbow populations may be present in this section, particularly in Lion Creek.

Kokanee

It is suspected that kokanee are not present.

Watershed Sensitivity

Stream channel stability

Most of the channels are confined, and streams exhibit little lateral instability.

Valley wall stability

The valley walls are generally unstable, with numerous old and many recent failures. Failures on the valley walls will result in the deposition of material directly into the stream channel.

Hillslope stability

A few large failures are evident. Because of the more gentle nature of many of these slopes, it is likely that most slope failures will not directly enter stream channels.

Water temperature concerns

Water temperature is not of concern.

Present and Proposed Land Use

Forestry

All forestry development has occurred in the Uplands sub-unit, and there is no proposed development in this area.

Mining

This area is within the "No Staking Placer Reserve". No other type of mineral development is proposed.

Fish Production Objectives

Salmon production

The prime management objective is to maintain existing production levels.

Resident species

No specific objectives are available for management of this unit.

Habitat Management

Forestry management

Logging, and especially road development, must be undertaken in such a way as to avoid unstable areas that drain directly into streams, in order to avoid downstream effects of sediment on salmon and kokanee spawning areas.

Fisheries management

Of key concern is the maintenance of water quality and quantity due to the importance of the areas downstream.

Timing of in-stream work

In an attempt to protect fisheries resources from the direct effects of development, it is expected that all in-stream work be done from July 1 to September 1. However, all streams with sockeye spawning have the specific timing of June 7 to July 15.

Water extraction prohibited

Due to high fisheries values and limited water supply, the Department of Fisheries and Oceans may not permit water extraction from the Driftwood, Lion, Hudson Bay, McLaing, Forsythe, and Ankwil creeks.

Limited water extraction

Due to high fish values, the Department of Fisheries and Oceans' approval is required before water extraction proceeds from all minor tributaries to the Driftwood River.

Action Required

Inventory

There is a requirement to determine the abundance and distribution of the fisheries resources present in these upper watersheds.

Assessment of the stability of stream channels and banks, valley walls and hillslopes is required to properly address the potential impacts of forest harvesting.

3. FISHERIES RESOURCES

The Stuart/Takla Habitat Management Area is known to produce sockeye salmon (*Oncorhynchus nerka*) and chinook salmon (*Oncorhynchus tshawytscha*) in economically, socially, and biologically significant numbers. Of the two species, sockeye, with total stock size numbering up to 4.3 million, are by far the most abundant; they are harvested in commercial fisheries along the Pacific Coast from Washington to Alaska. Harvest occurs predominately in Johnstone Strait, the Strait of Georgia, and the Strait of Juan de Fuca, as well as in aboriginal river fisheries, which extend from the Fraser estuary to upper Takla Lake. The much scarcer chinook are harvested to varying degrees in commercial fisheries, which extend along the coast from southern Alaska to Washington, in the Fraser River, and in the recreational fisheries which occur primarily in the Strait of Georgia. Sockeye spawning occurs in 34 tributaries to the Stuart/Trembleur/Takla Lakes watershed, while chinook spawning occurs primarily in the Stuart River; although small chinook stocks, are found in five tributary streams.

The dominant resident fish species found in the Stuart/Takla Habitat Management Area include: rainbow trout (*Oncorhynchus mykiss*) with two distinct populations of very large fish (up to 10 kg) and the standard smaller race of rainbow; lake trout (*Salvelinus namaycush*); kokanee salmon (*Oncorhynchus nerka*); lake whitefish (*Coregonus clupeaformis*); and Dolly Varden char (*Salvelinus malma*). Rainbow trout are found throughout the entire drainage in both lakes and streams, with the large race (maximum 10 kg) present in Stuart, Takla and Trembleur lakes. Lake trout are also found in the large lakes and in a number of the smaller lakes. Kokanee are abundant in the large lake systems and in many of the smaller lakes as well. Lake whitefish are present in most of the larger lake systems, whereas Dolly Varden are found in stream systems, most notably the Driftwood River. All these species are common throughout northern British Columbia; however, lake trout and rainbow trout fisheries in Stuart, Trembleur and Takla lakes provide the key sports fisheries in the region.

3.1 Sockeye Salmon

In the Stuart/Takla HMA, most sockeye populations are characterized by having one dominant year class in which the fish are very numerous, a sub-dominant year class in which fish abundance is two-thirds less than the dominant year class, and two smaller year classes. With a few exceptions, the dominant cycle for all sockeye populations occurs in the same year -- the 1989 cycle-year. The sub-dominant cycle occurs primarily in the 1991 cycle-year. With the exception of the odd precocious male that may mature at age three and spawn successfully, there is no exchange of genetic material between age classes, so that each year-class within the four-year cycle represents, and is considered, a separate population.

3.1.1 Life history

The sockeye salmon populations of the Stuart/Takla HMA, like virtually all Fraser River sockeye populations, reach maturity in four years. They exhibit only one life history strategy. After spawning in the fall (late July to late September) in the gravel beds of the streams and rivers, the eggs incubate over winter to hatch and emerge from the gravel the following spring. After emerging from the gravel, the fry usually migrate downstream into the nearest lake, where they rear until the following spring. In this second spring they migrate out of the lakes as smolts and move rapidly downstream until they enter the ocean. They reside in the ocean until beginning their sexual maturation process early in their fourth year, when they commence their return migration to the stream from which they hatched. The only exception to this may be a small percentage of precocious males that return in their third year.

3.1.2 Timing of migration and spawning

The Stuart/Takla sockeye populations exhibit two different migrational timing patterns separated by approximately one month, allowing fisheries managers to regulate the two resultant fisheries differently. The two population groups are called Early and Late Stuart; all catch and escapement information presented here will follow suit. Early Stuart stocks enter the lower Fraser River between approximately June 20 and July 24, while Late Stuart stocks enter between July 28 and August 21. The approximate periods of spawning for Early and Late Stuart populations are July 27 to August 23, and September 10 to September 28, respectively.

Because there is little overlap in migration timing, Early and Late Stuart sockeye are managed separately. Late Stuart sockeye do coincide in migration timing with other major Fraser sockeye stocks, including Chilko, Horsefly and Stellako, so they must be managed along with these other stocks.

3.1.3 Catches, escapements and escapement trends

Sockeye salmon produced in the Stuart/Takla HMA are caught primarily in commercial net fisheries in Queen Charlotte Strait, Johnstone Strait, the Strait of Juan de Fuca, the Strait of Georgia, the lower Fraser River, and Washington State. In recent years a significant percentage have been caught in commercial troll fisheries that operate in some of these areas, as well as off the west coast of Vancouver Island. Significant numbers are also taken by aboriginal fisheries that extend the length of the Fraser River from the estuary to Prince George, and in the Nechako and Stuart Rivers, well into upper Takla Lake.

The total commercial catch of Early and Late Stuart sockeye during the period 1952 to 1990 has ranged from a low of 14,000 in 1963 to a high of 3,322,569 in 1989. The annual catch is presented by cycle-year in Table 3.1. These figures clearly demonstrate the cyclical nature of the sockeye salmon stocks of Stuart/Takla watershed.

Table 3.1. Total annual catch by cycle-year for Stuart sockeye salmon.

Early Stuart							
Year**	Catch	Year	Catch	Year*	Catch	Year	Catch
1951		1952	158,132	1953	894,484	1954	206,767
1955	139,342	1956	68,366	1957	313,579	1958	118,866
1959	23,855	1960	68,026	1961	1,026,751	1962	81,816
1963	10,347	1964	44,287	1965	233,280	1966	60,223
1967	78,479	1968	26,610	1969	323,101	1970	50,423
1971	230,211	1972	19,102	1973	1,066,816	1974	147,589
1975	345,460	1976	32,200	1977	1,216,800	1978	91,300
1979	130,100	1980	15,274	1981	610,300	1982	54,968
1983	68,433	1984	6,692	1985	122,212	1986	16,185
1987	22,520	1988	41,092	1989	841,051	1990	56,224
Average	116,527		47,978		664,837		88,436

Late Stuart							
Year**	Catch	Year	Catch	Year*	Catch	Year	Catch
1951		1952	1,785	1953	1,158,122	1954	31,210
1955	50,972	1956	10,959	1957	1,020,152	1958	115,194
1959	44,675	1960	12,505	1961	949,291	1962	36,338
1963	3,843	1964	6,754	1965	558,404	1966	42,050
1967	12,248	1968	1,677	1969	896,900	1970	78,966
1971	6,610	1972	31,483	1973	1,392,827	1974	77,024
1975	51,298	1976	13,434	1977	458,300	1978	32,900
1979	165,400	1980	2,763	1981	1,160,600	1982	75,713
1983	12,273	1984	8,636	1985	1,700,153	1986	71,915
1987	28,079	1988	93,028	1989	2,481,518	1990	65,693
Average	41,711		18,302		1,177,627		62,700

* Dominant Cycle-Year ** Sub-Dominant Cycle
 Catch estimates from International Pacific Salmon Fisheries Commission: I.P.S.F.C, 1983.
 Catch estimates for 1983-1990 (W. Saito, pers. comm.)

Table 3.2 provides the total annual escapements by cycle-year. With few exceptions the spawning escapements to the Stuart/Takla drainage basin are highest on the 1989 cycle; the escapements for this dominant cycle are presented in Table 3.3. Escapements for the dominant cycle-year have been used because it is the dominant year class which makes the greatest use of the habitat and, thereby, establishes bounds for habitat management strategies.

Table 3.2. Total annual escapements by cycle-year for Stuart sockeye salmon.

Early Stuart							
Year	Escapement	Year	Escapement	Year	Escapement	Year	Escapement
-	-	1948	19,979	1949	582,228	1950	59,104
1951	60,423	1952	30,212	1953	154,036	1954	35,050
1955	2,159	1956	25,020	1957	234,850	1958	38,807
1959	2,670	1960	14,447	1961	198,921	1962	26,716
1963	4,607	1964	2,390	1965	23,045	1966	10,830
1967	21,044	1968	1,522	1969	109,655	1970	32,578
1971	95,940	1972	4,657	1973	299,892	1974	39,518
1975	65,754	1976	11,761	1977	117,445	1978	50,004
1979	92,746	1980	16,939	1981	129,457	1982	4,557
1983	23,867	1984	45,201	1985	234,519	1986	28,584
1987	148,194	1988	179,807	1989	384,799	1990	97,034
1991	140,780	-	-	-	-	-	-

Late Stuart							
Year	Escapement	Year	Escapement	Year	Escapement	Year	Escapement
-	-	1948	-	1949	107,752	1950	5,843
1951	4,364	1952	35	1953	368,634	1954	5,470
1955	7,582	1956	913	1957	531,108	1958	23,619
1959	8,225	1960	2,396	1961	410,887	1962	18,643
1963	3,222	1964	1,816	1965	214,943	1966	9,027
1967	1,629	1968	389	1969	207,014	1970	14,978
1971	1,535	1972	7,341	1973	214,230	1974	14,190
1975	14,229	1976	2,898	1977	146,459	1978	12,738
1979	31,918	1980	946	1981	249,494	1982	16,758
1983	2,246	1984	1,228	1985	274,621	1986	28,715
1987	6,472	1988	7,117	1989	575,697	1990	189,049
1991	76,999	-	-	-	-	-	-

In order to give the reader some perspective on the relative significance of these escapement figures, the 1989 sockeye escapement contribution of 960,610 from the Stuart/Takla HMA represents 24% of the total sockeye escapement to the Fraser basin in that year.

Table 3.3. Dominant cycle escapement trends for Stuart sockeye salmon.

Early Stuart						
Stream	Peak of spawning	1973	1977	1981	1985	1989
ANKWILL CR.	07/27 - 08/8	21,782	6,287	8,497	12,012	10,454
BIVOUAC CR.	07/27 - 08/8	1,884	941	285	937	2,150
BLANCHET CR.	07/26 - 08/2	603	167	257	169	314
CROW CR.	07/26 - 08/2	3,678	650	804	1,839	1,412
DRIFTWOOD R.	07/30 - 08/12	130,871	54,568	47,298	93,959	234,127
BLACKWATER R.	08/9 - 08/12			1,330	279	912
KASTBERG CR.	08/9 - 08/12			1,492	758	1,900
LION CR.	08/9 - 08/12			642	376	3,364
PORTER CR.	08/5 - 08/9			4,013	279	9,998
DUST CR.	07/25 - 08/5	17,832	16,200	5,040	5,459	12,587
FLEMING CR.	07/27 - 08/3	3,211	616	343	1,687	8,699
FORFAR CR.	07/26 - 08/7	18,887	3,512	12,219	19,430	10,822
FORSYTHE CR.	07/28 - 08/6	10,899	3,674	2,386	3,262	5,060
FRENCH CR.	08/1 - 08/6	2,415	695	219	661	268
FRYPAN CR.	07/28 - 08/4	5,799	4,383	1,864	3,044	5,372
GLUSKIE CR.	07/27 - 08/7	19,411	4,593	10,741	17,379	9,054
HOOKER CR.	07/26 - 08/2		252	287	399	868
HUDSON BAY CR.	LATE JULY		432	158	44	58
LEO CR.	08/2 - 08/4	1,376	644	78	29	0
MACDOUGALL CR.		106	400	11	30	0
MCLAING CR.	07/29 - 08/14	2,393	907	369	638	604
NARROWS CR.	07/26 - 08/5	5,707	2,829	3,583	4,209	7,836
O'NE-ELL CR.	07/26 - 08/8	22,350	5,729	13,447	20,345	22,528
PAULA CR.	07/27 - 08/8	2,770	892	1,624	3,219	7,508
POINT CR.	07/28 - 08/4	2,180	452	821	1,999	1,452
SAKENICHE R.	07/28 - 08/8	4,175	288	6	2,836	1,328
SANDPOINT CR.	07/26 - 08/5	3,178	1,508	1,224	1,577	726
SHALE CR.	07/29 - 08/6	3,260	1,667	1,630	1,678	2,258
SIDNEY CR.	07/27 - 08/15	7,445	2,124	6,194	20,606	15,478
VAN DECAR CR.	07/27 - 08/5	4,098	2,136	8,003	15,702	5,474
15 MILE CR.	07/29 - 08/14	1,081	452	815	352	1,212
25 MILE CR.	07/29 - 08/14	1,145	164	923	583	978
SUB-TOTALS		298,536	117,162	136,603	235,776	384,801

Late Stuart						
Stream	Peak of spawning	1973	1977	1981	1985	1989
KAZCHEK CR.	09/12 - 09/30	2,908	720	6,872	1,955	765
KUZKWA R.	09/21 - 09/30	20,108	9,013	20,520	2,624	4,122
MIDDLE R.	09/16 - 09/30	91,862	80,381	125,625	114,115	276,131
PINCHI CR.	09/20 - 09/30	1,271	1,716	1,494	0	7,357
SOWCHEA CR.	09/20 - 09/30	158				30
TACHIE R.	09/16 - 09/30	97,366	54,172	93,850	155,641	287,290
SUB-TOTALS		213,673	146,002	248,361	274,335	575,695
HMA TOTALS		512,209	263,164	384,964	510,111	960,496

All information is from the Fraser River Salmon Task Force.

3.1.4 Spawning habitat

Virtually all sockeye salmon populations of the Stuart/Takla HMA spawn in areas upstream of their lake rearing areas. The Early Stuart run utilizes 31 different streams for spawning purposes (Figure 3.1). Of these 31 streams, Driftwood River, located at the head of Takla Lake, accounts for approximately 37% of the total run on dominant-run years. No other single Early Stuart stream accounts for more than 10% of the total early run in the dominant cycle. The Late Stuart run utilizes five spawning streams. Two of these populations (i.e., those from the Tachie and Middle Rivers) account for 90% of the total Late Stuart run. In terms of total sockeye escapement (early and late) to the HMA in 1989 of approximately 960,000 fish, over 80% spawned in the Driftwood, Middle and Tachie rivers. These rivers are very large compared to other spawning streams tributary to these rivers, or to Takla, Trembleur and Stuart lakes.

The number of sockeye spawners that can be accommodated in any watershed will be governed by the availability of useable spawning gravel, its quality, and the spatial requirements for each redd and associated defense area. Once the eggs have been deposited their survival rate will depend primarily upon hydrologic conditions, climatic conditions, and human disturbances. The Fraser River Salmon Task Force (FRSTF:1990) made estimates of useable spawning area for the Stuart/Takla HMA. These are presented in Table 3.4.

From these estimates it is apparent that 86% of available spawning capacity is contained within the Middle, Tachie and Driftwood rivers, the major contributors to the total sockeye returns to the HMA on dominant cycle-years.

The habitat type limiting sockeye salmon productive capacity in the Stuart/Takla HMA is the availability of spawning habitat (i.e., there is more fry rearing capacity in the lakes than there is spawning area to produce the fry). The Fraser River Salmon Task Force (1990) concluded that the Stuart/Nechako sockeye spawning populations would be optimized if a density of 1 female/m² of spawning substrate were achieved. Assuming a 50:50 sex ratio, this translates into a spawner density of 2 sockeye/m². Using this as the criteria for establishing the productive capacity for sockeye in the watershed, and applying these to the useable area information presented in Table 3.4, the productive capacity for each watershed was calculated. These initial estimates were then scrutinized by field staff who, for the past several years, have enumerated the escapements to identify those streams for which the calculated escapement goals were unrealistic because of the nature of the spawning grounds.

**STUART - TAKLA
HABITAT MANAGEMENT AREA**



SK = Sockeye

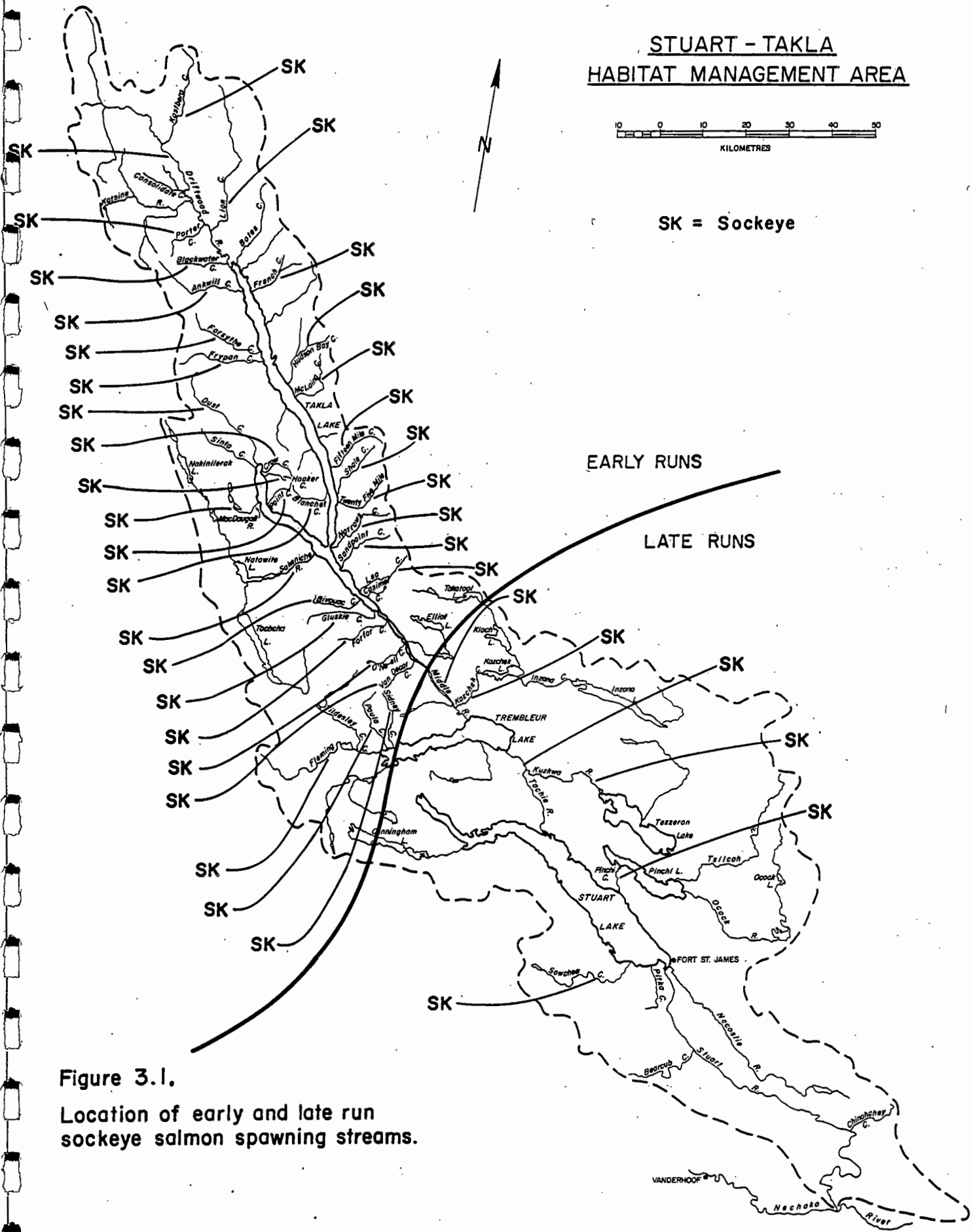


Figure 3.1.
Location of early and late run
sockeye salmon spawning streams.

Table 3.4. Estimated useable sockeye spawning area in the Stuart/Takla HMA.

Rearing Lake/Stock	Useable Area (m²)	Rearing Lake/Stock	Useable Area (m²)
Takla Lake		Trembleur Lake	
Ankwill Cr.	14,000	Kazchek Cr.	19,000
Bivouac Cr.	3,000	Middle R.	440,000
Blanchet Cr.	500	Sidney (Felix Cr.)	9,000
Crow Cr.	3,000	Fleming Cr.	5,000
Driftwood R.	165,000	Paula Cr.	6,000
Dust Cr.	14,000	Van Decar (Rosette Cr.)	6,000
Forsythe Cr.	5,000	Forfar Cr.	10,000
French Cr.	500	O' Ne-ell (Kynock Cr.)	23,000
Frypan Cr.	9,000	Trembleur Sub-total	518,000
Gluskie Cr.	11,000		
Hooker Cr.	200		
Hudson Bay Cr.	100		
Leo Cr.	2,000	Stuart Lake	
MacDougall Cr.	500	Kuzkwa R.	32,000
Narrows Cr.	13,600	Pinchi Cr.	800
Point Cr.	1,000	Tachie R.	220,000
Sandpoint Cr.	9,000	Stuart Sub-total	252,800
Shale Cr.	2,000		
McLaing (5 Mile Cr.)	100		
Fifteen Mile Cr.	200		
Twenty Five Mile Cr.	900		
Sakeniche R.	5,000		
Takla Sub-total	259,600		

Total useable area for sockeye spawning in HMA: 1,030,400 m²

According to information obtained from the Sockeye Task Force and presented in Table 3.5, the combined total spawning capacity for the Early and Late Stuart sockeye runs is 1,970,500 fish. A closer examination shows that the figure might be reduced by approximately 40,000 (Table 3.5) but both estimates suffer from an incomplete estimate of available capacity in the Driftwood River. Available spawning capacity in the Driftwood is believed to be underestimated by as much as a factor of two (Robin Kent, pers. comm.). The streams which account for the difference between the capacity estimates of the groups are identified in Table 3.5.

Table 3.5. Carrying capacities of sockeye spawning streams in the Stuart/Takla HMA.

Early Stuart		
Rearing Lake/Stock Estimate	Capacity (STF)	Adjusted Capacity
Takla Lake		
Ankwill Cr.	28,600	28,600
Bivouac Cr.	5,700	5,700
Blanchet Cr.	1,000	1,000
Crow Cr.	6,300	3,500 *
Driftwood R.	345,700	>345,000 **
Dust Cr.	29,500	17,000 *
Forsythe Cr.	9,500	>9,500 *
French Cr.	1,000	1,000
Frypan Cr.	19,000	19,000
Gluskie Cr.	24,100	18,000 *
Hooker Cr.	400	400
Hudson's Bay Cr.	200	200
Leo Cr.	4,800	0 ***
MacDougall Cr.	1,000	1,000
Narrows Cr.	28,600	20,000 *
Point Cr.	1,900	1,900
Sakeniche R.	10,000	7,000 *
Sandpoint Cr.	19,000	19,000
Shale Cr.	4,800	3,500 *
McLaing (5 Mile Cr.)	200	200
Fifteen Mile Cr.	400	400
Twenty Five Mile Cr.	1,900	1,900
Takla Sub-total	543,600	>503,800
Trembleur Lake		
Sidney (Felix Cr)	19,000	19,000
Fleming Cr.	9,500	>9,500 *
Forfar Cr.	18,300	18,300
O' Ne-ell (Kynock Cr.)	47,600	47,600
Paula Cr.	13,300	13,300
Van Decar Cr. (Rosette)	12,600	20,000 *
Trembleur Sub-total	120,300	>127,700
Early Stuart Grand Total	663,900	>631,500
Late Stuart		
Rearing Lake/Stock Est.	Capacity (STF)	Adjusted Capacity
Trembleur Lake		
Kazchek Cr.	37,400	37,400
Middle R.	804,100	804,100
Trembleur Sub-total	841,500	841,500
Stuart Lake		
Kuzkwa R.	62,000	62,000
Pinchi Cr.	1,600	1,600
Tachie R.	401,500	401,500
Stuart Sub-total	465,100	465,100
Late Stuart Grand Total	1,306,600	1,306,600
COMBINED TOTAL (E&L)	1,970,500	>1,938,100

* Adjusted downwards/upwards on advice of field staff.

** Opinion of field staff is that capacity assessment is far too low.

*** Field staff advise that stream access is totally blocked.

3.1.5 Incubation flow ratios

The sockeye salmon spawning streams of the Stuart/Takla watershed can be divided into four groups from a hydrological perspective:

- stable flow regime,
- lake-fed systems,
- streams with numerous tributaries, and
- small streams with no flow stability features.

The large rivers, which include the Stuart, Tachie and Middle rivers, are characterized by their relatively stable flow regime. Only the Stuart River has been the subject of regular and prolonged flow monitoring. General hydrologic observations made about this river could be applied to the other two rivers. The mean monthly flow for the month of September, which is the normal spawning month for the Late Stuart sockeye run, as well as for the chinook run, is 138 m³/sec. March is normally the month which exhibits the lowest mean monthly discharges and the time at which alevins and eggs would possibly be most vulnerable to freezing if the eggs were deposited in shallow water gravel beds. The mean monthly flow for March in the Stuart River is 45.7 m³/sec. The relationship between the flows at the time of spawning and the lowest flows during the incubation period is referred to as the "spawning to incubation flow ratio". On interior spawning grounds that have been saturated with an abundance of spawners, the spawning to incubation flow ratio will provide an indication of the vulnerability of eggs and alevins to desiccation in mild climates or to freezing in cold climates. On the Stuart River the average spawning to incubation flow ratio for 54 years of record is 3:1. Given the depth of water over the spawning beds at the time of spawning (Hickey and Lister, 1981), this ratio suggests that winter kill problems for eggs and alevins are probably not significant. These conclusions apply to both the Tachie and Middle rivers.

In terms of hydrologic stability, the second grouping of spawning streams are those lake-fed systems that are tributary to either the large lakes themselves or to the Tachie or Middle rivers. Like the larger rivers previously described, the Tachie and Middle rivers are characterized as having stable flow regimes, but they are much smaller in terms of annual runoff or physical stream size. Other streams in this category are Sakeniche River, Fleming Creek, Kazchek Creek, Pinchi Creek, and Kuzkwa River. Based on limited flow records available for this category of streams, it would appear that the spawning to incubation flow regime approximates 1:1, and it follows that overwinter survival of eggs and alevins should not be of concern unless the streams are so small that they freeze solid.

The Driftwood River is the only watershed in the Stuart/Takla HMA in the third category. Watersheds in this category are characterized as having many small tributaries with few lakes of any size; all tributaries feed into a mainstem stream with a significant drainage area. The

dominant flow periods coincide with snowmelt runoff in the spring. A much smaller subdominant flow peak in the early fall coincides with the onset of fall rains. The mean August flow -- the month of spawning for the Early Stuart run -- is 3.80 m³/sec, while the mean March flow is 0.77 m³/sec (11 year record) (Environment Canada, 1991). This indicates a spawning flow to incubation flow ratio of 4.9:1.

The fourth watershed type includes those small streams which have no flow stabilizing features and which flow directly into one of the three large lakes or into the Tachie or Middle rivers. None of these streams has been monitored for discharge, but they would be expected to be most troublesome with respect to spawning and incubation flows because of their quick response to rainfall events and their vulnerability to freezing. These streams could experience low flows at the time of spawning, so spawner access may be impaired. Twenty-six out of 35 salmon spawning streams in the Stuart/Takla HMA fall into this category.

There is one natural habitat factor which may temper the ability of the watershed to sustain levels of fish production equivalent to the carrying capacity of the available spawning substrate. This is the nature of the hydrologic regime which is being imposed on the vast majority of Early Stuart populations. Only two minor Early Stuart stocks (the Fleming Creek and Sackeniche River populations) account for a spawning capacity of approximately 16,500 fish and appear to have favourable incubation flow regimes. The Driftwood River is subject to relatively low winter flows and may well experience considerable winter kill of eggs in some locations, given a spawning to incubation flow ratio in the order of 4.9:1. This may not interfere with the successful accommodation of 345,000+ sockeye spawners because of a possible under-estimation of available spawning habitat, but it would become a factor if all of the habitat were utilized. The remaining 44% of the available spawning habitat for Early Stuart stocks can be found in the 25 small streams without headwater storage that drain directly into Takla and Trembleur lakes. These streams exhibit the most severe hydrologic regimes and are suspected of being subject to comparatively poor egg-to-fry survival rates during severe winters, due to freezing of eggs and alevins. The authors of this report question whether it is realistic to expect 270,000 sockeye spawners to be accommodated in these streams in all years, even though egg-to-fry survival rates can be quite high in mild winters (Hickey and Smith, 1990). In the absence of stream flow records for this type of stream, it is not possible to suggest a more realistic estimate of sockeye salmon spawner carrying capacity.

3.1.6 Rearing habitat

Another element that governs the production of sockeye in the freshwater rearing phase is lake rearing capacity. The ability to produce sockeye biomass in lakes used for rearing is dependent on available area, mean rearing temperature, and plankton production (Fraser River Salmon Task Force Report, 1990). Smolt size is dependent on the density of fingerlings and the number of smolts produced from sockeye biomass, and the number of smolts produced from the sockeye biomass is dependent on smolt size. Based on 30 years of data from Chilko Lake, no relationship exists between sockeye smolt size and marine survival rates. Data from Cultus Lake and Shuswap Lake suggests that returns from pre-smolts (October fingerlings) of less than 2 grams were one standard deviation below average returns for those populations, which indicates a threshold level that affects marine survival. With the resultant spring growth, these pre-smolts would exceed 3 grams at smolting, which is considerably larger than smolts from many coastal systems. The Fraser River Salmon Task Force determined the carrying capacity for each of the lakes in the Fraser Basin based on the target size of 2 grams for October pre-smolts. These results were then converted to numbers of effective female spawners and total spawners.

The rearing capacity in terms of total sockeye salmon spawners required to produce enough fry to fill the lakes for all of the accessible lakes in the Stuart/Takla HMA is 11,040,000 adults. Of this total, fry from 6,300,000 spawners could be accommodated in Stuart Lake, fry from 1,340,000 spawners in Trembleur Lake, and fry from 3,400,000 spawners in Takla Lake.

However, on the basis of the analysis conducted by the Fraser River Salmon Task Force using data originally collected by the International Pacific Salmon Fisheries Commission, the total spawning area available for sockeye salmon is 1,030,400 m². On the basis of a spawner density of one female/m² the Stuart/Takla Habitat Management Area should accommodate approximately 2,000,000 spawners. With respect to rearing capacity of the three large lakes that comprise the sockeye rearing habitat within the HMA, the estimated carrying capacity is equivalent to the fry produced from a spawning population of 11,040,000. It is apparent then that the availability of spawning habitat is the most likely limit to natural sockeye salmon production from the Stuart/Takla HMA once an escapement of 2 million is achieved.

With respect to interactions with other stocks or species, sockeye juveniles produced within the HMA must compete with a large juvenile kokanee population for food and rearing space. It is not known what effect such competition has on the productivity of the sockeye or kokanee stocks. Work done in 1988 by Wood and Raoke (1991) suggests that the sockeye and kokanee rearing in Takla Lake are 11.8 million; 70% of that (8.26 million) are sockeye fry. Although kokanee spawn at the same time and in the same streams as many of the sockeye, they do not appear to utilize the same spawning areas (R. Kent, pers. comm.). There is no known interaction between chinook

adults and sockeye adults or between juveniles of the two species within the HMA. As well, there is no knowledge of a possible interaction between the two salmon species and lake trout or Dolly Varden char, which are known to inhabit the watershed.

3.1.7 Production and management strategies

The following two factors are of prime significance when discussing sockeye salmon production:

1. even in the dominant cycle-years, sockeye salmon escapement is well below the carrying capacity of the amount of spawning gravel present for most streams in the system; and
2. insufficient spawning gravel is present in the system to provide enough fry to fill the existing lakes to their maximum sockeye fry rearing capacity.

In recognition of these factors, the DFO has embarked on a two-pronged program to increase sockeye salmon, in order to maximize utilization of the known spawning areas in the dominant cycle, and to substantially increase escapements in the other three cycles. Maximizing spawning habitat utilization in the dominant cycle has proven very successful with other Fraser stocks, such as the Adams and Horsefly, and increasing escapements in off-cycle years has already proven successful in the Stuart/Takla HMA over the past several years. (R. Harrison, pers. comm.). Consequently, the approach taken by DFO involves the establishment of cycle specific "interim" escapement goals for major stocks or stock groups. Escapements will be progressively increased and production monitored over several cycles in order to establish the most appropriate spawning escapements for each cycle. This will be done for both the Early Stuart and Late Stuart runs.

Of all Fraser River sockeye, Early Stuart sockeye are perhaps the most highly prized by both commercial and aboriginal food fishermen because they are the first of the season and retain their excellent quality until far up the river. They are important to the aboriginal people of the upper Fraser, particularly in the Stuart River watershed, because they are one of only two sockeye stocks to which they have access. Until the present, only the 1989 cycle (dominant) has produced a commercially harvestable surplus. In general, limited commercial and aboriginal food fisheries have been permitted in most years on this cycle. However, on the other three cycles, because spawning escapements have been increased to sufficiently high levels, commercial surpluses are theoretically available from now on (R. Harrison, pers. comm.).

To increase abundance of Early Stuart sockeye, the following escapement objectives have been developed.

- **1991 cycle (sub-dominant cycle):** increase spawning escapements from 148,000 in 1987 to 200,000 in two cycles (by 1995).
- **1992 cycle:** the interim goal of 200,000 was achieved in 1988. This goal may be adjusted based on assessment of returns from the 1988 escapements.
- **1989 cycle (dominant cycle):** increase spawning escapements from 385,000 in 1989 to 500,000 in two cycles (by 1997).
- **1990 cycle:** increase escapements from 100,000 in 1990 to 200,000 in one cycle (by 1994).

Conservation measures applied to Early Stuart sockeye in recent years have been successful in increasing spawning escapements to record high levels in most cycles. The interim goal has already been exceeded on the 1988 cycle and, with average return rates, it is likely that the goals on the other three cycles will be achieved in only one more cycle. Depending on production from these larger spawning escapements, a decision may be made to establish goals even higher than these interim levels. Since Early Stuart sockeye spawn in many tributaries, both the distribution of spawners, as well as total escapement, must be taken into account.

Total production from the interim spawning levels will depend on productivity of the stocks, as well as on the size of the spawning populations. Applying the historical average returns per spawner of 5:1 to the interim goals results in total average returns ranging from 750,000 to 2.5 million on the different cycles. Using a more conservative productivity assumption of 3:1 returns per spawner, the predicted average return ranges from 450,000 to 1.5 million.

If the escapements already achieved from 1987 to 1990 produce at an average productivity, harvestable surpluses are expected to occur annually starting in 1991. Certainly a less restrictive approach to managing the aboriginal food fisheries is likely and, if abundance is sufficient, commercial fishing for Early Stuart sockeye may be possible.

Information on the magnitude of the spawning area available for Late Stuart sockeye suggests that substantial production increases are possible. Furthermore, Trembleur and Stuart, the two lakes where the juveniles rear, could potentially accommodate many more sockeye fry than the spawning grounds could produce. Interim spawning goals were established for each cycle, but recent returns suggest that they may be too low. The following interim goals for Late Stuart sockeye were implemented starting in 1988.

- **1991 cycle (sub-dominant cycle):** increase escapements from 6,500 in 1987 to 200,000 within six cycles (by 2011).
- **1992 cycle:** increase escapement from 7,100 in 1988 to 50,000 within four cycles (by 2004).
- **1989 cycle (dominant cycle):** the escapement goal of 500,000 was to be achieved by 1997. However, due to a strong return in 1989 the actual escapement was 576,000, which exceeds the goal.
- **1990 cycle:** starting in 1986 with an escapement of 29,000, achieve an interim goal of 50,000 in two cycles. Due to a strong return in 1990 the actual escapement was approximately 190,000, more than three and one-half times the interim goal. Clearly, the goal needs to be reviewed and possibly increased to the same level as the dominant year.

The total average return expected from interim goals is from 150,000 to 250,000 on the 1990/91/92 cycles and from 1.5 to 2.5 million on the 1989 cycle, depending on the productivity assumed.

Achievement of the Late Stuart goals depends, to some extent, on the exploitation rates applied to co-migrating sockeye stocks. In the 1989 cycle, for example, management during the mid-timing period is directed toward the larger Horsefly stock, while in the 1992 cycle management is directed toward Chilko sockeye. However, since lower exploitation rates than in the past are being advocated as a means for increasing escapements, Late Stuart sockeye will benefit.

3.1.8 Enhancement/restoration plan

As has been previously stated in this report, when sockeye salmon escapement in the Stuart/Takla drainage basin exceeds 2 million fish, spawning habitat will be completely utilized (Table 3.5). This situation has precipitated considerable interest on the part of the former International Pacific Salmon Fisheries Commission (IPSFC) and, more recently, the Department of Fisheries and Oceans, who are interested in identifying and evaluating the enhancement opportunities that would address this limitation (IPSFC, 1972; Vernon, 1982; Lill *et. al*, 1983). The most comprehensive analysis of opportunities by the IPSFC (1972) considered several enhancement possibilities for the Stuart/Takla watershed, including development of spawning channels at Ankwil and Sakeniche creeks, Kazchek or Middle rivers, and Tachie River and Kuzkwa creeks. However, none of these opportunities had been developed as of 1985 when the IPSFC was officially dissolved.

Vernon (1982) did not support such a large enhancement initiative for the Stuart/Takla watershed in the initial stages, favouring, instead, a more concerted effort to increase escapements. He did, however, concur with the IPSFC recommendation for the development of increased spawning capacity on the Tachie River, recognizing that existing spawning gravels were of poor quality. His suggestion was for the construction of a side channel and gravel importation to provide accommodation for 163,000 female sockeye. He also concluded that an incubation channel, where artificially fertilized eggs or eyed eggs are planted into the gravel substrate, might be feasible at Pinchi Creek.

The Enhancement Opportunities Committee (Lill *et al.*, 1983) of the Salmonoid Enhancement Program re-evaluated the opportunities in the Stuart/Takla watershed. This committee concluded that Ankwil Creek was not a viable site for a spawning channel because of water availability. They concurred with the Vernon proposal for the Tachie River, and further recommended evaluation of the Driftwood River as a potential channel site. The committee also recommended that Takla and Trembleur lakes be further evaluated as enrichment candidates. Finally, since both Stuart and Takla lakes have a great abundance of lake trout, large rainbow and kokanee, a competitor control program or fishery was recommended on a trial basis.

At the time of writing, none of these opportunities have been developed, and it has been decided to monitor existing production. The Driftwood channel opportunity has been rejected because of low winter flow problems. The remainder have been considered by the Fraser River Salmon Task Force and the following projects are currently under review; recommendations will likely be developed by mid-1992. The projects under review include: Takla Lake Central Pilot Hatchery (for Early Stuart run enhancement), the Kazchek and Kuzkwa Storage Dams, and Tachie River Spawning Channel, and a Re-evaluation of Barriers (to spawning for late Stuart run enhancement). They are described in detail below.

Early Stuart Run Enhancement

Takla Lake Central Pilot Hatchery This hatchery, possibly to be located at either Kluskie or Leo Creek, would be used to rebuild several small Early Stuart runs and to advance the state-of-the-art and knowledge of enhancement and rehabilitation techniques. It would operate for a minimum of eight years (two cycles). The capital cost is expected to be \$950,000. After that period its future would depend on the success of the project and the success achieved through the manipulation of the fishery. Further feasibility work is required before a final decision can be made.

Late Stuart Run Enhancement

Kazchek and Kuzkwa Storage Dams These two projects, on tributaries to the Middle and Tachie Rivers, respectively, would augment natural storage on these lake-fed tributaries

and allow for temperature regulation. Kazchek Creek populations have endured high temperature-induced pre-spawning mortalities in the past, and it is believed that both streams would benefit from additional flow during the winter months. Further study of these populations and streams is necessary before an enhancement strategy can be developed. If these projects were to proceed the capital cost would approximate \$400,000 each.

Tachie River Spawning Channel This project, as it is now conceived, entails the development of an unstaffed spawning channel adjacent to the Tachie River, which has a paucity of quality spawning gravel. It would be sized to produce up to 500,000 fish on the dominant cycle-year (that figure has not yet been resolved). The capital cost of the project has been estimated at \$1.8 million. Considerable pre-approval engineering work is required before a decision can be made on this project.

Re-evaluation of Barriers There are also known barriers to sockeye migration on the Kuzkwa, Kazchek, and Pinchi Rivers. These barriers should be re-evaluated as to options and potential for development of fish passage structures as an alternative to construction of spawning channels.

These recommendations reflect a justifiably cautious approach to enhancement of the Stuart/Takla sockeye populations. The hydrologic features of most watersheds within the drainage basin do not lend themselves to the application of conventional spawning channel technology that has proven successful elsewhere in the province. There are also many uncertainties associated with the use of conventional or modified hatchery technology for the production of sockeye salmon, necessitating a step-by-step and evaluative approach to sockeye hatchery development. The uncertainty is compounded by the fact that considerable success has been achieved with other sockeye stocks in the Fraser Basin by simply increasing spawning escapements. This was made possible by a combination of above average return rates and a reduction of harvest rates. Clearly, the merits of any sockeye enhancement strategy must reflect a thorough consideration of the effectiveness and costs of further fishery manipulation.

3.1.9 Habitat monitoring

Because there have been relatively few human disturbances of the stream habitats, and none to date that necessitate remedial corrective action, the bulk of the Stuart/Takla drainage basin remains relatively pristine. However, there are some instances whereby natural factors have led to fish habitat loss or degradation. Following the decline of the fur trade, a number of streams have been adversely affected by an abundance of beaver. While the presence of beaver dams may

often be an asset in terms of flow stabilization, such dams are not beneficial when they preclude salmon access. For example, in 1989 sockeye salmon were totally prevented from entering Leo Creek to spawn, where there is capacity for 4,800 spawners.

Historically, there was a proactive program within DFO whereby such obstructions were systematically monitored by field staff and reported to district or regional headquarters. Such reports were directed to a small group of technically trained specialists. They would inspect these areas; determine how best to deal with the matter; and assemble the necessary workforce, which might include guardians, Fisheries Officers, or sub-contractors, to alleviate the problem. In recent years, the number of guardians has diminished along with operational funds, and Fishery Officer effort on enforcement matters has so expanded that this type of problem either is no longer actively pursued, or has been passed on to the divisional or sub-district Habitat Management staff. Given these circumstances, it is impossible to ensure that serious natural blockage could be detected or that effective removal procedures be initiated before a sockeye run arrives. A procedure to provide timely surveys of problem areas and remedial action before a run arrives is needed.

3.2 Chinook Salmon

The chinook salmon populations of the Stuart/Takla HMA spawn primarily in the Stuart River, although chinook have been observed in small numbers in six other tributaries in the drainage basin (Figure 3.2). Their age at maturity ranges from three to seven years, with the majority of the populations comprised of four and five-year-old fish. As a result of this mix of age classes, there is no cyclic pattern of abundance as with sockeye salmon.

3.2.1 Life history

Spawning commences in late August, peaks in mid-September, and ends in early October (Hickey and Lister, 1981). Based on scale analysis of returning adults, Hickey and Lister estimated that 98% of the population demonstrated a stream-type life history, (i.e., they spent at least one winter in fresh water). Few chinook spend two winters in fresh water and most enter the ocean in their first year of life. Juvenile trapping conducted in 1980 in the lower reaches of the Stuart River (Lister *et al.*, 1981) indicated that a major downstream movement of fry commenced in mid-April, peaked in mid-May, and was reduced to a trickle by mid-June and continued until the second week of September. Only a small number of smolts were captured, suggesting that they may have left before trapping began or that the traps were not effective in capturing larger fish. Of the small fraction of fry that do not migrate downstream to rear, most reside in the tributaries to the mainstem. All this demonstrates that chinook salmon of the watershed adopt the whole array of freshwater rearing strategies normally available to chinook salmon before they migrate to

sea. Although some of these smolts will take up residence in the Strait of Georgia, the bulk of the population is believed to rear for one or more years in the Gulf of Alaska before commencing their return migration to their natal streams.

3.2.2 Timing of migration and spawning

Chinook salmon returning to the Stuart/Takla HMA are classified as 'early timing stocks', which means they may enter the lower Fraser as early as March, peak in late June, and cease to enter the river in late July (Fraser *et al.*, 1982). Using available time-of-travel estimates derived from tagging data, Fraser *et al.* deduced it would take early timing stocks 25-40 days to reach Prince George. At this rate of travel, they would take another two or three days to reach the mouth of the Stuart River.

Spawning may commence as early as late August and extend into the first week of October. Peak of spawning is usually in the second and third weeks of September.

3.2.3 Catches, escapements and escapement trends

There are no reliable estimates of the Stuart/Takla chinook catch, although it is generally believed the bulk of the catch is taken in the southeast Alaskan and northern British Columbia troll and net fisheries. Some are undoubtedly harvested in the Strait of Georgia commercial and recreational fisheries. There are also no estimates of the contributions made by these stocks to the numerous aboriginal fisheries of the Fraser River.

Since 1985 there has been a marked increase in the escapements to the Stuart River, a fact which has been attributed to the restrictive management measures, arising from the Pacific Salmon Treaty of 1985, placed on many marine fisheries harvesting chinook salmon (including those in southeast Alaska and northern British Columbia). A 1991 escapement of 7,000 chinook was the highest ever recorded for the Stuart River.

**STUART - TAKLA
HABITAT MANAGEMENT AREA**



CH = Chinook Salmon
(25) = Average Escapement (1981 - 90)

CH* Known spawning areas

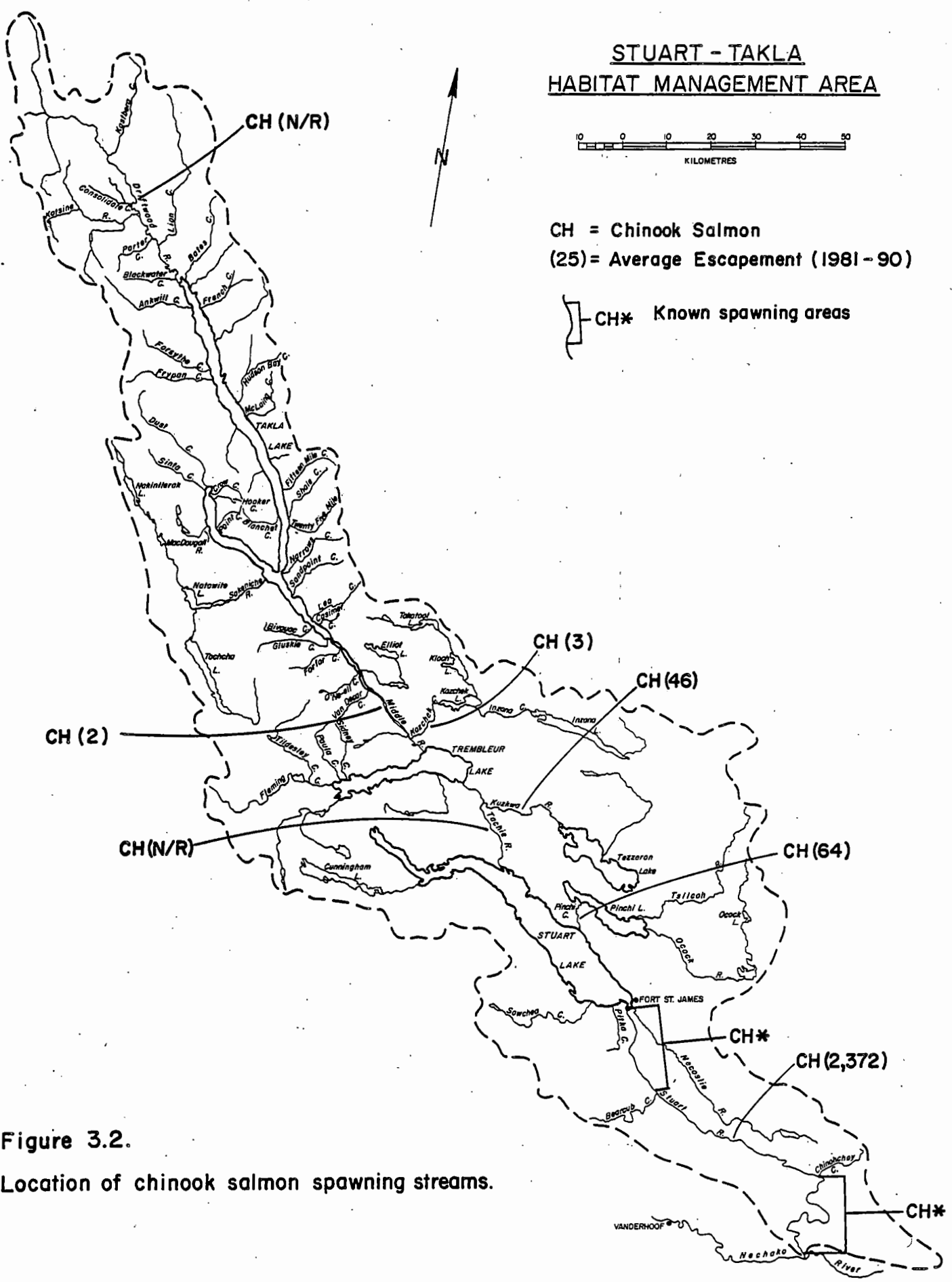


Figure 3.2.
Location of chinook salmon spawning streams.

The escapement trends for each known chinook salmon population in the Stuart/Takla HMA are shown in Table 3.6.

Table 3.6. Chinook salmon escapement trends for the Stuart/Takla HMA.

Stream	Escapement Averages				
	1951-60	1961-70	1971-80	1981-90	1986-90
Driftwood River	14	22	N/R	N/R	N/R
Kazchek Creek	45	25	25	3	2
Kuzkwa Creek	50	50	110	46	78
Middle River	25	25	21	2	N/R
Pinchi Creek	N/R	25	25	64	64
Stuart River	455	337	618	2332	3720
Tachie River	31	25	25	N/R	N/R
HMA Total	620	509	824	2447	3864

N/R = No Record

3.2.4 Spawning habitat

The principal spawning areas for chinook salmon are found in the Stuart River; that area was estimated by Hickey and Lister (1981) to be 182,400 m². Although this estimate was made during the second lowest mean monthly flow on record for September, it may be high, because both actively used spawning areas and areas of similar character were considered suitable for spawning.

Hickey and Lister (1981) described the distribution of spawning areas in detail, but the is be summarized here. The upper reach of the river from the highway bridge at the Stuart Lake outlet to 1 km below Bearcub Creek, a distance of 22.9 km, contains five spawning areas, with a total spawning area of 159,400 m². The lower reach of the river from Chinohchey Creek to the Nechako River contains seven spawning areas, whose total area is 23,000 m² scattered over 40.5 km of river. The 46.6 km of river between these two reaches contains no spawning area (Figure 3.2).

Although there obviously is spawning area available for use on the six other streams known to contain small chinook populations, no estimate of available spawning area has been made for these streams. However, the sockeye estimates found in Table 3.3 would be a reasonable approximation.

3.2.5 Rearing habitat

The most comprehensive assessment of chinook salmon rearing in Stuart River was undertaken by Lister *et al.* (1981) in the spring, summer and early fall of 1980. The following has been extracted and summarized from the original text.

- Chinook salmon of Stuart River exhibit the full array of rearing strategies that characterize "stream type" chinook. During the period April 16 to September 9, an estimated 1.24 million underyearling fingerlings migrated from the upper 65 km of river. Of that total, 90% of the migration occurred between May 9 and June 9. Approximately 1.8 million were newly emerged fry. An additional 62,000 fingerlings with varying amounts of stream growth were enumerated in the period June 4 to September 9 at the cessation of trapping. A handful of age 1+ smolts averaging 77 mm in length were also captured.
- Since trapping did not commence until 11 days after the ice left the river, Lister *et al.* (1981) concluded that it is probable that trapping commenced too late to sample anything but the final stages of the smolt migration. Previous experience in the Yukon and McGregor systems with age 1+ smolts indicates that smolt migration precedes any fry migration and may occur as ice is breaking up.
- Stuart River contains 112 km of main river and 18 km of tributary streams accessible to rearing chinook juveniles. Based on population sampling, it was estimated that the total post-emergent chinook fry population in this area was 206,000 and of that total more than 50% resided in the tributaries. In relation to their length, the tributary streams supported six times as many post-emergent fry as the mainstem river. It was postulated that this was generally due to more favourable temperatures, fewer predators and higher quality habitat in the tributary streams. Mainstem temperatures ranged between 16 and 20 °C from mid-June to the third week of August.

3.2.6 Habitat production limitations

The factors limiting chinook salmon production within the Fraser River system are not so readily quantifiable as they are with sockeye because of the relative paucity of research into the life history of the species.

With respect to spawning limitations, existing data suggests that chinook salmon are far more selective of their spawning habitats than other members of the genus *Oncorhynchus* (McLaren, 1952; Shepherd, 1979; Tutty, 1986; Jaremovic and Rowland, 1988; Nicholas and Hankin, 1989; and Schouwenburg, 1989). Based on the detailed adult surveys conducted by

Hickey and Lister (1981) and a close review of the annual spawning survey reports, the chinook spawners of Stuart River utilize 12 distinct sections of the river for spawning purposes. These spawning areas account for 7.15 km of the 110 km length of the Stuart River.

On the basis of information obtained and analyzed by Lister *et al.*, it is clear that Stuart/Takla chinook salmon juveniles exhibit a wide array of rearing strategies. However, there is no information from either the Fraser Basin or elsewhere that would enable an analysis of the comparative contribution to the total return from each distinct life history group. As a result, it is not possible to assign any rearing-oriented limiting factors to chinook production. Until more research information on the significance of rearing conditions to chinook production becomes available, chinook production goals will have to be derived from the assumption that spawning habitat and factors affecting the survival of eggs and alevins in that habitat are the only quantifiable limitations to production.

Any estimates of carrying capacity for chinook salmon will have to be based on those factors pertaining to the spawning environment. The carrying capacity of the chinook spawning grounds will be determined by the extent and quality of the available spawning areas and the area normally required for construction of a redd plus the area around the redd that would be defended.

In a comparative sense, the information on distribution of spawners and available spawning habitats within the watershed (Hickey and Lister, 1981) appears quite acceptable to fulfil the needs for quantifying the available spawning habitat. The available spawning area in the main Stuart River, as estimated by these researchers, is 182,400 m².

The area required per chinook spawner has been the subject of several studies conducted in the United States and Canada. Burner (1951), examined several chinook salmon spawning tributaries of the Columbia River and reported redd sizes ranging between 2.4 and 6.5 m². He further reported that the inter-redd space defended by the female was three times the area of the redd. These studies were based on wild populations. Neilson and Banford (1982) reported mean redd sizes of 9.7 and 10.0 m² for two "duned" spawning areas of the Nechako River in British Columbia. Chapman *et al.* (1986) reported an average redd size of 17 m² for a mainstem Columbia River spawning area.

Using the redd size estimates from these three studies and applying the inter-redd defense area estimate from Burner to the available spawning area estimates from Hickey and Lister, it is possible to bracket the range of possible spawning capacities for the Stuart River. These estimates are as follows:

Using Burner;

Estimated Spawner Capacity	-	<u>total estimated spawning area</u>		x 2
		area required/defended redd		
	-	$\frac{182,400 \text{ m}^2}{9.6 \text{ m}^2}$	x 2 to	$\frac{182,400 \text{ m}^2}{26 \text{ m}^2}$
	-	39,000 to 14,030		

Using Neilson and Banford;

Estimated Spawner Capacity	-	<u>total estimated spawning area</u>		x 2
		area required/defended redd		
	-	$\frac{182,400 \text{ m}^2}{36.4 \text{ m}^2}$	x 2 to	$\frac{182,400 \text{ m}^2}{40 \text{ m}^2}$
	-	10,022 to 9,120		

Using Neilson and Banford;

Estimated Spawner Capacity	-	<u>total estimated spawning area</u>		x 2
		area required/defended redd		
	-	$\frac{182,400 \text{ m}^2}{68 \text{ m}^2}$	x 2	
	-	5,364		

Close examination of these reports leads to the conclusion that redd size would be governed by the size of the fish and the spawning substrate which would, in turn, be governed by the hydrology and geology of the watershed. Thus, it would be wise to use stream-specific redd size information to derive capacity estimates if it is available.

Currently, there is no redd size information available for the Stuart River chinook population. However, there is other information available which is useful in considering which of these three estimates of spawning capacity has the greatest merit. Recent information obtained by the Nechako Fisheries Conservation Program initiative (Rowland, 1989) indicates that there is little difference in fish size between the Nechako and Stuart River populations. This would support the usage of the Neilson and Banford redd size estimate. There is also little difference in substrate size between the two rivers. Consequently, the use of Neilson and Banford redd size estimates were judged most appropriate. As a result, the spawner capacity for chinook salmon in the Stuart/Takla HMA is considered to range between 9,100 and 10,000. No estimate has been made for the other six streams, which contain remnant populations of chinook.

3.2.7 Species manageability and interactions

Chinook salmon of the Fraser River are managed under the auspices of the Canada/United States Salmon Treaty, which was signed in 1985. Under this agreement the parties agreed to rebuild chinook stocks so that escapement goals established by each country are achieved by 1998. Canada's escapement goals are to double the 1979-82 average escapements (or double 1984 escapements for key streams). The principal tool to be used to achieve this objective was the imposition of catch ceilings for chinook for all fisheries in southeastern Alaska and northern British Columbia, the West Coast Vancouver Island Troll Fishery, and the combined recreational and troll fisheries in the Strait of Georgia. The Fraser River commercial fishery for chinook has been closed since 1990 and recreational fishing has been restricted. Reduced fishing times have been applied to the Lower Fraser aboriginal fishery for sockeye to limit the catch of chinook. Enhancement is also being used on some stocks to speed up the rebuilding process.

Currently, the above noted mechanisms are the only means for regulating the harvest of chinook salmon outside the Fraser basin. The escapement average for the Stuart River for the 1979-82 period is 823 (Farwell *et al.*, 1987) and the goal which would meet the terms and conditions of the Salmon Treaty is 1,646. This goal was purely arbitrary and has no biological basis. It has, in fact, been exceeded considerably every year since 1985. At the present time there is no method for managing this specific stock other than those afforded under the auspices of the Salmon Treaty and the minimization of the chinook catch in the Fraser River fishery. The fishery manager does not have the information to manage the stock effectively and cannot ensure that any escapement objective can be met from one year to the next.

Stuart River chinook are considered to belong in the early timing migration group of chinook, which according to Fraser *et al.* (1982) would migrate through the lower river beginning in March, peaking in the month of June and ending in late July. As a result, they probably

coincide with Early Stuart sockeye, which are now being fished more heavily. The recreational catch of Stuart chinook is expected to be very small because of the very low effort expended in the early season by recreational fishermen. The bulk of the catch of this stock is believed to occur in Alaskan and northern British Columbia waters, but the overall exploitation rate for the stock is believed to be from 25 - 30% (N. Schubert, and R. Harrison, pers. comm.).

3.2.8 Habitat capability

The chinook salmon of the Stuart/Takla HMA are found almost entirely in Stuart River. It has been concluded that the available spawning area in the Stuart River could support between 9,100 and 10,000 spawners.

Within the context of the Canada/United States Salmon Treaty the 'official' chinook salmon escapement objective for Stuart River is 1,646. The parties to the treaty recognize the arbitrary nature of the chinook objectives; the DFO has, thus, always expressed the desire to exceed the target levels to adaptively establish the long-term chinook production capabilities of each chinook stream.

With the signing of the Canada/United States Salmon Treaty in 1985, chinook escapements have exceeded the 'official' target every year and have averaged 2,900. In 1985 the escapement was 5,010 -- three times the target.

The Habitat Management Plan concept was developed to link fish production with habitat capability on a sustainable basis; there is now a need to develop an open process to review production targets so that they will reflect current knowledge of the species and the condition of its habitat.

3.2.9 Production management and enhancement plans

If salmon production in the Stuart/Takla HMA is to be sustained at optimum levels, and if presently unused or under-utilized areas are to be brought into full production, it is imperative that strategies be adopted to rebuild depressed stocks and, when appropriate, to enhance production by artificial means. Without such strategies to increase salmon production from the available habitat, all the habitat management and protection initiatives described previously will not ensure that optimum production levels are achieved and sustained. Because the Stuart River is hydrologically stable there is little likelihood of any significant artificial changes that could affect the productivity of the river, there are impediments to steadily increasing escapements towards the suggested carrying capacity of the spawning grounds.

With respect to chinook salmon, there are no direct stock-specific fisheries on this species. The majority of management action is governed by the terms of the Canada/United States Salmon Treaty where the parties have agreed to rebuild chinook stocks. This has led to an interim escapement target of 1,646 chinook for the Stuart River. As a result of the reductions to the incidental catch of chinook and the imposition of quotas in fisheries extending from southeast Alaska to Puget Sound, all escapements to Stuart River since 1985 exceeded the interim target.

The Salmonid Enhancement Program began operating an experimental chinook hatchery at Fort St. James in 1980, and initially water quality problems (high iron content) on the groundwater supply had to be resolved. The facility has been operated by the Nechoslie Aboriginal Band since 1982; it is now operating at full capacity and producing approximately 100,000 pre-smolts annually. The survival rate of these pre-smolts is estimated at about 0.20% (W. Saito, pers. comm.). Although low, this is similar to survivals obtained at other chinook facilities working with Fraser chinook stocks of the 1+ freshwater age class. This indicates that current enhancement strategies are not effective, and until the problem is resolved chinook enhancement projects are unlikely to be expanded for stream-type populations.

3.3 Rainbow Trout

3.3.1 Life history

Rainbow trout are present in most of the lakes and streams in the HMA. Rainbow spawn in streams in the spring of the year, usually between April and June, with eggs usually emerging by early to late July. Unlike salmon, rainbow trout do not die after spawning, but return to their rearing areas, in many cases lakes, where they continue to feed and grow. Young rainbow trout from lake stocks will spend two to three years in the stream before migrating into the lake; resident stocks remain in streams.

3.3.2 Stocks

There are two distinct varieties of rainbow trout in the Stuart/Takla drainage. There is a race of large rainbow trout and the smaller, usually insect-eating variety.

The large rainbow, recorded in excess of 10 kg, are present only in Stuart and Trembleur lakes. There is no known reason for their absence in Takla Lake, but fish of the same size found in Stuart and Trembleur are not found in Takla. The population of large rainbow appears low, and there are concerns about reductions of the stock to such an extent that it no longer provides a sports fishery. The reduction in the stock of these large fish is most likely directly related to over-

fishing, and specific regulations can be imposed to protect them. These large rainbow feed on kokanee, and concerns have been raised as to the impact sockeye enhancement may have on kokanee, and hence on rainbow production. Studies of similar large rainbow in the Quesnel and Shuswap systems have shown their predominant diet is kokanee rather than the anadromous sockeye (D. Abelson, pers. comm.). These Shuswap fish do feed on out-migrating sockeye to some extent for only a short period of the year. Therefore, it is felt that enhancement programs that stimulate sockeye production will compete directly with kokanee stocks and pose a danger of depressing the kokanee population. These are key concerns of the B.C. Ministry of Environment, Lands and Parks (Fish and Wildlife Branch), and should be addressed as part of the sockeye enhancement strategy.

The smaller rainbow stocks are found mainly in smaller tributaries and other lakes throughout the entire HMA. Rainbow stocks are abundant and at present are not a management concern, because stocks appear to be maintained by existing natural spawning and rearing production. However, when initial fishing pressure on a previously unexploited rainbow stock, increases due to improved access, the largest fish are harvested, and the overall size range drops.

3.3.3 Spawning

A large percentage of the larger sized rainbow trout spawn in the Tachie River, whereas spawning runs of the smaller races of rainbow trout are found throughout the HMA, with no particular stream being more outstanding than the others.

3.4 Lake Trout

3.4.1 Life history

Lake trout are almost exclusively lake dwellers, although some fish are found for periods of time in the larger streams systems. Lake trout are fall spawners, usually spawn some time from September to November. They are lake spawners, usually preferring large boulder and rubble bed material. Eggs mature over the winter. The fry spend some time along the shallow shorelines of lakes then move into deeper waters within a month of emergence. Lake trout are very slow growing, with sexual maturity attained in six to seven years, but recorded as late at 13 years. (Scott and Crossman, 1973).

3.4.2 Stocks

The Stuart/Takla Habitat Management Unit was historically the heart of lake trout production and the lake trout sports fishery in British Columbia. Lake trout of up to 23 kg (50 lbs) have been caught, historically; now the odd 18 kg (40 lbs) fish is caught, and generally most fish are in the 7 to 11 kg (15 to 25 lb) class. The larger lake trout appear to be fast disappearing, a fact attributed mainly to increased fishing pressure by both sports and aboriginal food fisheries. At present the population is depressed and is exhibiting a downward trend (D. Abelson, pers. comm.).

Stuart, Takla, Trembleur, and Cunningham lakes are the main lake trout fishing lakes, and Cunningham Lake still has an international reputation for trophy-sized lake trout. The other lakes known to contain lake trout are shown in Figure 3.3.

3.4.3 Spawning

Lake trout are shore spawners. However, the location of spawning areas have not been documented.

STUART - TAKLA HABITAT MANAGEMENT AREA



LT = lake trout

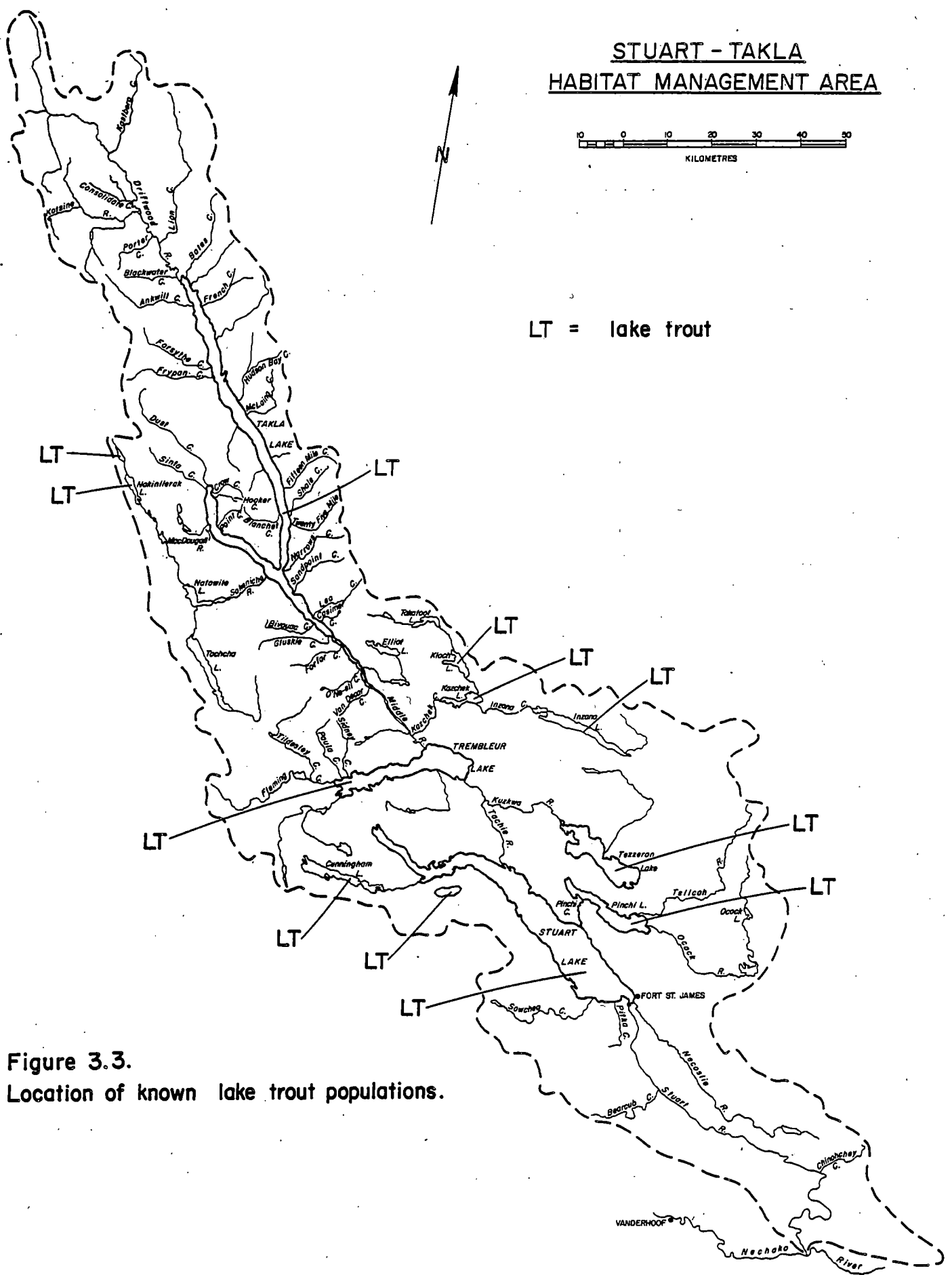


Figure 3.3.
Location of known lake trout populations.

3.5 Kokanee Salmon

3.5.1 Life history

Kokanee are landlocked sockeye salmon but they do not grow to the same size as sockeye. Kokanee reside in lakes rather than in the ocean and, like sockeye salmon, the adults die after spawning. Kokanee generally have a four year life cycle but the cycle can be as short as two years.

3.5.2 Stocks

Kokanee are found throughout the HMA and are abundant in most of the lakes. In many cases they provide valuable sports fisheries. Large lakes such as Stuart, Takla and Trembleur have particularly large populations of kokanee that provide both a sports fishery and an important food supply for the large rainbow trout and lake trout populations in these lakes. Little documentation exists on the status of stocks, life history, or population size for the various populations of kokanee salmon found in the Stuart/Takla HMA. However, work done on Takla Lake (Wood and Foote, 1991) has provided some new and important information. Based on hydro-acoustic data, it is estimated that the total population of kokanee and sockeye rearing in Takla Lake is 11.8 million. The kokanee component is estimated at 30% (C. Wood, pers. comm.), or 3.5 million. Based on a conservatively low survival rate of 30 to 50% per year, it is estimated that spawning escapement to Takla Lake streams could range from 100,000 to 500,000 adult kokanee. It was also noted that the size of mature kokanee in Takla Lake are smaller than the size of Babine or Shuswap lake kokanee, and has partially been attributed to limitations of food supply (C. Wood, pers. comm.).

3.5.3 Spawning

Figure 3.4 shows the location of 25 known kokanee spawning streams in the HMA. Streams of particular significance for Kokanee spawning (in large numbers) include the Driftwood River and Kazchek Creek. There is some overlap in kokanee and sockeye spawning, but kokanee tend to prefer smaller gravel and lower velocities than sockeye (C. Foote, pers. comm.).

3.6 Other Species

Dolly Varden Char: Dolly Varden char are present throughout the watershed but are found mainly in the larger river systems. There are substantial populations in the Stuart and Driftwood rivers, and some are present in the Tachie River, but the lakes do not appear to support significant populations.

Lake Whitefish: Lake whitefish are found in lakes throughout the HMA, and are of great importance as one of the target species of the aboriginal food fishery, but they are also an important forage species for rainbow, kokanee and lake trout.

White Sturgeon: White sturgeon (*Acipenser transmontanus* Richardson) are present in the Nechako River and their presence has been reported in the Stuart, Takla, and Trembleur lakes (D. Cadden, pers. comm.).

**STUART - TAKLA
HABITAT MANAGEMENT AREA**



KO = kokanee

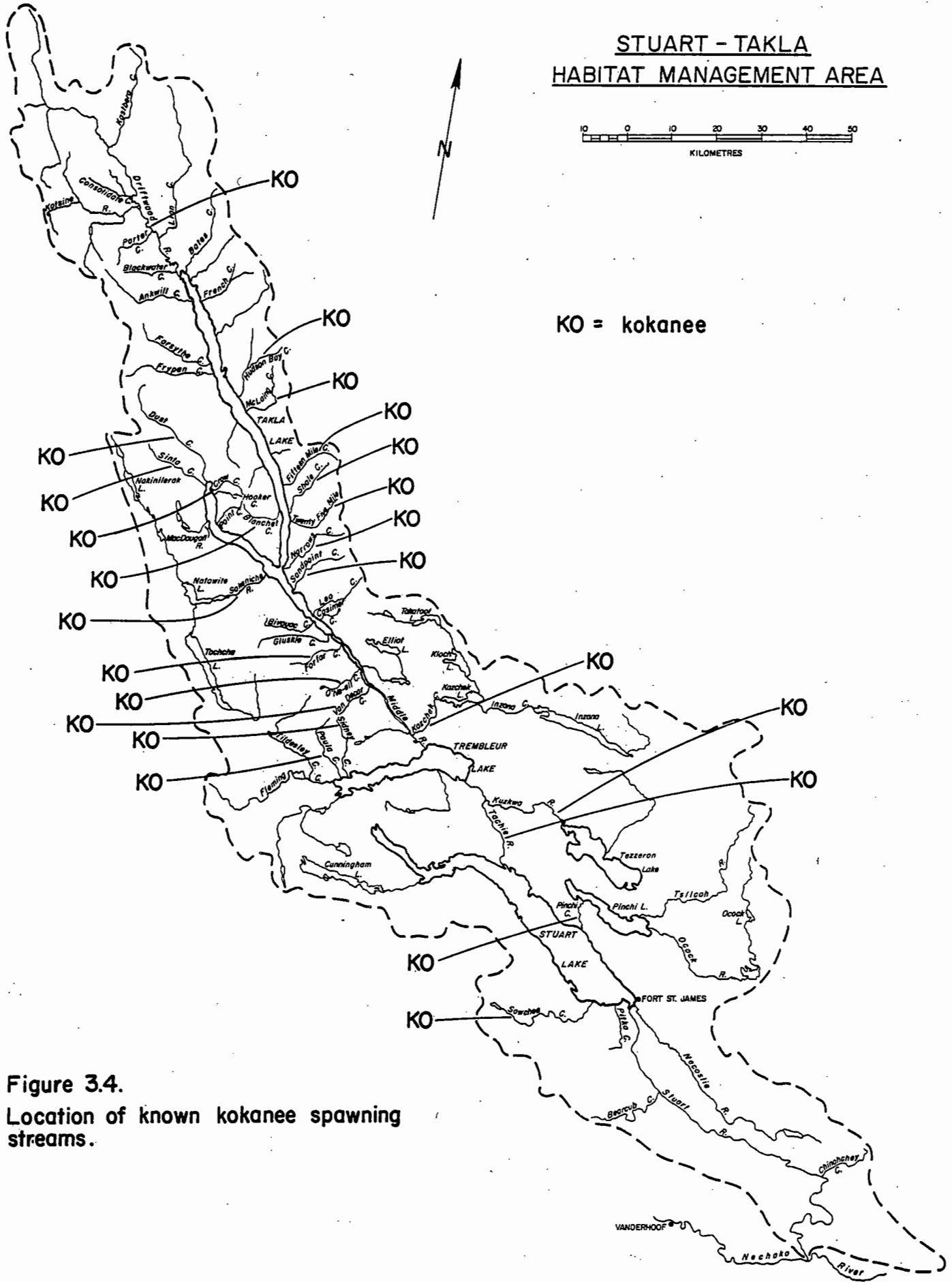


Figure 3.4.
Location of known kokanee spawning streams.

4. PHYSIOGRAPHIC FEATURES

4.1 Watershed Description

The Stuart River watershed consists of a major river and lake system which drains from the north through the Nechako Plateau, entering Nechako River near Vanderhoof (Figure 1.1). The upper segment of the watershed consists of Driftwood River, which drains into Takla Lake, and approximately 32 major feeder tributaries to the river and lake. Takla Lake is approximately 85 km long and 2 to 3 km wide. Middle River flows southward from Takla Lake for approximately 23 km and drains into Trembleur Lake. Trembleur Lake is fed by five major tributary systems. The lake is approximately 31 km long with an average width of 4 km. Trembleur Lake is connected to Stuart Lake by Tachie River, which is approximately 25 km long. The major tributary to the Tachie system is Kuzkwa River. Stuart Lake has four major tributaries and drains into Stuart River, which flows for approximately 112 km between Fort St. James and the Nechako River confluence near Vanderhoof.

4.2 Physiography

The upper Stuart River basin is characterized by four physiographic subdivisions (Holland, 1976), all of which are part of the interior system of the Canadian Cordillera (Figure 4.1). They are:

- Nechako Plateau
- Fraser Basin
- Nechako Plain
- Hogen Range of the Omineca Mountains

Nechako Plateau

Nechako Plateau makes up the largest area within the basin. It is an area of low relief generally lying between 1200 and 1500 m elevation. Bedrock dominantly consists of tertiary lava flows overlying older volcanic and sedimentary rocks. The volcanic rock types are comprised mainly of andesite, basalt and associated tuffs and breccias. The sedimentary rocks are dominantly chert, pebble conglomerate, shale and sandstone. Bedrock outcrops are uncommon, due to the thick cover of glacial drift material.

**STUART - TAKLA
HABITAT MANAGEMENT AREA**

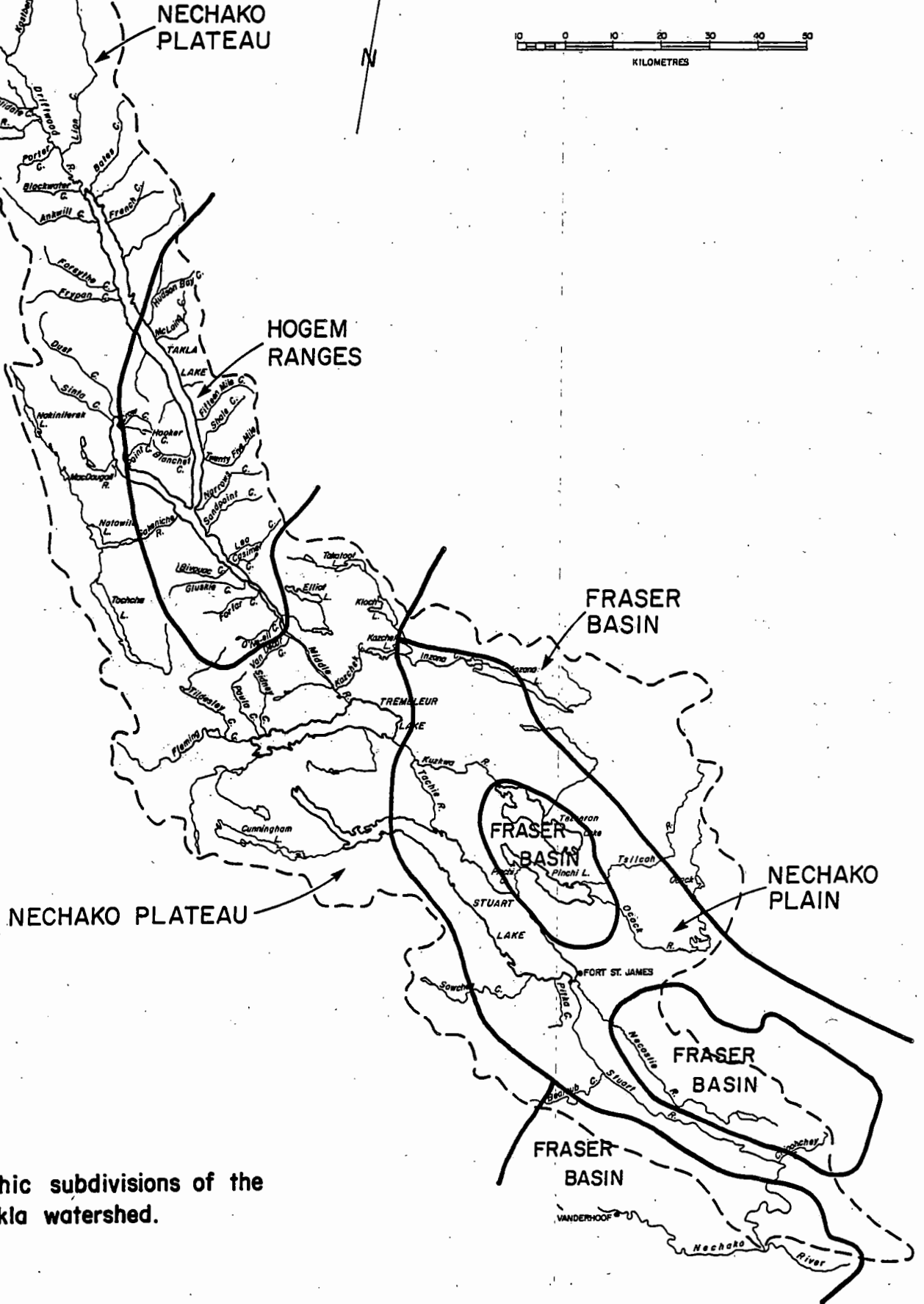


Figure 4.1.
**Physiographic subdivisions of the
Stuart/Takla watershed.**

Fraser Basin

Fraser Basin, lying north and east of Fort St. James, is also an area of low relief. It generally lies at a lower elevation (below 900 m) than the Nechako Plateau. Bedrock outcrops are rare due to the thick glacial drift.

Nechako Plain

Nechako Plain is quite a distinct feature due, to its formation from a glacial lake. These ice-dammed lakes formed during the glacial retreat and generally had lake levels below 800 m. Varved clays were deposited in these glacial lakes. They are evident today where streams and rivers have dissected the former lake bottom sediments.

Hogem Range

Hogem Range of the Omineca Mountains is also a very distinct feature in the basin due to its relatively high relief. Tsitsutl Mountain is approximately 2500 m elevation. Bedrock is predominantly two parts limestone and three parts argillite, with intrusions of granitic rock.

4.3 Surficial Geology and Landforms

During the Fraser Glaciation the entire basin was covered by a thick glacial ice sheet. Glacial till is the most extensive of the deposits resulting from this glaciation. The basin is characteristically expressed as a rolling and undulating plain with textures predominantly loam or clay loam. Where glacial ice did not retreat as an intact mass, but rather abated as a stagnant feature, the resulting till is usually coarser and contains stones and boulders. This is also true of glacial till occurring at higher elevations in the Hogem Range, where the till is often thin over bedrock and of a coarser (sandy loam) texture.

Outwash materials, resulting from the deposition of glacial materials by glacial meltwater, are not extensive. An example of such a feature is the delta at the south shore of Stuart Lake. These materials are dominantly gravelly in texture.

Lacustrine deposits were formed in glacial lake basins during the final stages of glaciation. In the Fort St. James area these deposits are at least 30 m thick and are dominantly heavy clays.

Fluvial materials laid by present day rivers and streams occur throughout the basin. Their textures are highly variable, but are generally silt loam overlying rocks and gravels. These landforms occur as inactive floodplain deposits or as fans at the mouths of streams as they enter a

broad valley. In the more steeply sloping zones (*e.g.* Hogem Range), areas influenced by mass-wasting have resulted in the deposition of colluvial deposits. These materials are dominantly coarse (sand and gravels) with bedrock occurring close to the surface.

4.4 Soil Landscapes

Nechako Plateau

Figure 4.2 provides a schematic illustration of the variety of materials found within Nechako Plateau. The glacial till materials are compact, with loam and clay loam textures, and are usually calcareous. The lacustrine materials range from clay to silty clay loam textures. Outwash deposits in the form of terraces, deltas and plains are consistently sandy loam and gravelly sandy loam. Both the glacial till and, more importantly, the lacustrine sediments, are considered significant sources of sediment to river and stream courses.

Fraser Basin

Figure 4.3 is a schematic of the common landscapes found in the Fraser Basin. The distinguishing feature is the occurrence of ablation till overlying basal till throughout much of the area. The ablation till tends to be loose, with texture ranging from gravelly sandy loam to gravelly loamy sand. The soils are generally acidic and the ablation till is often greater than 1 m thick. Due to topographic and texture factors these soils are not viewed as significant sediment producers.

Nechako Plain

Figure 4.4 illustrates a common landscape feature of the Nechako Plain. The most significant feature of this area is the extensive occurrence of lacustrine clays and silts. The soils are dominantly a heavy clay texture at the surface, with silts occurring at 3 to 4 m. These soils are considered very significant producers of stream sedimentation. However, due to their low relief, erosion does not appear to be a significant factor.

Hogem Range

Figure 4.5 is a schematic of the soil landscapes of the Hogem Range. The topography is often steep or moderately steep and soils are often shallow over bedrock glacial till. Colluvium tend to be loamy sand to sandy loam textures. These soils are generally considered moderate sediment producers but this is very dependent on slope and textural characteristics.

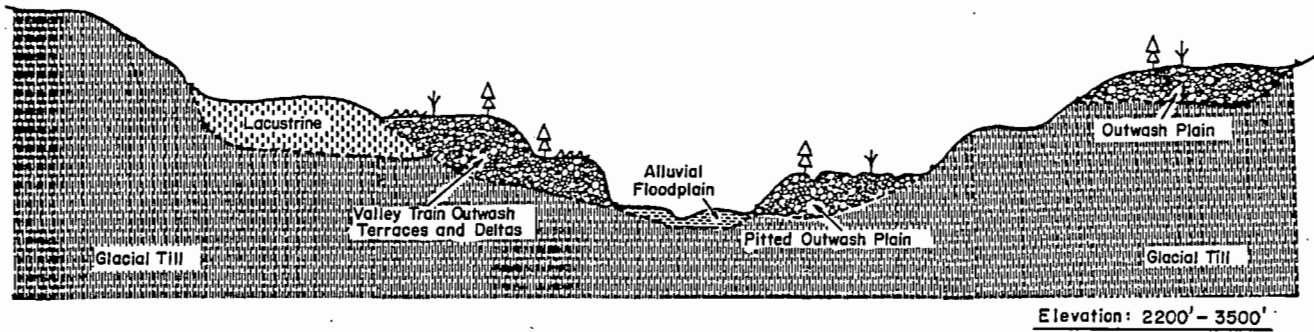


Figure 4.2. Common soil landscape of the Nechako Plateau.

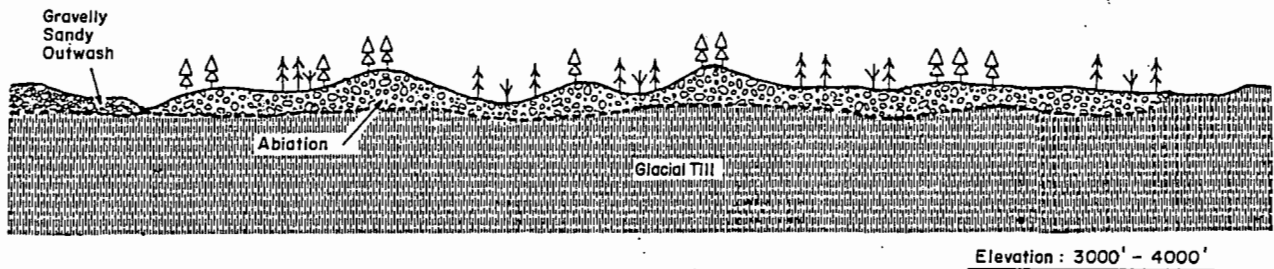


Figure 4.3. Common soil landscape of the Fraser Basin.

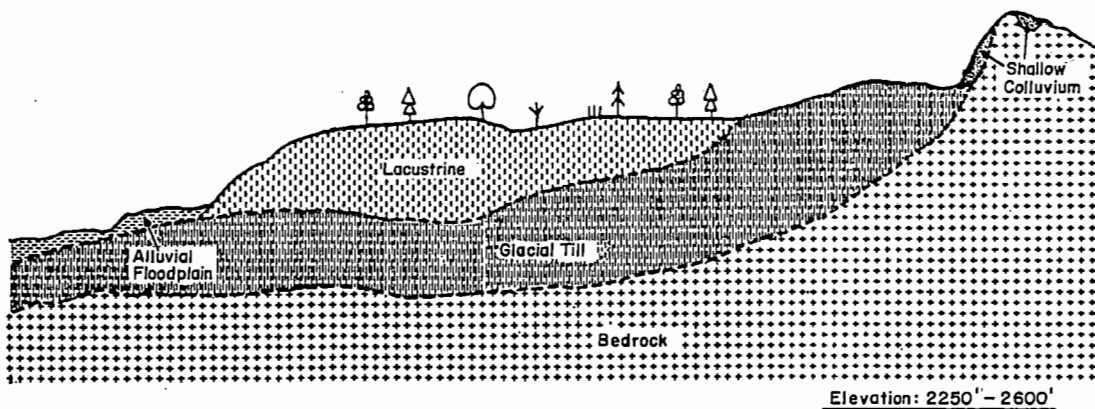


Figure 4.4. Common soil landscape of the Nechako Plain.

Where streams enter a main valley, fluvial fans often develop. This is a common feature in both Hogem Range and Nechako Plateau (see Figure 4.6). The fan materials are dominantly sandy loam texture, but are highly variable due to the diverse nature of the materials eroded to form the fans. Because streams usually dissect fan surfaces and fine textured materials can occur, these landforms may be significant sediment producers.

4.5 Channel/Slope Stability Assessment

The HMA was divided into seven habitat sub-units in order to classify and describe stream channel, valley wall and hillslope stability (Figure 4.7). Throughout the study area laterally unstable stream channels were generally associated with the fans at stream mouths. Fan development is most pronounced in the high relief physiographic regions, including the Hogem Ranges (Figure 4.1). Although meandering stream channels could be considered unstable over the long-term, indications from airphoto analysis suggests that lateral movement is slow within most of the meandering stream channels in the study area. Meandering stream channels are most common in the Stuart/Tezzeron Plain and Fleming Lowlands (Figure 4.7). There is generally a high degree of slope instability where significant downcutting through valley walls has occurred, and valley walls adjacent to areas of channel downcutting are generally unstable. In some cases valley walls are synonymous with hillslopes (Figures 4.8 and 4.9). Indications of valley wall instability was assessed on the basis of historic slope failures evident from 1982 aerial photography. Features such as landslides, avalanche tracks and obvious gullying were used to assess hillslope stability.

A general assessment of channel, valley wall and hillslope stability for each of the seven stability units is presented in the following sections. A more detailed assessment of stability concerns for each of the major salmon producing tributaries within the Stuart HMA is found in Appendix 1.

Stuart/Tezzeron Plain

This unit is composed of the entire Fraser Basin and Nechako Plain physiographic units, plus a small transitional portion of the Nechako Plateau. These areas were combined because stream channel morphology was similar and hillslopes were low gradient and stable.

The Stuart/Kazchek Plain (Figure 4.7) is a broad low lying area containing eight major lake systems and dotted with numerous small lakes, and wetlands. Most streams are characterized by low gradient, meandering channels, except for the areas adjacent to Stuart Lake, where they downcut through the plateau uplands.

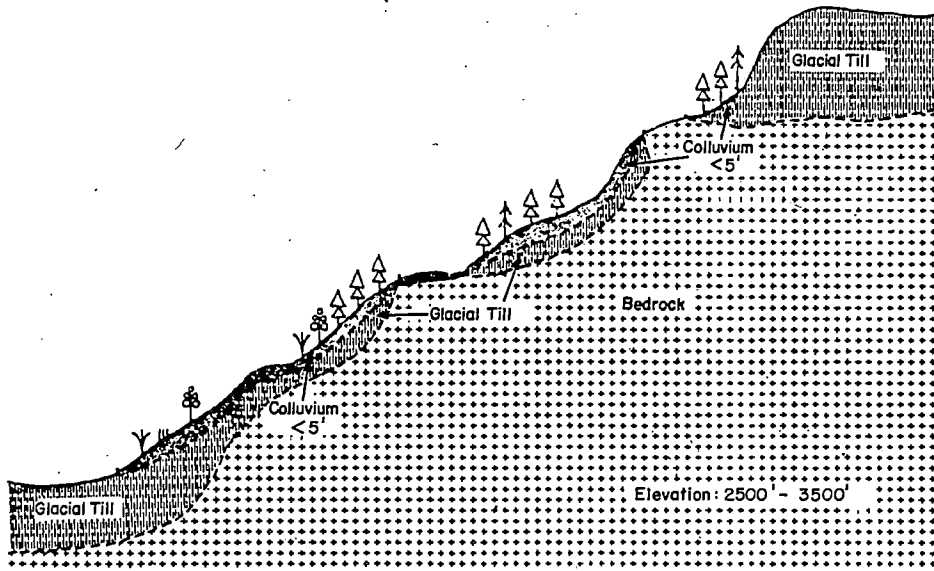


Figure 4.5. Common soil landscape of the Hogem Range.

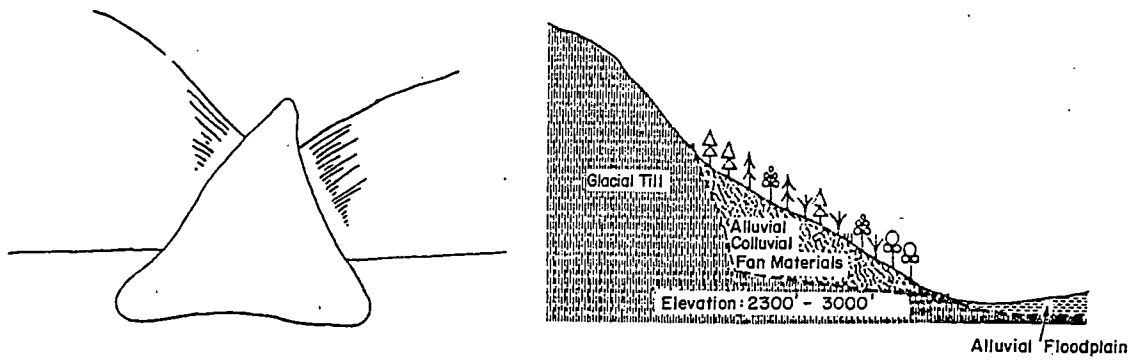


Figure 4.6. Common soil landscape on fluvial fan landforms.

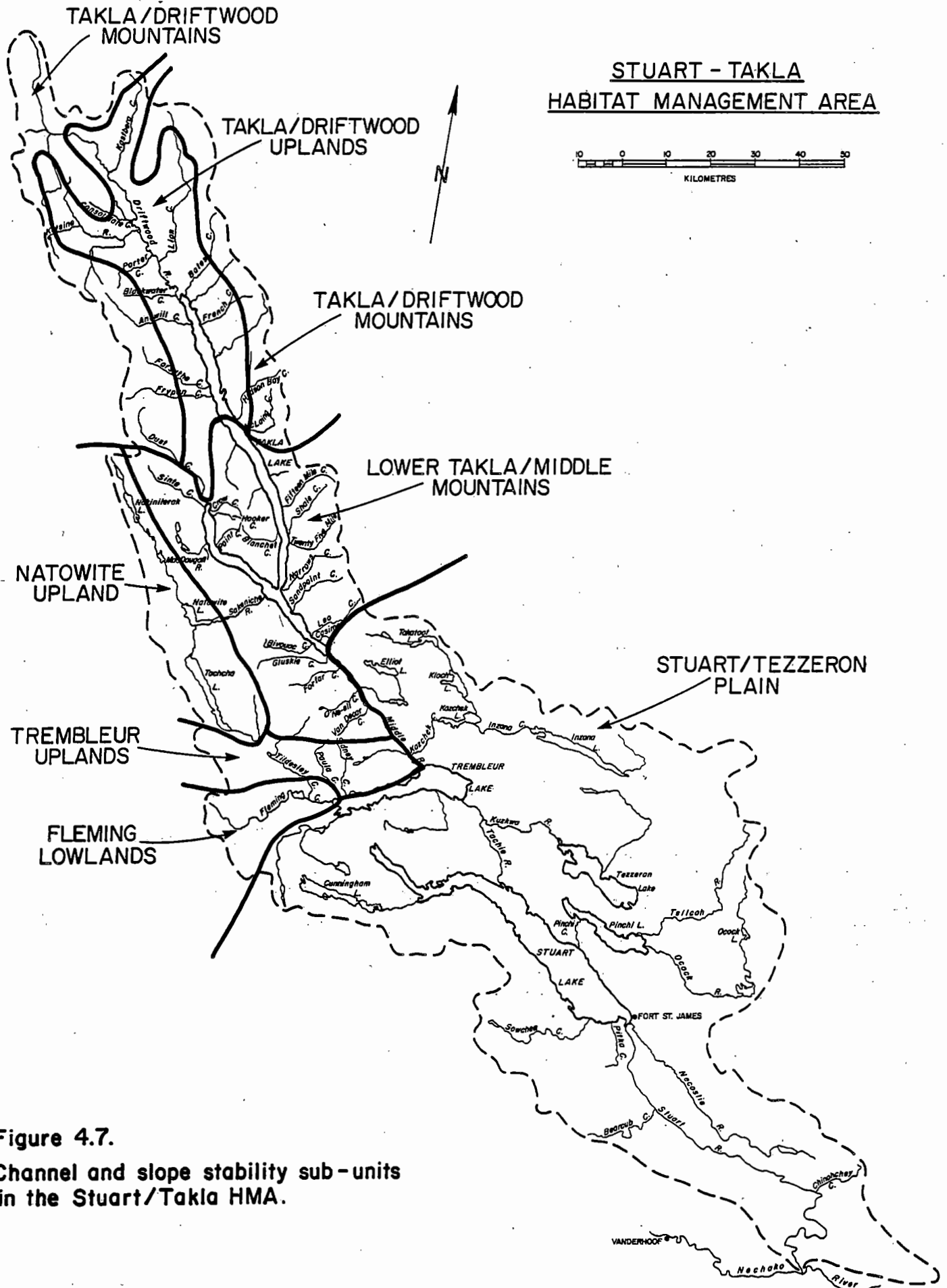


Figure 4.7.
Channel and slope stability sub-units
in the Stuart/Takla HMA.



Figure 4.8

A hillslope failure, common in mountainous terrain in the Stuart/Takla HMA. Photo courtesy of O.E. Langer



Figure 4.9

Typical valley wall failure found on many streams throughout the Stuart/Takla HMA. Photo courtesy of B. MacDonald.

Lateral Stability

The streams are low gradient and meandering, with little evidence of lateral instability. They are generally low energy and are not capable of flows that would cause significant lateral instability. Generally, the most unstable areas within this region are the fans, which also show relatively little evidence of lateral channel shifting.

Valley Wall Stability

Where streams have downcut, the valley walls are unstable. Numerous old revegetated and some recent slope failures indicate that the valley walls, when evident, are unstable throughout this unit. If slope failures occur in the Sowchea or Pinchi Creek valleys it is very likely that material will enter the creeks, because the stream channels and valley walls are most often adjacent.

Hillslope Stability

Where present hillslopes are low gradient and stable.

Fleming Lowland

The Fleming Lowland is a large wetland basin distinctive and large enough to merit being a separate unit, and this stability unit is restricted to the Fleming Creek valley (Figure 4.7).

Lateral Stability

Fleming Creek and the lower sections of the tributary streams meander through swamps and meadow areas of the valley bottom. Channels are relatively stable, with the exception of lower Fleming Creek below Tildesley Creek. Channel instability is the result of sediment input from Tildesley Creek.

Valley Wall Stability

Old instability features are evident along the valley walls throughout this unit. However, since the valley walls are generally set back from the streams there is relatively little risk of landslide from a valley wall entering the stream.

Hillslope Stability

Not applicable to this unit.

Trembleur Uplands

The Trembleur Uplands is a transition zone between the Hogem Range and the Nechako Plateau. This unit (Figure 4.7) encompasses a transition between the plateau and mountainous zones. Streams flowing through this unit are generally downcutting and have steep slopes, but are not adjacent to hillslopes.

Lateral Stability

Streams such as Paula and Sidney creeks have large fans with some noticeable indications of lateral instability within the active channel. There are no indications of old channels across the historic fans, suggesting relative stability.

Valley Wall Stability

Valley walls are unstable, with both numerous revegetated and recent failures evident. Failures on the valley walls will result in direct input of material into the stream channel.

Hillslope Stability

Hillslopes are not adjacent to the stream channels in this unit.

Lower Takla/Middle Mountains

The Lower Takla/Middle mountains are basically the Hogem Range with boundaries altered to include transition areas. The title was provided to give a better geographic description. Streams within this unit are steep and the entire drainage system is influenced by mountainous terrain (Figure 4.7). Sockeye spawning streams in this unit are typical of many Takla Lake streams (Figures 4.11 and 4.12).

Lateral Stability

The presence of large fans at the mouths of these streams indicates that the streams are of a high energy nature capable of moving large volumes of material. The largest fans are evident on the streams along the west side of Middle River and Takla Lake. These fans appear particularly unstable and in many instances former stream channels are visible at other locations on the fan, indicating that major shifts in channel locations may still be possible.

Valley Wall Stability

Valley walls throughout this unit are very unstable, with numerous revegetated and more recent failures evident on most of the slopes. Due to the narrowness of the valleys, slope failures on the valley walls will likely result in the direct input of material into the stream channel.



Figure 4.10

Trembleur Uplands, the transition zone between the plain and mountain sub-units, showing the lower Middle River. Photo courtesy of O.E. Langer



Figure 4.11

Sockeye spawning area on Van Decar Creek, a typical Takla Lake spawning stream. Photo courtesy of B. MacDonald.

Hillslope Stability

Hillslopes exhibit instability features such as old slides and gullying, suggesting extremely unstable conditions throughout this unit. In many instances the hillslopes are adjacent to the stream channel, so that material may enter directly into the streams.

Natowite Upland

The Natowite Upland is a very large basin in the Nechako Plateau of a size suitable as a discrete unit. It is characterized by a series of lowlands and adjacent uplands running the length of the Natowite Lake chain (Figure 4.7).

Lateral Stability

Streams in the upland areas are quite stable, although the meandering nature of some stream sections suggest that over time the channels will move. In the upland section the streams are well entrenched, hence quite stable.

Valley Wall Stability

In the upland areas the valley walls are quite unstable and failures from the valley walls will likely result in the direct input of materials to the stream channel.

Hillslope Stability

Not applicable in this unit.

Takla/Driftwood Uplands

The Takla/Driftwood Uplands are the non-mountainous parts of the Nechako Plateau. This area is sub-divided into the Driftwood River floodplain and the adjacent upland areas. The upland area covers the upper reaches of the tributary streams to Driftwood River and the creeks entering upper Takla Lake. The lowland area extends along the Driftwood River valley (Figures 4.7 and 4.13).

Lateral Stability

Meander patterns in Driftwood River indicate a gradual lateral shifting in the lower reaches with a moderate degree of instability. Lateral instability is substantially higher in the fans of the tributaries to Driftwood River and upper Takla Lake. The fan of Kotsine River, tributary to the Driftwood, exhibits a very high degree of lateral instability.



Figure 4.12 Sexually mature sockeye salmon in pre-spawning holding pattern in Van Decar Creek. Photo courtesy of B. MacDonald.



Figure 4.13 Takla/Driftwood Uplands showing the upper end of Takla Lake looking towards Driftwood River valley. Photo courtesy of B. MacDonald.

Valley Wall Stability

Valley walls within this unit show numerous old revegetated slope failures and numerous recent failures. Slope failures from the valley walls will likely result in direct input of material into the stream channel. Valley wall instability was most noticeable in the Kastberg Creek valley in the upper Driftwood system. This also appears to be a major source of sediment for the upper Driftwood River.

Hillslope Stability

Not applicable to this unit.

Takla/Driftwood Mountains

The Takla/Driftwood Mountains are the mountain ranges found within the Nechako Plateau. This sub-unit surrounds the Upper Takla and Driftwood Uplands. Most of the tributaries to Driftwood River, Takla Lake and the Driftwood River originate from these ranges (Figures 4.7 and 4.14).

Lateral Stability

Most of the channels are confined and streams exhibit little lateral instability.

Valley Wall Stability

The valley walls are generally unstable with numerous old and recent failures. Failures on the valley walls will result in the deposition of material directly into stream channels.

Hillside Stability

A few large failures are evident. Because of the reduced relief of many of these slopes it is unlikely that all failures will enter the stream channels.



Figure 4.14 The transition between the Takla/Driftwood upland and mountain sub-units in the upper reaches of Driftwood River. Photo courtesy of B. MacDonald.



Figure 4.15 British Columbia Railway culvert washout on an unstable valley wall. Photo courtesy of B. MacDonald.

5. HYDROLOGY AND CLIMATIC CONDITIONS

A variety of climatological model studies are now available which, in very rough terms, suggests how increases in global CO₂ concentrations may affect the hydrometeorological regime in British Columbia. There is, however, little or no basis for assessing the effects these predicted changes in temperature, precipitation or evaporation may have on surface runoff, stream characteristics or fish stocks. Long-term hydrometeorological data from central British Columbia have, therefore, been analyzed to identify persistent periods of above or below average conditions. On the basis of this analysis, speculation on the potential effects of climate change on stream characteristics and fisheries resources are presented.

5.1 The Hydrologic Setting

The Stuart River watershed receives approximately 500 mm of precipitation each year (Figure 5.1). The seasonal variation in precipitation (Figure 5.2) shows that approximately 40% of the annual precipitation occurs as snowfall during the winter months. Periods of peak monthly precipitation occur in both mid-winter and mid-summer.

Air temperature exhibits a marked seasonal variation, with average mean monthly temperatures below 0°C between November and March (Figure 5.3). Much of the snowfall in this period remains on the ground until spring. The seasonal variation in snow cover at Fort St. James (elevation 810 m) and at Kaza Lake (elevation 1,190 m), is illustrated in Figures 5.4 and 5.5. Station locations are shown in Figure 5.6. This data indicates that maximum snow accumulation generally occurs in March at Fort St. James and in May at Kaza Lake. The timing of snowmelt also varies regionally. The snow cover at Fort St. James has generally disappeared by May 1, while snowmelt at higher elevation sites such as Kaza Lake is substantially delayed and is not completed until early summer.

The seasonal variation in 24-hour rainfall and precipitation is illustrated in Figure 5.7. Maximum recorded rates of 24-hour precipitation were rainfall events that occurred in both the mid-summer and in the winter period.

Water level and stream discharge data are available from six sites in the Stuart River watershed (Table 5.1 and Figure 5.6). The seasonal variation in runoff at these sites reflects the precipitation regime discussed above. Representative data from Driftwood River above Kastberg Creek (basin area 407 km²) and Stuart River near Fort St. James (basin area 14,600 km²) are shown in Figure 5.8 and 5.9, respectively. This data illustrates how the annual discharge regime in small headwater basins is dominated by the snowmelt freshet, with some minor increases in

runoff during the period of fall rainstorms. The snowmelt freshet is also the dominant annual event on Stuart River. However, the larger basin size and lake regulation result in more persistent winter flows and somewhat less sensitivity to fall rainstorm events.

Table 5.1. Summary of Water Survey of Canada stream flow and water level data available in the Stuart River watershed.

Station	Name	Drainage Area (km ²)	Discharge Period	Record Type	Remarks	
08JD006	Driftwood River above Kastberg Creek	407	79	RS	NAT	
			80-88	RC		7
08JE001	Stuart River near Fort St. James	14,600	29-31	MS	NAT	
			32	M#		5
			33-34	MS		
			35-41	MC		
			42-47	MS		
			48	MC		
			49-50	MS		
08JE002	Pinchi Creek at Pinchi Lake	?	51-88	MC	NAT; data from COMINCO	
			41-42	MS		
08JE003	Stuart Lake near Fort St. James	-	55-63	*MS	NAT	
			64-77	*MC		
			78-85	*RC		
			86-88	*MC		
08JE004	Tsilcoh River near the mouth	414	75-88	RC	NAT	
08JE005	Kazchek Creek near the mouth	881	79	R#	NAT	
			80-88	RC		

NOTES: M - Manual Gauge C - Continuous Operation * - stage only
R - Recording Gauge S - Seasonal Operation # - miscellaneous data only

NAT - Natural Flow (i.e. unregulated)
5 - water quality data available
7 - satellite data collection platform



Figure 5.1. Spatial distribution of annual precipitation (mm) in British Columbia.
(From Fisheries and Environment Canada, 1978).

Figure 5.2. FORT ST. JAMES (1951-1980)
SEASONAL VARIATION IN PRECIPITATION

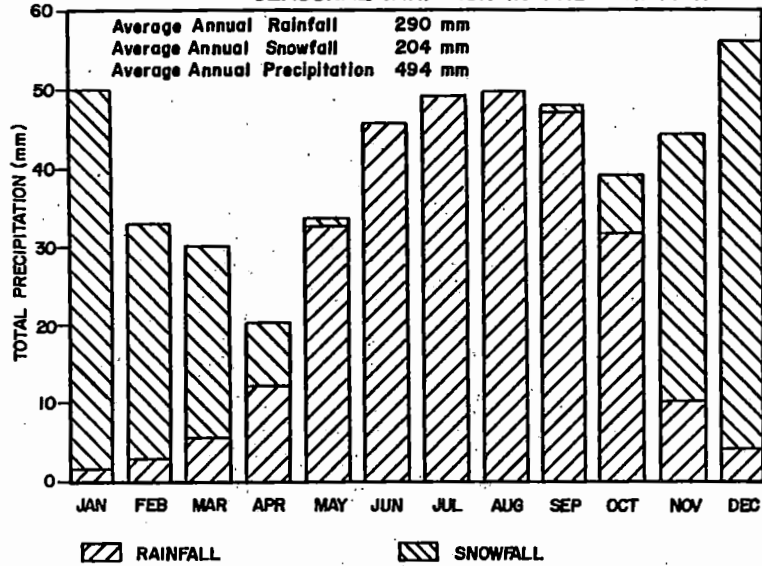


Figure 5.4. FORT ST. JAMES (1955-1988)
SEASONAL VARIATION IN SNOW ACCUMULATION

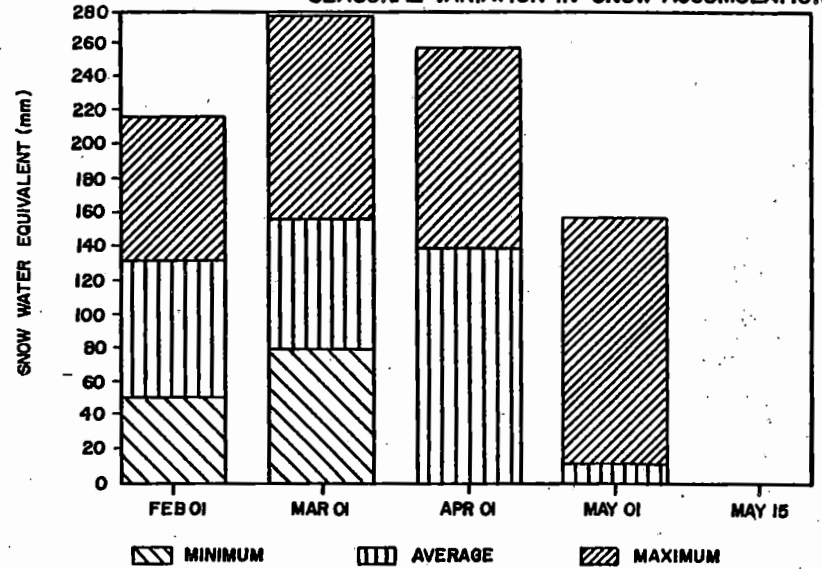


Figure 5.3. FORT ST. JAMES (1951-1980)
SEASONAL VARIATION IN AIR TEMPERATURE

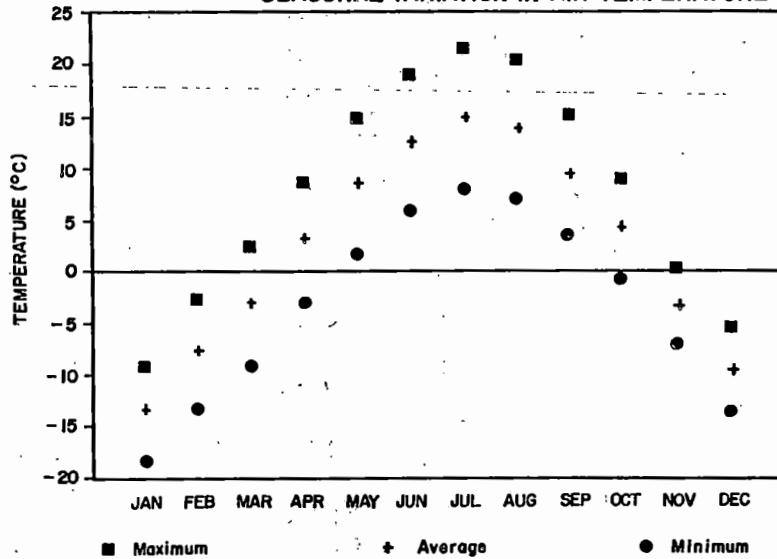
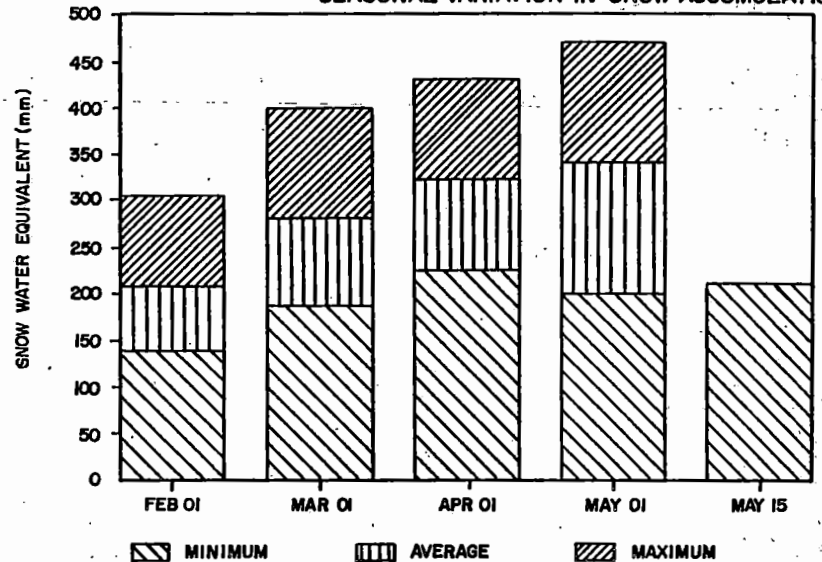


Figure 5.5. KAZA LAKE (1963-1988)
SEASONAL VARIATION IN SNOW ACCUMULATION



5-4

**STUART - TAKLA
HABITAT MANAGEMENT AREA**



Water Survey of Canada

- stream flow gauging site
- water level recording site

Water Management Branch
B.C. Ministry of Environment

- ★ snow course

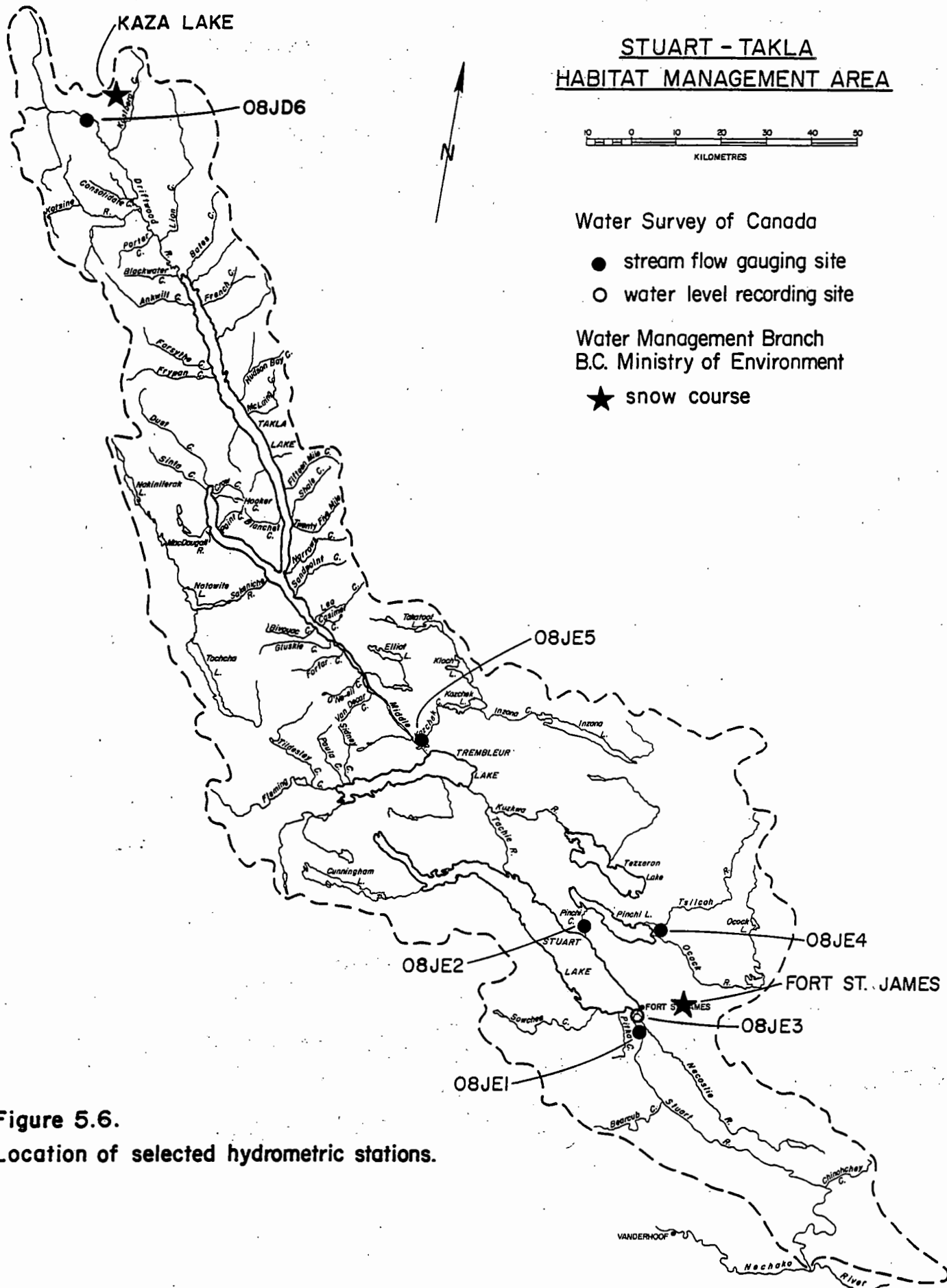


Figure 5.6.
Location of selected hydrometric stations.

Figure 5.7. FORT ST. JAMES (1895-1985)
SEASONAL VAR. IN 24-HR. PRECIP. OR RAIN

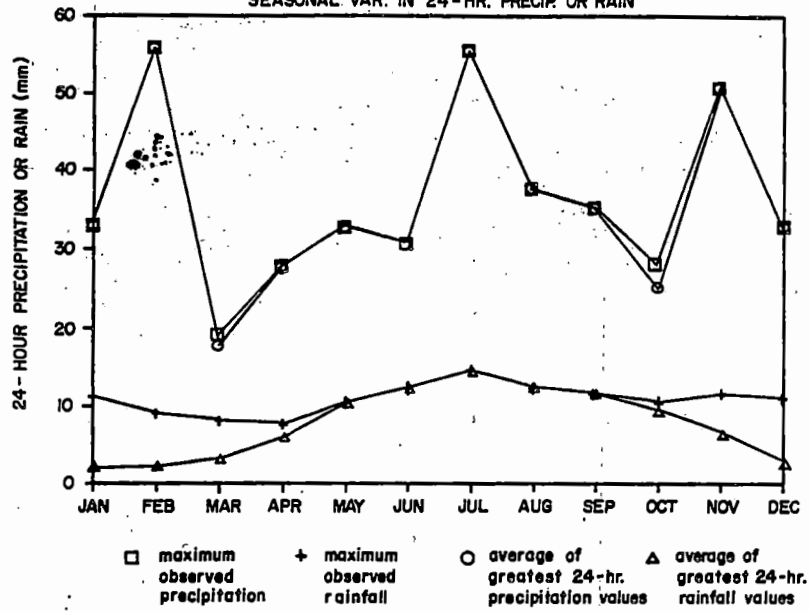


Figure 5.8. DRIFTWOOD R. AB. KASTBERG C.
SEASONAL VARIATION IN RUNOFF REGIME

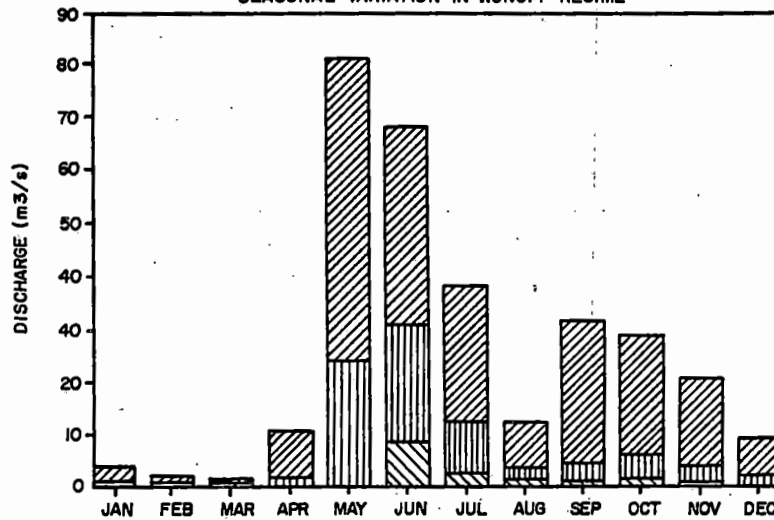
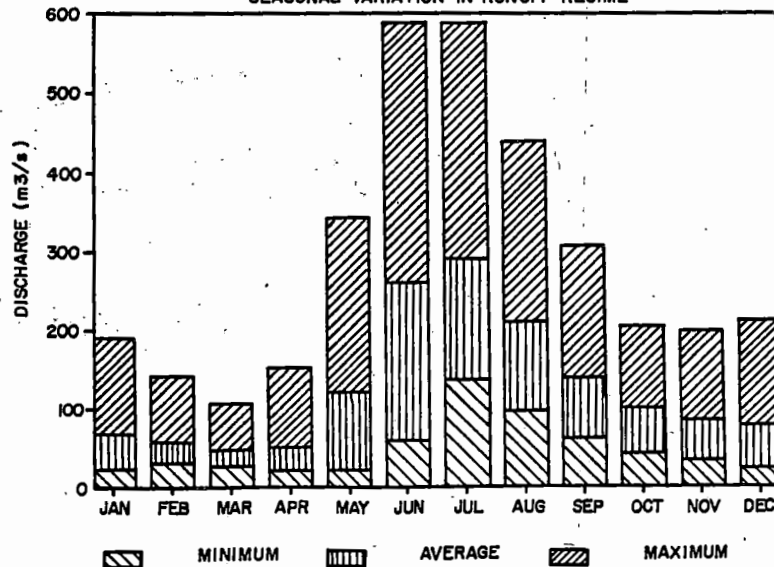


Figure 5.9. STUART R. NR. FORT ST. JAMES
SEASONAL VARIATION IN RUNOFF REGIME



5.2 Historical Variations in Precipitation, Air Temperature and Runoff

The data presented in Section 5.1 illustrates average precipitation, temperature and runoff values observed over the period of record. Studies such as Barrett (1979), and Church and Miles (1987), indicate that there have been relatively well-defined and persistent periods when hydrometeorological values have deviated from these average values. For example, Figures 5.10, 5.11 and 5.12 show annual minimum, annual mean and annual maximum daily runoff values observed on Fraser River near Hope. These graphs show both the observed value and the corresponding residual mass curve. The residual mass curve is a graphical technique for analyzing trends in time series data where the plotting position is given by the formula:

$$Y_i = 100 \sum_{i=1}^n \left[\frac{X_i}{\bar{x}} - 1 \right]$$

where: Y_i = cumulative percentage departure from the mean for year i
 X_i = value for year i
 \bar{x} = mean value for the period of record, and
 n = number of years of record.

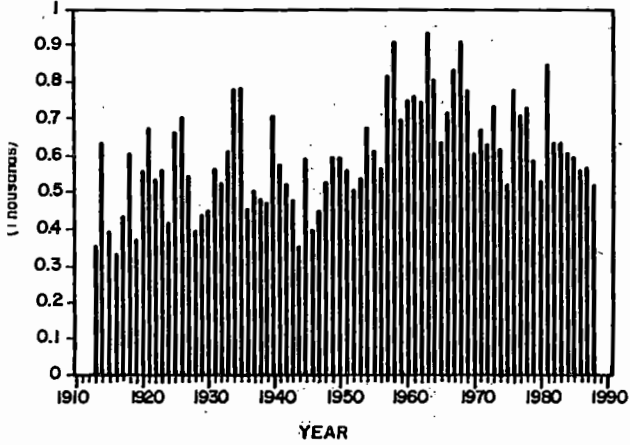
This plotting procedure is illustrated in Figure 5.13. A negative slope of the line connecting two data points indicates that the second value is less than average; a positive slope indicates a greater than average value; and a horizontal line indicates that the second value is equal to the long-term average. These graphs require some experience to interpret (for example, a "V-shape" can be indicative of a trend of increasing values).

Stream flow data from Fraser River at Hope integrates discharge characteristics from a 217,000 km² basin of which the Stuart River watershed comprises about 7%. The analyses in Figures 5.10 and 5.11 indicates that annual minimum and mean flows in the period between approximately 1950 and 1980 were greater than average, while values prior to approximately 1950 were, in general, less than average. This is a relatively large change, as average annual minimum and mean flows in the period between the mid-1950s and the early 1980s were 31% and 10% larger than the long-term average. Annual maximum flows show a more variable pattern, likely reflecting the variety of factors that combine to produce flood events. Nevertheless, the average annual maximum flows between 1946 and 1974 were 8% larger than the long-term average. Similar temporal variations have been reported from a variety of sites in B.C. (see Barrett, 1979).

Statistical tests (Q, R and W statistics, described in Buishand, 1982 and summarized in Table 5.2) suggest that there is a 90% to 99% probability that a statistically significant change has occurred in both the annual mean and minimum flow runoff regime of Fraser River at Hope. Changes in annual maximum flows are not significant at the 90% level of significance.

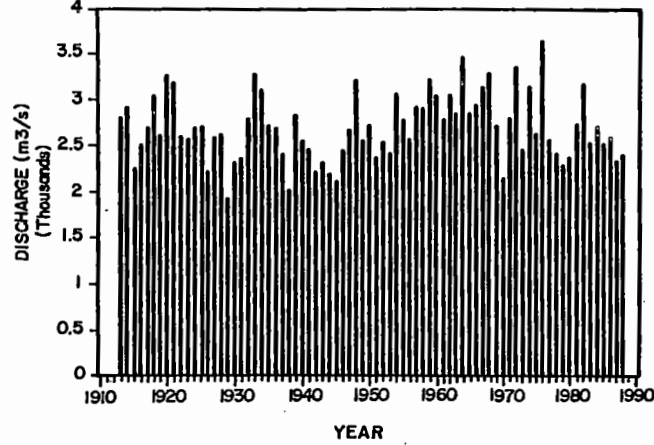
FRASER RIVER AT HOPE

MINIMUM DAILY DISCHARGE 1913-1988



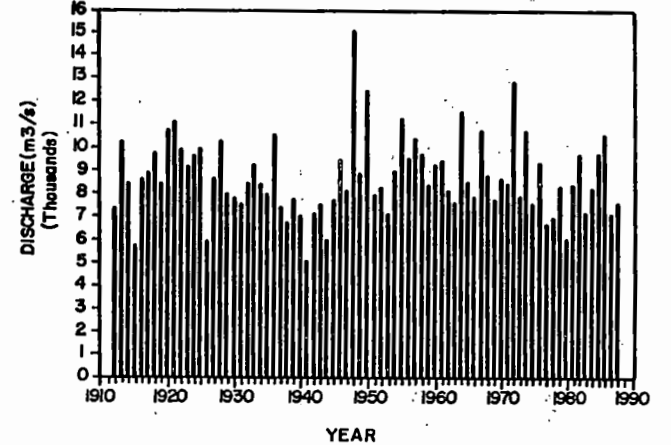
FRASER RIVER AT HOPE

ANNUAL MEAN DISCHARGE (m³/s) 1912-1988



FRASER RIVER AT HOPE

MAXIMUM DAILY DISCHARGE 1912-1988



FRASER RIVER AT HOPE

CUMULATIVE % DEPARTURE FROM THE MEAN

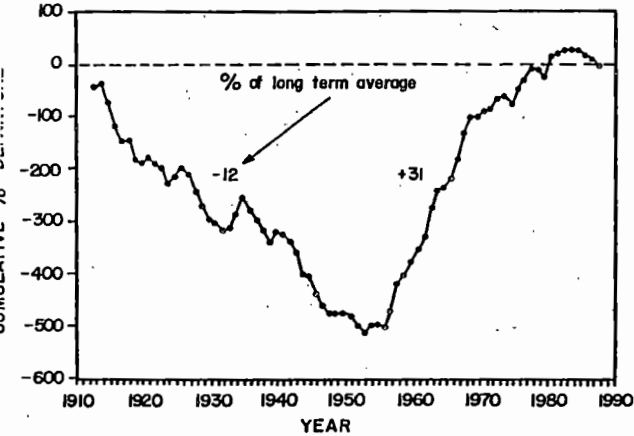


Figure 5.10. Historical variations in annual minimum daily flows, Fraser River at Hope.

FRASER RIVER AT HOPE

CUMULATIVE % DEPARTURE FROM THE MEAN

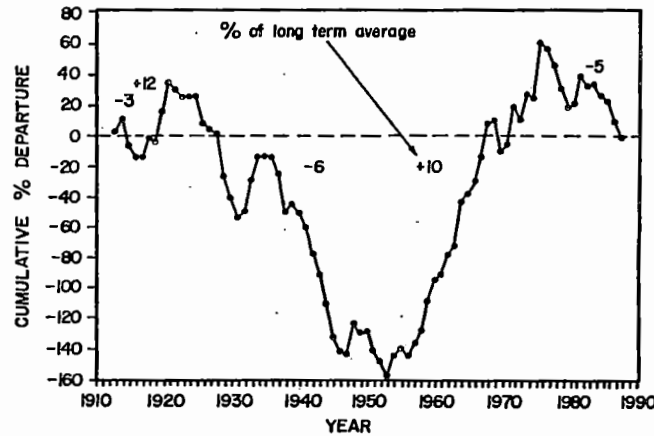


Figure 5.11. Historical variations in annual mean daily flows, Fraser River at Hope.

FRASER RIVER AT HOPE

CUMULATIVE % DEPARTURE FROM THE MEAN

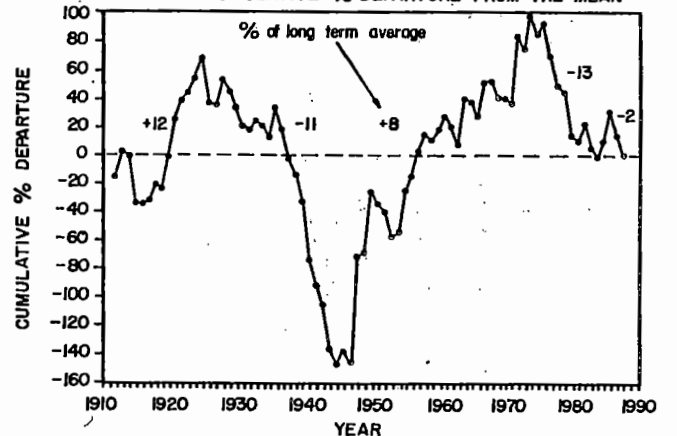


Figure 5.12. Historical variations in annual maximum daily flows, Fraser River at Hope.

CUMULATIVE % DEPARTURE FROM THE MEAN

Average value of 2

YEAR	VALUE	% DEPARTURE	CUMULATIVE DEPARTURE
0	-	-	0
1	1	-50	-50
2	1	-50	-100
3	2	0	-100
4	3	50	-50

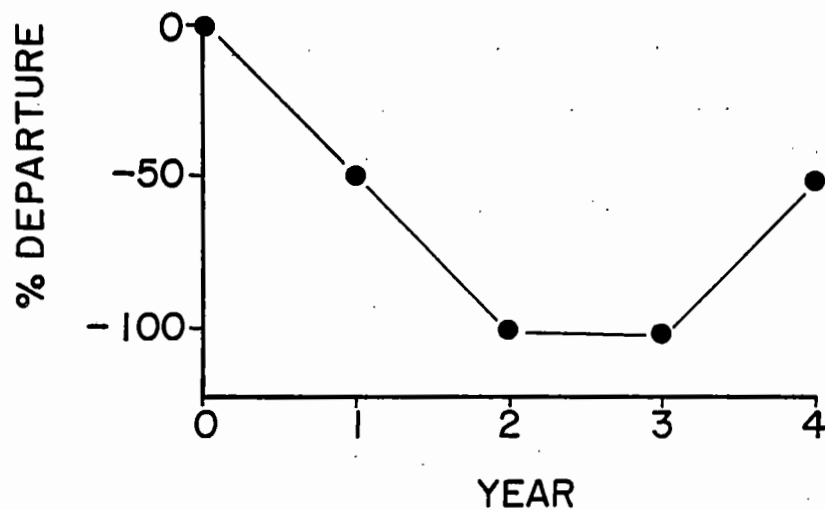


Figure 5.13. An example of the technique for computing residual mass curves for time series data.

Table 5.2. Statistical tests to determine the significance of temporal variations in selected hydrometeorological parameters.

PARAMETER AND STATION	PERIOD OF RECORD	YEARS OF RECORD	PROBABILITY (%) OF A STATISTICALLY SIGNIFICANT CHANGE IN MEAN VALUE (*)			NUMBER OF TESTS SIGNIFICANT AT:		
			Q Statistic	R Statistic	W Statistic	90% Level	95% Level	99% Level
1 Annual Precipitation								
Fort St. James	1895-1987	90	99	99	99	3	3	3
Vanderhoof	1917-1987	44	99	99	99	3	3	3
2 Annual Snowfall								
Fort St. James	1895-1987	90	99	99	99	3	3	3
Vanderhoof	1917-1987	44	NS	NS	NS	0	0	0
3 Average Mean Air Temp.								
Fort St. James	1895-1987	91	99	99	99	3	3	3
Vanderhoof	1917-1987	46	95	NS	99	2	2	1
4 Average August Air Temp.								
Fort St. James	1895-1987	94	99	99	99	3	3	3
Vanderhoof	1917-1988	57	95	90	99	3	2	1
5 Annual Mean Discharge								
Stuart R. Nr. Fort St. James	1935-1988	46	NS	95	NS	1	1	0
Fraser River at Hope	1913-1988	76	95	99	90	3	2	1
6 Mean August Discharge								
Stuart R. Near Fort St. James	1930-1987	57	90	95	NS	2	1	0
7 Annual Maximum Daily Discharge								
Stuart R. Near Fort St. James	1930-1988	58	90	95	90	3	1	0
Fraser River at Hope	1912-1988	77	NS	NS	NS	0	0	0
8 Annual Minimum Daily Discharge								
Stuart R. Near Fort St. James	1930-1988	54	90	95	NS	2	1	0
Fraser River at Hope	1913-1988	76	99	99	99	3	3	3

Note: NS indicates that the statistical tests are not significant at the 90% level.

Similar analyses have been conducted on climate and stream flow parameters from stations representative of conditions in the Stuart River watershed, in order to determine if comparable changes have occurred. Table 5.2 lists the specific parameters which have been analyzed, along with the results of the statistical tests described above.

The results indicate that there is a 99% probability that the climatological regime at Fort St. James has undergone a statistically significant change over the period of record. The historical data indicates that annual precipitation, annual snowfall, average mean air temperature and average August air temperature have generally increased over the period of record (Harder, 1989). The magnitude of this change is substantial as annual precipitation and annual snowfall since the 1945/1950 period have increased by 24% and 46%, respectively, than those before 1945/1950. Average mean air temperature has also risen significantly since 1923, averaging 1.5°C higher than before 1922. Climatological data from Vanderhoof generally shows similar trends and appears to support these observations. Nevertheless, the shorter period of record (a composite of data from three different climatological sites) does not allow the quantification of climatological conditions during the early part of the century. The statistical significance of the apparent trends are, therefore, frequently less reliable.

Annual minimum, mean and maximum flows on Stuart River near Fort St. James show similar temporal variations to those previously described for Fraser River at Hope. Average annual minimum flows between 1941 and 1957 were 23% less than average, while the average value between 1958 and 1977 is 15% greater than average. Since 1977, minimum flows have generally been 5% less than average. Mean August flows show a similar variation, with values in the period 1952-1977 being 13% larger, and 1978-1987 being 10% smaller than the long-term average. Average mean flows in the period 1958-1977 were 13% greater than average, while those in the 1978-1987 period were 14% less than average. Annual maximum flows also show similar patterns, with flows in the periods 1930-1947, 1948-1976 and 1977-1988 being 16% less than average, 13% more than average, and 8% less than average, respectively. However, these hydrological analyses are difficult to interpret, as the statistical tests (summarized in Table 5.2) have variable results, with annual maximum flows being the only parameter for which all three tests were significant at the 90% level.

The lower statistical significance of change in stream flow regime compared to the higher significance levels associated with changes in the climatological regime at Fort St. James is not surprising. Stream flow data is only available after 1930, which is near the inflection point between cooler/drier and warmer/wetter conditions at Fort St. James. Thus, the stream flow data is heavily biased to samples in the warmer and wetter post-1945/1950 period. Additionally, even if the length of record were comparable, stream flow data may not show as strong a statistical significance, due to the potential for random processes to affect the relationship between climate

and runoff. Similarly, there is the potential for additional factors to affect any relationship between stream flow, stream characteristics and fish populations. Thus, even with the above clearly defined climatological trends, there may be substantial difficulty in determining associated biological effects.

5.3 Predicted Climate Change Resulting from Doubling Atmospheric Carbon Dioxide Concentrations

Human activities have resulted in a variety of gases, aerosols and particulate matter being discharged into the earth's atmosphere, and each with potential climatic effects. Large-scale modification of land surfaces or releases of heat may also influence local or regional climate. Studies by Kellogg (1977) suggest that climatic change resulting from increasing atmospheric concentrations of carbon dioxide "emerge as by far the most dominant" process. Ripley (1987) presents an up-to-date review of the potential effects of this so-called "greenhouse effect" on the Canadian hydrological regime, and interested readers are referred to this excellent paper for a comprehensive discussion. From the perspective of the present project, the most important information (adapted from Ripley, 1987) can be summarized as follows:

- The magnitude and direction of future climatic change is uncertain. In addition to natural variability, other "green-house" gases and aerosols being released concurrently with CO₂ may be equivalent in magnitude to the CO₂ effect but in an opposing direction. Secondly, if increasing CO₂ concentrations resulted in increased ocean surface temperatures, an increase in evaporation rate, and hence air humidity would result, thus enhancing the greenhouse effect. This could lead to increased cloud cover, which would reduce the radiation reaching the surface and lead to cooling. A radiative-convective model predicted that a 10% increase in cloudiness could completely compensate for the warming produced by CO₂ doubling.
- The rate at which CO₂ concentrations will increase is uncertain, but estimates range from 1-2% per year. The frequently cited figure of doubling CO₂ concentrations by the year 2085 lies between these two scenarios.
- Due to the potential interactions among a wide variety of factors, climate models to predict the effect of increasing CO₂ concentrations have been developed. At present the most sophisticated or "general circulation models" (GCM) predict that doubling of atmospheric CO₂ would result in a global warming of 2 to 4°C. Various models produce different predictions with values ranging from 0.2 to 3.9°C. Suggested changes in global precipitation vary from a reduction of 2.5% to an increase of 8%.

- The most recently available GCM was developed by the United Kingdom Meteorological Office (UKMO, Mitchell, 1983). This model has been used by Ripley (1987) as a basis for estimating the effects of doubling atmospheric CO₂ concentrations on various regions of Canada. As indicated in Figure 5.14, annual mean temperatures in central British Columbia are predicted to increase by approximately 3°C. Winter temperatures may be increased to a greater extent than summer temperatures. This increase in temperature is expected to result in an approximately 10 to 12% increase in evaporation rates.
- Precipitation increases predicted on the basis of the UKMO GCM are shown in Figure 5.15. They indicate that annual precipitation totals might increase by 200 mm in central B.C. This represents a 40% increase over natural conditions; a large proportion of this annual increase will likely occur during the winter months. Increases in precipitation will be more important than increased rates of evaporation and annual runoff values may therefore increase by 30% or more. The increase in annual precipitation will likely lead to greater winter snowpack accumulation. However, warmer temperatures will result in the earlier arrival of the snowmelt season, with reduced periods of winter ice cover on rivers and a longer growing period, with associated increases in evapotranspiration.

The expected change in climate resulting from doubling of atmospheric CO₂ concentration is increased precipitation, particularly in the winter months, causing increased snowfall and air temperatures. The effect on stream discharge, though less predictable, is expected to increase. Flood flows might also be expected to increase, but the variability in flood-causing events may make any changes difficult to detect. The effects on low flows will likely vary regionally in response to changes in the magnitude and timing of summer snowmelt. In areas of increased snowpack, extended snowmelt could result in increased late-summer minimum flows. In contrast, in areas of little snow accumulation, an earlier onset of snowmelt, higher summer temperatures and greater evapotranspiration could lead to decreased summer flows and longer drought periods. These predictions are, however, subject to considerable uncertainty. A recent review paper published by the provincial Water Management Branch (Coulson, 1988) concluded that, "It is not that we just don't know the magnitude of the change on the water resource - we don't even know the direction the change will take."

5.4 Effects of Climate Change on Stream Channels

The results of this study indicate that the observed trends in precipitation, air temperature and snow cover at Fort St. James during the period of instrumented record are similar to those predicted to occur as a result of the "greenhouse effect". The changes in stream flow, stream

habitat characteristics and fish populations since the turn of the century may therefore provide a basis for estimating what effects might occur if these climatological trends continue. However, quantification of the relationship between these parameters is beyond the scope of the present project.

In general terms, increased temperature, precipitation and snow cover could lead to more frequent rain-on-snow flood events and possibly to larger spring snowmelt floods. Stream channel dimensions are related to the size of flood flows. A variety of empirical equations which relate channel characteristics to the 2-year return period flood are available. Data from alluvial gravel bed rivers in Alberta (Bray, 1978) indicate that:

$$W_m = 2.38 Q_2^{0.527}$$

$$A_m = 0.632 Q_2^{0.860}$$

$$V_m = 1.58 Q_2^{0.140}$$

$$D_m = 0.266 Q_2^{0.333}$$

where W_m is mean width (ft.), A_m is mean cross-sectional area (ft²), V_m is mean velocity (ft/sec.), D_m is mean depth (ft) and Q_2 is the 2-year return period flood discharge in ft³/sec.

Assuming that no threshold conditions are crossed, an increase in flow could result in an increase in channel width, cross-sectional area, average velocity and stream depth. For example, the analysis of stream flow data for Stuart River near Fort St. James indicates that the average annual maximum daily flows between 1948 and 1976 (359m³/s) were 34% larger than the average values between 1930 and 1947 (268 m³/s). Assuming the stream channel had the time required to adapt to this change in flow, an increase in width, cross-sectional area, average velocity and mean depth of 17, 29, 4 and 10%, respectively, might be expected. As previously discussed, the effect of future climatic change on the size of peak flow events is unknown, but changes at least as large as those which have occurred over the period of record appear to be possible.

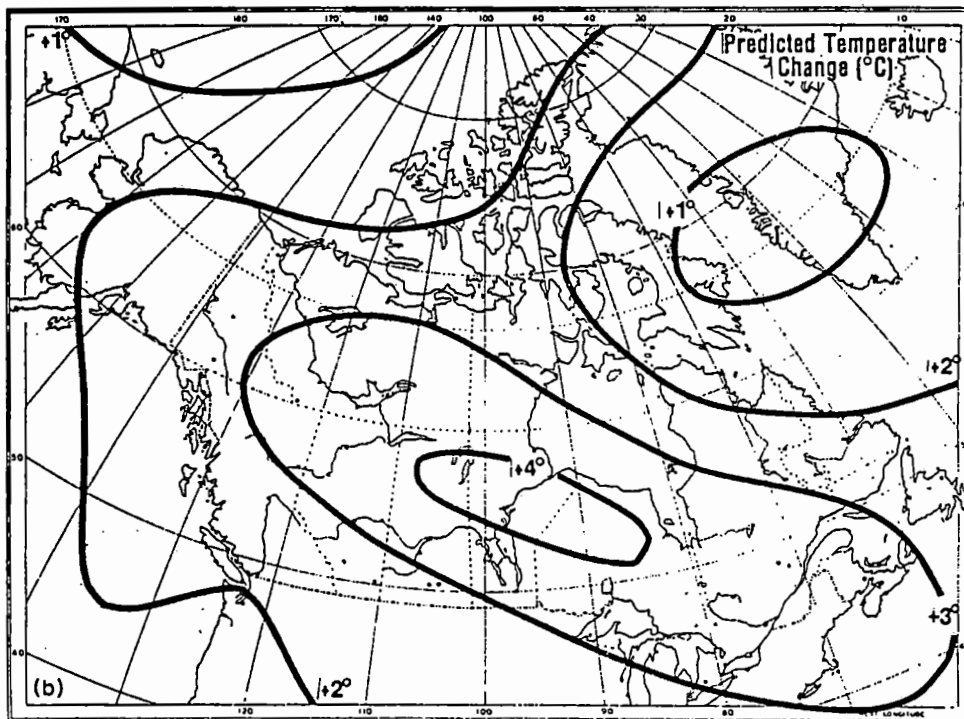
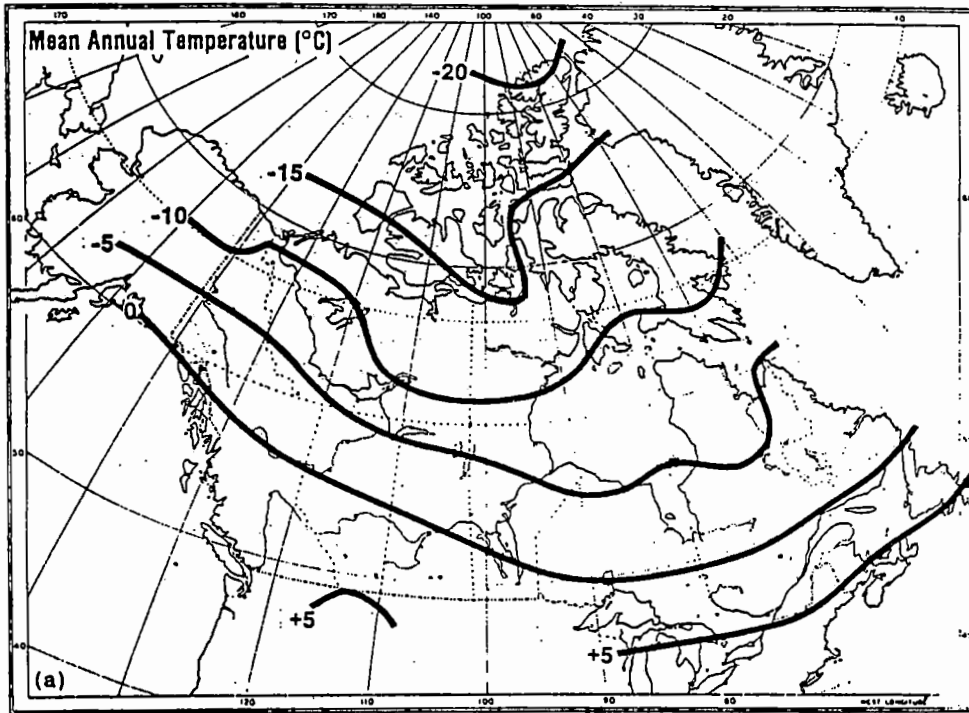


FIG. 7. (a) Present geographical distribution of mean annual temperature in Canada (adapted from Hare and Hay 1974); (b) model prediction of mean annual temperature change (2085-1985) for Canada (adapted from Mitchell 1983).

Figure 5.14. Predicted increase in annual temperature as a result of doubling atmospheric CO₂ concentrations (from Ripley, 1987).

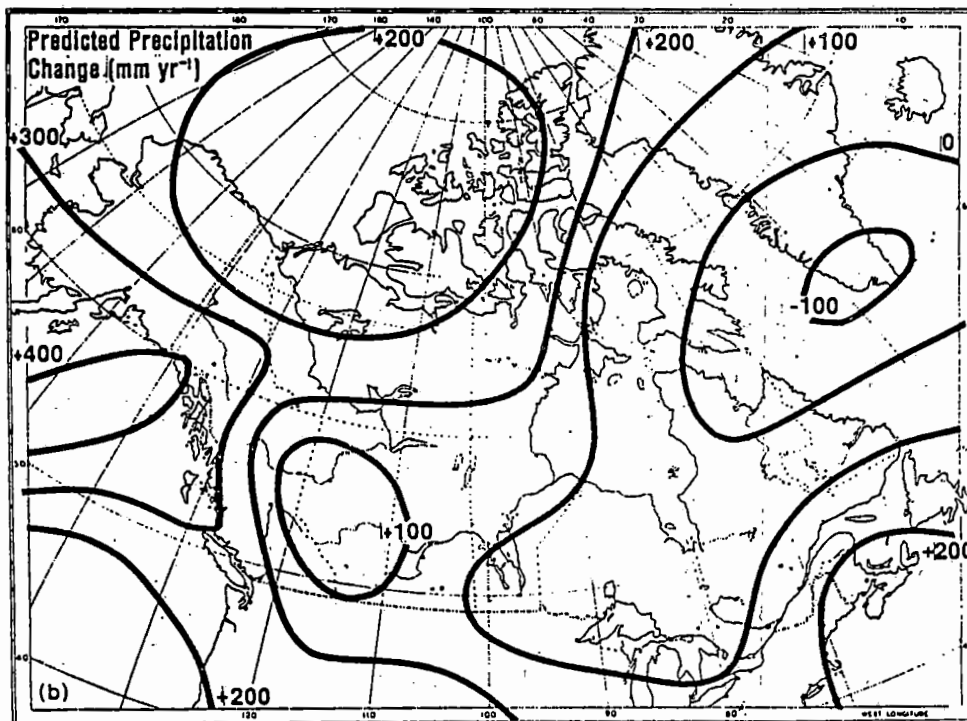
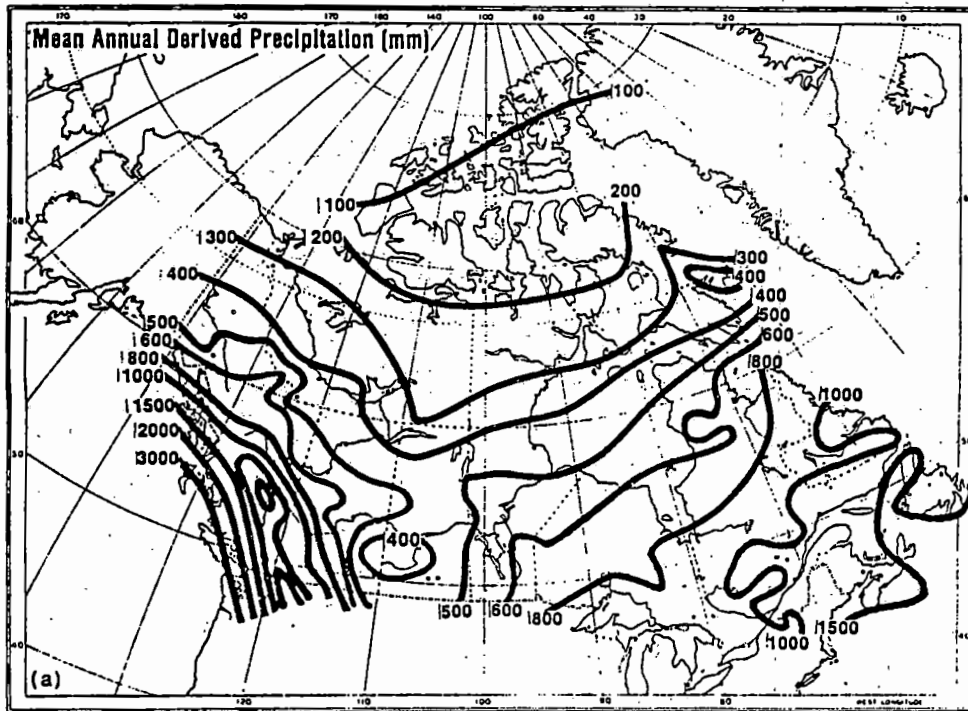


FIG. 8. (a) Present geographical distribution of mean annual derived precipitation in Canada (adapted from den Hartog and Ferguson 1978); (b) model prediction of mean annual precipitation change (2085-1985) for Canada (adapted from Mitchell 1983).

Figure 5.15. Predicted increase in annual precipitation as a result of doubling atmospheric CO₂ concentrations (from Ripley, 1987).

6. INTERACTING LAND AND WATER USES

Land and Water Uses is a broad overview of the resource development issues that are likely to influence fish management decisions within the Stuart/Takla HMA. This information has been compiled through discussions with regional resource managers and industry representatives. More detailed information on specific tributaries to the Stuart, Trembleur and Takla Lake systems is presented in Appendix I. The detailed stream summary information sheets are intended to compliment the existing SSIS - Federal/Provincial Fish Habitat Inventory Database. Appendix II provides a further list of stream sensitivity ratings which can be used to assess potential impacts of development on individual stream reaches.

6.1 Impacts of Growth and Development on Fish and Fish Habitat

To the uninitiated, the significance of population growth and related human development activities to fisheries resources is not readily apparent. Even to those with considerable exposure to ecological issues, the difficulties of sustaining fisheries production in the face of population and industrial growth pressures can often be underestimated. This section will attempt to clarify the importance of some of the interactions between fisheries and other resource sectors, and between the fisheries resource and the human population. Only those resource activities within the Stuart/Takla HMA considered to be of sufficient magnitude to influence fish production will be addressed.

6.1.1 Forestry

The forest industry is by far the most significant, widespread and diversified resource sector in British Columbia, both in terms of its economic value and its impact on the environment. The harvesting of trees and the production of pulp, paper and lumber present a wide array of potential problems. If improperly managed, they will adversely affect the production of fish. Forestry operations are the principal activities of concern in the Stuart/Takla HMA.

Logging is, by its very nature, environmentally disruptive, affecting not only the forest community but the faunal community as well. Prior to harvesting the timber, access roads must be built; if they are not built properly they can contribute large quantities of sediment to the streams that roads intersect. Improperly installed culverts may block fish access to the streams or become point sources of erosion. Depending on soil or geologic conditions, the road construction activity can be a major cause of mass wasting which will tax road building engineers' skills to the limit. Once logging commences, site conditions, climatic conditions and logging methods will dictate how much sediment is generated and released into the streams. Special stream prescriptions must be devised to prevent slash from entering the streams, to maintain streambank

integrity and provide for long-term input of large organic debris (trees) into streams. The accumulated slash and debris may block fish or cause small-scale erosion, while the breakdown of streambank integrity can cause substantial and long-term sediment deposition in water courses. The loss of streambank cover can affect stream temperatures to the detriment of fish production. Logging too much of a drainage basin too quickly can alter stream hydrology and reduce the biological productivity of streams. The application of herbicides to control deciduous tree growth along roadsides or to encourage coniferous growth at planting sites may also present risks to fish in nearby streams. All of these circumstances require careful assessment and thoughtful application of known technology if fish production is to be sustained. In the case of the Stuart/Takla drainage basin, previous experience with the construction of B. C. Rail in the early 1970s strongly suggests that soil conditions in many areas will necessitate extraordinary precautions during logging road construction and will require extensive maintenance.

Significant lumber or pulp manufacturing is not expected to take place within the Stuart/Takla HMA. However, the proposed construction of a pulp mill at Vanderhoof utilizing wood from the Stuart/Takla drainage will require a very careful assessment of potential water quality conditions in the Nechako River, downstream of the confluence of the Stuart and Nechako rivers. The combined effect of reduced stream flows, high stream temperatures and degraded water quality could impair fish migration, alter survival rates of the exposed population and alter the quality of the fish to the extent that they could no longer be used by aboriginal fishermen at Fort St. James. These concerns will be thoroughly addressed in production plans for the Nechako HMA.

6.1.2 Mineral exploration and development

Mineral exploration is of concern to those who manage fisheries resources, because exploration roads are rarely constructed to sound engineering specifications and with sufficient funds to do the job in an environmentally sensitive manner. The specific concerns closely parallel those identified above for logging road construction. In addition, newly exposed mineral deposits can, under certain circumstances, become sources of heavy metal contamination which may be toxic to resident fish.

Operating mines produce large quantities of tailings that must be contained within well designed and maintained impoundments if sediment levels in nearby streams are to remain within the natural limits. Sediment-free wastewaters may be innocuous or lethal to fish, depending on the mineral being recovered and the processes employed. If the wastewaters are known to be toxic to fish they must be treated and rendered non-toxic before being discharged into watercourses. In order to prevent the acidification of tailing ponds and the contamination of streams with heavy metals following the closure of a mine, abandonment conditions and bonding commensurate with the perceived problem have to be negotiated. In certain cases, mining operations and their

subsequent abandonment exacerbate natural conditions, to the detriment of fish utilization. Because of the combined effects of natural leaching of cinnabar deposits and leaching of mercury from the tailings of an abandoned mercury mine, fish in Pinchi Lake have been rendered unfit for human consumption.

Placer mining operations are especially destructive of stream habitats because the valley floor may be completely overturned, with the stream left to run through the mined area. The results are sediment-laden and biologically barren streams incapable of supporting viable fish populations and not readily amenable to rehabilitation.

Placer mining proposals present the fisheries habitat manager with situations to which there may be no technical solutions. Fortunately, as a matter of provincial government policy, placer claims can be staked on only a relatively few watersheds.

6.1.3 Railway development

Railway construction activities can be extremely destructive of stream habitats because of the grade and curve constraints to which the railbed must be designed. If grades are too steep and curves are too tight, the rate of travel, and hence the efficiency of the railway will be impaired, at great cost over the normal life of a railroad. As a result of these constraints, cuts and fills are more massive than for conventional roads. There is limited opportunity to avoid encroachment into stream channels and a greater frequency of culvert use. All of these factors increase the difficulties of protecting and maintaining stream habitats. Such problems become even more complex if geologic and soil conditions are unusually difficult. It became apparent during the construction of the B.C. Rail extension from Fort St. James to Dease Lake in the late 1960s to mid-1970s that such conditions in parts of the Stuart/Takla watershed were the cause of many serious sedimentation and construction problems.

The subsequent abandonment of much of the extension more than a decade ago will necessitate substantial reconstruction throughout its length before it can be used to move logs to the mills in Prince George.

6.2 Population Trends

Either accelerated population growth or the changing aspirations of a relatively stable population can significantly affect the environment of a whole province, a region or a local community. Growing populations will exert increasing demands on the land base for living and recreational space, as well as on the resource base. Changing aspirations can lead to changes in recreational land demand; as populations become older and more affluent, demands for jobs and

services, for water, energy and transportation corridors all increase. All of these can, either directly or indirectly, affect fish harvest and production or fish habitats.

As reported in Dorcey and Griggs (1991) the population for the Stuart sub-basin in 1985 was 6,564. The only major settlement included in this calculation is Fort St. James. The Nechako area to the south, which includes all settlements from east of Prince George to Burns Lake, had a population of 19,533. Hence, the total population within and adjacent to the Stuart basin was estimated to be 26,097.

As of 1986 it was found that of the 6,564 people in the Stuart basin:

- 21% of the population are aboriginal, 33% are of European origin and the remainder are of mixed origin; and
- 33% are under 15 years of age, 63% are 15 to 64 years of age and 4% are over 65 years.

In 1986, of those employed in the Stuart basin, 19% were in primary industries (mainly forestry), 32% were in secondary industries (mainly manufacturing) and 48% were in the service sectors (Dorcey and Griggs, 1991).

Population harvest and projections have been made for the Nechako local health area for the period 1976 to 2016 (Ministry of Finance and Corporate Relations, 1990). This area encompasses all of the Stuart/Takla drainage basin, the Vanderhoof area and that part of the Nechako drainage south of the Stuart River confluence extending westward to the Skins Lake spillway. No attempt has been made to separate the Stuart/Takla segment from the total, on the assumption that the population trends will be similar over the whole area (Dorcey and Griggs, 1991).

In the Nechako local health area (#56), the population has remained relatively stable over the past 15 years. However, it is projected that by 2016 there will be an increase in the age groups of 20 to 59 and over 60 (Table 6.1).

Given these trends, local population pressures could be a significant driving force behind development initiatives that could affect the habitats of fish in the Stuart/Takla HMA. The number of people in the workforce will probably be doubled, especially with the percentage of women actively seeking employment steadily increasing over that period. A significant proportion of these jobs will result from changing and expanding land use patterns within the Stuart drainage basin. The greater numbers of people in the over 60 age category will undoubtedly lead to increased demands for recreational and retirement property, and the primary source for such property will be the Stuart/Takla region.

Table 6.1. Nechako Health Area #56. Population predictions to the year 2016.

YEAR	TOTAL POPULATION	POPULATION AGE CLASSES		
		under 20	20 to 59	over 60
1976	14,360			
1983	16,692			
1989	14,982	5,634 = 37%	7,987 = 53%	1,363 = 9%
2016	25,476	7,503 = 29%	13,614 = 53%	4,358 = 17%

6.2.1 Aboriginal population

From a jurisdictional perspective the Stuart/Takla HMA is located within the Carrier - Sekoni traditional territory. Of the seven nations that make up the Carrier - Sekoni, the Necosli Band (Fort St. James), the Tl-azt-em Nation (Stuart/Trembleur lake) and the Takla Lake Band are located within the HMA.

6.3 Forestry

Data sources used in the following sections included 1:50,000 Forest Cover and History maps prepared by the District Forest Offices and updated to 1988, Landsat photography of the watershed for 1987 and 1988, and 1:250,000 scale maps delineating existing and planned road access within the upper Stuart watershed. A reduced version of the Landsat photomosaic has been included as Figure 6.1 in this report. Other data sources included interviews with district foresters, Ministry of Forests reports on the Prince George Timber Supply Area Plan (Cuthbert, 1985 and Walker, 1983) and data supplied by Industrial Forest Service Ltd.. Figures 6.2 and 6.3 show typical logging clearcuts found throughout the HMA.

6.3.1 Administration

Most of the Stuart/Takla HMA is administered through the Fort St. James District Forestry Office, with the exception of Stuart River below Stuart Lake. This area lies within two separate jurisdictions. The area south of Stuart River (Figure 6.4) between the Nechako River confluence and the northern boundary of Pitka Creek watershed is administered by Vanderhoof Forest District Office. Those areas north of Stuart River between Nechako River and the Bear Creek confluences are within Prince George West District. Most of the forest lands within these areas are managed through Public Sustained Yield Units (PYSU), with the exception of Tree Farm License (TFL) 42, which is administered and managed by Tanizul Timber Ltd.. TFL 42 encompasses the area between Trembleur and Stuart lakes west of Tachie River (Figure 6.4). Timber rights on Aboriginal reserve lands within the Stuart/Takla HMA are also administered and managed by Tanizul Timber Ltd. under the terms of TFL 42.

6.3.2 Status of present forest harvest and road developments

Fort St. James District: Stuart/Takla PYSU

Within the lower portion of the Fort St. James District, extensive logging activity has occurred around most of Stuart Lake and on the southwest shore of Tezzeron Lake. Logging activity within the Trembleur Lake portion of the district has occurred throughout selected sections of TFL 42 (Figure 6.3) lying between Trembleur and Stuart lakes and along parts of the upper Tachie River, including the Kuzkwa River valley.

The heaviest logging activity within the upper Stuart watershed has occurred in the portion of the district around the southern and northern ends of Takla Lake. At the lower end of Takla Lake logging has been heaviest around Sakeniche River and Bivouac and Leo creeks, which drain into Takla Lake. Logging activity has also been heavy in the Kazchek drainage, which enters into the lower Middle River near the village of Trembleur. At the upper end of Takla Lake logging activity has been concentrated in the Hudson Bay's Creek valley and the Cheztainya Lake area between Takla Landing and Lovell Cove at the northeast end of Takla Lake. This appears to have been the most heavily logged area in the upper watershed. There has also been a moderate degree of logging in the lower Ankwil Creek valley and along an unnamed tributary north of Ankwil Creek at the northwest end of the lake. Similar activity has also occurred along the lower Driftwood Valley.



Figure 6.1 Landsat photograph of Stuart/Takla Habitat Management Area. Courtesy B.C. Ministry of Forests, Fort St. James





Figure 6.2

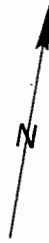
A typical cut block near Ankwil Creek. Photo courtesy of B. MacDonald.



Figure 6.3

A typical cut block adjacent to the Tachie River. Photo courtesy of B. MacDonald.

**STUART - TAKLA
HABITAT MANAGEMENT AREA**



Burns Lake
Forestry District

Fort St. James
Forestry District

Prince George
Forestry District

Vanderhoof
Forestry District

T.F.L.#42

FORT ST. JAMES

VANDERHOOF

Nechako
River

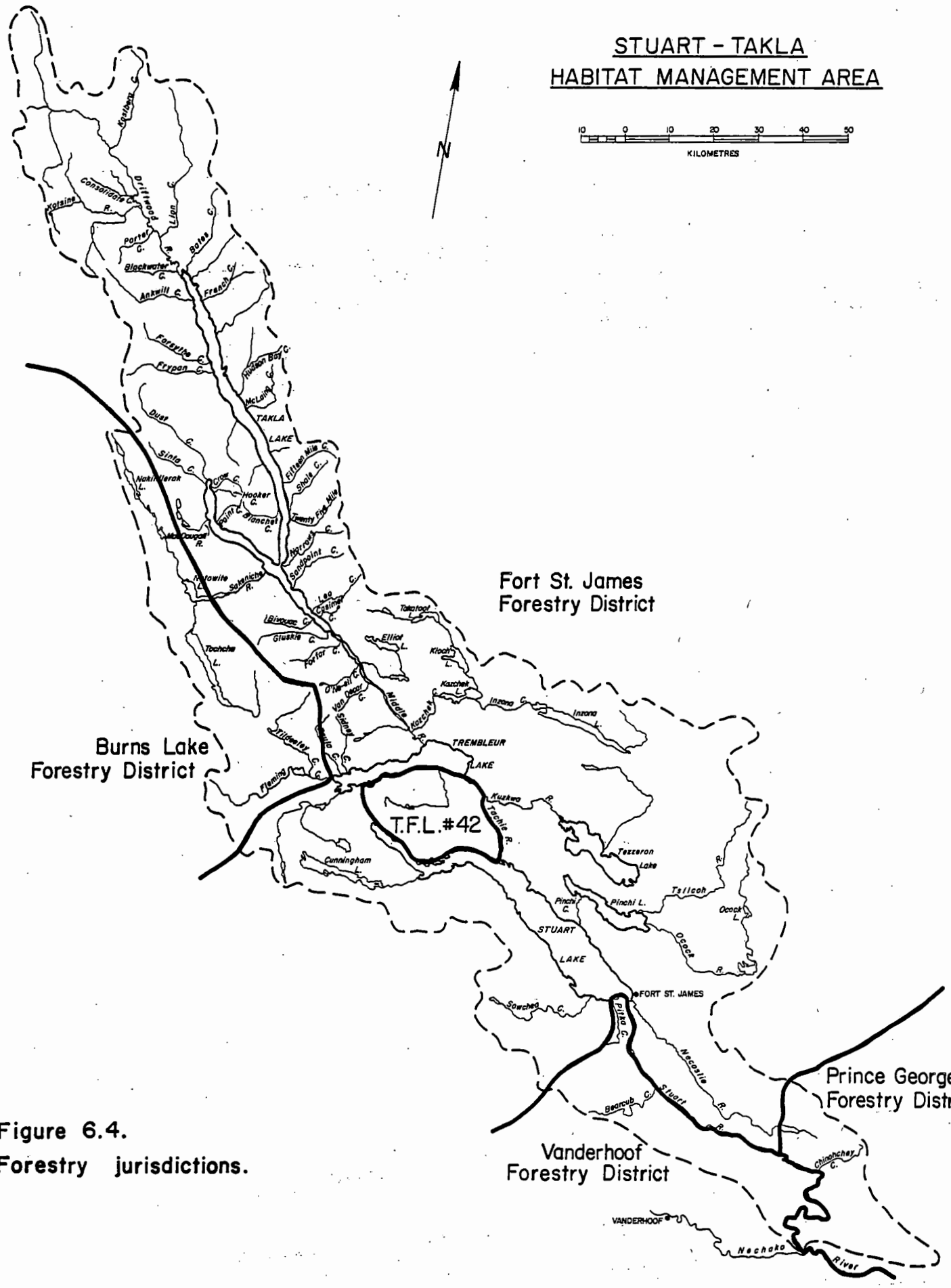


Figure 6.4.
Forestry jurisdictions.

Since 1982, logging in the upper Stuart watershed has been restricted to the Kazchek, Kuskwa, Tachie and Middle River systems. Logging activity within these watersheds has been moderate. Although there have been no major reforestation programs in the area, natural revegetation and soil stabilization will likely have occurred in most areas disturbed prior to 1982.

Existing Road Access (Figure 6.5)

The east side of Stuart Lake has a main haul access road running parallel to the lake through the mid-reaches of the tributaries and up to the top end of Cunningham Lake west of Stuart Lake (West Arm). Most of the major tributaries within this area have branch lines into the headwater areas. There is also a road running along the Stuart Lake shoreline between Fort St. James and Camsell Creek.

The block of land to the east and north of Stuart Lake and south of Inzana Lake has a well developed network of main haul and branch lines extending up to Takla Narrows (Figure 6.5).

There is no road access to the east and mid-west shores of Takla Lake, and these areas have not been logged. A major haul road into Takla Landing extends from Germasen Landing in the Mackenzie District and runs down to the West Kwanika Creek.

Tree Farm License 42

To date, most of the harvest has been from the east section of the license area between Trembleur and Stuart lakes. A total of 37 cut blocks have been harvested. One of these cut blocks borders the southwest bank of the Tachie River approximately 5 km below Trembleur Lake. There are three mainline access roads plus a number of branch lines in the TFL. Access into the TFL is from a bridge crossing of the lower Tachie River from the Tachie Road, approximately 4 km up river of Tachie village (Figure 6.5).

Prince George West Forest District

Over the period 1980 to 1990 logging activity north of Stuart River has been minor. Similar to the area south of the Stuart River, disturbed areas have not been extensive and there has been no logging activity on the northwest bank of the Stuart River. Cutting rights within the area are granted through small Timber Sales Licenses and there are no major companies holding cutting rights in the area. The area has road access north from Saxon Lake and from Nukko Lake to the east.

**STUART - TAKLA
HABITAT MANAGEMENT AREA**



- Proposed forestry access roads
- Present forestry access roads

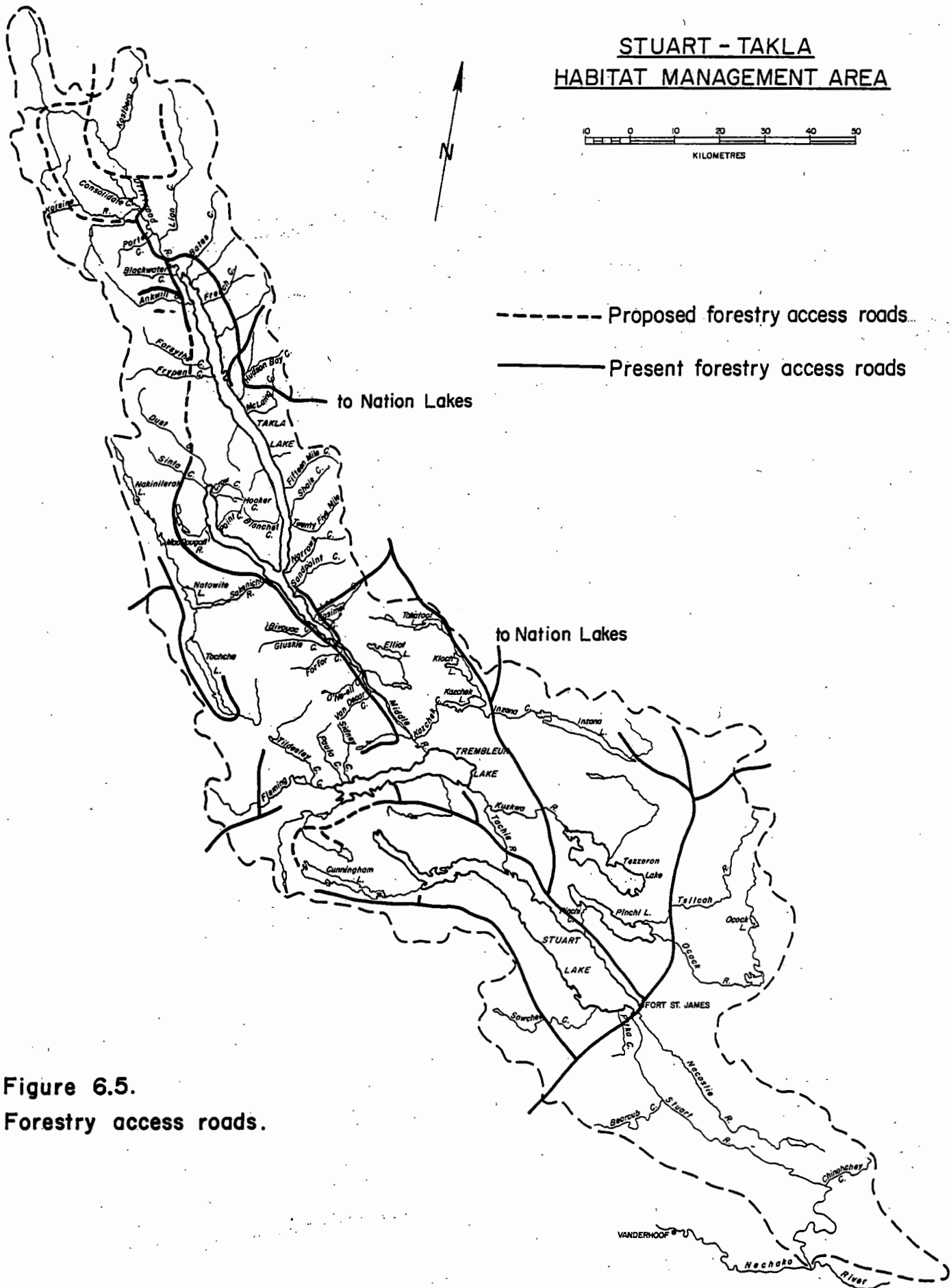


Figure 6.5.
Forestry access roads.

Vanderhoof Forest District

The southern portion of Stuart River below Pitka Creek has had little logging activity over the last ten years. Disturbed areas have generally revegetated and appear to be stable in terms of erosion potential and sediment production. With the exception of an old burn area in the lower Stuart River, there have been no major disturbances along the southwest bank of the Stuart River between Fort St. James and the Nechako River confluence. The area has road access north from Finmore and east off of Highway 27, which runs between Vanderhoof and Fort St. James.

6.3.3 Preliminary cutting plans

Fort St. James District: Stuart/Takla PYSU

Preliminary logging plans up to 1996 for the Stuart/Takla PYSU are summarized in Figure 6.6. These plans outline the five year cutting plans for this area.

In addition to a continuation of logging in the Pinchi, Kazchek, Sackeniche, Hudson Bay, and McLaing drainages through to 1996, there will also be moderate to heavy logging activity in the upper Driftwood, Ankwil, Forsythe, and the Rubyrock drainages during 1992. Although most of the creeks slated for logging in this period have previously been logged, past activity has been minimal in most drainages.

Four major access road extensions are planned, corresponding to the above cutting schedules (Figure 6.5). These extensions include the Tarnezell/Cunningham Road located to the southwest of Trembleur Lake. This road will open up the Tarnezell, Rubyrock and Butterfield drainages.

Minor extensions are planned between Lovell and Bulkley at the northeast end of Takla Lake, as well as branch lines along the upper reaches of the Driftwood River and into the Condit Creek and Kotsine River valleys. A new road will also be constructed along the north side of Lion Creek and extending into the headwaters (Figure 6.5).

Tree Farm License 42

Cutting plans for the 1992 to 1996 period within TFL 42 include extensive cut blocks from south of Trembleur Lake to the north shore of Stuart Lake (Figure 6.6).

Prince George West District: Carp PYSU

Prince George District Forestry Office has indicated that there will likely be no major logging activity within the Stuart River portion of the Carp PYSU in the next 5 to 10 years. Timber values are relatively low throughout most of this area and much of it is under agricultural use. However, a series of clearcuts are proposed for the period 1994 to 1996 for the land adjacent to the Stuart River on the west side, near the vicinity of Chinohchey Creek, and on the east side near Bearcub Creek (Figure 6.6).

Vanderhoof District: Nechako PYSU

Vanderhoof District Forestry Office has indicated that there will be relatively little logging activity in the Stuart River portion of the Nechako PYSU to 1996. There are no cutting plans for major companies in the area. Logging activity in the near future will be restricted to private properties outside the jurisdiction for the Ministry of Forests. There are no new forestry access roads planned for this area.

6.4 Mineral Exploration and Development

Jurisdiction over mineral rights within the Stuart River watershed is administered by the Omineca (Prince George) and Smithers District Offices of the Ministry of Energy, Mines, and Petroleum Resources. The following information summarizes mineral exploration and development activity and placer mining status within the Stuart/Takla HMA. Specific information on mineral claims and development activity for both mineral and placer deposits are presented in Appendix I.

6.4.1 Operational mines

There are no large scale operational mines in the Stuart/Takla HMA. The biggest mining operation, abandoned since the 1940s, was the Pinchi Lake cinnibar mercury mine. Although the mine is inactive, surrounding water bodies, including Pinchi Lake, have been contaminated by mercury because mine tailings were discharged directly into Pinchi Lake.

A 12 m falls at the outlet of Pinchi Lake prevents the entry of migratory fish into Pinchi Lake. Nevertheless, numerous species of resident fish, such as kokanee, rainbow trout, and lake whitefish are present in Pinchi lake. As a result of a 1970s study by Reid and Morley, 1975, which identified mercury contamination in the water and fish tissue, the B.C. government imposed an advisory warning to fishermen not to eat their catch. That consumption advisory still exists today.

A recent survey of closed and abandoned mines in B.C. for acid mine drainage, prepared for the B.C. Ministry of Energy, Mines and Petroleum Resources (Steffen, *et al.*, 1992) documented the current potential for the Pinchi Lake mine to generate acid run-off from waste piles and tailings.

The authors concluded that, despite high concentrations of arsenic, barium, and mercury in the tailings, a very low potential for acid generation exists due to a slow release of the metallic constituents. However, recent sampling of the portal drainage by the B.C. Ministry of Environment, Lands and Parks (1991), showed high levels of mercury and chromium from the portals.

6.4.2 Mineral claims

A listing of mineral claims in the Stuart/Takla watershed are presented in Table 6.2. There are approximately 48 claims in the watershed, only 12 of which are site-specific designations to within 330 m of the deposit. The remaining claims are more general in nature and encompass claim areas with a radius of up to 3 km or more. This list was compiled from mineral inventory maps prepared and updated to 1988 by the Ministry of Energy, Mines, and Petroleum Resources.

6.4.3 Exploration and development plans

The B.C. Ministry of Energy, Mines, and Petroleum Resources inspectors for the Prince George and Smithers Regions have indicated that no major exploration programs are planned in the Stuart/Takla HMA at this time. Although there are some gold deposits within the area, most gold interest and activity is centred further east of the Stuart River watershed, along the Pinchi Fault and into the Quesnel Trench, where the degree of mineralization has been greater (T. Faulkner, pers. comm.). There is considerable interest in the Mount Milligan area in relation to deposits. However, this area is part of the Nation drainage system and it is unlikely that potential development plans would have any impact on the Stuart watershed.

There is some long-term potential for further exploration and staking in the upper Takla system with respect to possible copper deposits (T. Faulkner, pers. comm.). In general, exploration activity in the upper Stuart watershed will likely increase in the next 5 to 10 years, due to the planned improvements for road and rail access to the area.

Table 6.2. Mineral claims and interests within the Stuart/Takla HMA.

Watershed Name	Number of Claims	Mineral Deposits
Ankwill	1	Cu, Ag
Bates	0	NA
Baptiste	2	Cr, Talc
Bivouac	0	NA
Blanchet	0	NA
Gluskie	0	NA
Casimer (Crow)	0	NA
Driftwood	2	Cu, Mo
Kotsine	1	Cu, Ag, Au
Dust	1	Cu
Sidney (Felix)	2	Cr, Asbestos
15 Mile	1	Cr
Fleming	5	Cu, Mo, Cr
Forfar	1	Sn, Mn, Va, Co, Zn, and Ro
Forsythe	0	NA
French	0	NA
Frypan	0	NA
Hooker	0	NA
Hudson Bay	0	NA
Leo	1	Cr
MacDougall	1	Cu
McLaing	0	NA
Narrows	6	Cr
O'Ne-ell (Kynock)	1	Jade
Paula	0	NA
Point	0	NA
Sakeniche	9	Cu, Mo
Sandpoint	0	NA
Shale	0	NA
25 Mile	1	Mo
Van Decar (Rossette)	4	Cr, Ag, Asbestos
Kazchek	1	Hg
Kuzkwa	6	Ag, Hg, Pb, Zn, Cu, W and Mo
Middle	1	Cr
Pinchi	5	Hg, Mt
Stuart	9	Cr, Hg, Ls, Au, Sb, Sc and Cu
Dog	P	Ag
Sowchea	P	Ag
Trembleur Lake	2	Pb, Talc
Takla Lake	1	Cu

6.4.4 Placer mining

The majority of the Stuart River watershed is within a "No Staking Placer Reserve" as designated by the B.C. Ministry of Energy, Mines, and Petroleum Resources. Designated placer mining areas within the watershed are found at four locations. These areas are identified in Figure 6.7.

Area 1 lies west of Fort St. James and encompasses the entire Dog and Sowchea Creek watersheds, plus the headwater reach of Pitka Creek. This was a previously established placer area prior to implementation of the new Placer Mining Act in 1988. Placer activity within this area has been very light in recent years. There is moderate potential for further activity here in the near future (Figure 6.7).

Area 2 encompasses the upper tributaries to the Inzana, Tezzeron and Pinchi Lake systems. There is a no staking reserve designated within approximately 1 km of the lake shorelines. Placer activity within this area has again been light in recent years. There is moderate potential for further activity here in the near future (Figure 6.7).

Area 3 encompasses Tocha Lake and surrounding tributaries in the upper Sakeniche watershed. This is a newly designated area and has not previously been subject to significant placer mining activity. With the new designation it is anticipated that there will be moderate interest in establishing and working new claims (Figure 6.7).

Area 4 is a linear unit running in a southeast direction adjacent to the lower Necosli River. This corridor crosses the lower mid-reach of the Necosli River near Mile Post 20 and runs almost due south across the Stuart River and through the Kec Creek valley (Figure 6.7).

Potential downstream impacts of placer activities within Areas 2 and 3 will likely be moderated by the buffering and settling capacity of the mid-reach lakes within these watersheds. There is no buffering or settling capacity within the Dog and Sowchea Creek watersheds of Area 1. Similarly, there is no natural buffering capacity within the Necosli/Stuart Placer Corridor (Area 4).

Although most of the Stuart watershed is in a designated "No Staking Placer Reserve", there may be some pressure to re-assess this classification since it is the general mandate of the B.C. Ministry of Energy, Mines, and Petroleum Resources to maximize the availability of potential placer areas. However, within the immediate future this potential pressure may be tempered by relatively low placer prospects within the watershed and by low gold prices. It will also be difficult to re-assess the classification of those areas which are deemed highly significant in terms of salmon production.

STUART - TAKLA HABITAT MANAGEMENT AREA



All areas not designated as placer mining areas are considered "No Staking Placer Reserves"

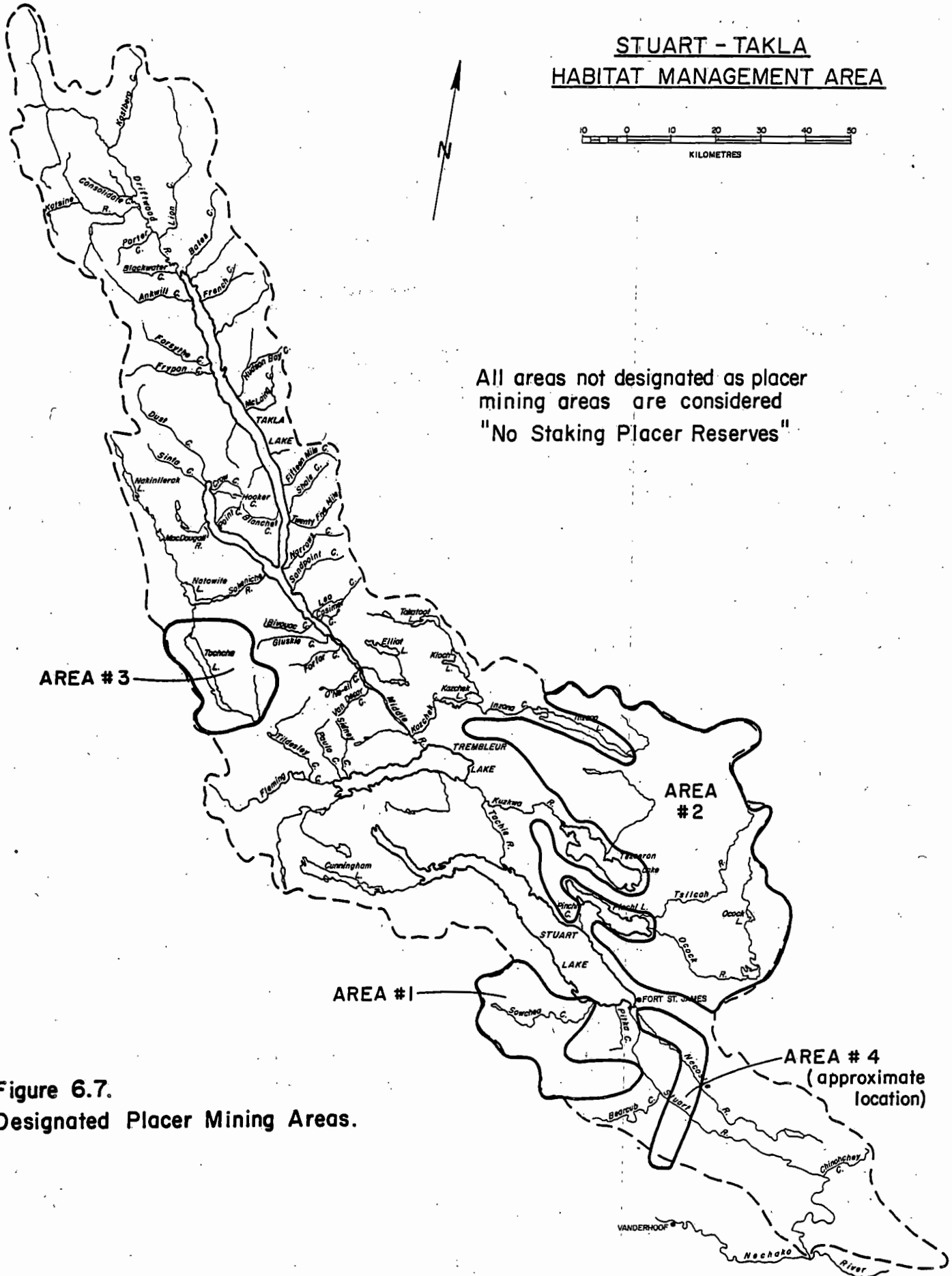
AREA #3

AREA #2

AREA #1

AREA #4
(approximate location)

Figure 6.7.
Designated Placer Mining Areas.



6.5 Hydroelectric Generation

There are presently no hydroelectric generation facilities within the Stuart/Takla HMA. A review of the files within the Provincial Water Management Branch indicates that there are no applications in progress or pending. Furthermore, B.C. Hydro indicated that there is little potential for large-scale hydro development within the watershed. Similarly, the sparsity of urban communities and low population density suggest that pressure for small-scale hydro development will be minimal.

6.6 Railroad Development

The B.C. Rail line between Fort St. James and Takla Landing was established during the late 1960s and into the early 1970s. This line runs north through the east side of Stuart/Takla Valley along the lake shorelines and the east bank of the Tachie and Middle rivers. The line was semi-operational for a number of years before being shut down due to maintenance difficulties and internal management decisions within B.C. Rail. The right-of-way was extended from Takla Landing through the headwaters of Driftwood River into Dease Lake between 1970 and 1976. This portion of the line has not been operational to date (Figure 6.8).

The rail line crosses every east bank tributary to the Stuart, Trembleur and Takla systems. Construction of the rail line resulted in major impacts to the aquatic environment between 1967 and 1973. Much of the work was conducted outside of the normal no-construction periods enforced by DFO. These impacts were related to stream crossing disturbances and localized areas of bank erosion along the alignment (Figure 6.9). Since construction these disturbances have stabilized and, in most cases, there has been a gradual natural rehabilitation of the initial impacts to the stream environments.

Increasing timber demands in the upper Stuart watershed and new mineral exploration and development in northern B.C. have led to the re-opening of the B.C. Rail line. The line is operational up to Lovell Cove on the upper end of Takla Lake (Figure 6.8). It is expected that the Driftwood River section of the alignment will be upgraded by 1993. Two bridges in this section require replacement. Major in-stream work will be required at Azukoltz Creek south of Bear Lake and on the Bird Creek fan.

6.7 Other Development Issues

Other concerns in this HMA relate to human habitations and waste control. Recreational property and village development can have some localized impact that will require attention. Sewage and waste disposal at Fort St. James is adjacent to the Stuart River is an example



Figure 6.9 British Columbia Railway near Middle River showing typical construction cut and associated bank erosion issues. Photo courtesy of B. MacDonald.



Figure 6.10 Fort St. James sewage treatment lagoon on Necoslie River. Photo courtesy B. MacDonald.

7. REFERENCES

- Barrett, G.E. 1979. Changes in the discharge of selected rivers in British Columbia during the period of instrumental record. Unpublished B.Sc. Thesis. Department of Geography, University of British Columbia. 141 p.
- Bray, D.I. 1973. Regime relations for Alberta gravel bed rivers. *In: Fluvial processes and sedimentation, Proceedings of Hydrology Symposium held at University of Alberta, Edmonton. May 8 and 9, 1973. National Research Council, Associate Committee on Geodesy and Geophysics Subcommittee on Hydrology.* pp. 440-452.
- Buishand, T.A. 1982. Some methods for testing the homogeneity of rainfall records. *Journal of Hydrology*, vol. 58, p. 11-27.
- Burner, C.J. 1951. Characteristics of spawning nests of Columbia River Salmon. U.S. Fish and Wildlife Service, Fish. Bull. No. 52, pp 97 - 110.
- Chapman, D.W. 1986. Effects of river flow on the distribution of chinook salmon redds. *Transactions of the American Fisheries Society*, vol. 115, no 4, pp. 537-547.
- Church, M. A. and M.J. Miles. 1987. Meteorological antecedents to debris flow in southwestern British Columbia: some case studies. J.E. Costa and G.F. Wieczorek, (ed.), *In: Reviews in Engineering geology, Volume VII, Debris flows/avalanches: Process recognition and mitigation.* Geological Society of America, Colorado, U.S.A. pp. 63-79.
- Coulson, C.H. (in press). Climate variability and change. *In: Proceedings, meeting on the impact of climate variability and change on British Columbia. December 14, 1988. Atmospheric Environment Service, Environment Canada.* 9 pp.
- Den Hartog, G. and H.L. Ferguson. 1978. Water balance -- derived precipitation and evapotranspiration, Plate 25, *In: Hydrological Atlas of Canada.* Fisheries and Environment Canada, Supply and Services, Ottawa, Ont.
- Dorcey A.H.J. and J.R. Griggs. 1991. Water in sustainable development: exploring our common future in the Fraser River basin. *Research Program on Water in Sustainable Development, Volume II.* Westwater Research Centre, Faculty of Graduate Studies, The University of British Columbia. 288 pp.
- Environment Canada. 1991. Historical streamflow summary, British Columbia, to 1990. *Inland Waters Directorate, Ottawa, Ont.*
- Farwell M.K., N.D. Schubert, K.H. Wilson and C.R. Harrison. 1987. Salmon escapements to streams entering statistical areas 28 and 29, 1951 to 1985. Department of Fisheries and Oceans, Fisheries Branch, New Westminster, B.C.
- Fisheries and Environment Canada. 1978. *Hydrological Atlas of Canada.* Ottawa, Ont. 34 pp.
- Harder P.A., 1989. An overview of fish resources in the Stuart/Takla watershed and an assessment of potential resource use conflicts, The Department of Fisheries and Oceans, Habitat Division, Vancouver B.C. 100 p.

- Hare, F.K. and J. E. Hay. 1974. The climate of Canada and Alaska, Chapter 2. In: R.A. Bryson and F. K. Hare (ed.) *Climates of North America*. Elsevier, Amsterdam.
- Hickey, D.G. and D.B. Lister. 1981. Salmonoid enhancement baseline investigations at Stuart River, B.C., in 1980. Prepared for Department of Fisheries and Oceans. 49 pp.
- Holland, S.S. 1976. Land forms of British Columbia. Bulletin 48, B.C. Department of Mines and Petroleum Resources, Victoria, B.C. 138 pp.
- Jaremovic, J. and D. Rowland. 1988. Review of chinook salmon escapements in the Nechako River, British Columbia. Canadian Manuscript Series, Rep. Fsh. Aqua. Sci. No. 1963.
- Kellogg, W. W. 1977. Effects of human activities on global climate - Part 1. World Meteorol. Org. Bull. 26: 229-240.
- McLaren, R.E. 1952. Nechako River Report, 1951. Department of Fisheries and Oceans. Unpublished report.
- McDougall R.D. 1987. Classification of British Columbia salmon stream escapements by species and subdistrict. Planning and Economics Branch, Department of Fisheries and Oceans, #400 - 555 W. Hastings, Vancouver, B.C.
- Marshall, D.E. and C.I. Manzon. 1980. Catalogue of salmon streams and spawning escapements of Prince George Subdistrict. Fish. Mar. Ser. Data Rep. 79: 252.
- Mitchell, J.F.B. 1983. The seasonal response of a global circulation model to changes in CO₂ and sea temperatures. Q. J. R. Meteorol. Soc. 109: 113 - 152.
- Neilson, J.D. and C.E. Banford. 1983. Chinook salmon (*Oncorhynchus tshawytscha*) spawner characteristics in relation to redd physical features. Can. J. Zool. 61: 1524-1531.
- Reid D.S. and R.L. Morley. 1975. Mercury contamination of fish from Pinchi Lake B.C. Habitat Protection Section, Fish and Wildlife Branch, Department of Recreation and Conservation, Victoria, B.C.
- Ripley, E.A. 1987. Climate change and the hydrological regime. Chapter 6. In: M.C. Healey and R.R. Wallace, (ed.), *Canadian Aquatic Resources*. Canadian Bulletin of Fisheries and Aquatic Sciences # 215. pp. 137-178.
- Schowenburg, B. 1989. Discussion paper on sockeye salmon production in the Stuart Watershed. Unpublished report. Department of Fisheries and Oceans. 10 pp.
- Scott W.B. and E.J. Crossman. 1973. *Freshwater Fishes of Canada*. Bulletin 184, Fisheries Research Board of Canada, Ottawa, Ont. 966 pp.
- Steffen, Roberston and Kirsten (B.C.) Inc. 1992. Survey of closed and abandoned mines in B.C. for acid mine drainage. Prepared for Supply and Services Canada, Richmond B.C. and the Ministry of Energy Mines and Petroleum Resources, Victoria, B.C.
- Tutty, B.D. 1986. Dune formation associated with multiple redd construction by chinook salmon in the upper Nechako River, B.C., Canada. Can. Ms. Rept. Fish. Aqua. Sci. No. 1893.

Wood C.C. and C.J. Foote. 1991. Genetic and ecological differentiation of sympatric anadromous and non-anadromous morphs of sockeye salmon (*Onchorhyncus nerka*). Department of Fisheries and Oceans, Biological Sciences Branch, Nanaimo, B.C. Unpublished Manuscript. 70pp.

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APPENDIX I

**Stream Summary Data: Fish Production,
Channel Stability and Resource Use Status**

PREFACE TO APPENDIX I

The following information has been compiled from various data sources and is intended to compliment SSIS data files for the Stuart/Takla HMA. Data sources are identified and any limitations to the interpretations are explained.

Fish Production

Escapement data has been presented by run for separate cycle years as well as over ten year periods that combine all four run cycles. Escapement data and estimated production capabilities have been taken from DFO files. Production constraints and enhancement potential are from DFO files in Prince George and discussion papers by headquarters staff (Schouwenburg, 1989).

Channel Stability Assessment

Based on 1984 aerial photography with a scale of 1:50,000, this is a very broad overview assessment of channel and terrain instability for individual tributaries in the Stuart/Takla HMA. At the onset of this work, it was intended that this initial effort would be followed up with a more thorough assessment, using a sequence of aerial photographs to assess relative rates of change and instability. It would also be advisable to conduct subsequent assessments on selected tributaries in conjunction with a review of the detailed cutting plan.

Resource Use Status (Preliminary)

The primary focus of this study has been directed towards forestry, mining, and rail and road developments for each of the salmon producing streams and rivers within the HMA.

Forestry information was derived from discussion with Ministry of Forests staff in Prince George, Fort St. James and Vanderhoof, as well as staff from Industrial Forest Service Ltd. Landsat Photo Imagery was used to assess existing harvest status within specific watersheds. Other forestry data sources included 1:50,000 forest cover maps and 1:250,000 road planning maps provided by the Ministry of Forests.

Mining information was derived from a review of mineral claim and placer lease maps, as well as from discussions with the Regional Mines Inspectors from the Smithers and Prince George offices of the Ministry of Mines, Petroleum and Resources.

Information pertaining to linear developments was taken from Ministry of Forests planning maps. Northwood Pulp and Paper Ltd. provided a general overview of the BCR line re-development plan.

Major Resource Use Conflicts

In all cases the major resource use conflicts were related to logging plans. Other development issues were, for the most part, relatively minor. An initial assessment of potential resource use conflicts was made on the basis of terrain and channel instability, coupled with existing and potential fish production values.

STREAM LISTING

SOCKEYE SALMON

EARLY STUART STOCK

Ankwill Creek	1
Bates Creek	2
Bivouac Creek	2
Blanchet Creek	3
Crow Creek	4
Driftwood River	5
Dust Creek	7
Fifteen Mile Creek	8
Fleming Creek	9
Forfar Creek	10
Forsythe Creek	11
French Creek	12
Frypan Creek	13
Gluskie Creek	14
Hooker Creek	15
Hudson Bay Creek	16
Leo Creek	17
MacDougall Creek	18
Mclaing Creek (Five Mile)	19
Narrows Creek	20
O'Ne-ell Creek (Kynock)	21
Paula Creek	22
Point Creek	22
Sakeniche River	23
Sandpoint Creek	25
Shale Creek	26
Sidney (Felix) Creek	26
Twenty-Five Mile Creek	27
Van Decar (Rossette) Creek	28

LATE STUART STOCK

Kazchek Creek	30
Kuzkwa River	31
Middle River	32
Pinchi Creek	34
Tachie River	35
Stuart River	36

EARLY STUART STOCK

Ankwill Creek - Takla System

Drainage Area: Total watershed area of 116 km². Drains into lower Takla Lake, immediately upstream of the Middle River outlet.

Stream Description: Approximately 20 km long. Fish access to 6 km at upper canyon. Most spawning occurs in lower 2 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 28,600 adults. Highest annual escapement has been 21,800 fish in 1973.

Cycle-Year Averages

	1951/91	1952/88	1953/89	1954/90
Average escapement	300	100	11,000	600
% of early run	1%	1%	7%	2%

Ten Year Escapement Trends

	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	1,500	3,800	3,100	3,600

Production Constraints: Low winter flows. Stream has glacial characteristics.

Enhancement Potential: Originally considered for a spawning channel site by IPSFC, but was subsequently rejected because of poor flow regime.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

A 1 km fan at the mouth of the stream shows some indication of instability; above this point the stream is entrenched. Lateral instability within the valley bottom is common. Stream banks are very unstable. The valley walls and hillslopes are unstable throughout this drainage.

Resource Use Status

Forestry: There are four cut blocks on the south side of Ankwill Creek in the lower third of the watershed. The area was logged prior to 1982. A logging access road enters the lower watershed from the north. The upper watershed is undisturbed. There are plans for a new forestry access road into the lower south side of the watershed. Preliminary cutting plans indicate that areas will be logged from 1992 to 1996

Mining: Within "No Staking Placer Reserve". Rainbow claim for gold and copper. No immediate exploration or development plans.

Linear Developments: Accessed by forestry road, one bridge crossing in lower reach. A new branch line is planned into the southern side of the lower watershed.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Planned logging and new road construction could have a significant impact on habitat quality in this system. Impact potential is high due to relatively high rates of channel and hillslope instability as well as high fish production values.

Based on estimated spawner capacities, this system accounts for 1.5% of the total potential sockeye production in the Stuart HMA.

Bates Creek - Takla System

Drainage Area: Total watershed area of 116 km². Drains into upper Takla Lake, immediately downstream of Driftwood River.

Stream Description: Approximately 24 km long. Fish access to 8 km. Lower reach is 1.5% to 2.5% gradient over 8 km. Creek is low gradient well above 8 km. No barriers identified.

Fish Production

Sockeye: DFO estimate of spawning capacity not made as creek supports only small numbers of sockeye on an intermittent basis.

Ten Year Escapement Trends

	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	N/R	N/R	100	N/R

Production Constraints: Not identified on records.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 6 km of the stream is laterally unstable and is bounded by valley walls. The upper ends of the tributaries are entrenched within the hillslopes.

The lower 6 km also have unstable valley walls. The upper main channel is not affected by the unstable hillslopes, which are some distance away from the main channel.

Resource Use Status

Forestry: The forest cover map indicates that there is no logging or forest cover disturbance throughout the entire watershed. Bates Creek has not been included in the preliminary cutting plans prepared for the 1992 to 1996 period.

Mining: Within placer "No Staking Reserve". No mineral deposits or interests recorded.

Linear Developments: Crossed by BC Rail line. Minor bridge repair and upgrading of approach planned in 1990. Major stream impacts are not anticipated. A new forest access road extending into the lower southern boundary of the Bates Creek watershed, is planned.

Aboriginal Fisheries: Could be interceptions at the Bulkley House Reserve.

Major Resource Use Conflicts

No major resource use conflicts are anticipated in the immediate future. Minimal future impact potential due to low fish production values.

Bivouac Creek - Takla System

Drainage Area: Total watershed area of 51 km². Drains into lower Takla Lake on west side above Gluskie Creek.

Stream Description: Approximately 18 km long. Fish access to 3.2 km. Lower reach is 1.5% gradient over 2 km; gradient increases to 4% at 2 km above mouth. Impassable falls 3.2 km from mouth. Log jam at 2 km is a possible barrier.

Fish Production

Sockeye: DFO estimate of spawning capacity is 5,700 adults. Spawning escapement exceeded estimated capacity in 1953 and 1957.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	1,700	1,100	2,700	200
% of early run	3%	1%	2%	<1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	1,900	200	1,000	1,200

Production Constraints: Winter freezing could be a problem. Thirty meter high impassable falls at 3.2 km.

Enhancement Potential: Log jam removal at 2 km.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

A large unstable fan extends for 1.5 km from the mouth; half has been logged. Bank erosion problems are evident. Above that point the channel is entrenched, restricting lateral channel movement.

The valley walls and hillslopes throughout the drainage are stable.

Resource Use Status

Forestry: There are several cut blocks on the north and south sides of Bivouac Creek in the lower third of the watershed. The area was logged in 1979. A logging access road enters the lower watershed from the southeast. This system has been included in the preliminary cutting plans for the 1992 to 1996 period. There may be a need to replace the existing logging bridge in the lower system.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry roads through lower portion of watershed.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Logging on the hillslopes of the upper watershed could be conducted with minimal disturbances to the creek, since there is a relatively high degree of stability in this area. However, habitat degradation may result if there is activity in the lower reaches, where stream banks are unstable. There is also the potential for localized erosion at the existing bridge site.

Bivouac Creek accounts for approximately 0.3% of the total sockeye production capacity in the Stuart HMA.

Blanchet Creek - Takla System

Drainage Area: Total watershed area of 31 km². Drains east into the west side of Takla Lake above Takla Narrows.

Stream Description: Approximately 11 km long. Fish access to 0.8 km upstream from mouth. Lower reach is 1 to 2% gradient over 0.5 km; gradient increases to 5% at 2 km above mouth.

Fish Production

Sockeye: DFO estimate of spawning capacity is 1,000 adults. Maximum observed escapement was 900 fish in 1987.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	<300	<100	250	100
% of early run	<1%	<1%	<1%	<1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	<100	<100	<150	250

Production Constraints: Impassable falls at 0.8 km. Poor spawning gravel quality.
Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 1.5 km is a fan somewhat confined by adjacent valley walls, reducing the potential of lateral movement. The remainder of the channel is entrenched in mountainous terrain. The valley walls and hillslopes are very unstable, with numerous slides evident along the channel length.

Resource Use Status

Forestry: The forest cover map indicates no logging or forest cover disturbance. The south side of the creek shows signs of bark beetle kill. There are no access roads into the watershed. However, Blanchet Creek is scheduled for logging from 1995 to 1996, which is a serious concern due to stability issues.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: No road access. None planned.

Aboriginal Fisheries: None

Major Resource Use Conflicts

No major resource use conflicts anticipated in the immediate future. Significance of potential impacts in the future is minor, due to low fish production and capability values.

Crow Creek - Takla System

Drainage Area: Total watershed area of 23 km². Drains west into northwest arm of Takla Lake, just southeast of Dust Creek.

Stream Description: Approximately 15 km long. Accessible to spawners throughout.

Fish Production

Sockeye: DFO estimate of spawning capacity is 3,500 adults. Annual escapement exceeded estimated capacity in 1957 and 1973.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	300	300	1,400	450
% of early run	<1%	<1%	1%	1%

Ten Year Escapement Trends

	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	500	200	700	750

Production Constraints: Low flows.

Enhancement Potential: Superb spawning potential for sockeye.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 0.8 km is a steep and potentially unstable fan. Upstream of the fan, the stream is confined in mountainous terrain.

The hillslopes and valley walls throughout the watershed are very unstable.

Resource Use Status

Forestry: The forest cover map indicates no logging or forest cover disturbance throughout the entire watershed. Crow Creek has not been identified in the preliminary cutting plans for the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: None

Aboriginal Fisheries: None

Major Resource Use Conflicts

No immediate resource use conflicts. Future logging in the system could result in significant erosion due to the relatively high degree of terrain instability in the watershed.

Crow Creek accounts for approximately 0.3% of the total sockeye production potential in the Stuart HMA.

Driftwood River - Takla System

Drainage Area: Total watershed area of 800 km². Drains southeast into the north end of Takla Lake.

Stream Description: Approximately 100 km long. Fish access to 92 km, where 10 m vertical falls are a total barrier. Lower reach from mouth to 50 km is 0.5 to 2% gradient. Gradient increases to 2 to 5% at 63 km. Chutes and falls start at 62 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 345,700 adults. Maximum spawner escapement of 234,135 in 1989.

Cycle-Year Averages

	1951/91	1952/88	1953/89	1954/90
Average escapement	100	100	73,600	1,700
% of early run	<1%	<1%	37%	4%

Ten Year Escapement Trends

	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	8,100	3,700	4,100	4,500

Production Constraints: Low flows and velocity barriers may impede fish migration. Some siltation from Banana Lake tributary during flood periods. Significant over-winter mortality, due to poor spawning-to-incubation flow ratios, is suspected.

Enhancement Potential: Barrier removal. Was considered a good candidate for spawning channel by IPSFC; however, recent information indicates that winter flow volumes are inadequate for a production facility.

Chinook: There have been incidental records in the Driftwood River.

Channel Stability Assessment (Preliminary)

The lower 40 km from the mouth and upstream to Pathway and Tetana Lakes is located in a broad lowland. The stream has a generally meandering channel pattern, with laterally stable reaches between Tuwatenindlay Rapids and Kastberg Creek. Throughout the system, unstable hillslopes are set far enough away from the stream that they are not an issue. Valley walls in the lower 40 km are also usually set far enough back from the stream channel that valley wall failures will not enter the stream channel. In the upper Driftwood it is more likely that unstable valley walls could fail directly into the channel.

Resource Use Status

Forestry: There are several cut blocks in the lower end of the watershed. The area was logged from 1981 to 1982. Logging access roads run from Takla Lake to the headwaters. Preliminary cutting plans indicate that the watershed will be logged during 1992 to 1996 period. Extensive clear cuts are planned from Porter Creek to the Kastberg Creek junction. New access is planned along the west bank of the Driftwood River between Tuwatenindlay Rapids and Bear Lake.

Mining: Within "No Staking Placer Reserve". There are two general mineral claims in the mainstem Driftwood Valley. These are the Fire (Cu) and Carr (Cu, Mo) claims. There is also a general claim in the Kotsine Valley; this is the Driftwood Claim for Cu, Ag and Au.

Linear Developments: (See Forestry Discussion). Upgrading of BCR line along the east side of the Driftwood River between Bates Creek and Bear Lake is planned in Year 4 of the redevelopment. This will entail the replacement of the Banana Creek bridge and minor restoration work along the entire alignment.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Extensive road construction and logging plans in the next five years could result in substantial impacts to spawning habitats in the Driftwood River.

Hillslope logging in the upper system would likely result in significant impacts to the aquatic environment, due to the high degree of instability. Similar concerns have been identified for planned road construction activities in the upper system. Similarly, any logging activity near the active channel of the mainstem Driftwood River could result in significant erosion and sediment production. Logging on the hillslopes of the lower system could be conducted with low potential for disturbances to the river, since most areas of instability are set back from the watercourse.

There may be potential habitat degradation associated with the replacement of the Banana Creek rail bridge.

With new rail access into the watershed it is likely that there will be new mineral exploration activity and possibly mine development.

These concerns warrant further investigation and impact assessment prior to finalization of the cutting plans and the railroad work.

Habitat degradation in Driftwood River would have a major significance, as the system accounts for approximately 17.5% of the total sockeye production potential in the Stuart HMA.

Dust Creek - Takla System

Drainage Area: Total watershed area of 250 km². Drains southeast into the northwest arm of Takla Lake.

Stream Description: Approximately 40 km long. Fish access throughout. Lower reaches are very low gradient.

Fish Production

Sockeye: DFO estimate of spawning capacity is 17,000 adults. Spawning escapement approached estimated capacity in 1953, 1973 and 1977.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	700	850	10,500	1,300
% of early run	1%	2%	7%	4%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	3,800	1,900	3,900	3,400

Production Constraints: Temperature problems noted for summer and winter periods. No conflict with kokanee populations.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Kokanee: Major population.

Channel Stability Assessment (Preliminary)

The lower 15 km (to about 4 km above Beaverdale Creek) is a laterally unstable meandering channel. Above that point the stream channel is confined by hillslopes and valley walls.

The mountainous area above Beaverdale Creek has extensive unstable valley walls, but hillslopes appear relatively stable.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging or forest cover disturbance. There is one old logging access road on the east side of the creek, but its status is unknown. Preliminary cutting plans indicate the system will be logged in the 1989/90, however this did not occur and 1992 to 1997 plans do not include logging in this watershed.

Mining: Within "No Staking Placer Reserve". There is one mineral claim (Cuuz) for copper in the watershed.

Linear Developments: A new main haul line is planned across the mid-reach of the watershed.

Aboriginal Fisheries: None

Major Resource Use Conflicts

There is moderate potential for streambank erosion and sedimentation in this system, due to the laterally unstable meandering channel in the lower system and the high incidence of slope failures on the valley walls. Logging in the mountainous areas above Beaverdale Creek could result in major sediment production. Logging on the upper hillslopes would present less erosion potential.

Erosion potential related to the new road crossing requires investigation. Dust Creek accounts for approximately 1.5% of the total sockeye production potential in the Stuart HMA.

Fifteen Mile Creek - Takla System

Drainage Area: Total watershed area of 62 km². Drains southwest into Takla Lake, above Takla Narrows.

Stream Description: Approximately 20 km long. Fish access to 0.5 km above mouth. Impassable falls at 0.5 km upstream from mouth.

Fish Production

Sockeye: DFO estimate of spawning capacity is 400 adults. Escapement has exceeded estimated capacity in 1953, 1957, 1961, 1973, 1977, 1981 and 1989.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	<100	<100	650	<100
% of early run	<1%	<1%	<1%	<1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	200	100	300	300

Production Constraints: Limited access and spawning area.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The mouth of the stream is a short (100 m), probably unstable, fan. The remainder of the channel is confined by moderately unstable hillslopes and valley walls. Hillslopes and valley walls throughout the drainage are unstable.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no signs of logging access roads. Fifteen Mile Creek has not been identified in the preliminary cutting plans for the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". One unspecified mineral claim in watershed.

Linear Developments: Accessed by forestry road with one bridge crossing in the lower reach. No new forestry roads planned. Upgrading of the BCR line across Fifteen Mile Creek is planned in Year 2 or 3 of the redevelopment.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Resource use conflicts are not anticipated in the near future.

Future logging in the watershed could lead to habitat degradation, due to the high erosion potential in the upper system. Increased lateral channel activity could be anticipated on the fan if this area is logged or if large quantities of debris are introduced.

Fifteen Mile Creek accounts for less than 0.3% of the total sockeye production capabilities in the Stuart HMA.

Fleming Creek - Trembleur System

Drainage Area: Total watershed area of 584 km². Drains east into the west end of Trembleur Lake.

Stream Description: Approximately 35 km long. Fish access to upper sections of creek. Lower reach is 0.5 to 2% gradient over 8 km. Extensive side channels in system. Numerous log jams and beaver dams, which wash out at high water. Major flow contribution comes from Tildesley Creek.

Fish Production

Sockeye: DFO estimate of spawning capacity is 9,500 adults. Maximum annual escapement was 8,699 sockeye in 1989.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	2,700	<1,800	1,700	550
% of early run	5%	<1%	1%	<1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	<100	<100	1,000	2,400

Production Constraints: Production from Fleming Creek below the lake is severely limited by high spawning temperatures. Sustained production in this system appears to be dependant on capabilities associated with Tildesley Creek, which drains into Fleming Creek immediately below the Fleming Lake outlet. High turbidity (algae) and low oxygen limitations noted above lake.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 5 km between the mouth and Tildesley Creek is meandering and laterally unstable. Above Fleming Lake the stream is still meandering in pattern, but the channel is relatively stable.

Some sections of the valley wall are unstable; however, there is relatively little potential for slides entering the creek, due to the set back nature of the valley wall.

Resource Use Status

Forestry: The upper watershed above Fleming Lake has been heavily logged. This area is within the Babine PYSU. Access is from the Babine system. The lower system below Fleming Lake has not been logged. Preliminary cutting plans indicate that this system will not be logged during the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". There are five mineral claims in the watershed, including one in Tildesley Creek. Mineral interests include Cr, Cu and Mo.

Linear Developments: Accessed by forestry road, one bridge crossing in lower reach. No new roads are planned into the watershed.

Aboriginal Fisheries: None

Major Resource Use Conflicts

No immediate resource use conflicts. Future logging in the system could result in moderate erosion problems if the valley bottom and creek sides in the lower system are logged. Flemming Lake provides a buffer between activities in the upper and lower watershed. Existing production capabilities can probably be maintained by restricting logging to above the lake and protecting habitat quality in Tildesley Creek.

Fleming Creek and its major tributary, Tildesley Creek, account for approximately 0.7% of the total sockeye production capacity in the Stuart HMA.

Forfar Creek - Middle River System

Drainage Area: Total watershed area of 42 km². Drains northeast into upper Middle River, below Gluskie Creek.

Stream Description: Approximately 18 km long. Fish access to falls at 3.2 km. Lower reach is 1 to 2% gradient over 2 km with extensive side channels. Gradient increases to 5% at 2 km above mouth. Cascade at 3.2 km and large falls at 4.8 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 18,300 adults. Escapement has exceeded estimated capacity in 1971, 1973, 1985, 1987 and 1988.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	9,000	4,800	12,600	6,300
% of early run	18%	16%	9%	18%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	7,900	4,400	9,000	2,200

Production Constraints: None identified.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 3.5 km is an unstable fan in which several old channels are still present. Upstream of the fan the channel is confined by hillslopes and valley walls. The valley walls and hillslopes throughout the drainage are highly unstable.

Resource Use Status

Forestry: Some logging in the 1990/91 period. Preliminary cutting plans indicate that this creek will be logged in the 1992 to 1997 cutting period.

Mining: Within "No Staking Placer Reserve". The Tsitsult Mountain tin claim has interests in Sn, Mn, Va, Co, Zn and Ro.

Linear Developments: Accessed by forestry road, one bridge crossing in lower reach.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Logging activity may result in severe erosion and sedimentation problems if the presently unstable fan is disturbed. The potential for erosion in the upper watershed is also high, due to unstable nature and setting of the valley walls and hillslopes.

Forfar Creek accounts for approximately 1.4% of the total sockeye production capabilities in the Stuart HMA.

Forsythe Creek - Takla System

Drainage Area: Total watershed area of 94 km². Drains east into upper Takla Lake, immediately upstream of Frypan Creek.

Stream Description: Approximately 30 km long. Fish access throughout system. Low to moderate gradient stream. Canyon at 1.5 km upstream from mouth is passable to fish. Log jams were causing river to cut new channel in 1974; these were blasted out.

Fish Production

Sockeye: DFO estimate of spawning capacity is 9,500 adults. Estimated capacity was exceeded once in 1973.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	150	<300	4,500	200
% of early run	<1%	<1%	3%	<1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	3,600	1,500	2,200	1,400

Production Constraints: Some reference to stream temperatures and glacial nature of stream. Low incubation flows noted.

Enhancement Potential: Incubation facility could augment production (DFO Files, Prince George).

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 9 km of the stream, including the fan, are bounded by valley walls, as is the fan at the mouth. Lateral channel stability is limited to the valley flat throughout the lower stream. The valley walls over the lower nine km are unstable although no recent (1987) failures are evident. In the upper river there are numerous hillslope and valley wall failures.

Resource Use Status

Forestry: Some logging occurred in this system during the 1989/93 period. Preliminary cutting plans indicate that will be some additional logging in this system during the 1992 to 1996 cutting period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: None planned.

Aboriginal Fisheries: None

Major Resource Use Conflicts

No immediate resource use conflicts. Future logging in the system could result in moderate erosion problems if the valley bottom and creek sides are logged.

Forsythe Creek accounts for approximately 0.7% of the total sockeye production capacity in the Stuart HMA.

French Creek - Takla System

Drainage Area: Total watershed area of 66 km². Drains west into the north end of Takla Lake downstream of Bates Creek.

Stream Description: Approximately 20 km long. Fish access throughout system. Creek is 1 to 2% gradient over 12 km. Partial barriers in the form of log jams and debris accumulate throughout system.

Fish Production

Sockeye: DFO estimate of spawning capacity is 1,000 adults. Escapement exceeded estimated capacity once in 1973.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	<100	0	800	<100
% of early run	<1%	0%	1%	<1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	N/O	400	800	250

Production Constraints: Some reference to frazil ice.
Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The 1 km fan at the mouth is laterally unstable, while the remainder of the stream channel is entrenched within the valley walls and hillsides. The valley walls are extremely unstable from 1 to 9 km above the mouth; further upstream both hillslopes and valley walls are unstable.

Resource Use Status

Forestry: There are several cut blocks located on the southside of the tributary. This area was logged from 1977 to 1980. No further logging is planned for the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: A new forest access road from Cheztaina Lake will be built through the lower watershed in the next two to three years. The BCR line will be upgraded in this area during the third year of the redevelopment plan.

Aboriginal Fisheries: None

Major Resource Use Conflicts

There may be some localized problems related to the construction of the new road and the French Creek crossing. However, major resource use conflicts are not anticipated in the next three to four years as there are no current logging plans. Work on the BCR line is not expected to have any impact on the French Creek crossing.

French Creek accounts for approximately 0.1% of the total production capabilities in the Stuart HMA.

Frypan Creek - Takla System

Drainage Area: Total watershed area of 122 km². Drains east into upper Takla Lake, immediately downstream of Forsythe Creek.

Stream Description: Approximately 24 km long. Fish access throughout system. Creek is 1.5 to 2.5% gradient over 7 km with steep section at 20 km above mouth. Broad flood plain indicates extreme seasonal fluctuations in channel width.

Fish Production

Sockeye: DFO estimate of spawning capacity is 19,000 adults. A maximum escapement of 10,900 occurred in 1961.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	200	100	4,300	400
% of early run	<1%	<1%	3%	2%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	900	1,500	1,200	1,400

Production Constraints: Some reference to possible ice problems. Glacial waters.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

A 1.5 km unstable fan is located at the mouth of this stream. The remainder of the stream channel is entrenched within valley walls and hillslopes, although some lateral instability is evident. Immediately upstream of the fan are numerous valley wall failures. In the upper, more mountainous reaches, the hillslopes and valley walls are also unstable.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no signs of logging access roads. Preliminary cutting plans indicate that the watershed was to be logged in 1991/92. However, logging did not occur during this period and none is planned for the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach. A new forestry road between Ankwil and Dust creeks crossing Frypan Creek approximately 6 km above the mouth is planned.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Planned logging and road construction activities have the potential for major impacts to the aquatic environment, due to the general instability of the watershed.

Frypan Creek accounts for approximately 1% of the total sockeye production capabilities in the Stuart HMA.

Gluskie Creek - Takla System

Drainage Area: Total watershed area of 55 km². Drains northeast into lower Takla Lake, upstream of Forfar Creek.

Stream Description: Approximately 19 km long. Fish access to 3 km above mouth. Lower reach is 1 to 2% gradient over 0.8 km, increasing to 11% at 1.5 km above mouth. Side channels are found throughout the lower 1 km. Several chutes and a series of rapids in the upper reach may be impeding upstream migration some years.

Fish Production

Sockeye: DFO estimate of spawning capacity is 18,000 adults. Escapement has exceeded estimated capacity in 1957, 1973 and 1987.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	7,500	3,800	11,200	4,300
% of early run	14%	14%	8%	11%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	6,200	2,400	7,100	10,200

Production Constraints: Availability of spawning gravels as it is suspected that spawning has been at saturation in recent years.

Enhancement Potential: Identified as a possible spawning channel site by DFO in November, 1988.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 1 km of the channel is an unstable fan; lateral stability above the fan is somewhat confined by the valley walls. The upper channel is entrenched by valley walls and hillslopes. The valley walls within the mid-reach of the system between 1 and 4 km upstream of the mouth are unstable. Further upstream the hillslopes are also unstable, but in many locations they are set back from the stream channel.

Resource Use Status

Forestry: There are two cut blocks in the lower third of the watershed, on the north side of the valley. The uppermost cutblock borders the creek channel. The area was logged in 1971. The logging access roads are limited to the cut block areas on the north side of the valley and across the mouth of the creek. The upper watershed is located in the Babine PSYU; there have been no disturbances in this portion of the watershed. Preliminary cutting plans indicate that the lower system will be logged during the 1989/90 period. Logging was deferred because this stream was included as part of the effects of logging study.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road along lower north side of valley; one bridge crossing in lower fan. No new road construction plans have been identified.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Logging on the hillslopes of the upper watershed could be conducted with minimal disturbances to the creek as unstable areas are well back from the channel. Logging in the lower elevations of the mid-reach and on the lower fan would likely have a major impact on fish habitat, due to a relatively high degree of instability in this area.

Gluskie Creek accounts for approximately 1.2% of the total sockeye production capacity in the Stuart HMA.

Hooker Creek - Takla System

Drainage Area: Total watershed area of 13 km². Drains west into northwest arm of Takla Lake, immediately downstream of Crow Creek.

Stream Description: Approximately 14 km long. Fish access to 0.2 km. Steep gradient creek with several small falls created by deadfalls; 1.5 m high falls in lower reach.

Fish Production

Sockeye: DFO estimate of spawning capacity is 400 adults. Escapement reached capacity levels in 1985, 1987, 1988 and 1989.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	200	250	450	100
% of early run	0%	0%	<1%	0%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	N/R	N/R	<100	500

Production Constraints: Limited spawning gravels.
Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

There is a short 200 m fan which is very unstable laterally. The upper channel is entrenched and stable. This drainage has very unstable hillslopes and valley walls.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no signs of logging access roads. Preliminary cutting plans indicate no logging activity is planned in the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: None planned.

Aboriginal Fisheries: None

Major Resource Use Conflicts

No major resource use conflicts are anticipated in the next four years. A high degree of instability in the watershed suggests that future logging activities could have a serious impact on fish habitat.

Hudson Bay Creek - Takla System

Drainage Area: Total watershed area of 119 km². Drains southwest into Takla Lake, above McLaing Creek.

Stream Description: Approximately 16 km long. Fish access to 8.4 km. Lower 5 km is 2.5 to 3% gradient. A 30 m high chute at 8.4 km is impassable to all fish.

Fish Production

Sockeye: DFO estimate of spawning capacity is 200 adults. Escapement exceeded estimated capacity in 1961 and 1977.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	<10	<10	250	0
% of early run	<1%	<1%	<1%	0%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	<10	<100	<100	<100

Production Constraints: Low flows often limit access to spawners.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The channel is bounded within valley walls and lateral movement is restricted. The valley walls are unstable throughout the mainstem length. The hillslopes are unstable, and material from the hillslopes could enter the stream through the mountainous tributaries.

Resource Use Status

Forestry: There are cut blocks throughout the watershed on both sides of the creek, extending from the mid-reaches, along the northern boundary of the watershed, into the headwaters. The area was logged between 1973 and 1982. There is logging road access across the mouth of the creek and across the mid-reach, extending up the north side of the valley into the headwaters. Preliminary cutting plans indicate the watershed will be logged further during the 1992 to 1996 cutting period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road, one bridge crossing in lower reach. BCR line work in Year 4 of the redevelopment.

Aboriginal Fisheries: Potential for interceptions from Takla Landing Village.

Major Resource Use Conflicts

Preliminary plans indicate that the watershed will be logged during the 1991/92 period. Although the mainstem creek is relatively stable, there is a moderately high potential for sediment input to the upper tributary systems that may in turn affect habitat quality in the lower system. The lower fan is not well developed and is more stable than other fans

in the area. Habitat degradation in Hudson's Bay Creek could reduce the estimated sockeye production capabilities for the creek.

The existing estimate is for 200 fish, representing less than 0.1% of the total sockeye capabilities within the Stuart HMA.

Leo Creek - Takla System

Drainage Area: Total watershed area of 96 km². Drains southeast into east side of lower Takla Lake.

Stream Description: Approximately 18 km long. Fish access throughout system. Lower reach is 1 to 2% gradient over 2.8 km, increasing to 3 to 4% in canyon area above 3 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 4,800 adults. Maximum escapement of 10,620 adults occurred in 1957.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	400	100	2,400	<100
% of early run	1%	<1%	2%	<1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	1,700	200	400	<100

Production Constraints: Heavy beaver activity has prevented sockeye from entering the system since 1986.

Enhancement Potential: Beaver dam removal recommended.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower four km of the stream forms a low gradient and relatively stable fan. The upper stream is confined by valley walls and hillslopes. Numerous failures are evident on valley walls and hillslopes throughout the headwaters of this stream.

Resource Use Status

Forestry: There are two cut blocks in the lower watershed and four in the middle and upper watershed. This area was logged from 1973 to 1978. A logging access road runs along the south side of the creek from Takla Lake. Logging occurred during the 1989/90 period, but no logging is planned for the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". One mineral claim for Cr.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach. Upgrading of BCR line Year three of the redevelopment.

Aboriginal Fisheries: None

Major Resource Use Conflicts

There is active logging in the Leo Creek drainage at the present time, and it is expected that the area will be active through to 1991. Existing production potential in Leo Creek is severely limited by beaver dams in the lower system. Fish access may be further restricted if large quantities of log debris are introduced into the system. Site specific assessment of

the numerous slope failures in the upper system should be conducted in conjunction with cut block planning over the next three years in order to minimize sediment production.

Habitat degradation in the system could have a relatively significant impact on production potential that is currently limited by stream access. It is estimated that the system could produce approximately 4,800 sockeye if beaver dams were cleared and access maintained.

MacDougall Creek - Takla System

Drainage Area: Total watershed area of 79 km². Drains northeast into the northwest arm of Takla Creek opposite Point Creek.

Stream Description: Approximately 20 km long. Fish access to 0.3 km, due to beaver dams. Lower reach is 0.5 to 2% gradient over 1.2 km. Extreme flats in lower reach near mouth.

Fish Production

Sockeye: DFO estimate of spawning capacity is 1,000 adults. Escapement exceeded estimated capacity in 1953 and 1957.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	0	<50	800	<50
% of early run	0%	0%	1%	0%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	400	<50	<100	<50

Production Constraints: Beaver dams and flats at mouth combined with low flows limit access in some years.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower five km is a low gradient channel that appears to be laterally stable. The stream is a low energy system. Hillslopes and valley walls are unstable throughout the watershed.

Resource Use Status

Forestry: There is one cut block located to the south of MacDougall Creek in an unnamed tributary. Logging occurred during the 1989/90 period and additional logging is planned for the 1995 to 1996 period.

Mining: Within "No Staking Placer Reserve". One mineral claim for copper is referred to as the Adda Property.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach. A new access road is planned through the mid-reaches of the system as part of the Ankwil/Dust Creek extension.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Logging is planned for the 1989/90 period and a main haul line road will be constructed through the middle of the watershed. Logging activity within the lower 5 km could be

conducted with minimal disturbance to the creek if the banks are protected. Lateral channel stability is relatively high in this area. Road construction and logging in the upper system has the potential to introduce large amounts of sediment. Site specific planning and assessment will be required to preserve existing production potential within the system. This potential is estimated at approximately 0.1% of the total capacity for the Stuart HMA.

Mclaing Creek (Five Mile) - Takla System

Drainage Area: Total watershed area of 89 km². Drains southwest into lower Takla Lake, below Hudson's Bay Creek.

Stream Description: Approximately 15 km long. Fish access to 10 m high impassable falls at 2.4 km. Lower reach is 1 to 3% gradient over 1 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 200 adults. Escapement exceeded estimated capacity in 1953, 1957, 1961, 1969, 1973, 1974, 1977, 1981, 1985 and 1989. Maximum escapement was recorded in 1957 with 3,821 sockeye.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	<100	<100	1,300	100
% of early run	1%	1%	1%	1%

Production Constraints: Some reference to low flow conditions during spawning.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

Incomplete.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There is one old logging access road located on the north side of the watershed, but its condition is unknown. Logging plans for the 1992 to 1996 call for logging.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach. BCR line upgrading expected in Year 3 of the redevelopment.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Resource development in this watershed is not anticipated in the near future. An investigation of channel stability should be conducted in order to assist in protecting stream habitat once logging plans are proposed.

Narrows Creek - Takla System

Drainage Area: Total watershed area of 60 km². Drains southwest into lower Takla Lake at Takla Narrows.

Stream Description: Approximately 20 km long. Fish access to falls at 3 km. Lower reach is 1 to 3% gradient over 3.5 km. Falls at 2.5 km and cascades at 2.8 and 6 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 20,000 adults. Maximum escapement was recorded in 1953 with 20,600 sockeye.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	2,200	1,100	7,700	1,400
% of early run	4%	3%	5%	3%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	4,500	1,800	1,700	4,200

Production Constraints: Not identified on records.

Enhancement Potential: Preliminary plans for a spawning channel facility.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The number of relic channels present indicates that the 0.5 km fan at the stream mouth is very unstable. The remainder of the stream is entrenched by valley walls and hillslopes, which are unstable throughout the entire drainage.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no signs of logging access roads. Preliminary logging plans indicate that the system will not be logged in the 1992 to 1996 period.

Mining: Within "No Staking Placer Reserve". There are six claims for chromium in the watershed. No immediate development plans have been identified.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach. BCR line upgrading in Year 3 of the redevelopment.

Aboriginal Fisheries: None

Major Resource Use Conflicts

No resource development activities are anticipated in the near future. Any logging would presumably take place after 1993. The relatively high degree of instability throughout the watershed indicates the potential for substantial impacts if the area is heavily logged. Further channel stability assessment work should be conducted at this time.

This system has an estimated production potential of approximately 20,000 sockeye or 1.5% of the total production potential for the Stuart HMA.

O'Ne-il Creek (Kynock) - Middle River System

Drainage Area: Drains northeast into Middle River, upstream of Van Decar Creek.

Stream Description: Approximately 15 km long. Fish access from 5 to 6 km. Lower reach 0.5 to 2% gradient over 1.6 km. Gradient increases to 7 to 8% by 3 km. Many side channels at high flows. Impassable falls at 3.6 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 47,600 adults. Maximum escapement of 53,500 sockeye occurred in 1988.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	15,800	11,800	14,300	9,100
% of early run	34%	42%	9%	26%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	1,600	5,600	5,200	500

Production Constraints: Possibly incubation flows.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower 1.9 km is a very unstable fan, with several relic channels present. A logging road has been constructed across the upstream end of this fan, limiting the lateral movements of the channel. The upper channel is bounded by the adjacent hillslopes and valley walls. Hillslopes and valley walls are quite unstable.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. The logging access road crosses the creek in the lower watershed and runs into a large cut block in Van Decar Creek drainage (see Van Decar for more details). Preliminary logging plans indicate that this creek will not be logged in 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". Genesis claim for jade interests.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Resource use conflicts are not anticipated in the near future. This system has not been included in the preliminary 1988/93 logging plans. The high degree of lateral instability in the lower fan and hillslope instability in the upper watershed indicate that there could be serious sediment production problems in the system if future logging activities are not well planned.

Kynock Creek has an estimated production capacity of approximately 47,000 sockeye or 3.6% of the total production capacity within the Stuart HMA.

Paula Creek - Trembleur System

Drainage Area: Total watershed area of 50 km². Drains southeast into Trembleur Lake at west end.

Stream Description: Approximately 19 km long. Fish access may be restricted to about 2.5 km due to beaver dams. Gradient is less than 1% for 11 km from the mouth and rapidly increasing to 8%.

Fish Production

Sockeye: DFO estimates a spawning capacity of 13,300 adults. A maximum escapement of 8,300 sockeye was recorded in 1988.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	1,700	1,800	2,800	950
% of early run	3%	1%	1%	2%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	1,000	300	1,400	3,400

Enhancement Potential: Beaver dam removal.

Production Constraints: None identified.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The lower stream course is a four km long fan, which appears to be highly unstable. The remainder of the stream channel is confined within valley walls and hillslopes. Hillslopes and valley walls are unstable throughout the drainage system.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no signs of logging access roads. Preliminary cutting plans indicate that no logging will occur in the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Resource use conflicts are not anticipated in the near future. This system has not been included in the preliminary 1988/93 logging plans. The high degree of lateral instability in the lower fan as well as hillslope instability in the upper watershed indicate the potential for serious sediment production problems if future logging activities are not well planned.

Paula Creek has an estimated production capacity of approximately 13,300 sockeye, or 1.0% of the total production capacity within the Stuart HMA.

Point Creek - Takla System

Drainage Area: Total watershed area of 31 km². Drains west into northwest arm of Takla Lake, opposite MacDougall River.

Stream Description: Approximately 10 km long. Fish access to 25 m high falls at 1.2 km from mouth. Lower reach is 2 to 5% gradient over 0.3 km. Gradient increases to 5 to 10% above. Several 1 to 2 m log jam falls in canyon areas create partial barriers.

Fish Production

Sockeye: DFO estimate of spawning capacity is 1,900 adults. Escapement exceeded estimated capacity in 1973, 1974, 1975, 1979, and 1985.

Cycle-Year Averages

	1951/91	1952/88	1953/89	1954/90
Average escapement	1,700	200	1,300	600
% of early run	1%	0%	1%	<1%

Ten Year Escapement Trends

	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	300	500	1,500	1,000

Production Constraints: Extensive debris accumulations noted.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

A steep, 200 m fan, present at the stream mouth, appears to be highly unstable. Hillslopes and valley walls are unstable throughout the watershed.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no signs of logging access roads. Preliminary cut plans indicate the area will not be logged prior in the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Resource use conflicts are not anticipated in the near future. This system has not been included in the preliminary 1988/93 logging plans at this time. The high degree of lateral instability in the lower fan and hillslope instability in the upper watershed indicate the potential for serious sediment production problems if future logging activities are not well planned.

Point Creek has an estimated production capacity of approximately 1,900 sockeye or 0.1% of the total production capacity within the Stuart HMA.

Sakeniche River - Takla System

Drainage Area: Total watershed area of 1021 km². Drains northeast into Takla Lake at Takla Narrows.

Stream Description: Approximately 12 km long. Fish access to 5 meter high falls at 8.8 km from mouth. Lower reach is 0 to 0.5% gradient over 1.6 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 7,000 adults. Maximum escapement of 7,400 sockeye occurred in 1961.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	300	<100	2,900	350
% of early run	1%	0%	2%	1%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	1,000	800	500	900

Production Constraints: Some reference to stream temperatures.

Enhancement Potential: Not identified on records.

Chinook: None observed since 1958.

Channel Stability Assessment (Preliminary)

The lower one kilometer is a fan, which has the potential to be unstable as evidenced by the presence of several relic channels. Upstream of the fan the channel is bounded by valley walls and lateral movement is restricted. Upstream of Natowite Lake the streams meander through stable low lands. A laterally unstable fan is present at the mouth of Gloyazicut Creek.

Unstable valley walls are present throughout the drainage.

Resource Use Status

Forestry: There are extensive cut blocks in planning cell 2100 to the south of the creek. Two other cut blocks are located in planning cell 2151 on the north side of the creek. There are extensive logging access roads to the cut blocks on the south and north sides of the river. One road crosses the creek near the mouth. Preliminary cut plans indicate the system was logged during the 1989/90 period and will be again during the 1992 to 1996 period.

Mining: Port of watershed is within "No Staking Placer Reserve", while Tochcha Lake basin is in designated placer area. There are nine claims in the watershed with the prime interest in copper. One claim also shows a molybdenum deposit.

Linear Developments: Accessed by several forestry roads in the upper and lower watershed. One bridge crossing in the lower system below Natowite Lake.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Logging activity is slated for the 1989/90 period. It is unlikely that sockeye production capabilities in the lower system would be affected by logging activity in the upper system, due to the buffering capacity of Natowite Lake. However, extensive logging in the lower system could destabilize the fan. A further assessment of potential instability on the fan should be conducted in conjunction with a review of site specific cutting plans for the lower system.

The Sakeniche drainage accounts for approximately 0.5% of the total sockeye production capabilities for the Stuart HMA.

Sandpoint Creek - Takla System

Drainage Area: Total watershed area of 80 km². Drains southwest into lower Takla Lake, downstream from Takla Narrows.

Stream Description: Approximately 20 km long. Fish access to impassable falls at 4 km from mouth. Lower reach is less than 1% gradient over 1.6 km, increasing to 4% above 1.6 km and to 5 to 6% by 4 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 19,000 adults. Escapement exceeded estimated capacity in 1957 with 20,900 fish.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	1,500	1,200	3,600	550
% of early run	0.8%	2.3%	0.5%	3.4%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	4,100	900	1,200	1,500

Production Constraints: Some reference to stream temperatures and low spawning flows.
Enhancement Potential: Preliminary plans for a spawning channel.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

Extensive fan development (5 km long) which appears unstable. The upper stream, above the fan, is entrenched and stable. Hillslopes and valley walls are unstable throughout the drainage.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There is one logging access road located just above the BCR bridge (5155 file) that is not shown on the forest cover map. No logging plans for the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach. BCR line upgrading planned for Year 3 of the redevelopment.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Major resource use conflicts are not anticipated in the near future. A more detailed assessment of terrain and channel stability should be conducted for future planning purposes, given the high production potential and enhancement plans for this system.

The Sandpoint drainage accounts for approximately 1% of the total sockeye production capabilities for the Stuart HMA.

Shale Creek - Takla System

Drainage Area: Total watershed area of 54 km². Drains into lower Takla Lake, immediately upstream of Middle River outlet.

Stream Description: Approximately 16 km long. Fish access to 3 km at upper canyon. Lower reach is 1 to 2% gradient over 0.8 km with side channels; gradient increases to 11% at 1 km above mouth. Several chutes and a series of rapids in upper reach.

Fish Production

Sockeye: DFO estimate of spawning capacity is 3,500 adults. Escapement exceeded estimated capacity in 1953 with 3,800 fish.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	450	200	1,900	400
% of early run	0.8%	2.3%	0.5%	3.4%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	800	400	700	1,100

Production Constraints: Some reference to stream temperatures.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

A small, unstable, 100 m fan is present at the stream mouth. The remainder of the channel is entrenched in hillslopes and valley walls, which are extremely unstable.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no signs of logging access roads. Preliminary cut plans indicate the area will not be logged during the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". No mineral deposits or interests recorded.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Shale Creek is presently an undisturbed watershed. There are no logging or road construction plans for the immediate future. A high degree of valley wall and hillslope instability indicates considerable potential for stream side erosion and sediment production.

Shale Creek accounts for approximately 0.5% of the total sockeye production capabilities for the Stuart HMA.

Sidney (Felix) Creek - Trembleur System

Drainage Area: Total watershed area of 57 km². Drains south into the west end of Trembleur Lake, immediately east of Paula Creek.

Stream Description: Approximately 15 km long. Fish access to falls at 4 km. Gradient is 0.5 to 2% from mouth to 2.5 km increasing to 5% above 2.5 km. Chutes at 2.5 km are a possible barrier.

Fish Production

Sockeye: DFO estimate of spawning capacity is 19,000 adults. Escapement of 20,600 sockeye in 1985 exceeded estimated capacity.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	2,800	2,000	7,000	3,000
% of early run	5%	2%	4%	7%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	900	1,700	2,800	8,300

Production Constraints: Beaver dams near mouth of creek could create migration barrier. Chutes from 2.5 to 4 km also create possible barriers.

Enhancement Potential: Barrier removal at 2.5 and 3.5 km could be worthwhile.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

There is an extensive fan over the lower 3 km that appears relatively stable at this time. The upper channel is highly confined within the valley walls. The valley walls and hillslopes are unstable throughout this watershed.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging or forest cover disturbance. There is no sign of any logging access roads. Sidney Creek has been identified in the preliminary cutting plans for the 1992 to 1996 period.

Mining: Within "No Staking Placer Reserve". Two mineral claims (Sidney, Cr: Mount Sidney Williams, Asbestos). Activity unknown.

Linear Developments: Accessed by forestry road; one bridge crossing in lower reach. No new access planned at this time.

Aboriginal Fisheries: None

Major Resource Use Conflicts

There are no immediate resource use conflicts. Future logging in the system could result in significant erosion, due to the relatively high degree of terrain instability in the upper watershed. Existing fan stability could also be lost through major logging activity.

Sidney Creek accounts for approximately 1.5% of the sockeye production potential in the Stuart HMA.

Twenty-Five Mile Creek: - Takla System

Drainage Area: Total watershed area of 56 km². Drains southwest into lower Takla Lake, above Takla Narrows.

Stream Description: Approximately 18 km long. Fish access to falls at 1 km; the majority of sockeye spawning occurs in the lower 0.8 km.

Fish Production

Sockeye: DFO estimate of spawning capacity is 1,900 adults. Spawning escapement exceeded estimated capacity once in 1953.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	400	<100	900	350
% of early run	0.6%	1.1%	0.6%	0.7%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	600	500	300	800

Production Constraints: Some reference to stream temperatures.

Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

The mouth of the stream is a short (100 m) probably unstable fan. The remainder of the channel is confined by hillslopes and valley walls, which are unstable throughout the drainage.

Resource Use Status

Forestry: The forest cover map indicates that the entire watershed is free of logging and forest cover disturbance. There are no logging roads in the watershed. Preliminary cutting plans indicate that the watershed will not be logged during the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". One mineral claim for molybdenum.

Linear Developments: BCR line upgrading planned for Year 3 of the redevelopment.

Aboriginal Fisheries: None

Major Resource Use Conflicts

No major resource use impacts are anticipated. Impact potential from future logging activity could be managed at a low level due to the relative stability of the upper stream channel. There is no indication of any further mineral exploration or development planned.

Production potential from this system accounts for approximately 0.1% of the total production potential in the Stuart HMA.

Van Decar (Rossette) Creek - Middle River System

Drainage Area: Total watershed area of 31 km². Drains northeast into Middle River, midway between Takla and Trembleur lakes.

Stream Description: Approximately 11 km long. Fish access to 5 km. Lower reach is 1 to 2% gradient over 1.6 km; this is where the majority of spawning occurs.

Fish Production

Sockeye: DFO estimate of spawning capacity is 20,000 adults. Maximum spawning escapement recorded was 19,000 in 1988.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	7,800	4,700	5,700	4,900
% of early run	15.3%	17.1%	3.8%	15.8%

Ten Year Escapement Trends

	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	4,600	3,200	6,500	8,800

Production Constraints: Low incubation flows may be a constraint in some years.
Enhancement Potential: Not identified on records.

Chinook: None in system.

Channel Stability Assessment (Preliminary)

A long (3.5 km) at the mouth of the stream appears to be unstable, based on the presence of several relic channels. The remainder of the stream is confined by valley walls and hillslopes. This drainage has extremely unstable valley walls and hillslopes.

Resource Use Status

Forestry: There is one large cut block located in the lower end of the watershed, on the north side of Van Decar Creek. The logging access road runs into the lower watershed from the north. Headwater areas have not been disturbed. Logging is not planned for this system during the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". Three mineral claims for Cr and asbestos.

Linear Developments: Accessed by forestry road along the north side of the lower creek valley, with one bridge crossing near the mouth. New forestry branch lines may be required.

Aboriginal Fisheries: None

Major Resource Use Conflicts

The potential for habitat degradation in this system is high, due to the extremely unstable nature of the valley walls and hillslopes, which are in close proximity to the creek channel. Current logging plans should be reviewed on a site specific basis to ensure that unstable areas of the watershed are not affected. A more detailed assessment of terrain stability will be required in order to protect habitat values.

Production potential from this system accounts for approximately 1.5% of the total production potential in the Stuart HMA.

LATE STUART STOCK

Kazchek Creek - Middle River

Drainage Area: Total watershed area of 875 km². Drains northeast into Middle River a short distance above Trembleur Lake.

Stream Description: Approximately 15 km long between the outlet of Kazchek Creek and the confluence with the Middle River. Sockeye access to 2.5 km at lower canyon. Lower reach is 1% gradient over 2.5 km. There are several lakes in the system which tend to stabilize flow levels and provide a buffer for disturbances in the upper watershed.

Fish Production

Sockeye: DFO estimate of spawning capacity is 37,400 adults. Maximum spawning escapement recorded was 20,000 in 1957. The highest escapement recorded in the last decade has been 7,200 fish in 1981.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	150	100	6,100	300
% of early run	0.2%	0.6%	4.4%	0.7%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	2,900	2,000	400	1,400

Production Constraints: Barrier in canyon 2.5 km above mouth. High stream temperatures have been identified as the cause of reported pre-spawning mortalities, which have been over 50% in several years. Sub-optimum gravel size for sockeye production may also be a limitation. An extremely large population of kokanee in the system may further limit sockeye production.

Enhancement Potential: Removal of the barrier would extend the present distribution of sockeye salmon, thereby utilizing production potential in the upper system. An alternate approach to barrier removal would be to airlift adult sockeye above the canyon section. In addition to these enhancement possibilities, a potential spawning channel site has been identified on the left bank below the canyon section. The preliminary design plans encompass an area of approximately 31,000 m² with a capacity for 974,000 fish. The spawning channel may require winter flow augmentation by way of a storage dam on either Kazchek or Inzana Lakes.

Chinook: Remnant population. Spawn throughout system, with heaviest concentrations just below canyon section of creek.

Channel Stability Assessment (Preliminary)

The lower 0.5 kilometres is a fan located in the flood plain of the Middle River. The remainder of the stream up to Kazchek Lake is bounded by valley walls. The valley walls, from the mouth to Kazchek Lake are unstable with the greatest instability in the lower 5 km.

Resource Use Status

Forestry: This area was logged between 1986 and 1988. A logging access road runs from Kuzkwa River into the west end of Kazchek Lake. There are three cut blocks below the lake, as well as several along the eastern headwater boundary of the watershed. Preliminary cutting plans indicate that logging operations will be active throughout the upper system during the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve". One mineral claim for mercury (Takatoot Lake) on the watershed boundary.

Linear Developments: Accessed by forestry roads throughout lower and upper system. New road plans have not been identified at this time.

Aboriginal Fisheries: No major fisheries.

Major Resource Use Conflicts

Continued logging and clear cutting in the upper system may aggravate existing water temperature problems. The buffering capacity of Kazchek and Inzana lakes will lessen impact potential to downstream habitats in relation to logging activities in the upper watershed. Logging activity in the lower system below Kazchek Lake may result in significant habitat degradation, particularly if there is extensive stream-side cutting in the lower 5 km of the system where there is a relatively high degree of terrain instability.

Production potential from this system accounts for approximately 2.9% of the total sockeye production potential in the Stuart HMA, exclusive of any consideration of potential spawning channel production.

Kuzkwa River - Tachie System

Drainage Area: Total watershed area of 1,500 km². Drains to the northwest from Tezzeron Lake to Tachie River, approximately 8 km below the outlet of Trembleur Lake.

Stream Description: Approximately 28 km long. Fish access to Tezzeron Lake. Lower reach is 1.5% gradient over 18.4 km. Primarily a single channel throughout. Most sockeye spawning occurs in a 4 km reach below Tezzeron Lake except during dominant and sub-dominant cycle years when spawner distributions are more widespread.

Fish Production

Sockeye: DFO estimate of spawning capacity is 62,000 adults. Maximum spawning escapement recorded was 50,000 in 1957. The highest escapement recorded in the last decade has been 21,000 fish in 1981.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	750	950	16,800	2,700
% of early run	1.2%	0%	4%	2.2%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	5,400	5,800	3,300	5,200

Production Constraints: Low velocity spawning habitats and an absence of side channel habitat.

Enhancement Potential: Was considered a potential spawning channel site by IPSFC. However, it is now thought that the costs of developing a suitable water supply from Tezzeron Lake would be prohibitive.

Chinook: Remnant population, 100 adults reported in 1988.

Channel Stability Assessment (Preliminary)

A bounded channel with limited lateral instability occurring from the mouth to Tezzeron Lake. The lower channel is characterized by numerous meanders. Several steep clay and silt banks in the lower reach contribute to a high sediment load during high discharge events. Numerous valley wall failures are found along the entire length of the stream. Tezzeron Lake is a sediment trap for material eroded from upstream areas.

Resource Use Status

Forestry: There are several moderate to large cut blocks in the upper watershed. This area was logged from 1981 to 1982. There is a logging access road from the north crossing

of the river in the upper watershed. Visual examination of Landsat photography indicates that approximately 15 to 20% of the upper watershed area has been logged. Preliminary cutting plans indicate that logging operations will be active in the 1992 to 1996 period in the area between Tezzeron and Pinchi lakes.

Mining: The upper watershed above Tezzeron Lake is within a designated placer mining area; however, it has been reported that placer activity has been relatively minor in the past. The mines inspector also feels that the potential for significantly increased placer activity is minor. In addition to the potential placer activity there are six mineral claims in the watershed, including the Salmoon Lake, Toad, Tezzeron Lake, Tas, Hat and Chuchi claims. Mineral interests include Au, Ag, Hg, Pb, Zn, Cu and Mo.

Linear Developments: Accessed by forestry roads throughout upper and lower watershed. No new roads are planned.

Aboriginal Fisheries: None

Major Resource Use Conflicts

Downstream effects of logging and planning activity in the upper watershed will be lessened to some extent by the buffering capacity of Tezzeron Lake. However, further logging or road construction in the lower system below Tezzeron Lake could seriously degrade existing habitat quality, due to the high degree of clay bank instability.

Future mineral development in the watershed could also lead to major habitat protection problems. However, there is no indication that further exploration or development is planned.

Production potential from this system accounts for approximately 4.6% of the total production potential in the Stuart HMA.

Middle River - Trembleur System

Drainage Area: The Middle River drainage encompasses the upper third of the Stuart HMA above Trembleur Lake. The river drains from Takla Lake, southeast into Trembleur Lake.

Stream Description: Approximately 36 km long. Fish access throughout with most sockeye spawning activity occurring on bars at the mouths of Rossette, Kynock and Forfar creeks and in an area extending approximately 1 km below and 4 km above Kazchek Creek. The gradient of the river is extremely low throughout, with an estimated drop of 3 m over its entire length. The substrate is primarily fine gravel, sand and silt except for the larger sized gravel deposits noted above. Aquatic weeds are common.

Fish Production

Sockeye: DFO estimate of spawning capacity is 804,000 adults. Maximum spawning escapement recorded was 336,000 in 1957. The highest escapement recorded in the last decade has been 276,000 fish in 1989.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	4,400	2,400	159,700	7,200
% of early run	7.3%	3%	34.5%	17.2%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	60,800	46,100	21,300	55,400

Production Constraints: Some reference to stream temperatures. Occasional high pre-spawn mortality has been observed.

Enhancement Potential: IPSFC originally examined the possibility of a spawning channel adjacent to Middle River. However, more recently enhancement planning has focused on the possible addition of clean, graded gravels to existing spawning areas. The possibility of large annual egg takes, coupled with a stream-side incubation project during dominant cycle years, has also been identified as a possible enhancement strategy for Middle River.

Chinook: Remnant population.

Channel Stability Assessment (Preliminary)

This river channel is very stable. There are no adjacent hillslopes or valley walls that appear unstable. It is apparent that all sediment production for this stream comes from its tributaries. Protecting the tributary systems will ensure the protection of Middle River.

Resource Use Status

Forestry: There is one large cut block in the Van Decar Creek watershed and three small ones on the north side of the river above Natazutto Creek. There are also seven cut blocks on the hillslopes of the east valley. These areas were logged prior to 1982 (refer to Landsat Photograph). Further logging activity along the Middle River valley is slated for the 1992 to 1996 period.

Mining: Within "No Staking Placer Reserve". There is one mineral claim (Middle River) along the river bottom, with an interest in Cr. There is little likelihood that this claim will be active in the near future.

Linear Developments: The BC Rail line runs along the east bank of the Middle River between Trembleur and Stuart lakes. This line would be upgraded in Year 2 of the redevelopment. There is also a logging road along the east bank near the outlet of Takla Lake, and a road that runs from Takla Lake down the west bank of the river to Van Decar Creek. There are no bridge crossings on Middle River. The river is navigable over its entire length.

Aboriginal Fisheries: Based out of the village of Trembleur Lake.

Major Resource Use Conflicts

Logging activity along the valley flat of Middle River could have a relatively minor impact on Middle River habitats, provided that the banks are not disturbed. However, existing logging plans in Rossette and Forfar creeks could introduce sediment into Middle River and, more specifically, could degrade gravel quality on the bars at the mouths of these creeks; these areas provide the most important spawning areas for Middle River sockeye populations. Similarly, any disturbances in the lower reach of Kazchek Creek could have a significant impact on sockeye spawning habitats in the Middle River below the Kazchek confluence.

It is recommended that existing logging plans for Rossette and Forfar creeks be examined in conjunction with a more detailed assessment of terrain stability in these tributaries in the immediate future. It is also recommended that logging activity in the Kazchek drainage be restricted to the upper watershed above Kazchek Lake in order to protect Middle River spawning habitats.

Production potential from the Middle River accounts for approximately 59% of the total production potential in the Stuart HMA, exclusive of any potential realized from a possible egg take and incubation enhancement program. Therefore, any habitat degradation in the Middle River system could have a significant impact on existing and future sockeye production from the Stuart HMA.

Pinchi Creek - Stuart System

Drainage Area: Total watershed area of 990 km². Drains southwest from Pinchi Lake into Stuart Lake, approximately 30 km north of Fort St. James.

Stream Description: Approximately 6.5 km long. Fish access to falls near outlet of Pinchi Lake. These falls are 13 m in height and are located approximately 5.1 km above the Pinchi Creek mouth. The lower reach has a gradient of approximately 0.5%, increasing to 3% in the upper reach near the falls.

Fish Production

Sockeye: DFO estimate of spawning capacity is 1,600 adults. Spawning escapement exceeded estimated capacity in 1957 (6,400) and 1977 (1,700). The highest escapement recorded in the last decade was 7,357 fish recorded in 1989.

Cycle-Year Averages

	1951/91	1952/88	1953/89	1954/90
Average escapement	300	325	2,450	600
% of early run	0.5%	0%	0.4%	0.5%

Ten Year Escapement Trends

	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	700	150	400	1,600

Production Constraints: Falls prevent access to upstream spawning habitat at lake outlet.
Enhancement Potential: Not identified on records.

Chinook: Remnant population; 125 spawners observed in 1988. There is an important juvenile chinook rearing area below the falls.

Channel Stability Assessment (Preliminary)

This creek is a bounded channel from Stuart Lake to Pinchi Lake, with some lateral channel movement. Valley walls are unstable and old failures are evident. Banks and valley walls are the primary sources of sediment.

Resource Use Status

Forestry: There is one large cut block on the east side of Pinchi Creek below Pinchi Lake. Two moderate sized cut blocks are located in the lower watershed. A logging access road crosses the creek 1 km above Stuart Lake and there are logging roads into the upper watershed. There are several cut blocks along the southern headwater boundary. Preliminary cutting plans indicate that further logging activity is planned for the 1992 to 1996 period.

Mining: The upper watershed above Pinchi Lake, excluding a 1 to 2 km wide buffer zone around the lake, is within a designated placer staking area. However, placer activity in this area has been minimal and an increase in activity is not anticipated in the near future, according to the regional mines inspector. In addition to the placer interests, there are five mineral claims for mercury, including the abandoned Pinchi Lake mercury mine which was operational in the early 1940s and late 1960s.

Linear Developments: Accessed by an extensive network of forestry roads throughout the upper and lower watershed.

Aboriginal Fisheries: Minor fishery at Pinchi village.

Major Resource Use Conflicts

Fish production capabilities in the Pinchi Creek system could be protected by restricting future logging activity to the upper watershed. In this manner any sediment production

resulting from activities in the upper watershed would be controlled by the buffering capacity of Pinchi Lake. Any logging or mining activity in the lower watershed should be planned in conjunction with a detailed assessment of terrain and channel stability below Pinchi Lake.

Production potential from Pinchi Creek accounts for approximately 0.1% of the total production potential in the Stuart HMA.

Tachie River - Stuart System

Drainage Area: Drains in a southerly direction from Trembleur Lake to Stuart Lake.
Stream Description: Approximately 25 km long. Fish access throughout the system. This system has a very stable discharge as influenced by the Trembleur Lake outflow. The section of river between the mouth of the Kuzkwa River and Stuart Lake has a very low gradient and is characterized by a mud and sand substrate with abundant growth of aquatic vegetation. Sockeye spawning occurs mainly in an area known as the "Grand Rapids" immediately below the Kuskwa River confluence.

Fish Production

Sockeye: DFO estimate of spawning capacity is 401,500 adults. The maximum recorded spawner escapement was 287,000 sockeye in 1989.

	Cycle-Year Averages			
	1951/91	1952/88	1953/89	1954/90
Average escapement	3,100	2,300	124,600	15,800
% of early run	5.2%	9%	2.6%	15%

	Ten Year Escapement Trends			
	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990
Average escapement	26,000	34,200	19,400	66,300

Production Constraints: Availability of suitable spawning gravels.

Enhancement Potential: Two potential spawning channel sites have been identified; these are located on the right bank of the river, 2 and 8 km below the Kuzkwa River confluence. An alternative enhancement approach under consideration is the placement of graded gravels.

Chinook: Remnant population. None observed since 1972.

Channel Stability Assessment (Preliminary)

This is a very stable river channel. There are no obvious valley walls or hillside failures. The sediment sources for gravel appear restricted to the Kuzkwa River.

Resource Use Status

Forestry: There is one large cut block located in the upper eastern watershed. This area was logged from 1981 to 1982. A logging access road runs from the south, along the east side of the river to Trembleur Lake. Additional logging was planned in the Tachie watershed during the 1989/90 period but none is planned for the 1992 to 1997 period.

Mining: Within "No Staking Placer Reserve".

Linear Developments: Accessed along the east side by the BCR line and a bridge crossing 2 km above the mouth of the river. A logging road exists on the west side of the river and

extends up through TFL 42 adjacent to the Grand Rapids reserve. The BCR line will be upgraded in Year 2 of the redevelopment.

Aboriginal Fisheries: Fisheries are based out of the four villages situated along Tachie River. These include Tachie Village at the outlet into Stuart Lake, the Grand Rapids reserve at the Kuzkwa River outlet, the smaller Stevan reserve and the Teeslee Village at the outlet of Trembleur Lake.

Major Resource Use Conflicts

Logging activities in the Tachie River valley flat should have relatively little impact on habitat capabilities in the Tachie River, provided that it is restricted from the bank areas. The highest potential for mainstem habitat degradation is associated with logging activities in the lower Kuzkwa River below Tezzeron Lake.

Production potential from the Tachie River accounts for approximately 30.7% of the total production potential in the Stuart HMA.

Stuart River

Drainage Area: Drains in a southerly direction from Stuart Lake to the Nechako River confluence below Vanderhoof.

Stream Description: Approximately 112 km long. Fish access throughout the system. This system has a very stable discharge as influenced by the Stuart Lake outflow. A reported gradient of 8.2% in the lower 40 km of river decreasing to 2.1% in the upper 70 km.

Fish Production

Sockeye: Used mainly as a sockeye migration corridor, with less than 200 spawners in the mainstem Stuart River

Production Constraints: Sufficient chinook salmon escapement to seed rearing capacity.
Enhancement Potential: Not identified on records. There is a chinook salmon hatchery facility near Necosli that is operated by the Fort St. James Native Band. Incubation capabilities at this facility have been increased to handle 175,000 eggs in 1988.

Chinook: Main population within the Stuart HMA. Maximum recorded escapement occurred in 1990 with approximately 6,000 adult spawners. Most chinook spawning occurs immediately below the Dog Creek confluence.

Channel Stability Assessment

Not assessed at this time.

Resource Use Status

Forestry: There has been light logging activity on both sides of the Stuart River and no riverside logging to date. Generally, timber values are low in this area. Most of the area is managed under Small Log Sales Licences. Several cutting plans are proposed for areas along the Stuart River for the 1993 to 1996 period.

Mining: Most of the Stuart River valley bottom is excluded from placer staking. However, designated placer areas encompass the Sowchea and Dog Creek watersheds. A designated corridor for placer work runs along the northeast side of the Necosli River and crosses the Stuart River immediately downstream of Bearcub Creek. Placer activity is allowed in this area, with restrictions. Similar to other placer areas within the Stuart HMA, placer mining activity has been at a very low level in past years. In addition to placer interests, there are nine mineral claims adjacent to Stuart Lake and the Stuart River. These are the MR, Sunshine, Calex, Fort St. James, Dickinson Mountain, Necoslie River Limestone,

Snowbird, Noble and Dog Creek claims. These claims have interests in Cr, Hg, Ls, Hg, Au, Sb, Se and Cu.

Linear Developments: There is very little road access to most sections of Stuart River. There is one major road crossing at Fort St. James and a ferry crossing near Margaret Lake.

Aboriginal Fisheries: Fisheries are based out of Fort St. James and at the Tatselawas Reserve opposite the Dog Creek confluence.

Major Resource Use Conflicts

There appears to be relatively little resource use pressure in the immediate future, no major conflicts are anticipated at this time. There is the potential for significant impacts if future mining or logging activity in the Dog Creek watershed affect chinook spawning habitats in the mainstem Stuart River.

The Stuart River chinook salmon population is the main remaining population in the Stuart HMA and is critical to the re-establishment of now remnant populations in the tributaries above Stuart Lake.

APPENDIX II

Stream Sensitivity Ratings

Purpose

The purpose of the Stream Sensitivity Rating is to identify the fish habitat sensitivities of each stream and lake in the Stuart/Takla Habitat Management Area. The ratings provide a quick reference to the general habitat sensitivities and/or concerns for each stream or lake in the HMA. The rating includes information on the following:

- (1) stream or lake name;
- (2) physiographic subdivision;
- (3) salmon production target;
- (4) geomorphic stability and/or soils concerns;
- (5) water temperature concerns;
- (6) hydrology concerns;
- (7) zones of high sensitivity;
- (8) specific comments on each stream or lake.

General Information - Sensitivity

The sensitivities and habitat concerns noted in the ratings were derived primarily from general information and/or watershed level assessments of aerial photography, surficial geology and landform assessment (Chapter 3). Site or stream specific field observations and data were incorporated if they were known. Specific information and observations for each stream or lake can be found in Appendix I, the individual stream summaries.

The sensitivity rating rates each drainage in the HMA according to the known terrain, temperature or hydrology sensitivities of the drainage. The drainages are rated on a sensitivity scale of 1 - 10. A rating of 1 - 3 signifies a low level of concern, 4 - 7 a moderate level of concern, and 8 - 10 that a high level of concern exists for that drainage. Unknown means that insufficient information exists to make a definitive statement on the sensitivity of that stream or lake.

Streams or lakes that have only general level terrain or hydrology assessment information have a rating of 1 (low), 5 (moderate) or 10 (high). This is the case for all streams and lakes in the Stuart/Takla HMA. Streams and lakes that have more detailed assessment information have more accurate sensitivity grades such as 2 (low), 6 (moderate) or 9 (high). The ratings highlight fish habitat sensitivities that other resource users or developers must consider when planning or conducting activities in the HMA.

Stream Specific Information - Sensitivity

Detailed information on each stream and lake in the HMA is contained in the stream summary section. The information available includes:

1. salmon production goals for the stream;
2. assessment of valley slope or streambank instability (could result in physical destruction of fish habitats);
3. documentation of highly erosive soil conditions (could cause sedimentation of spawning or rearing habitats);
4. documentation of elevated stream temperature problems;
5. documentation of unstable stream channels susceptible to changes in peak stream flows;
6. documentation of low flow conditions (could cause obstructed fish access and/or winter freezing of fish eggs or alevins);
7. documentation of barriers to fish migration such as falls, beaver dams, log jams, etc.;
8. documentation of zones or areas of high sensitivity, high productivity or unique habitats that require special protection; and
9. comments on special habitat features, observations or circumstances.

Site specific information on habitat sensitivities or fish utilization in many cases is not available for streams or portions of streams. As stream specific observations, habitat monitoring or intensive study results are accumulated the information will be added to the plan. The information may be added by resource agencies, developers, other resource users, or private groups on a regular basis. Constant upgrading and updating of information is essential to the plan. In some cases specific information on terrain stability, soil analysis or hydrology may be required by DFO before a development or project that has the potential to impact fish habitat can be approved.

Summary

The purpose of the rating, therefore, is to identify some general concerns of each of the watersheds in the HMA. If more detailed information is required the stream summaries should be consulted. Finally, if insignificant information exists then site specific analysis and/or assessment may be required by the proponent.

Those watersheds with the highest salmon values or the most habitat concerns will logically require the most detailed assessment, the highest degree of protection and the most stringent control on development.



STREAM SENSITIVITY RATINGS

STUART/TAKLA HABITAT PROTECTION PLAN - STREAM SENSITIVITY RATINGS

STREAM NAME	PHYSIOGRAPHIC SUBDIVISION	TARGET PRODUCTION CH/SK	STABILITY/SOILS CONCERNS	TEMPERATURE CONCERNS	HYDROLOGY CONCERNS	HIGH SENSITIVITY ZONES	COMMENTS
Stuart River	Stuart/Tezzeron Plain	CH - 9100 - 1000 SK - M	1 1	2 2	1 1	D/S Dog Creek	Main spawning area
Saxton Creek		CH - R	2	1	5		Access BD/LF
Weasel Creek		CH - R	2	1	5		Access BD/LF
Burnstead Creek		CH - R	2	1	5		Access BD/LF
Mandalay Creek		CH - R	2	1	5		Access BD/LF
Chinohchey Creek		CH - R	2	1	5		Access BD/LF
Welch Creek		CH - R	2	1	5		Access BD/LF
Breadalbane Creek		CH - R	2	1	5		Access BD/LF
QH Creek		CH - R	2	1	5		Access BD/LF
Kec Creek		CH - R	2	1	5		Access BD/LF
Mud Creek		CH - R	2	1	5		Access BD/LF
Bearcub Creek		CH - R	2	1	5		Access BD/LF
Dog Creek		CH - R	2	1	5		Access BD/LF
Others		CH - R	2	1	5		Access BD/LF
> 2 km tributary		UK	2	1	5		Access BD/LF
Necoslie River		NIL	0	0	0		
Stuart Lake		CH - M/R SK - M/R	0 0	0 0	0 0		
Tributaries		UK	0	0	0		Streams not listed
Sowchea Creek		SK - P	1	1	5		Access BD
Tributaries		UK	1	1	5		Access BD
Pinchi Creek		CH - 100 SK - 1600	5 5	1 1	1 1		Slope stability, access F
Tributaries		CH - R	5	1	1		
Tachie River		SK - 4015 00 CH - P	2 2	1 1	1 1	D/S Grand Rapids	Main spawning area

ABBREVIATIONS:			SENSITIVITY RATINGS:		
CH = Chinook	P = Presence	LJ = Log jams	1 = low	3 = moderate (extensive assessment)	5 = high (extensive assessment)
SK = Sockeye	LF = Low Flow	D/S = Downstream	2 = moderate (limited assessment)	4 = high (limited assessment)	0 = insufficient information
M = Migration	BD = Beaver Dams	U/S = Upstream			
R = Rearing	F = Falls	UK = Unknown			

STUART/TAKLA HABITAT PROTECTION PLAN - STREAM SENSITIVITY RATINGS

STREAM NAME	PHYSIOGRAPHIC SUBDIVISION	TARGET PRODUCTION CHASK	STABILITY/SOILS CONCERNS	TEMPERATURE CONCERNS	HYDROLOGY CONCERNS	HIGH SENSITIVITY ZONES	COMMENTS
Tributaries		SK - Nil	2	1	1		
		CH - R	2	1	1		
Kuzkwa Creek		SK - 62000	5	1	1		Fine soils
		CH - 100	5	1	1		
Tributaries		CH - R	5	UNK	UNK		
Trembleur Lake		CH - M/R	1	1	1		
		SK - M/R	1	1	1		
Tributaries		UK	UNK	UNK	UNK		Streams not listed
Middle River		SK - 804000	5	5	1	D/S main	Main spawning area, fine soils
		CH - P	5	5	1	tributaries	
Tributaries (east)		UK	5	5	1		Fine soils
Kazchek Creek		SK - 37400	2	1	1	Lower 2.5 km	Main spawning
		CH - P	2	1	1		Access F
Tributaries		NIL	2	1	1		
Fleming Creek	Fleming Lowlands	SK - 9500	2	5	2	D/S lake	Access BD, bank stability
Tributaries		NIL	2	5	2		
Tildesley Creek	Trembleur Uplands	See Fleming	2	1	2	D/S lake	Access BD, bank stability
Tributaries		NIL	2	1	2		
Paula Creek		SK - 13300	5	1	2	Lower 4 km	Access BD, bank & slope stability
Tributaries		NIL	5	1	2		
Sidney (Felix) Creek		SK - 19000	5	1	2	Lower 4 km	Access BD/F
Tributaries		NIL	5	1	2		
Natowite Lake	Natowite Uplands	NIL	UNK	5	1		
Tributaries		NIL	UNK	UNK	1		

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M = Migration	BD = Beaver Dams	U/S = Upstream			
R = Rearing	F = Falls	UK = Unknown			

STUART/TAKLA HABITAT PROTECTION PLAN - STREAM SENSITIVITY RATINGS

STREAM NAME	PHYSIOGRAPHIC SUBDIVISION	TARGET PRODUCTION CHASK	STABILITY/SOILS CONCERNS	TEMPERATURE CONCERNS	HYDROLOGY CONCERNS	HIGH SENSITIVITY ZONES	COMMENTS
Middle River	Lower Takla Mtns.	SK - 804000	5	5	1	D/S main	Main spawning area, limited
		CH - P	5	5	1	tributaries	gravels, fine soils
Tributaries(west)	See tributaries		5	5	1		Fine soils
Baptiste Creek		NIL	5	5	1		Spawning at mouth
Tributaries		NIL	5	5	1		
Van Decar (Rosette) Creek		SK - 20000	5	5	5	Lower 5 km	Main spawning area, LF, bank & slope stability, debris
Tributaries		NIL	5	5	5		
O' Ne-el (Kynock) Creek		SK - 47600	5	5	5	Lower 6 km	Main spawning area, LF, bank & slope stability
Tributaries		NIL	5	5	5		
Forfar Creek		SK - 18300	5	5	5	Lower 3.2 km	Main spawning area, access F bank & slope stability
Tributaries		NIL	5	5	5		
Takla Lake		SK - M/R	1	1	1		
Tributaries		UK	1	1	1		Streams not listed
Gluskie Creek		SK - 18000	2	1	1	Lower 3 km	Main spawning area
Tributaries		NIL	2	1	1		Slope stability
Bivouac Creek		SK - 5700	2	5	5	Lower 3.2 km	Access F/LJ
Tributaries		NIL	2	5	5		Bank stability
Sakeniche River		SK - 7000	2	5	2	Lower 8.8 km	Access F, bank & slope stability
Tributaries		NIL	2	5	2		
McDougal Creek		SK - 1000	2	5	5		Access BD/LF
Tributaries		NIL	2	5	5		Access BD/LF
Sinta Creek		SK - P	UNK	UNK	5		Access BD
Tributaries		NIL	UNK	UNK	5		Access BD

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SK = Sockeye	LF = Low Flow	D/S = Downstream	2 = moderate (limited assessment)	4 = high (limited assessment)	0 = insufficient information
M = Migration	BD = Beaver Dams	U/S = Upstream			
R = Rearing	F = Falls	UK = Unknown			

STUART/TAKLA HABITAT PROTECTION PLAN - STREAM SENSITIVITY RATINGS

STREAM NAME	PHYSIOGRAPHIC SUBDIVISION	TARGET PRODUCTION CH\SK	STABILITY/SOILS CONCERNS	TEMPERATURE CONCERNS	HYDROLOGY CONCERNS	HIGH SENSITIVITY ZONES	COMMENTS
Crow Creek		SK - 3500	5	1	5		Access LF
Tributaries		Nil	5	1	5		Slope stability
Hooker Creek		SK - 400	5	1	2	Lower 0.2 km	Limited gravel, bank & slope stability
Tributaries		Nil	5	1	2		slope stability
Point Creek		SK - 1900	5	1	2	Lower 1.3 km	Access F, debris
Tributaries		Nil	5	1	2		Bank & slope stability
Leo Creek		SK - 4800	5	1	2	Lower 3 km	Access BD
Tributaries		Nil	5	1	2		Slope stability
Sandpoint Creek		SK - 19000	5	5	5	Lower 4 km	Access LF/F, bank & slope stability
Tributaries		Nil	5	5	5		slope stability
Narrows Creek		SK - 20000	5	1	2	Lower 3 km	Access F, bank & slope stability
Tributaries		Nil	5	1	2		slope stability
Blanchet Creek		SK - 1000	5	1	2	Lower 0.8 km	Access F
Tributaries		Nil	5	1	2		Slope stability
Twenty-Five Mile Creek		SK - 1900	5	5	2	Lower 0.8 km	Bank & slope stability
Tributaries		Nil	5	5	2		
Shale Creek		SK - 3500	5	5	2	Lower 3 km	Bank & slope stability
Tributaries		Nil	5	5	2		
Fifteen Mile Creek		SK - 400	5	1	2	Lower 0.5 km	Access F, limited gravel
Tributaries		Nil	5	1	2		Bank & slope stability
Dust Creek	Takla/Driftwood	SK - 17000	5	5	2		Bank & slope stability
Tributaries	Uplands	Nil	5	5	2		

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SK = Sockeye	LF = Low Flow	D/S = Downstream	2 = moderate (limited assessment)	4 = high (limited assessment)	0 = insufficient information
M = Migration	BD = Beaver Dams	U/S = Upstream			
R = Rearing	F = Falls	UK = Unknown			

STUART/TAKLA HABITAT PROTECTION PLAN - STREAM SENSITIVITY RATINGS

STREAM NAME	PHYSIOGRAPHIC SUBDIVISION	TARGET PRODUCTION CHASK	STABILITY/SOILS CONCERNS	TEMPERATURE CONCERNS	HYDROLOGY CONCERNS	HIGH SENSITIVITY ZONES	COMMENTS
McLaing Creek	Takla Uplands/ Driftwood Mts	SK - 200	UNK	UNK	2	Lower 2.4 km	Access LF/F
Tributaries		Nil	UNK	UNK	2		
Hudson Bay Creek		SK - 200	5	1	2	Lower 8.4 km	Access LF
Tributaries		NIL	5	1	2		Slope stability
Frypan Creek		SK - 19000	5	1	5		ice, bank stability
Tributaries		Nil	5	1	5		Slope stability
Forsythe Creek		SK - 9500	2	5	5		Access LF, bank &
Tributaries		Nil	2	5	5		slope stability
Ankwill Creek		SK - 28600	5	2	5	Lower 6 km	Access LF, bank &
Tributaries		Nil	5	2	5		slope stability
French Creek		SK - 1000	5	2	5		Access LF/LJ
Tributaries		Nil	5	2	5		Bank & slope stability
Bates Creek		SK - P	2	1	2		Bank & slope stability
Tributaries		NIL	2	1	2		
Driftwood River	SK-345700	5	1	5	Lower 92 km	Access LF	
Tributaries	See Driftwood	5	1	5		Slope stability	
Lion Creek	See Driftwood	5	1	2	Lower reaches	Access LF	
Tributaries		NIL	5	1	2		Bank & slope stability
Kostine Creek	See Driftwood	5	1	2	Lower reaches	Access LF	
Tributaries		NIL	5	1	2		Bank & slope stability
Kastberg Creek	See Driftwood	5	1	2	Lower reaches	Access LF	
Tributaries		NIL	5	1	2		Bank & slope stability

ABBREVIATIONS:			SENSITIVITY RATINGS:		
CH = Chinook	P = Presence	LJ = Log jams	1 = low	3 = moderate (extensive assessment)	5 = high (extensive assessment)
SK = Sockeye	LF = Low Flow	D/S = Downstream	2 = moderate (limited assessment)	4 = high (limited assessment)	0 = insufficient information
M = Migration	BD = Beaver Dams	U/S = Upstream			
R = Rearing	F = Falls	UK = Unknown			