USING INDIGENOUS KNOWLEDGE IN RESOURCE MANAGEMENT:

KNOWLEDGE OF SALMON IN THE UPPER ST'ÁT'IMC (LILLOOET, B.C.)

by

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ABSTRACT

Recognition and use of indigenous knowledge in resource management can increase the information available about the resource and facilitate establishment of a larger management role for local resource users. This paper examines the use of indigenous knowledge in resource management using the case of knowledge of Pacific salmon (*Oncorhynchus spp.*) among the Upper St'át'imc, near Lillooet, British Columbia (B.C.). Salmon in the study area are currently managed by the federal Department of Fisheries and Oceans (DFO). This system was established in the 1940s and overlays a traditional management system consisting of fishing site ownership, a well-defined system of access to sites, rules of conduct at fishing sites for the catching and processing of fish, and harvest restrictions. Recent DFO policy changes, signified by the Aboriginal Fisheries Strategy, indicate a movement toward a larger management role for First Nations. This study addresses what indigenous knowledge is available, how it compares to knowledge used by the Department of Fisheries and Oceans, and how indigenous knowledge can be used in modern salmon stock management. A literature review was supplemented by interviews with elders, young Upper St'át'imc leaders, and both DFO and non-DFO biologists.

Current indigenous knowledge pertains to salmon stocks, habitat, and practices and philosophy. Indigenous knowledge can be primarily distinguished from western scientific knowledge on the basis of the following properties of the indigenous system: a greater amount of qualitative vs. quantitative information; an obvious recognition and discussion of anomalies; the perception of a wide range of variables in a region; the use of specific local technology; the development of analysis based on both observations over a medium-sized area and traditional ideologies; and differences in institutional arrangements for gathering knowledge. Differences

between indigenous and western scientific knowledge are related to the requirement that DFO accumulate and process a large amount of information over a very large geographical area.

Several barriers exist to using indigenous knowledge in modern resource management, including the fact that indigenous knowledge does not fit readily into established methods for gathering and analyzing data. Using indigenous knowledge may be facilitated by innovations at both the local and state levels.

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> There are many ways to be poor, but in today's world not having the right kind of information represents a certain kind of poverty ...(a Nunavik Inuk 1978, quoted in Kemp and Brooke 1995).

1. INTRODUCTION

1.1 Purpose

1.1.1 Purpose of this Study

The purpose of this study is to contribute to the literature on indigenous environmental knowledge and its use in a modern context. This purpose is achieved through an inquiry into knowledge of Pacific salmon (*Oncorhynchus spp.*) in an indigenous community. I provide: 1) a case-specific examination of the applicability of indigenous knowledge to modern salmon management both historically and in the present day, 2) differences between indigenous knowledge and the western scientific knowledge possessed by the state agency responsible for salmon management, 3) an examination of the barriers to using indigenous knowledge in the modern resource management context and, 4) suggestions concerning ways in which these barriers could be overcome.

1.1.2 Indigenous Knowledge

Indigenous knowledge is: **knowledge built up by a community over years or generations through intensive and continuous contact with a particular environment. It is manifest in certain customs and laws as part of a self-management system for using a resource.** Indigenous knowledge is, thus, specific to both a location and a community in which the local knowledge system exists. Knowledge systems consist of methods of acquisition of

information; methods of verification of information; methods of transmission of information; and theories and philosophies of the nature of things and their relationships to each other.

Indigenous knowledge is variously termed folk knowledge, local knowledge, ethno-ecology, and traditional knowledge, etc. in the literature (eg. Johnson 1990, Traditional Knowledge Working Group 1991). This study uses 'indigenous knowledge' for the most part since this phrase is emerging as one of the most widely accepted in the literature. The term is, however, used in both a broad and in a restricted sense. Indigenous knowledge refers to knowledge that has been passed down word-for-word from grandparents and parents. In addition, it may include information held by individuals which cannot be traced word-for-word to the previous generation and knowledge which is compatible with the former types of knowledge, but which could only be formed recently because of recent changes in environmental conditions. These may all be referred to as indigenous knowledge. Further, the literature on indigenous knowledge does not limit itself to knowledge in indigenous communities since common elements exist between knowledge systems in indigenous and non-indigenous communities (eg. Dewalt 1994). These common features are found both in the perceptions of them by scientists and policy-makers and in the characteristics of the information themselves. This study maintains an inclusive approach to indigenous knowledge based on the above definition and the possible variations described here.

1.1.3 Western Scientific Knowledge

Western scientific knowledge is: **the body of knowledge that has emerged and continues to emerge from western societies and is supported by state and international institutions**. Despite the term, *western*, this type of knowledge is *international* in the same way that the U.S. dollar is. Western science involves international networks of practitioners, plays

important roles in political situations around the world, and extends its influence across borders constantly. The term 'western science' also reflects norms in the literature and in popular media. Use of the term is not intended to imply that western society has science and other societies have an inferior type of 'non-scientific' activity. The views of this author are compatible with Pam Colorado's (1988) use of the phrase "native science" and the perspective that aboriginal societies have methods that exist within a comprehensive ideology, both of which support the acquisition, analysis, and transfer of information.

1.1.4 Resource Management

This study applies the term, resource management, to activities carried out by the federal agency responsible for fish resources (the Department of Fisheries and Oceans). The term also includes the activities and practices related to fish harvesting and consumption which are observable at the community-level and which have, to some extent, been socially, politically, or culturally institutionalized.

Resource management has several potential functions including (Pinkerton 1989):

1) data gathering and analysis
2) logistical harvesting decisions, such as licensing, timing, location, and vessel or gear restrictions
3) harvest allocation decisions
4) protection from habitat or water quality damage by other water resource users
5) enforcement of regulations or practices guiding harvesting logistics, allocation, and resource protection
6) enhancement and long-term planning
7) broad policy decision-making

The data gathering and analysis function of resource management is the focus of this study. However, the study describes other functions of the salmon resource management system as context for the knowledge system component. Note that resource management systems may

include some, but not necessarily all, of the above functions. (Section 4.3.2 below describes how each of the management regimes in this study carries out these functions.)

This study addresses the use of indigenous knowledge in resource management in a modern context. "Modern context" refers to the current complex situations, occurring in many places around the world, in which the state plays a large role in resource management, often in situations where previously existing management practices and cultural, social, and/or political systems contrast with those of the state system. The use of indigenous knowledge in resource systems with state involvement arises, as an issue, out of this particular context.

1.1.5 Approach

Indigenous knowledge exists as a significant sub-field in both anthropology and common property theory. Anthropological studies on knowledge contribute to the understanding that indigenous knowledge systems are legitimate ways of knowing and that they may differ from the western, state-level counterpart in terms of substance, methods, and philosophy. Common property theory (Berkes 1989a, Ostrom 1990, McCay and Acheson 1987) and indigenous knowledge are related fields of inquiry and are both concerned with community-level mechanisms for resource management and the institutional aspects of resource management. Contributions to the literature on indigenous knowledge are interdisciplinary, and come from many other fields, including biology, economics, geography, sociology and political science.

The present study maintains a focus both on community-level resource management and on the substantive, methodological, and philosophical differences between indigenous and western scientific knowledge. The present research, however, differentiates itself from the familiar treatment of knowledge in introductory science texts and some anthropological research (eg. Johnson 1990). Sub-fields within sociology (eg. Jasanoff 1990) and philosophy of science (eg.

Kuhn 1992) are used to characterize science in terms of its actual operation, social dynamics, use in public policy, and the role of technology and other features. Indigenous knowledge is characterized using the same type of framework. Throughout the study, knowledge is analyzed as a product of technical, institutional, and social processes rather than as the result of specific unique ideals (eg. logic, objectivism, rationality, etc.). The former approach is not a major component of the common property literature. However, the approach is congruous with the attention given to institutional arrangements and local management capacity found in common property theory.

1.1.6 The Case

Knowledge of salmon possessed by elders, local managers, and fishers in the Upper St'át'imc provides the focus for this analysis. The Upper St'át'imc are members of the Interior Salish group of First Nations and live in the southwestern interior of the province of British Columbia. Their territory is located on and around the Middle Fraser River near the town of Lillooet (please see the map of the study area, figure 1, and also the map of the St'át'imc territory, figure 3 in Chapter 3).

1.2 Problem Definition

1.2.1 Declining Natural Resources and Biodiversity

Popular media, academic reports, and non-governmental agencies present shocking images of diminishing natural resources over the last 40 years. Evidence for this decline exists in trends of global biodiversity (species and habitat loss), area of forest cover, area of wetlands, airborne contaminants in cities and other areas, water contaminants worldwide, stratospheric ozone depletion, etc. Many researchers recognize the enormity of potential change with predictions of

about 20 years for a monumental shift in human actions to avert ecological catastrophe (Brown et al. 1991).

The decline in natural resources has not taken place in the absence of resource management. Indeed, many of the resources in decline are under active "management". Certainly for each of these resources and variables, monitoring exists or, at least, the relevant activities fall within the jurisdiction of existing national and international bodies. However, resource management has been hampered by both the inability to make difficult political decisions and uncertainty about ecological phenomena (Ludwig et al. 1993).

1.2.2 Evidence of Diminishing Fish Stocks in North America

Close to home, the demise of the North Atlantic ground fish stocks was an example to Canadians of the potential immediacy of natural resource decline. The uncertainty associated with the decline, both as it became apparent and in the current discussion of when (or if) the fish will return, has served to raise questions about and decrease trust in the federal government-administered management regime.

Across the continent, in a situation that may parallel the early changes in the ground fish populations, the failure of certain Pacific salmon populations in 1994 prompted U.S. President Bill Clinton to declare parts of Oregon and Washington states major disaster areas. This failure was perceived to be the result of habitat destruction caused by hydroelectric dams. In addition, the disappearance of over one million Fraser River sockeye in the same year resulted in questions about the extent to which current management and fishing practices are protecting stocks from overharvesting.

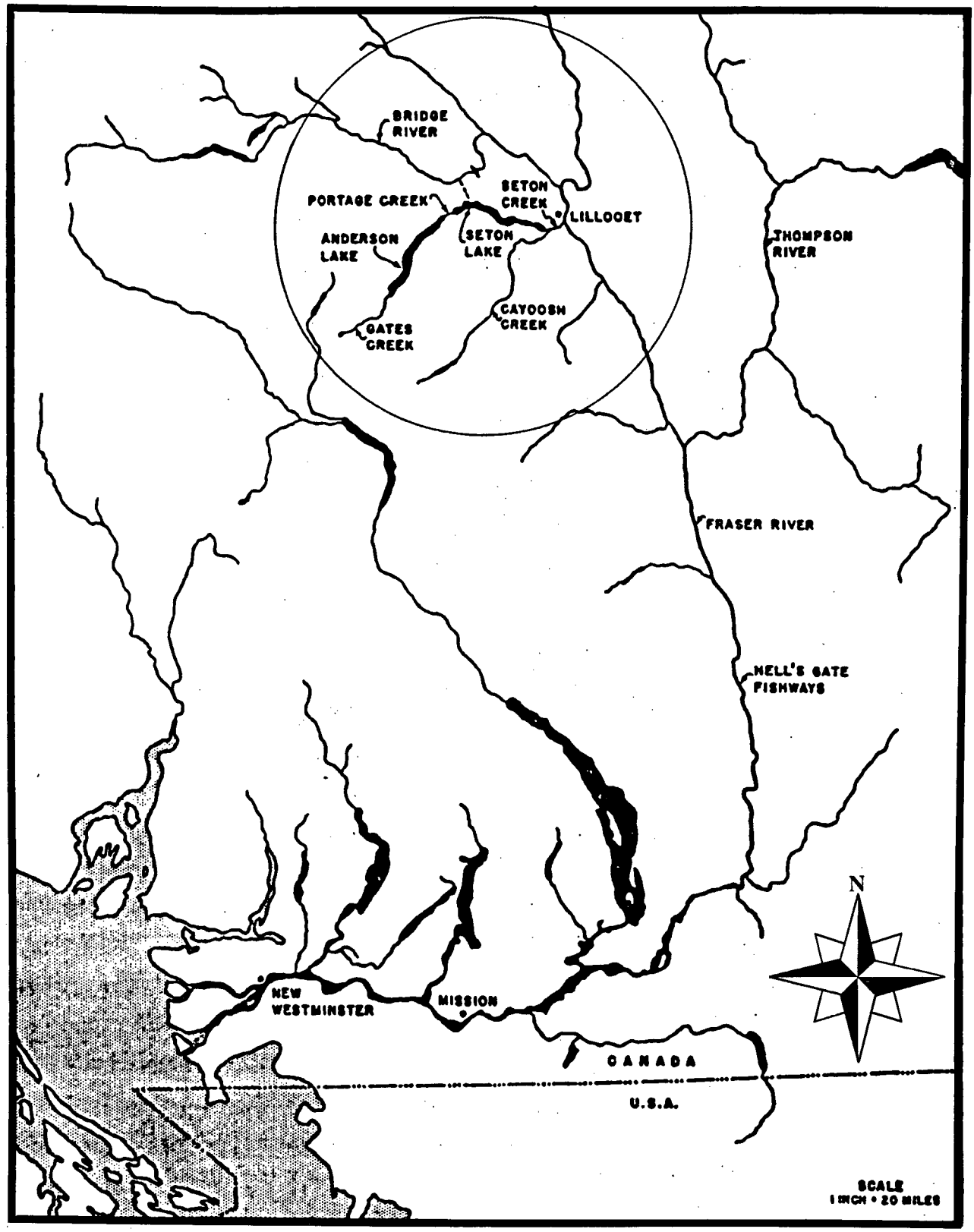

Figure 1. Map of Study Area and Major Waterways
(extracted from an untitled Lillooet Tribal Council document)

1.2.3 State Responses to Environmental Issues

A facet of the state-level response to environmental issues is the use of interest group participation processes to facilitate environmental decision-making. Even at the international level, local organizations are gaining access to policy-making processes. As an example, for the landmark 1992 United Nations Conference on Environment and Development, not only were representatives of non-governmental organizations consulted by Canada's negotiating team but, in addition, special fora were attended by non-governmental organizations world-wide.

The expansion of involvement processes for environmental decision-making is concurrent with increased demands by local communities for decision-making power over issues affecting them. Moreover, aboriginal groups have recently been more successful than in the past in using the courts to access resources and help resolve issues of aboriginal land title and jurisdiction . In response, Canadian governments recently drafted legislation under which negotiations may take place among provincial, Federal and First Nations governments.

The multitude of involvement processes in Canada has included round tables (national, provincial, and local), the Commission on Resources and the Environment in British Columbia, environmental and social impact assessments, and a host of other land use decision-making processes occurring at all levels. In the specific case of fisheries, the Federal Aboriginal Fisheries Strategy (section 1.3.4.3) was initiated in 1992. One of the goals of this strategy was to involve First Nations in fisheries co-management. Fisheries officials in Newfoundland also responded to the criticism over the North Atlantic cod failure in part by opening up their data collection processes. There, the Department of Fisheries and Oceans established a small program to include the traditional inshore fishery in information gathering, employing one biologist (Finlayson 1994).

All these processes are means to use the knowledge available to various government agencies together with other information existing outside those agencies. This is often framed as integrating or reconciling different interests, knowledge, or values. The final intent is to facilitate making difficult decisions and improve the information used for decision-making.

1.2.4 The Knowledge Dilemma

The widespread attempt to increase information used in environmental decision-making and, in particular, to involve non-governmental groups in that decision-making results in a series of dilemmas. First, participation processes generally attempt to reconcile different values pertaining to the environment. In situations involving different groups, however, those bodies may not agree on what the facts are. In particular, First Nations or local communities may have access to a different body of information which they perceive as legitimate and which is gained through local observations and local networks. Second, some information will be perceived to be more important than others and this will vary among participants. In Newfoundland, fisheries scientists stated that data from offshore fishers showed stable populations while inshore fishers maintained that the small size of fish and low catch volume indicated a population decline. Finally, participants may not agree on what constitutes valid knowledge. First Nations and local communities may develop different ideas of what constitutes a valid methodology and these may be at odds with the methods state scientists use. Each of these dilemmas revolves around the existence of an indigenous knowledge system distinct from the state-sponsored scientific system.

The potential contribution of indigenous knowledge to environmental decision-making is argued in the literature (eg. Johannes 1989, Freeman 1992, Johnson 1990, Inglis 1993). This study now addresses indigenous knowledge in the context of public decision-making. In this context, indigenous knowledge is one of the types of knowledge which generally is not brought

into decision-making whether special involvement processes exist or not. However, use of indigenous knowledge is important for bringing knowledge into the public policy process and in making the decision-making process more fair and accessible to those whom participation processes are intended to involve.

1.2.5 Interest in Indigenous Knowledge

Interest in indigenous knowledge has increased in the past decade with the depletion of many natural resource stocks under state management and the high level of concern about the environment that that depletion has generated. While western anthropologists have long been aware of "folk-practices" and "ethnoscience" in indigenous cultures (Berkes 1993), recently, international agencies (UNCED 1992, Durning 1992, WCED 1987) and regional governments (Traditional Knowledge Working Group 1991) have become interested in indigenous knowledge and resource management. The Brundtland Commission (WCED 1987) drew the world's attention to environmental problems in the mid-1980s and stated:

> Tribal and indigenous peoples'...lifestyles can offer modern societies many lessons in the management of resources in complex forest, mountain and dryland ecosystems (WCED 1987, 12).

Advocacy of use of indigenous knowledge in natural resource management comes also from researchers and practitioners in the development planning field who present a strong case for using traditional knowledge for socio-economic reasons:

> We see indigenous knowledge as complementary to conventional science, which has proved to be inadequate, on its own, to solve problems of rural development. To incorporate in development planning indigenous knowledge: is a courtesy to the people concerned; is an essential first step to successful development; emphasizes human needs and resources, rather than the material ones alone; makes possible the adaptation of technology to local needs; is the most efficient way of using western "Research and Development" in developing countries; preserves valuable local knowledge; encourages community self-diagnosis and heightens awareness; leads to a healthy local pride; can use local skills in monitoring and early warning systems; and involves the users in feedback systems, for example, on crop varieties (Brokensha et al. 1980, 8).

Thus, the call to use indigenous knowledge in resource management comes from practitioners concerned with both ecological and socioeconomic goals and from international agencies, regional governments, and academia. In addition to journal articles, academic books, and popular publications (eg. Knudtson and Suzuki 1992), several newsletters are published, including *Indigenous Knowledge and Development Monitor* (edited by Tick--see Reference section) with over 3000 recipients in 120 countries.

The potential applications of indigenous knowledge to achieve improved resource management are numerous. As a minimum, local knowledge can:

- Provide more detailed knowledge or at least different knowledge than is available through western scientific methods. While western research is more selective than indigenous knowledge in accumulation of information (Johnson 1990), indigenous science methods can produce a large amount of ecological data:

  > the folk scientist controls a larger data base [than the western scientist] in respect to two important characteristics: firstly, a long time series of observations and secondly (sic), data sets of a wide-ranging and supplementary nature that somehow have bearing on the outcome that is to be predicted (Freeman 1979, 347, quoted in Waldram 1986, 121).

- Improve legitimacy of a resource management system. If the management system is based on indigenous knowledge, that system is more likely to be acceptable to local and, in particular, First Nations users.

- Provide a framework where local participation is facilitated. When the knowledge system of traditional harvesters of a resource is used, those harvesters will be less hesitant to provide further input. Use of local knowledge can help bridge the cultural and linguistic barriers that can stop people from becoming involved in management.

- Provide baseline data or ecological history data that would be very difficult to obtain otherwise. This is particularly important for environmental assessment (eg. Nakashima 1990).

1.2.6 Indigenous Resource Management Systems

Part of the recent interest in indigenous knowledge is due to observations of indigenous resource management systems. These are local, community-based systems which carry out some of the functions of resource management including, in some cases, the ability to estimate appropriate harvest levels and restrict harvest. Such systems have persisted, in an evolving state, for centuries or millennia, yet they have only recently been documented by Western academics. Indigenous systems which have successfully used and managed natural resources for extended periods of time have the potential for expanding our understanding of the biological, economic and social problems of resource management (eg. Weinstein 1994).

1.3 The Case

1.3.1 Pacific Salmon Lifecycle

The five species of Pacific salmon (chinook or spring, *Oncorhynchus tshawytscha*; chum, *O. keta*; coho, *O. kisutch*; pink, *O. gorbuscha*; and sockeye, *O. nerka*) are characterized by having life phases in two very different environments. Eggs hatch and the young rear (for up to two years) in freshwater. Salmon then migrate to the sea, undergo the physiological changes necessary for living in a marine environment, and live most of their lives in the ocean. As the salmon approach sexual maturity, each migrates back to the precise location in which it hatched; the timing for this migration is specific to the population spawning in a location.

1.3.2 Salmon Stocks

Each population which spawns in a particular location is termed a stock and is adapted to the local environmental conditions in which it hatches, rears, and spawns. The specificity with which salmon will return to their spawning area results in reproductive isolation and maintains genetic adaptations to the local environment within the stock (Nehlsen et al. 1991). Management of stocks is a prerequisite to maintenance and restoration of genetic diversity within populations and also to the maintenance and restoration of the species in general (MacLean and Evans 1981).

1.3.3 Historic Trends in Pacific Salmon Stocks

1.3.3.1 Declining Stocks

The number of Pacific salmon stocks have decreased profoundly since 1950 (Walters 1994). Eighty percent of coho now come from approximately 20 streams (Walters and Cahoon 1985) and evidence of declining stocks is similar for chinook in the Georgia Strait (Walters 1994). Twenty to 30 percent of these small population losses are directly due to habitat damage.

1.3.3.2 Fraser River Stocks

Salmon stocks on the Fraser River were exposed to several pressures during the late nineteenth and the twentieth centuries. Dams, mining operations, and railway construction, which caused the Hell's Gate slide of 1913, severely depleted stocks by the middle of this century. In addition, harvesting regimes which attempt to target strong stocks may deplete weaker stocks migrating at the same time. In a mixed stock fishery, it is very difficult to harvest one stock. The result is that weak stocks are fished at a rate that cannot be sustained. Department of Fisheries and Oceans' studies predicted, in 1986, that, within 40 years, 35% of the current sockeye, pink, and chum stocks of the Inner South Coast (including the Fraser River) will be reduced to remnant

levels or extinction under current harvesting practices (DFO 1988). In addition, chinook stocks spawning in the lower Fraser are extremely depressed. Upper and Middle Fraser stocks are either below historic levels or rebuilding from previous lows. (In many cases trends are uncertain since trends in the data from the past four decades are complicated by the increase in counting efforts over this time period, Healey 1982). The current high catches of Fraser River sockeye are in part attributable to an increase in the carrying capacity of the north Pacific for sockeye and pink salmon since 1975 and the rebuilding of some highly productive natural populations (Walters 1994).

1.3.4 Salmon Management in the Lillooet, B.C. Region

Salmon management in the Lillooet region can be classified into three historic phases: pre-1940, 1940 to the recent past, and an emerging present system.

1.3.4.1 Pre-1940 Salmon Management System

Salmon management in the Lillooet region before 1940 was carried out as part of a self-management system. This was a partial management system which included: a system of fishing rock "ownership" with shared use within a defined group of people; a ranked system defining different levels of access to fishing rocks and trading privileges for different communities and Nations; well-defined rules of conduct at fishing stations regarding sharing of fish nets; and rules about the use and processing of fish and disposal of fish remains. In addition, there is evidence that a restricted harvest period was observed at the beginning of the season. The primary political and economic unit was the extended family, with organization at the sub-nation and Nation level (i.e. the Upper St'át'imc and the St'át'imc). These practices provided regulation of who could fish, the timing and location of harvest, and harvest allocation (management functions 2 and 3 in

section 1.1.4). Further, the institutional arrangements provided the structure which would have been necessary to protect habitat, enforce regulations, enhance the resource and plan for the long-term, and engage in broad policy decision-making (management functions 4, 5, 6, and 7). Not all of the functions of management were necessarily practiced by the Upper St'át'imc (and, in fact, not all of the functions of management may have been required during the pre-contact era).

The extent to which people observed the salmon and its habitat and then analyzed and communicated that information (the first management function) was partially determined by the lifestyle of living beside the River during the summer and intensively using resources over a larger area throughout the year. Observation was also partially determined by the fishing methods (most common were variations on bag nets and spears). Fishing with these methods was focussed on specific sites or "rocks" where observations could be made as fish were harvested a few at a time over many days and many years. Finally, the community was the basis for the collective analysis and communication of information. The description of local knowledge of salmon in Chapter 4 supports the existence of data gathering and analysis as a function of the traditional management system.

1.3.4.2 1940 to the Recent Past

The Department of Fisheries and Oceans under the Federal *Fisheries Act*, enforced Federal regulations in the Lillooet region starting in 1940. The Federal system attempted to eliminate certain aboriginal methods of fishing, including the gaff (spear) used by the Upper St'át'imc and restrict the days on which fishing was allowed. One of the most significant implications of the DFO-administered system, however, was the lack of recognition of the pre-existing system with its specific rules of access to rocks and trading rights. Fishing in the Lillooet

region was administered as part of the *Indian Food Fishery* which reduced the extensive subsistence and trading system to merely "food fishing" and, concurrently, extended (food) fishing rights to all First Nations' citizens irrespective of traditional laws regulating access to the resource.

1.3.4.3 Emerging Present System

In the late 1980s a third salmon management system began to emerge, to a large extent, as a result of the *R.* v. *Sparrow* [1990] 1 S.C.R. 1075 decision in the Supreme Court of Canada and other court decisions affirming an aboriginal right of first use of salmon. The DFO response to this was a policy change in 1992 administered through the Aboriginal Fisheries Strategy (AFS). Among the several goals of the AFS were providing economic opportunities in aboriginal communities and involving First Nations in salmon management. Agreements have been made under the AFS for local catch monitoring, for quotas for the sale of salmon, and for other projects. Yet, the outcome of the present phase of salmon management remains to be seen. It is a period in which First Nations are continuing to seek affirmation of their fishing rights, and doing so increasingly through the courts.

In the Lillooet area, the role of First Nation communities in the state recognized management system is limited. In fact, the only significant example of sharing of management is in the case of Cayoose Creek. Here, one community has assumed operation of a regionally important pink salmon spawning channel. (Continued operation of this channel is uncertain, due to budget restraints.) The existence of negotiation sessions between the St'át'imc and DFO personnel in both 1993 and 1994 suggest that opportunities still exist for greater recognition of St'át'imc fishing rights and the traditional salmon management system.

DFO and First Nations communities in B.C. are negotiating agreements to carry out several salmon management functions including negotiation of harvest allocation, enhancement, enforcement, and data gathering and analysis (i.e. catch monitoring). However, local participation in data gathering and analysis, and the potential benefits derived from that participation, fall short of what might be possible from an examination of the literature. The use of local knowledge in this case requires a greater understanding of the potential benefits of using local knowledge and the barriers to that use.

1.4 Research Questions

This study addresses the following questions:

1. What indigenous knowledge is available in this case and how does it compare to the knowledge used by the Department of Fisheries and Oceans in the study area?
    a. How were salmon managed in the pre-contact era (including access to the resource, use of political units as management units, techniques of fishing, and distribution of catch) and what were the implications of this for the collection, analysis and use of information about local salmon stocks?
    b. What are the major factual and cultural elements of indigenous knowledge today?
    c. What are the basic components of the management system administered by the Government of Canada for salmon in the study area and, in particular, how are data collected, updated, analyzed and used?
    d. What comparisons and contrasts can be made between indigenous knowledge and western scientific knowledge possessed by the Department of Fisheries and Oceans?

2. How can indigenous knowledge be used in modern salmon stock management in the study area and what are the possible benefits of that use?
   a. What evidence exists for the use, or potential for use (i.e. applicability), of indigenous knowledge by state salmon managers in the past century?
   b. How do changes in stock abundance, importance of road access, pre-emptive land use by other parties, and major projects in the local area affect the potential for use of indigenous knowledge in modern stock management?
   c. How could indigenous knowledge be used together with western scientific knowledge in this case?
   d. What barriers exist to using indigenous knowledge together with western scientific knowledge in this case and can these be addressed?

1.5 Scope

This study of present day indigenous knowledge of salmon in the Upper St'át'imc communities uses the current co-management initiatives in B.C. as a context for examining the use of local knowledge in a modern context. The study does not specifically address co-management of the salmon resources in B.C. Instead, an assumption is made that DFO initiatives are evolving and that during the coming years First Nations will continue to bring issues of aboriginal rights into legal or political fora. Thus, the present work does not address co-management arrangements between First Nations groups or the relationship between First Nation and non-First Nation fishing communities. Instead I focus on how indigenous knowledge in the specific example may be used in a context of a movement toward co-operative management activities.

The present Pacific salmon management situation is exceedingly complex, involving negotiations among multiple users and between different countries. This present research does not attempt to address the use of indigenous knowledge in all situations but, instead, focuses on its applicability to local salmon management and to habitat monitoring and assessment of stocks spawning in and migrating through the study area, in particular. Description of the western system of management of these stocks is limited to the concepts of active and passive management, gross and net escapement goals, harvest targets and stock and habitat assessment.

The Upper St'át'imc reside on the Middle Fraser and its tributaries, north and east of their neighbours, the Lower St'át'imc with whom they share the language. Culturally, geographically, and politically, however, these groups are separate. The Lower St'át'imc reside on and around the Lillooet River, which flows into tributaries of the Lower Fraser River, while the Upper St'át'imc are located on the Mid-Fraser where they experience different climate, vegetation, and topography. There are also small but significant cultural differences between the two groups. For example, the Lower St'át'imc had a social organization similar to that of the Coast Salish in the pre-contact era, while the Upper St'át'imc had the looser social organization typical of Interior groups. This difference is also reflected in the material culture: for example, the Upper St'át'imc used underground winter dwellings and the Lower St'át'imc were more likely to use an above ground winter home during the pre-contact era (Hill-Tout 1978, orig. 1904). Today, the two groups are associated with two different tribal councils (and one independent community). The Upper St'át'imc are defined here as the five First Nation communities which make up the Lillooet Tribal Council: Cayoose Creek, Lillooet, Shalath, Bridge River, and Pavillion and also the Fountain community.

This work focuses on sockeye and chinook since these two species are the most important to the people around Lillooet, historically and today.

1.6 Methodology

The above research questions are addressed through a literature review, supplemented by sample ethnographic interviews with 15 elders, 4 First Nations managers, 5 DFO personnel and one non-DFO biologist. Literature review provided a background to the cultural context and fishing system of the Upper St'át'imc. Semi-directed interviews of Upper St'át'imc elders were combined with more specific questions. The semi-directed approach involves an open style of interviewing whereby the participant is encouraged to emphasize and dwell upon those topics deemed to be important to him or her. Used effectively elsewhere in traditional knowledge research (Nakashima 1990; Nakashima and Murray 1988; Johnson and Ruttan 1990), this method was found to be appropriate because depending on the interviewee's level of comfort with a researcher and his/her response to different types of questions, the length of interview, style of questions, topics, and use of recording equipment could be altered. Interview questions and names of St'át'imc elders consulted for this study are provided in Appendices I and II.

Permission to begin research was given in the summer of 1993 by the Lillooet Tribal Council. I conducted interviews that summer and fall and again in the Spring of 1994. The Tribal Council, through the Upper St'át'imc Language and Culture Authority reviewed the work to ensure the quality of research and comment on the interpretations.

Before beginning the research, Mike Leach, Tribal Chief of the Lillooet Native community suggested that I do "a sweat". A sweat is a traditional sacred practice which involves, in part, sitting in a circle in a small lodge, formerly made of branches and mud, around a pit into which

glowing hot rocks are placed. Tobacco, dried sagebrush, and water dropped on the rocks produces abundant steam and smoke which contributes, at least, to the physical sense of the term "sweat". This was recommended in order to purify myself. I was able to participate in a sweat twice. For me, this was both an honour and a challenge.

I contacted each of the Chiefs of the six communities to inform them of the research, to request permission to proceed in their communities and to obtain names of elders who might be especially qualified and interested in the study. I obtained names of others through participants and through friends and acquaintances in the area. This resulted in "snowball" sampling in which individuals were "gathered" along the way. The selection was not representative (specialized knowledge does not need to be), except that an effort was made to involve members of each community and to interview both men and women.

I introduced myself in person to each elder, sometimes accompanied by a friend or, in one case, the community's chief. In each case, I discussed who I was, what the research was about, and where the materials would go. I let them know that the materials would be left with the Tribal Council and that myself and the Tribal Council would be co-owners of the information. In most cases, I asked permission to tape the interview. In some cases, however, the participant seemed uncomfortable and I chose not to do any taping. Instead I took notes during and after the discussion. In addition to six individual interviews, a meeting was held with 13 elders from five of the communities and three individuals from the Tribal Council. This interview was tape recorded. Notes were taken during interviews with four young First Nations individuals (chiefs or others with fisheries management responsibility).

The western fisheries management system was researched through the literature and by telephone and in-person interviews with DFO personnel.

As I was finishing my interviewing sessions I heard Harold Cardinal speak about people doing research with Aboriginal people in Canada. He said that when his people want to work in the "white world", they must train to learn the language and required conduct. "Why then should researchers not train to work in our communities?" he asked. I had tried to approach this work in this way within the short time frame available. Unfortunately, I was unable to learn more than a few words of barely recognizable St'át'imcets. I had, however, tried to remain open to the way of interacting, understanding, and learning of the people in the communities.

1.7 Organization

The theory, case background, and results and conclusions of this study comprise four chapters. Chapter 2 addresses theoretical aspects of indigenous and western scientific knowledge including the concept of common pool resources, and a sociological perspective on western science. The next chapter describes the traditional salmon management system of the Upper St'át'imc, and the management system administered by the Federal Government through the Department of Fisheries and Oceans. The past use and potential use of indigenous knowledge and the types of indigenous knowledge found in this case are described in Chapter 4. Finally, Chapter 5 concludes the study with an examination of barriers to using indigenous knowledge in this case and recommendations for the use of indigenous knowledge.

2. INDIGENOUS AND WESTERN SCIENTIFIC KNOWLEDGE

This chapter discusses the differences between western scientific and indigenous knowledge based on review of the literature. The first section is a theoretical context for the discussion of indigenous knowledge and includes a definition of common pool resources and identification of the four regimes under which they are managed. The second section briefly recognizes one of the standard approaches to differences between western scientific and indigenous knowledge. An alternative approach is based on recent work within sociology and other social sciences. This latter section attempts to establish a basis for the comparison of indigenous and western scientific knowledge.

2.1 Common Pool Resources

2.1.1 Definition of Common Pool Resources

All common pool resources (CPRs[1]) share the characteristics that 1) the cost of excluding potential users from accessing the resource is high and 2) use of the resource by one user subtracts from the amount available to other users (Feeny et al. 1990). While these concepts are frequently applied to water, fish, wildlife, forests, and grazing lands, the above definition would also include parks, highways, oil pools (Oakerson 1986), bridges, parking garages and mainframe computer systems (Ostrom 1992) as CPRs, since they share the characteristics of "excludability" and "subtractability".

[1] Common pool resources (eg. Ostrum 1986, 1992) are also referred to as common property resources. 'Property', however, refers to a social relationship between a thing and a user or group of users that provides rights of use to that thing. Despite this definition, "common property" is frequently used in cases where there are no rights of use to the thing and, in particular, the term is used to emphasize the absence of specific rights limiting users. This sense of the term, in which common property belongs to everyone, cannot be defined as property.

The concept of common pool resources (without the precise definition and terminology) has been a dominant component of resource management since Hardin described "The Tragedy of the Commons" in 1968. Hardin used a thought experiment to characterize the tragedy of the commons paradigm: imagine a commons in England used for grazing sheep. Each herder will add a sheep to the commons as long as the benefit derived from that addition (i.e. another sheep) is greater than the costs (i.e. slightly less grass for the sheep herder's other sheep). Hardin correctly perceived the problem of resources which can be appropriated by individuals to the detriment of the collective.

The terms 'commons' and 'common property' are used to refer alternately to a collectively owned resource or a resource owned by no-one. Hardin himself assumes that common property is open-access, whereas Ciriacy-Wantrup and Bishop (1975) note that 'property' implies the exclusion of some potential users of the resource. The recent trend (eg. Berkes 1989b, National Research Council 1986) is towards using "common property" to refer to the resource, defined in terms of excludability and subtractability and to use more precise terminology to refer to different regimes for governing the use of such resources. Ostrom (1990, 1992) proposes the term common pool resources, in order to avoid the use of the word *property* in situations where the resource is not owned by anyone.

2.1.2 Types of Property-Rights Regimes

Common pool resources are held in one of four basic property-rights regimes: open access, private property, state property, and communal property (Ciriacy-Wantrup and Bishop 1975)[2].

Open access places no restrictions in defining the user group and how the common pool resource must be used. This is the type of arrangement usually associated with the "Tragedy of the Commons" as described by Hardin.

Private property assigns exclusive use of certain rights to a resource to an individual or a corporation.

State property is a type of tenure in which the state retains ownership of a resource and provides rights to use a resource and regulations for that use.

Communal property is held by a group of people who hold certain exclusive rights to a resource. The group regulates membership, often on the basis of residency or a reciprocal access agreement and regulates the use of the resource.

2.1.3 Communal Management (Self-Management)

The argument that human societies are incapable or unlikely to cooperate to conserve resources is made by Hardin and others. This idea is also promoted by scholars who find evidence for destructive hunting practices resulting in mass extinction of game animals in pre-history (Ponting 1991). The fact that no anthropological evidence exists to support this view suggests that the mass faunal extinctions have a more complex cause than simply pre-historic predation

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[2] McKean (1992) distinguishes between state property that is used exclusively by state organizations (eg. a public works yard) and that which is used by the public (eg. highways, parks). She also distinguishes between private property owned by a single individual, private property owned by more than one person and communally owned property. She thus defines six different types of property ownership.

(Butzer 1971). The additional evidence that, more recently, indigenous groups have harvested resources at constant levels and with more efficient technology than their ancestors, supports the view that these mass extinctions had multiple causes and were not necessarily the result of human activity alone.

In contrast to the perspective of Hardin and others, small scale societies which are in a position to observe key parts of the lifecycle and have experienced the effects of a potentially unsustainable harvesting technology on a species are likely to develop practices which conserve an essential species (Pinkerton 1994). These practices are frequently reinforced by social and cultural institutions and/or philosophical systems.

The management of common pool resources in community-based management regimes is an alternative to state and private property regimes that is based on community-level institutions. Communal (or self-) management systems are:

> local or regional systems for regulating the use of wildlife and/or for managing the wildlife themselves, which originate and are legitimated and practiced by local or regional societies, or groups of users (Feit 1988).

Many different types of communal management systems have been described, including those for irrigation systems (Cruz 1989), pasture, fishing, farming (Moorehead 1989), forests (McKean 1986), hunting territories (Berkes 1989b), and others. These systems have been documented for most regions of the world in both non-industrialized and industrialized countries, such as Japan (eg. Ruddle 1989) and Canada (eg. Berkes 1989b).

2.1.4 Local-State Co-Management

Co-operative management, or co-management (Berkes et al. 1991, Pinkerton 1989) is the sharing of responsibility for one or more management functions by different groups, such as by a state agency and a local user group. Local-state co-operative management has developed, on the

one hand, out of an awareness of the considerable knowledge and skills within self-management systems (eg. Fleming 1990) and, on the other hand, from an attempt to address the assertion of local rights to traditional use of a resource and traditional harvest practices. This option indicates that, under some circumstances, successful management regimes can develop that include a management role for both state agencies and local resource users. Co-management agreements can "promote conservation and enhancement of fish stocks, ... improve the quality of data and data analysis, ... reduce excessive investments by fishermen in competitive gear, ... make allocation of fishing opportunities more equitable, ... promote community economic development, and ... reduce conflict between government and fishermen, and conflict among fishermen's groups" (Pinkerton 1989, 4).

2.2 Western Scientific and Indigenous Knowledge

2.2.1 What Is Science?

Several disciplines and schools characterize the norms or methods which distinguish science from other intellectual activities and have done so in many volumes. This section *briefly* describes some examples of characterizations of science and the problems in doing so. The present purpose is not to detail alternative theories but to demonstrate that different ones exist and that characterizing science is often problematic. Table 2.1, below, describes three examples of these characterizations and demonstrates the variety of approaches to the problem, "what is science".

Table 2.1 Some Examples of Characterizations of Science (Norms or Methods)

Source	Defining Characteristic(s) of Science	Comment
Scientific Method Approach (Introductory science textbooks)	Scientific method exists consisting of observation, hypothesis formation and hypothesis testing by comparison of hypotheses with "real world". Science is rational, objective, and logical, leading to its inherent legitimacy.	No one scientific method exists. Impossible to compare hypotheses with the "real world".
Norms of Scientific Activity (Early Sociological Approach, Merton 1942; see also Zuckerman 1988)	Two types of norms exist to guide scientific activity: technical and moral. Technical norms include adequate and reliable empirical evidence and logical consistency. The original four moral norms are universalism (existence of preestablished impersonal criteria), communism (or communalism refers to the sharing of knowledge within the scientific community), disinterestedness (elimination of personal bias), and organized skepticism (suspension of judgment until the necessary evidence is available).	Norms, such as logic, tend to be universal to all types of intellectual pursuit (Boulding 1980). No societies themselves subscribe to illogical activity. Many authors argue that norms like universalism (Collins 1982), communism (Salter 1988), and others are not followed in all cases of scientific investigation. They do, however, exist as norms, even though they may be nearly impossible to maintain.
Popper's Requirement of Falsifiability (Popper 1968; see also Miller 1985)	Error is inherent in intellectual activity and, thus, scientific statements must be open to criticism (falsification) by empirical evidence. If a statement *can* conflict with facts, it is scientific. Facts reside in a separate world from both physical reality and our minds.	Facts can be relative; even observed phenomena can be interpreted differently (Kuhn 1992). Criteria for falsifiability are changeable. Facts are often disputed. Even in physics, the paragon of rational, objective science, the subject-object duality can no longer be maintained in some situations (Capra 1982).

Science holds a lot of power in western society and the international arena. What do we mean by *science*? Despite the common term "the scientific method", no universal scientific method exists which distinguishes science from non-science. Instead, different disciplines within science use different methods (Boulding 1980). Further, those methods will include analytical components, such as the use of logic, as well as interactive components such as peer review. (These are related to Merton's technical and moral norms respectively). Finally, science can be characterized either in terms of its operation in scientific settings or in terms of how it is depicted in social contexts. Within social contexts, science may be presented in an ideal form. This ideal

may be secondary to its actual operation; however, the existence of the ideal has implications for the production and use of scientific knowledge.

These technical difficulties are in addition to a critique of some of the core concepts frequently associated with science. Those concepts include objectivity, the comparison of hypotheses with the real world, use of logic, and others. This critique emerged and continues to do so primarily from recent studies in sociology but also from philosophy, history, and other disciplines. The scope of this study does not allow a detailed examination of the critique of science and its popular conception put forth in the social sciences. However, this literature provides six important aspects of science relevant to the present discussion. These are described below.

2.2.1.1 The Perception of Truth

Scientific endeavour is an incremental process, driven from behind "rather than pulled toward some fixed goal [of *truth*]to which it grows ever closer" (Kuhn 1992, 14). Science is poorly characterized as a persistent plod from observation and experimentation via deduction or induction towards truth. It proceeds not through the detection of "right" hypotheses, but by the perception of those that are "better" than previous ones. In addition, the comparison of a hypothesis with the real world through observation is a key element in "the scientific method". However, supposedly solid observations can be pliable and vary in small, but crucial, ways depending on the observer (Kuhn 1992). Finally, the attributes of science, such as logic, falsifiability, and rationality are problematic. No other intellectual pursuits would attribute "illogic", "irrationality" or the complete absence of *criteria* of falsifiability to their fields.

2.2.1.2 Use of Criteria

Science proceeds by the application of criteria, such as accuracy, consistency, breadth of applicability, and simplicity in choosing between hypothesis (Kuhn 1992). However, the criteria themselves and how they are used can vary between individuals, scientific communities, and disciplines.

2.2.1.3 Social Context

The definition of science and the distinction of good science from bad science is not a matter of application of objective criteria. These activities occur in social settings, such as conferences, editorial boards, universities, etc. and using criteria such as those in section 2.2.1.2 above (Jasanoff 1990). At times, other criteria come into use in judging scientific work, such as, reputation of the researcher, the size of their laboratory, university of origin, etc. (Collins 1982). Direction of scientific inquiry are not necessarily guided by utility or scientific interest, but may be shaped by whether the scientific question is likely to be easily answered (Kuhn 1972) or even whether it might be considered part of a trend. For example, one physicist remarked:

> I don't know how it is, but fashions appear in physics.... Very often 'big shots' endorse a theory. Two or more of them will do so at a conference. Then an impression is generated by them that something has been achieved. Even at the conference, speakers begin to defer to this. Then they return and report on the new idea. And then a huge number of papers appears on this. Then it lives for a while until a new fad begins and the old one dies out. (Quoted in Dolby 1977, 18)

The process whereby legitimacy of science in general is determined is also a social process. Scientists delineate their activity from other intellectual pursuits not only to provide guidance for themselves and their fellow scientists, but also to pursue professional goals (Gieryn 1983). This 'boundary work' clarifies the relationship of science to other activities and aids in the "acquisition of intellectual authority and protection of the autonomy of scientific research from

political interference" (Gieryn 1983, 781). In summary, groups of scientists interact socially in ways which are not obvious by observation of the individual scientist.

2.2.1.4 Relationship with Technology

A common perception exists that science drives technological development. Two qualifications of this view are necessary. The relationship between science and technology did not always exist and was not present during the early part of the expansion of western scientific activity, in the 17th century. In fact, the impact of science on technology was minor before about 1860. The industrial revolution in England was not the result of improved science, but largely a "continuation of the long improvement in folk technology in Europe which began after the fall of Rome. The steam engine, for instance, owed nothing to thermodynamics. Thermodynamics owed a great deal to the steam engine." (Boulding 1980, 835). Thus, technology is not necessarily dependent on science. Furthermore, today scientific activity relies heavily on technology and, frequently, certain types of research are suddenly worthwhile because of changes in technology.

2.2.1.5 Quantification and Replication

The success of physics during the past three centuries in developing a large amount of information has produced the indicative phrase, "physics envy", which is applied to practitioners in other fields and the social sciences in particular. An outcome has been the use of methods requiring quantification and replication. Physics methods are often carried over into over fields where they may not be as useful. For example, Boulding (1980) remarks that in cases where extreme data points are highly significant, the experimental method may be of limited value and indeed be quite inappropriate. Further, "one of the unfortunate effects of ... correlational statistics

has been to divert attention from extreme cases, which are simply rejected as deviations, whereas they may contain important knowledge about extreme positions of the field" (Boulding 1980, 835).

2.2.1.6 Science and Public Policy-Making

Science tends to be associated with truth, whereas other information is often categorized as either values or "political considerations". Science and public policy have a significant relationship, not only because of the status accorded science, but also because science performed as part of decision-making is shaped by that process. Salter (1988) identifies four features of "mandated science", or science used in public policy formation:

i) The expectations of mandated science are idealized. It is expected to be intelligible to a non-scientific audience, it must be value-free, invariably credible, and public (open to debate, peer reviewed, etc.). However, in practice these features rarely apply to mandated science.

ii) Mandated science is imbued with legal considerations. The norms and conventions of mandated science are influenced by both scientific and legal requirements and are not identical to either one.

iii) Uncertainty and judgment-calls are not common in mandated science. Mandated science is required to produce "bottom-line", definitive results.

iv) Scientists are requested to translate science into recommendations for policy and are, thus, often required to deal with moral questions. These recommendations have a significant socio-political impact.

2.2.2 Indigenous Knowledge and Western Scientific Knowledge

Conventional anthropological approaches to indigenous knowledge include summaries of the contrasts between indigenous knowledge and western scientific knowledge. Lists of contrasting characteristics can be drawn from these (Johnson 1990; Wolfe et al. 1991 and Dewalt 1994 contain similar lists; note that these authors write specifically about traditional ecological knowledge in indigenous communities).

Table 2.2 Depictions of Indigenous and Western Scientific Knowledge (Johnson 1990)

Indigenous Knowledge	Western Scientific Knowledge
1. oral tradition used	1. written word used
2. learned through observation and hands-on experience	2. taught and learned in an abstracted context
3. all parts of the natural world have life force	3. animate and inanimate objects are completely distinct
4. all life-forms are interdependent and have kinship relationships	4. western science operates in a cultural context where humans can legitimately exploit other life-forms
5. holistic	5. reductionist
6. intuitive thought emphasizes emotional involvement and subjective certainty of understanding	6. analytical thought emphasizes abstract reasoning and the need to separate oneself from that being observed; replicability emphasized
7. qualitative, based on trends and behavioural observations	7. quantitative, with emphasis on mathematical models
8. data generated by resource users tends to be inclusive	8. data generated by researchers is more selective and deliberate
9. long time series of information on one locality	9. short time series over a large area
10. social context is relations based on reciprocity and obligations toward both community members and other life-forms	10. managers are distinct from harvesters, authority is centralized, and institutional arrangements require that the environment is managed in "discrete" components
11. explanations based on cumulative, collective experience, checked, validated, and revised daily and seasonally	11. hypotheses are generated, tested, and verified

The approach typified by Table 2.2 emphasizes the ideological differences between western scientific and indigenous knowledge evident in their world-view and explanatory mechanisms. This characterization is correct to point out that indigenous knowledge has counterparts to important components of western knowledge systems. For example, the west has writing, small-scale societies have oral literature, and so on. However, this approach does not emphasize the difference between the *operation* of science (in choosing possible explanations, analyzing, conducting peer review, etc.) and the *representation* of science in a social context (as objective, analytical, and in contrast to indigenous knowledge). Further, this approach does not recognize the contribution of the philosophy of knowledge which suggests that similarities exist among different intellectual pursuits.

The table below compares and contrasts the two knowledge systems using the methodological, philosophical, and social considerations covered in section 2.2.1. The first five items refer to the operation of science and the last feature refers to the representation of western science and indigenous knowledge in the public policy process.

Table 2.3 Comparison and Contrast of Indigenous and Western Scientific Knowledge

Characteristic	Western scientific knowledge	Indigenous knowledge
Hypothesis "testing"	Knowledge develops as an incremental process involving choosing between hypotheses, not a detection of "correct" hypotheses (Kuhn 1972, 1992).	Evidence exists that indigenous people use observation together with trial and error to develop knowledge over many years (Dewalt 1994). Knowledge is passed down and stored in oral form. The trial and error approach is parallel to the concept developed by Kuhn (1992) of examining alternate hypotheses to determine which best meets criteria such as how it fits observations and is consistent with other theory.

Table 2.3 cont'd

Modes of operation and communication	Criteria aid in judging hypotheses based on observation. These criteria are flexible and may vary. Written mode of communication.	The folk scientist will also need to establish some criteria, which "make sense", to compare different hypotheses. Logic, applied to observations, is a universal component of human inquiry and not the sole domain of western science (Boulding 1980). Oral mode of communication.
Social dynamics	Science judged and defined in a social setting (eg. conferences, peer review, informal exchanges, etc.). These social settings review information, acting as a "gatekeeper" and influence the content.	Indigenous knowledge judged and defined in a social setting (eg. meetings, discussions during harvesting activities, and informal settings). These social settings provide a review of information and also influence content.
Role of technology	Western technology and western science closely related. Execution of western science is dependent on and shaped by available technology. Technology is general (in that innovations are general enough to be applied to multiple situations).	Indigenous knowledge is dependent on and shaped by local technology. Technology is specific and may allow people access to specific data.
Experimentation and quantification	The influence of physics and statistics is evident in the emphasis on experimentation and quantification of data for statistical analysis. Not all disciplines, however, follow the physical model closely and ecologists, in particular, find replication difficult to achieve. Science tends to be reductionist.	Not directly affected by physics and statistics. Observation of behavioural and other phenomena and detection of long-term trends are common. Examples of use of quantification in indigenous knowledge systems exist (Feit 1988). Tends not to be reductionist. Ultimate explanations are often spiritual.
Use in public policy	Science used extensively in public policy formation. Science is distinguished from indigenous knowledge by both scientists and public policy makers.	Indigenous knowledge becomes "values" in the policy formation process. Occasionally, indigenous knowledge intrudes on the policy process and is perceived as contributing knowledge, not values, through confrontation (Freeman 1989) or advocacy. Local knowledge does not have access to the mechanisms which allow science to build and maintain its legitimacy. These mechanisms are: acceptable language, government funding for institutions, schools, conferences, academic credentials, and journals and other publications.

Table 2.3 is significantly different from Table 2.2 because of two concepts. First, science as an operation is distinguished from science as popularly constructed in Table 2.3. This results in clearer understandings of the roles of science and indigenous knowledge in public

decision-making and also of the difference between the two knowledge systems. Second, operation of indigenous knowledge is considered from the perspective of philosophy of knowledge and from assumptions based on actual examples of knowledge. Thus, Table 2.3 tends to emphasize the similarities among knowledge systems rather than differences based on cultural factors.

3. CASE DESCRIPTION

3.1 Salmon in the Lillooet Area

3.1.1 Spawning Areas

Farwell et al. (1987) indicate two main salmon producing areas in the study area: the Seton River system and the Bridge River system.

Table 3.1 Salmon Escapements to Streams in the Study Area, average 1981-85 *

	Seton River System					Bridge River System	
	Seton Channel (Lower)	Seton Channel (Upper)	Seton River	Cayoose Creek	Portage Creek	Bridge River	Yalakom River
Chinook			75	137		446	47
Coho			142	35	165	383	30
Pink	32 899	8 193	351 537	21 683	11 017	49 201	
Sockeye	50				8 369	1 005	1 200

* extracted from Farwell et al (1987)

3.1.2 Migrating Salmon Stocks

Six major sockeye runs migrate through the study area: Early Stuart, Early Summer, Quesnel, Chilko, Late Stuart and Stellako. Chinook runs are divided into overlapping Spring and Summer runs which include escapements to the Quesnel, Chilcotin, Chilko, Westroad, Cottonwood, Stuart, Bowron, Holmes, Swift, Slim, and Upper Fraser Rivers. In addition, numerous smaller runs of sockeye and chinook and very few coho and pink salmon migrate up the Fraser River past Lillooet.

Table 3.2 Numbers of Sockeye Spawning past the Bridge River System, ave. 1981-85 *

Early Stuart	87542
Early Summer	
Bowron River	5225
Early Nadina River	746
Late Nadina River	1286
Chilko Lake South	39257
Taseko Lake	2201
Quesnel	429219
Chilko	229754
Late Stuart	108915
Stellako	63293

* extracted from Farwell et al (1987); numbers are approximate

Table 3.3 Numbers of Chinook Spawning past the Bridge River System, ave. 1981-85 *

Quesnel	1420
Chilcotin	920
Chilko	4720
Westroad	3150
Cottonwood	785
Stuart	943
Bowron	3777
Holmes	1310
Swift	794
Slim	2387
Upper Fraser	3953

* extracted from Farwell et al (1987); numbers are approximate

3.1.3 Hydroelectric and Other Development in the Study Area

Hydroelectric development has had a major economic and environmental impact in the study area. In 1948, the LaJoie Dam was built by the British Columbia Electric Company. It was redeveloped in 1957 and B.C. Hydro is currently reviewing the feasibility of additional development. The Dam is located 90 km above the confluence of the Bridge and Fraser Rivers and is 87 m high and 1000 m long. Downton Lake behind the Dam has an approximate surface area of 2400 ha. Between 1946 and 1948, BCE constructed the Mission dam, approximately 15 km upstream of the Bridge River and Yalakom River confluence which partially diverted the

upper Bridge River into Shalath Powerhouse No. 1 at Seton Lake. The Terzaghi Dam was constructed in 1960 at the site of the Mission Dam. The Terzaghi Dam is 54 m high and 360 m long with a gated spillway and completely diverts the upper Bridge River through two 5 km tunnels to Seton Lake. The reservoir behind the Dam, Carpenter Lake, is approximately 4900 ha. A low dam at the end of Seton Lake with a fish ladder allows water from Seton Lake to be transferred, via canal, to the third generating station on the Fraser River (please see figure 2).

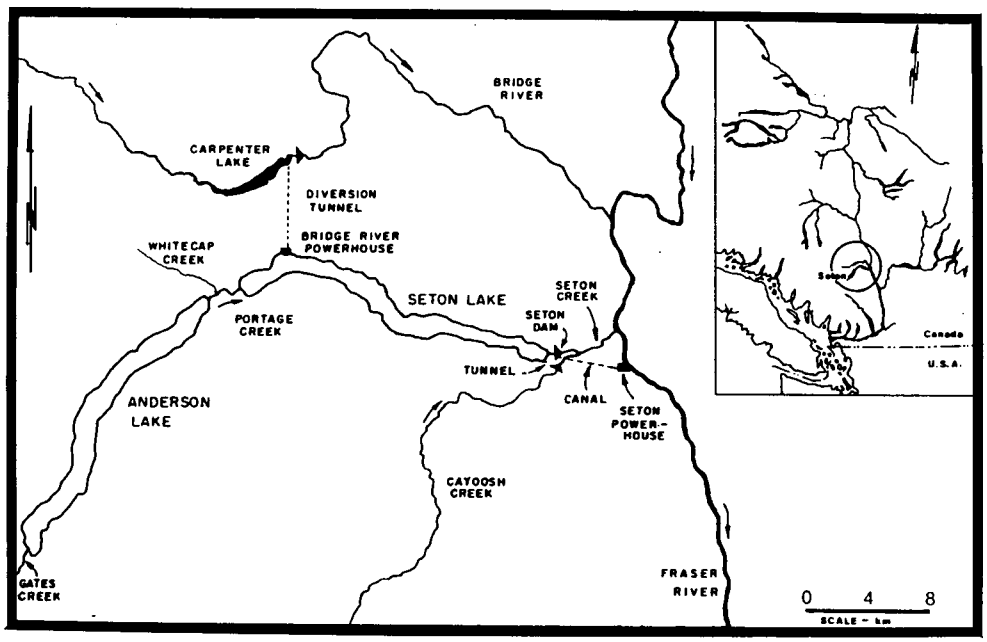

Figure 2. Map Showing Location of Hydroelectric Projects in Study Area (extracted from Fretwell 1989, figure 1)

The Terzaghi Dam does not release water except during flood events. This occurred every 3.5 years, on average, during the period 1960-1991. In 1991 and 1992, release of water washed out salmon habitat on the Bridge River downstream of the Dam. DFO pressed charges and the first case is expected to go to court soon.

Seton River has also lost gravel, due to water release at the Seton Dam (Hebert 1994 pers. comm.). Cayoose Creek was impacted by the construction of a small temporary dam necessary to reroute spawning salmon into Seton Lake and away from the hydro installation. The dam frequently blows out, causing the scarification and cementing over of gravel downstream of the dam.

Hydroelectric activity was not the first impact on salmon in the study area in the post-contact era. Placer mining during the first part of this century also impacted salmon populations on the upper Bridge River. Cayoose Creek was dynamited to lower its water level and hydraulic mining and dredging was carried out (Drake-Terry 1989). Water was diverted by flumes for mining purposes. All of these activities impacted salmon, yet the effects are even less well-documented than those of the hydroelectric projects.

3.2 Traditional St'át'imc Management Before 1940

3.2.1 Social Units

The basic political unit of the St'át'imc in pre-contact times was the clan, comprised of more than one family:

> ...before the priests came, these people have clans like, families, but it seems to me that there's always more than one or two families in the clan. They always say, 'We have a chief. He's the head.' He tells them when to get ready to go and fish, when to get ready and go and hunt. He leads his people to everything they do to make their living.... (The late Sam Mitchell, quoted in Romanoff 1992, 224)

Hunting sites, root-gathering spots, trails, and berry patches were the property of the Nation. Berry patches were under the supervision of the clan chiefs, who regulated the timing of berry-picking. Traps and snares were private property, as were the game they caught (Teit 1906). Hunting parties, however, divided equally the game that was shot (Teit 1906).

One interviewee reported that during pre-contact times the fishing season was regulated by an elder:

> JS: What had happened a long time ago, was, there was an old man he sat around the mouth of the Bridge River at the confluence of the Bridge River and the Fraser. He sat there for a day and a quarter, day and a half. And people waited, waited until he made a signal. And he sat there and he seems to know how many fish have gone by. And then at that time he'd call the fishermen over, then they'd all go fishing.

This is consistent with the use of chiefs in regulating other subsistence activities. However, whether all sites were regulated or just the (mostly publicly available) sites near the mouth of the Bridge River were regulated in this way is uncertain.

Teit (1906, 252) writes that "at one time each village community consisted of a single clan", descended from a common ancestor. However, during Teit's work among the St'át'imc, he noted that a large community consisted of two or more clans, each descended from different ancestors and represented by one head chief. Each of the Upper and Lower St'át'imc also had a political head, an influential local chief whose responsibility it was to represent the group as a whole and look after its interests (Hill-Tout 1978, orig. 1904). These chiefs had no authority over the local affairs of the other villages. Intermarriage was important for making and maintaining ties among nations, and was ensured by prohibitions on marrying close cousins (Romanoff 1992, Hill-Tout 1978, orig. 1904).

3.2.2 Fishing Methods

Salmon fishing by the St'át'imc in the pre-contact era was most often with a "bag net", used on the mainstem of the Fraser River between Lillooet and Fountain (Teit 1906). The set-net was one of two types of bag nets and consisted of a long pole, of fir or cedar, attached to a large hoop, of the same material. Small horn rings were hung from the hoop and, attached to them, was the mouth of a bag net. A string attached to a point on the mouth of the bag near the pole

was used to hold the bag open. To fish, the net was placed in a back eddy of the river and when a salmon swam into the net, the string was released, the net was allowed to close and fall to the end of the hoop, and the pole was quickly raised out of the water.

A simpler version of the bag-net is the dip net, in which the net is attached directly to a hoop. The fisher scoops the net into the back eddy where fish rest as they move through the rapids. Teit (1906) also records the use of single, double and triple-pronged spears (or harpoon, gaff-hook, and leister--Kennedy and Bouchard 1992) in fishing. Basketry traps were used for sockeye smolts and spawning trout near the outlets of lakes. Elder Louie Bob describes a method used by older women: a rock enclosure was built beside the river where the river waters would splash into, occasionally leaving a salmon stranded. These could then be easily removed.

Teit (1906) also describes a basket trap used along the banks of swift flowing rivers and kept in place with poles. Fish enter the trap and pass out through the end into a small corral made of sticks and brush and are then speared. Fishers also used line and baited hooks (Teit 1906). These last two devices are not mentioned in recent studies (Kennedy and Bouchard 1992), or by the St'át'imc participants in the present study and it is uncertain whether the basket trap used along a river bank or the hook and line methods refer specifically to the Lower St'át'imc or are methods that are not recalled by fishers and elders today.

Fishing platforms were commonly used, with the dip net or set net, for spring salmon fishing. These platforms were constructed over rapid water and were built and owned by an individual. Rules for sharing, however, allowed them to be used by others. Platforms are no longer used by the St'át'imc today because of the shift from spring to sockeye salmon as the species that makes up the most part of the catch (Kennedy and Bouchard 1992, Romanoff 1992).

3.2.3 Fishing Rocks

3.2.3.1 Access to Fishing Rocks

Fishing rocks are the specific sites where either platforms are built or people are able to fish directly from the edge of the river. In the pre-contact era, different rocks were accessible to different individuals or groups (Romanoff 1992). Individually-owned rocks were passed down from an individual to his/her son, daughter or other relative. The owner was not the exclusive user of the rock, but did most of the fishing at that site (Romanoff 1992) and was responsible for maintaining the platform. Access to that rock was by invitation or by request and was guided by a rule of obligatory sharing. This system is still in place to the extent that people recognize that some rocks are owned.

"Residence-group-associated sites" are sites associated with a particular village and were identified as a class of sites by Romanoff (1992). The nature of the rights associated with these sites is, however, unclear. In addition, residence-group-associated sites may be the result of the Federal Government's attempts in the late 19th century to determine fishing sites along the river for each band in the area. Encouragement by missionaries to farm and other developments may also have influenced residence-groups to claim their own fishing grounds. (Romanoff 1992)

Public-access sites were located on both sides of the Fraser River at six-mile and Bridge River rapids and were accessible to the entire Nation. Arrangements with some neighbouring groups also allowed access to public fishing rocks in exchange for access by St'át'imc groups to neighbouring resources. Another opinion, however, states that "shared access was a localized phenomenon, based on kin and other immediate ties" and that it was not an established pattern for

regional interrelationships (Canon unpubl., 21). The six-mile and Bridge River rapids sites are the most productive sites today and probably were similarly productive in the pre-contact era.

3.2.3.2 Specificity of Technology

Fishing rocks not only differed based on access rules, but also on the species of salmon which could be caught using that rock and the time of the year in which the site could be used. These factors are related to access to particular areas where fish migrated and the height of the water. (Romanoff 1992, Bouchard and Kennedy 1992). This is discussed further in section 4.2.1.4.

Specific stocks or groups of stocks had names which related to their timing or use. In addition, traditional methods *could* have allowed for some selection based on size, species, sex or stock, if identification methods were available. The only example of active selection of individual salmon in this study was, ironically, the preference for salmon which were tagged by DFO. These fish were taken with a gaff and the tag was returned for 25 cents, 50 cents or a dollar (Bill Edwards). (Bobo Jack reports that people put females back in the river during the pre-contact era. Bob Louie, however, states that it is difficult to differentiate males from females.) Selection would have been possible with the dip net, set net, the method that Bob Louie reported elders used, and the gaff and other spear-like technologies to a lesser extent. (The gaff hook can only be selective where the fish is visible before it is speared.) Public rocks were used during the large sockeye salmon harvest in late July and in August. At these times fish could be caught faster than they could be cut and hung to dry and the requirement of preservation placed a limit on the number of salmon caught. However, some families had access to rocks which made smaller runs of salmon, and spring salmon in particular, available throughout the season.

3.2.4 Economic Importance of Fishing

Teit (1906) describes salmon-fishing as the most important industry of the St'át'imc. Not only was salmon an essential food item but it was also a source of oil and material during the pre-contact era (eg. some poor people wore salmon-skin shoes). A large amount of salmon was traded, particularly at the mouth of the Bridge River where many communities and several nations would visit during the summer sockeye runs. Neighbouring communities caught their own salmon under reciprocal access agreements but dried salmon and salmon oil were traded, with the Shuswap and the Thompson for example, for skins, hemp-bark, horses and other commodities. (Teit 1906)

3.2.5 Other Cultural Aspects of Fishing

Fishing was a large component of the seasonal routine in the pre-contact era which also included blocks of time for berry-picking and hunting. Families spent several weeks camped by the river catching and drying salmon. Evenings were spent listening to elders share stories; the stories comprised an oral literature in the St'át'imc culture. Camping at the river and fishing intensively allowed for the communication of cultural concepts and for the sharing and development of information about stocks. Fishing was hard work but it was also a very social activity which included trading, story-telling, and playing games.

3.2.6 Opportunities and Incentives for Observation of Salmon

Fishing and other subsistence activities provided an opportunity to observe the salmon. The local technology allowed for the observation of where salmon were traveling in the mainstem and what the various characteristics of salmon were at different times of the season. Further, many people fished on the Fraser tributaries in the pre-contact era. Shalath people fished at Seton

Lake and on Portage Creek, Xwisten members fished on the upper Bridge River, and the Cayoose Creek community fished on Cayoose Creek. The observation of salmon in tributaries on and near their spawning grounds was an opportunity for observing salmon more closely and at a more advanced stage in their lifecycle, compared to that on the Fraser mainstem.

Fishers in the pre-contact era may have also had an incentive to observe salmon and learn about changes in population size and about the salmon lifecycle. This incentive is derived from the fact that the use of local technology may have had an extreme negative effect on salmon stocks. Trapping of salmon smolts on tributaries, which was carried out traditionally, is probably the best example of an aboriginal practice with a potential negative effect on population size of returning salmon. (There was also a regulation which restricted the season for this harvest, Kennedy and Bouchard 1992). In addition, the impact of aboriginal harvesting on mature salmon runs on local tributaries and on the spring salmon runs, which were highly valued and probably not as abundant as the sockeye were later in the season, were potentially significant and negative. The detection of different stages in the lifecycle, of the connection between smolts and returning salmon, and of changes in population size may have provided an opportunity to adapt harvesting techniques or timing in order to prevent stock overexploitation.

The second incentive for obtaining information about stocks was the existence of a structure in which to use the information. Clan chiefs and divisional heads may have acted as leaders in using knowledge gained by observations by fishers. In addition, the existence of an oral literature, as found in the anthropological literature (Teit 1906), is evidence that the social and theoretical infrastructure existed to support the discussion, analysis, and dispersion of local knowledge.

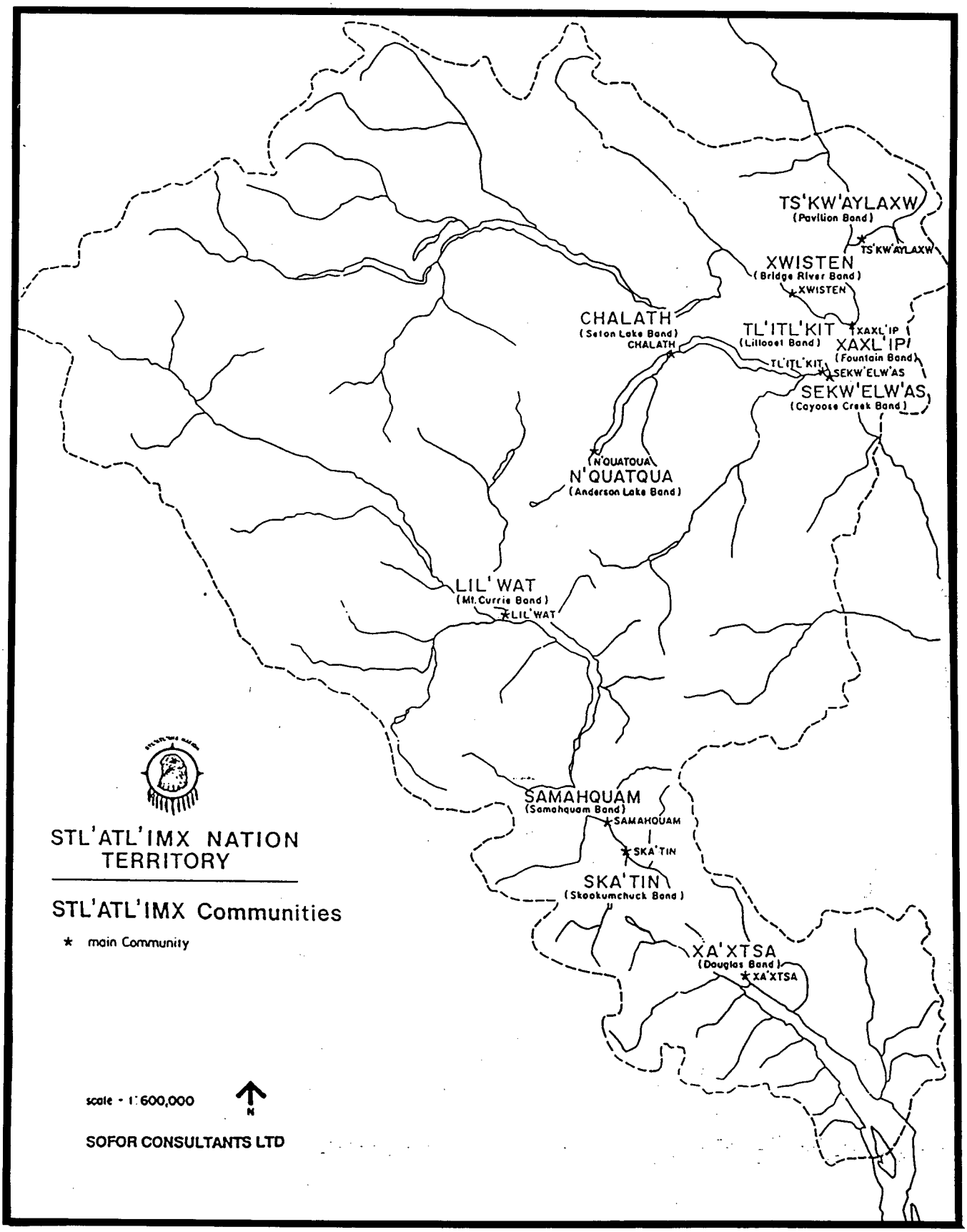

Figure 3. Map of St'át'imc (Stl'atl'imx) Territory
Map produced by Sofor Consultants Ltd and obtained from the Cayoose Creek Administration

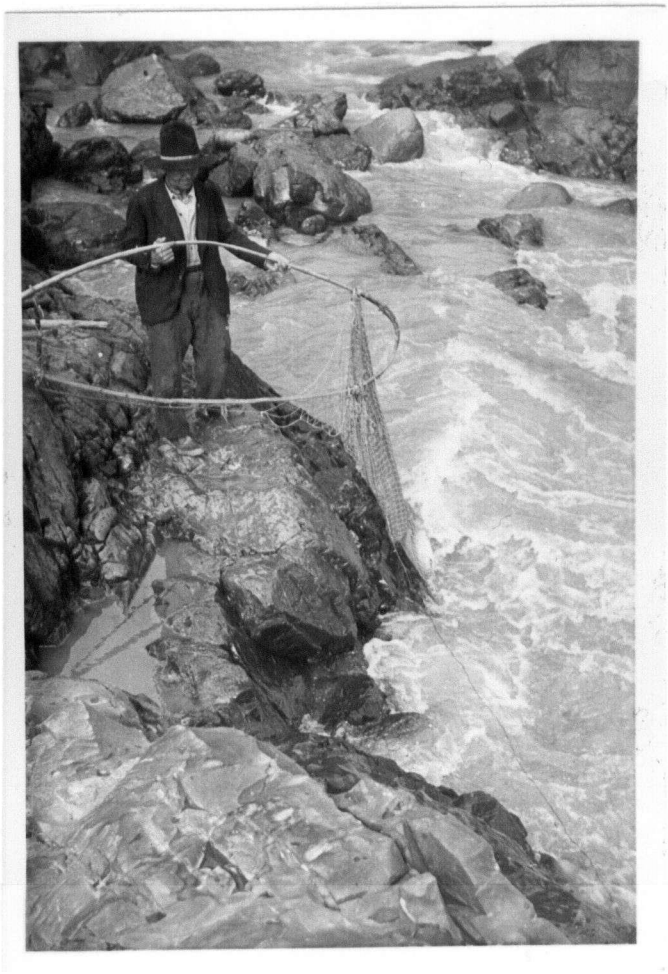

Figure 4. Fishing at Bridge River with a Set-Net (c. 1940)
Set-nets today are no longer this large. Figure 5., below shows a much smaller set-net also used at this time.

courtesy of Pacific Salmon Commission

Figure 5. Alphonse Joseph fishing at Bridge River Rapids with a Set-Net (c. 1940)

courtesy of Pacific Salmon Commission

Figure 6. Charlie Link using a Platform and Set-Net to fish at Bridge River Rapids (c. 1940)

courtesy of Pacific Salmon Commission

Figure 7. Drying Rack for Air-Drying Salmon (c. 1940)

courtesy of Pacific Salmon Commission

Figure 8. Nancy Scotchman outside Her Home Holding Dried Salmon (c. 1940)

courtesy of Pacific Salmon Commission

Figure 9. Seton Lake from East Side
Seton Lake obtained its green tinge from water diverted through Mission Mountain on its west side from the Upper Bridge River. Seton Lake drains east into the Fraser River via Seton Creek.

Figure 10. Behind the Terzaghi Dam where the Upper Bridge River Flowed
(The blue and yellow graphic painted on the concrete depicts four salmon and reads "Water for life".)

3.3 Department of Fisheries and Oceans Management System

3.3.1 Institutional Arrangements

The Federal Government of Canada is responsible for the conservation and habitat protection of anadromous salmon under *The Constitution Act (1981)*. These tasks are administered by the Department of Fisheries and Oceans through *The Fisheries Act* and other legislation which empower the Department to restrict harvests, issue licenses, and prosecute damagers of fish habitat. DFO works with representatives of the various gear-types and with processors through advisory boards and committees in allocating harvest. In addition, DFO now negotiates with First Nations fishers on harvest and other arrangements through the Aboriginal Fisheries Strategy. (Walters 1994)

Pacific salmon caught in both American and Canadian fisheries are further managed by the Pacific Salmon Commission (PSC). The PSC manages the harvests of sockeye and pink salmon migrating to the Fraser River and those passing through the Juan de Fuca Strait. The Commission is also responsible for international allocations and protection of chinook, coho, and chum caught in coastal troll and recreational fisheries. Harvest allocations within B.C. are, however, the sole responsibility of DFO.

3.3.2 General Stock Management on the Fraser

DFO sets escapement goals and regulates catch for some stocks which are called actively managed stocks. Other stocks are impacted by active management of other stocks but are not directly managed. These stocks are passively managed.

Fraser River sockeye salmon management is based on availability of spawning habitat as the limiting factor in sockeye salmon production. Maximum spawning capacity on the Fraser

River is determined by Department of Fisheries and Oceans to be six million returning sockeye spawners and catch regulations are set in order to meet this goal. (Seto 1993 pers. comm.) Ceilings are set for marine chinook harvests which aim to increase escapement throughout the province. The terminal Fraser River chinook fishery has been reduced with the closure of the commercial gillnet fishery at the mouth which appears to have stabilized the Fraser chinook populations (Schubert pers. comm. 1993, Healey 1982). None of the stocks which spawn in the study area are actively managed by DFO.

3.3.3 Historical Data Available Through DFO

Historical data available to DFO consist of publications, such as Farwell et al.'s (1987) "Salmon Escapements to Streams Entering Statistical Areas 28 and 29, 1951 to 1985", older published documents, and archived files including fisheries officer's reports. These reports for the Lillooet area, reportedly archived in the DFO Kamloops District office, were not located during this study, perhaps because they were being used in the court case involving DFO and BC Hydro. Records kept by the Provincial Government are also available. John Babcock was the first Fisheries Commissioner in the Province and his reports (various dates) are published from the turn of the century. These do not contain much detail on the study area. The most useful data available for understanding salmon stocks historically in the study area is the material assembled by Farwell et al. (1987). This is limited by both the short timespan it covers and the fact that data for many of the streams it lists were either not recorded in the past and/or are now not recorded.

3.3.4 DFO Monitoring in the Study Area

Different activities in the study area are carried out by different individuals and organizations. The local office in Lillooet is largely concerned with monitoring the food fishery.

It has responsibility for some habitat monitoring and enumeration of escapements (particularly on the Bridge River before 1991), but the office's activities are constrained by low funding. The Kamloops office administers the Lillooet region and also monitors habitat for the area. The Kamloops office was mainly responsible for gathering evidence in the dispute with B.C. Hydro over the 1991 and 1992 spillage events.

The Department of Fisheries and Oceans uses information gathered by the local office for generating gross and net escapement data which are used for estimating future populations. In general, information used by central offices is gathered by several different individuals and may then be used for different purposes, i.e. estimates of future stocks, negotiations with different parties, resolving disputes with bodies such as B.C. Hydro.

3.3.4.1 Seton System

Enumeration of salmon spawning in Cayoose Creek and Seton River is contracted out to local trained individuals. (Before 1991, DFO Management Biology Division did a mark-recapture on Seton River for several weeks in the summer.) Salmon escapement to Portage Creek is enumerated by an individual who does a one-day trip by train from New Westminster.

The Seton Spawning Channel has been administered by the Cayoose Creek Band since 1990 through a contract with DFO. The spawning channel is now being considered, along with other enhancement activities in the Interior, for closure due to funding constraints.

3.3.4.2 Bridge River System

Fisheries scientists assumed that the Bridge River was a "dead river" after the Terzaghi Dam was completed because the low water flow in the River past the dam was believed to be inadequate to support salmon. This low flow was, however, sufficiently stable and warm (it rarely

freezes over) to maintain salmon. Studies after the recent flooding found that juvenile fish densities rival those of some of the most productive interior streams in the Province (Hubert 1994, pers. comm.).

Activities on the Bridge River have been funded by B.C. Hydro since 1991. Recently, a juvenile reconnaissance study was performed and a counting fence is operated on the Bridge River. As well, gravel was laboriously put in place to replace that lost in flooding. The technicians involved in the present research and enhancement activities include a local individual associated with the chinook hatchery operated by the Lillooet Rod and Gun Club hatchery (Deb Spear) and also members of the Upper St'át'imc trained through the Cayoose Creek community fisheries training program.

Neither DFO nor the Provincial Ministry of the Environment currently funds activities on the Bridge River.

4. RESULTS

4.1 Historical Evidence of Indigenous Knowledge

4.1.1 Twentieth Century Changes in Use of the Bridge River

4.1.1.1 Traditional Use of the Bridge River

The Bridge River Valley is the traditional hunting area of the Shalath and Bridge River communities. Today, the Valley is used by St'át'imc communities, and non-First Nations people as well, for hunting, forestry, and fishing. In particular, the mouth of the Bridge River and along the Fraser River, from that point upstream is a very important aboriginal salmon fishing area, sections of which have also supported a small recreational fishery in the past.

The Bridge River mouth was, in the pre-contact era, an important site for trading, playing games, and telling stories and, as such, was probably important for the economic, social, and political activities of the St'át'imc and of the Nations which visited. The Bridge River was probably first mentioned by Europeans when Simon Fraser wrote in his journal:

> June 13 - ...Encampt (sic) at a considerable river, which flows from the right and which we call 'Shaw's River'.... The country through which we passed this day was the most savage that can be imagined, yet we were always in a beaten path and always in sight of the river (Fraser 1960, 79).

Subsequent interest and development in the region by outsiders was shaped by the Valley's mining and hydroelectric potential. The discovery of gold in the Valley in the 1850s brought the first large wave of Europeans, Chinese, and Americans to the area. By the 1930's, the upper Valley was used extensively for mining activities, including Canada's largest gold mine at that time. The most drastic changes, however, occurred with the construction of, first, the LaJoie and, later, the Terzaghi Dams which completely blocked the upper Bridge River (as

described in Chapter 3). The consequences were: 1) eradication of the upper Bridge River salmon runs, 2) massive changes to habitat in the upper Bridge River used by freshwater fish, 3) reduced water flow in the lower Bridge River, compared to pre-dam levels, 4) disruption of the regular flow regime in the lower Bridge River including periodic gravel washouts (which resulted in the 1991 and 1992 court cases), and 5) changes to the water flow and water quality in the Seton system.

4.1.1.2 DFO Historical Knowledge about the Bridge River System

Federal fisheries officers were aware, at least in the 1940s, of the importance of the junction of the Bridge and Fraser Rivers for fishing (Bouchard and Kennedy 1992). However, the present study found no evidence of observations of salmon runs on the Bridge River itself in the early part of this century. Farwell, et al. (1987) indicates that chinook escapements on the Bridge River were not recorded until 1974 and were recorded on the Yalakom (a major tributary to the Bridge) River only periodically since 1951. Bridge River sockeye were not recorded until 1967 and data for this species were recorded only since 1981 on the Yalakom River. Early fisheries reports (such as Thompson 1945 and Babcock, various dates) do not address the Bridge River system.

In a 1948 memorandum located at DFO and entitled "Re: Bridge River Power Project and Question of Fishery Needs", the author states that "the only fishery given consideration during the period 1926-1929 was the sockeye salmon run at Seton Lake".

> The reason the fisheries of Bridge river were not particularly considered appears to be that there was no knowledge at that time that a salmon run of significance or importance might be affected. That part of the Fraser watershed had not been developed at all; the terrain was uninhabited, mountainous, rough, and almost impossible of travel, and there had been no close examination of the fisheries resources there. Even at this date our information and data relating to fisheries there is sketchy and incomplete.

The memorandum recommended research on 1) the salmon of the upper Bridge River and the Yalakom, 2) the opportunity left to the progeny of this run to descend past the project, and 3) the question of if "the mouth [should] be blocked off in such a way as to send the returning salmon up the Yalakom". The following positions required more information according to the document: a fishway or fish ladder could be required, but, "our engineering facilities at this juncture are such that we are not in a position to specify the design for an installation such as this". Furthermore,

> if the facts concerning the salmon run were found to be substantially as we think they are at the present time, yet in view of the company's representations..., the Minister felt that he could not insist upon applying the applicable provisions of the Fisheries Act, we would be in a much better position to claim a policy of give-and-take in our stand in the relationship of fisheries to other natural resources.... It is appreciated that, having regard to the considerable publicity which has been given in the press recently to the power development, and the bearing such may have upon fisheries, any action at this time which would have the effect of deferring facilities and installations by the company at Bridge River may bring forth some considerable criticism from the fishing industry. However, it is believed that the issue of a carefully prepared statement by the Department, taking into consideration the several points above brought forth, would assist in an understanding by the Industry and others concerned of the Department's endeavours and policy in this matter.

4.1.1.3 St'át'imc Use and Knowledge of the Bridge River

The above description of the Valley as uninhabited was an exaggeration, particularly considering that mining activity had already attracted thousands of outsiders to the area. The Bridge River Valley was also used extensively by the St'át'imc for hunting both in the pre-contact era and in this century . In addition, one family, of the Shalath community, had a farm on the upper Bridge River and hunted and fished in the Valley at the time of dam construction. The memorandum both failed to recognize that use can occur without habitation and that residents did exist in the Valley.

Carl Alexander, whose family was dislocated by the hydroelectric project, reports that three salmon runs used the upper Bridge River, a spring, a coho, and a sockeye run. At the time the two dams were built, this information was available among local people but, apparently, not to the Department of Fisheries and Oceans.

Recently, B.C. Hydro has come under some pressure to enhance fisheries on the Bridge River. They have turned to local residents as a source of information on fish populations before 1957 in order to identify possible enhancement activities. In this case, indigenous knowledge is the primary way of obtaining this information. However, if this information had been obtained earlier in the process of erecting the dams, the options for mitigating impacts of the dam would have been greater.

4.1.2 The Seton Hatchery

4.1.2.1 The Seton System Salmon Runs

B.C.'s first Fisheries Commissioner, John Babcock (various dates), reports that the Seton system had at least two sockeye runs. An early run in July and August was observed from 1902 to 1914 and a later run from September to November was observed during the years 1901 to 1937, when the Babcock reports ended . After 1937, this run declined (Thompson 1945). However, this "late run" was recorded as not being cyclic nor consistent in magnitude, suggesting that two or more runs may be involved. Today, Portage Creek and Gates Channel both have significant sockeye runs and these early reports may refer to runs which migrated through Seton River and Seton Lake to Portage Creek and Gates Creek. In addition, however, a large run of pink salmon spawn in Seton spawning channels.

4.1.2.2 Construction and Operation of the Seton Hatchery

The sockeye hatchery on Seton River, near to Seton Lake was built in 1903 "after one season's observations of spawning and was from the first a disappointment" (Thompson 1945, 59). The hatchery was closed around 1918 due to decline of runs through Seton River. The failure has at least two possible causes: either the runs declined as a result of the hatchery or they declined for some other reason.

Fraser salmon stocks declined during 1899 to 1904 due to overfishing (Marchak et al. 1987) and again after 1913 due to still uncertain factors. One of the causes was, however, the Hell's Gate slide of 1913 which blocked salmon migrating through the middle Fraser (Thompson 1945). The possibility that the hatchery had a negative impact on Seton runs cannot be ruled out. The delay of returning sockeye in weirs before their spawning grounds and the use of different stocks (including those migrating upstream and found resting in Seton River) may have had an adverse effect on salmon stocks (Thompson 1945).

4.1.3 Former Use of Indigenous Knowledge

The use of indigenous knowledge by state agencies may, in fact, have a short but indicative history. Early records by Fisheries Commissioner Babcock on salmon run size and timing were often based on reports of local people (both indigenous and more recent settlers). Early fisheries reports on catch size and details of runs were also frequently based on reports from local people and, in 1919, local people informed the local fisheries officer that salmon ascended the Bridge River thirty miles to a falls which blocked further migration (Bouchard and Kennedy 1992).

Local people in the Lillooet area also informed state agents about the damage poorly placed culverts can cause fish populations:

> ... I've approached the Public Works ... and I says, we'd like to preserve some of our trout, I says they come in there and spawn. I says, even the Cohos, the Dolly Varden, even the Sockeye, I says, they can't get up on these little streams on account of these streams that crosses the highway and when you come to put a culvert on you put it up about four or five feet high [above the normal channel level]. (Ed Thevarge, quoted in Lillooet and South Central Tribal Councils 1980, 5.)

Other reports of not only the usefulness of indigenous knowledge but, in fact, its use include that of indigenous people informing state fisheries personnel about the use of electric shock to direct salmon at the Seton spawning channels. This practice apparently disoriented the salmon and caused them to "stay down and ... fight amongst themselves," as they tried to avoid the shock (Ed Thevarge, quoted in Lillooet and South Central Tribal Councils, 6). According to Mr. Thevarge, this practice was changed after he reported his observations to state fisheries personnel.

4.1.4 Lessons from Historical Evidence of Indigenous Knowledge

Two observations are important based on past evidence of indigenous knowledge. First, important indigenous knowledge has been in existence in the past. The example of Bridge River suggests, however, that the value of indigenous knowledge is more easily seen in hindsight. The difference in the knowledge available to local people and to state managers was unclear at the time the knowledge was needed before the Lajoie and Terzaghi Dams were built. Federal Fisheries officials seemed to assume that local people did not know about this local use and knowledge of the area, (or even that it was inhabited). Second, indigenous knowledge was not only of potential use but it was, in fact, *used* by state fisheries personnel at times.

The following section examines what indigenous knowledge of salmon is today in St'át'imc communities.

4.2 Indigenous Knowledge Today

Indigenous knowledge consists of three types of knowledge: information on salmon stocks, information on habitat, and practices and philosophy.

4.2.1 Salmon Stocks

4.2.1.1 Historic Stocks

At least six runs in the study area have been eliminated or greatly decreased according to interviewees. In addition, the fishing season is now shorter, and overall salmon abundance is less today than what participants remember in the past.

Cayoose Creek appears to have supported a large sockeye run in the past:

> TA: And often Sam Mitchell [a respected informant and contributor to several anthropological reports] told me, he says, Cayoose used to be the biggest spawning channel or river, it's just as big as the Adams Lake run. And that's all faded and gone. Cayoose Creek. Sam used to always say that's the biggest spawning ground next to Adams Lake

> JS: Brother Paul and I used to go down in late October, early November, snowing to beat hell and in several hours we got a hundred and sixty five. Yeah, we don't get that anymore now.

Jones and Marshall Creeks had significant spring salmon runs:

> TA: When I was working at Mission Dam there and we shut it off and we had the spillway through the rocks there. And we used to, in the evening, we used to go down there and watch the spring salmon all turning red down in that pool there where the waterfalls come down. And that's the ones that were going to Jones Creek and Marshall Creek where they go to spawn.

In addition, Tyax Creek supported spring and coho salmon runs. Carl Alexander reported that a large spring salmon run migrated up Tyax Creek in the early part of July. A small coho run migrated up Tyax Creek after the spring salmon. A sockeye run migrated into the upper Bridge River in August, as far as the settlement of Minto, since abandoned because of flooding by the reservoir.

4.2.1.2 Stock Timing

St'át'imc names exist for different salmon species and also for different runs. The first salmon run comes in the spring:

> LB: See, go down the road, around May, you see the buttercups, little flower ... the salmon that goes by then, that's the spring salmon called skwéxem. Then, later, the rosebushes bloom, kel'k, call them kel'k, that's rosebush, kel'k, kel'kásuth that's the spring salmon that goes by when the rose blooms, see.

(Kennedy and Bouchard ,1992, record that the first spring salmon (skwéxem) appears around April.) Later in the summer, in July and August the zúmak (a spring salmon) and pkas (a white-fleshed spring salmon) arrive. The second spring salmon run is, apparently, a very quick salmon that will leave a net if it is not quickly pulled from the water (Kennedy and Bouchard 1992).

Sockeye salmon are called sxwa7s (Kennedy and Bouchard 1992), except for the term tsekwalúps which refers to a sockeye that has turned red. Significant sockeye runs for fishing are the Stuart, the Chilko and the Seton Creek run. The Horsefly run was not identified as an important run and one interviewee (CA) stated that it is not a big one in the study area. Carl Alexander also reported that the small fish run last, and that is how fishers know that the run is nearly finished: "when the salmon looks like trout, that's the tail end of that run".

4.2.1.3 Stock Status

Interviewees noted two main changes in quality in salmon. Carl Alexander stated that he sometimes finds worms in the flesh, about three inches long, which he does not remember seeing in the '60s. He noted that they were becoming increasingly abundant and thought that it was because of the pollution in the river.

Maggie and Roger Adolph also reported a large change in the fat content of salmon which they perceived as a noticeable decrease in the grease given off by salmon while hanging to dry. Bobo Jack, fisheries patrol for the Bridge River community, noticed that when the water is warm the salmon flesh goes soft.

In the 1992 season, Desmond Peters reported that he noticed a large number of salmon floating downstream. Bobo Jack also noticed spring salmon floating downstream that same year. "Anomalies", such as this, are generally not recorded by researchers who spend little time at a site. This is either because the outside researcher simply misses the event or because the researcher is expected to gather a large amount of data in a limited time and, because the event is an anomaly, he or she is not expected to look for the event. This selection and limitation of variables is extreme in the case of computerized data collection in which water temperature, water level, and other factors are obtained with electronic monitors. Finally, anomalies can be lost in statistical calculations where they are disregarded as an insignificant aberration. Despite statistical uncertainty, they may be biologically very significant.

4.2.1.4 Stock Migrations

Awareness of stock migration paths is an interesting example of indigenous knowledge because it would be very difficult for an outside researcher to detect these paths, even with modern technology, on the middle Fraser River.

Fishers obtain knowledge about where the fish are migrating and different rocks are known to be usable at different times of the season because season affects both the run(s) available and also the water level. For example, Bill Edwards states,

> There's one place there, six-mile. They make a platform way out, you got to have a long pole with a gaff at the end to get that down, down and you hit the bottom and you feel the gravel and you just kind of go aaaall like that, just feel around, you don't have to go like this or anything like that, just the next thing, you know, you have one, that's the spring

salmon, they go way under there, that's where they [go]. You're going to be tied up, cause its very strong, you could fight with it.

Kennedy and Bouchard (1992) record over fifty fishing rocks. Many of these, their interviewees noted, were used at specific times, with specific gear, and for a specific species of salmon. For example, ts'iw't, a fishing rock on the east side of the Fraser, was used only when the river level is high in June and July for catching spring and sockeye salmon using a set-net and scaffold. A fishing rocked named lhkw'u'kw'lets was used for catching the first run of spring salmon. Nk'ák'mekstewal' was used at high water with two nets, "one behind the other, one a little deeper than the other" (Kennedy and Bouchard 1992, 338, quoting Sam Mitchell) and k'awáwkza7 ('net slants') was used in April for spring salmon and required that the fisher hold the net out into the water (slanting) rather than in a vertical position. Another spring salmon fishing rock, nlikw'kán'm required the fisher to push the set-net down deep into the water because "even though the water is rough on top ..., the water is calm underneath" where the fish run (Kennedy and Bouchard 1992, 341, paraphrased from Sam Mitchell).

The specific use of this information on migrating stocks is unclear, other than for fishing, of course. However, data on the regions within the river where stocks run could be used in work currently in progress on the energetics of salmon migration. Studies on the energetics of salmon migration attempt to identify river sections in which salmon metabolism increases and to explain that increase.

4.2.2 Habitat

4.2.2.1 Water Level

Many interviewees reported a lower water level on the Fraser River, especially during the 1993 year. Carl Alexander reported that in the 50s and early 60s, there were lots of fish up until

then, and that the decrease is because of the water decreasing. Also, "it could be all the oil spills they have in the ocean, because the fish spend four years there".

When asked why the runs were slack this year, Carl Alexander stated, "I don't have an idea, kind of think its because not much water now. Even the Fraser doesn't come up as far as it used to". He reported the reason for the low water level was that, "when it snows, even in early spring, the sun comes out and the snow melts".

> CA: The water comes down quickly, not slowly. There are very few places where I know there's snow under the trees in July. All the big trees up on the hillside where the snow is are cut down. The snow melts too fast and in the summer nothing is left .... I think last went up in May, about the third week in May, went up to have a look, and there were already patches of ground past Marshall Lake.
>
> CD: That was unusual?
>
> CA: Yes

Low water levels were also observed by Desmond Peters, Sr., and were noted to affect water quality and the fish themselves, (see next section).

4.2.2.2 Water Quality

Interviewees also noted a change in the colour of the water and a noticeable odor, in addition to the low or fluctuating water level:

> DP: ... today what we are fighting is the water is fluctuating so bad. I was down there yesterday and you could see the humpbacks, the pink salmon going by 10 feet from shore, but during the height of fishing season you can't see the salmon because of the glacier waters running into the Fraser and the tributaries, but all you can see right now is dark greenish, but it's light enough to be able to see the salmon floating by and you can smell the chemicals from the water. Today the sun is shining, you can see the salmon going and they are actually dying, go up, because, also of the Kemano, the Nechako diversion. That's what causes it, the low water. Cause they can divert that water so fast. You know some of the salmon don't even reach their spawning grounds, they die, you know.
>
> CD: The water right now is very green.
>
> DP: Because, well the tributaries have drained off for the summer, because there's a lack of snow during the past year and we've had these hot periods and the water has drained off down there, and control of the water of the Nechako, ... the Stuart Lake and they diverted that water for Kemano II and when they do shut it off there, what little tributaries there is,

its dropped to a considerable..., its the most I've even seen it ever since I can remember, the water went down that low, and the fishing rocks, you could almost walk across the river, down at certain points, where that big sand bar is. Its pitifully low, I'm not sure we could do anything about it, I don't know who controls that, but nature does its own thing.... Really smells, you can go down there probably tomorrow and you can go right to the river, and you'll see the salmon there. And as a general rule water doesn't smell unless its stagnant, as in a pond or whatever, and this water is running, down to the mouth at New Westminster.

CD: Do you notice a lot that it smells, or mostly right now?

DP: Right now, 'cause the water is lower than generally it is supposed to be .... Its really down to a low, low point.

Bobo Jack also stated that pulp mill smell is noticeable in spring and that the colour change was related to the diversion of the Nechako River, which carried a lot of sediment.

4.2.3 Practices and Philosophy

4.2.3.1 Salmon Migration

One of the traditional fishing rules is about the removal of dead salmon. Fish waste (guts, fins, gills and heads) are always to be thrown into the water. There is also an awareness that salmon use smell to migrate, which western-trained biologists are also aware of. Further, people perceive that what the fish smell is the fish waste.

EN: Tommy, do you remember when they had that hatchery out here?

JS: I remember that one.... They hauled that fish and buried them, the mothers and the fathers. Buried them somewhere else, but not in the river. For four years they had it running and not a fish come back 'cause the fish didn't know where to go.

....

EN: But I mean, that shows that they did go by smell, right, you know, because them didn't come back, the fish. They turned lots loose for four years and nothing came back.

Another interviewee stated the connection between migration and smell:

DP: When they closed the Carpenter Lake and the fish that were there, for a good spawning up there, and through that slime that comes off the salmon, these salmon went up, they followed it. It came in through the Bridge River and the water that was coming through the power intakes and the huge pipes that come down to feed the powerhouse and the fish were trying to go up into the powerhouse and you could see them milling around,

> and usually that slime that they follow, I guess that's what they follow, I don't know, it's just a rough guess. For years those salmon were going up and they were getting into the turbines, they would climb up into the powerhouse and people thought that was something, you know. And they were snagging them right there at the powerhouse, and after that they disappeared, because those were the spring salmon that were going to spawn in the Bridge River that were trying to go up in through the turbines.

The late Eddy Thevarge was adamant about the rule on fish waste. At the hatchery: "I went right up to the caretaker there, I says, I want you to make a report, I says, to your superiors. I says, I don't want any salmon taken out from the creek even after it's dead" (Lillooet and South Central Tribal Councils 1980, 6).

4.2.3.2 Non-interference

Despite some local administrations' interest in hatcheries and spawning channels, interviewees were, in general, not in favour of high levels of interference with natural processes:

> MP: When Bradley [Jack] was working for fisheries he tried transferring the salmon from the pool below the dam, he had a net down there to catch the spawning fish and he'd transfer them, even if it were just one or two. I don't think he got very much.
>
> MA: To me, that's all interfering with nature, when the fish was doing their *own* thing, when the water was when they didn't damage the water, they didn't put up all these dams, there was a lot of water. And the fish spawned anywhere they wanted to right as far as they can go. And they spawn, there'd always be some. That's why there were lots of fish. But now we got all these dams and its drying up all these spawning places. But something we can't do is interfere with nature.... All these fisheries hatcheries they have, I don't believe in them myself. They count them, but how many of that goes down to the river? Not very much.

Another interviewee stated:

> LB: I do remember that, when the salmon were low, that was when the shamas, white peoples, they closed it down Mission someplace, I don't know where exactly, down Hell's Gate. So they ruined the salmon. They were injured, see the backs all cut up and everything else, trying to go through that, however, they stopped them down there, see.... They only kill fish themselves, not the Indians. Its nature brings the worlds together, brings the fish. Then you make fisheries hatcheries, no that doesn't work. Its nature, that's why the salmon were just thick on the Fraser River.

Louie Bob's comment that "nature brings the worlds together" may stem from the St'át'imc understanding that different components of nature (eg. human, salmon) exist in their own, interconnected worlds.

4.2.3.3 Conservation and Productivity

Participant Carl Alexander stated that the Early Stuart run is allowed to pass through: "we let the first run go right through, the Stuart River run. Since the fish started..., runs started disappearing, they have to let some go through for spawning". When the fishing is slow, "you have to let them go, like this year [1994], in order to have enough for next year. Before there used to be fish all the time. I don't think we ever had any real slack year like this year". Desmond Peters also stated that the Early Stuart Run is "allowed to pass". This is consistent with Anderson's (nd; circa 1860) observations of First Nations salmon harvesting practices on the Fraser:

> At the discharge of the Fraser's and Stuart's Lakes the stream is fenced across, and the sunken basket is used; immense numbers are thus caught in ordinary years. The fence, however, is rarely so secure but that the main portion of the shoal contrives to force a passage; and even admitting it were perfectly close, the natives have a conventional understanding that the fish shall be allowed to pass towards their neighbours further inland, who in turn do not seek to intercept the main body from their spawning grounds. (Anderson nd, 57, quoted in Kew 1992, 216)

The threat of raids of salmon caches by upriver First Nations may have been a factor in this "conventional understanding". Raids for salmon by the Chilcotin are reported in the anthropological literature for the pre-contact era.

4.2.4 Comparing Indigenous and Western Scientific Knowledge

Table 4.1 is a preliminary comparison and contrast of western scientific and indigenous knowledge in this case.

Table 4.1 Comparison and Contrast of Western Scientific and Indigenous Knowledge of Salmon in the Study Area (Lillooet, B.C.)

Characteristics	Western scientific	Indigenous Knowledge
Quantitative	Escapements available, but not consistently available over time.	Very general (eg. number of runs).
Qualitative	Some historically and presently.	Historical data; anomalies; trends, general sizes of runs.
Able to perceive and process anomalies	Mechanisms for perceiving and analyzing anomalies are not a dominant feature.	Anomalies noticed and discussed among community members.
Mode of data gathering	Various offices and contracted technicians collect data. Data requirements set by central agency.	Data gathered in process of harvesting and other activities by local resource users.
Comprehensiveness	Based on observation of a large region.	Based on perception of many variables.
Historical continuity	Historical information is difficult to access and availability is highly variable.	Information on changes approximate but continuous over recent historical period (eg. 50 years or more).
Explanatory theories and analysis	Exist and are based on in-depth but very specific studies which tend to be generalized to a larger system (by scientific induction).	Exist and are based on observations over a medium-size geographical area and on learned knowledge and traditional ideologies.
Role of Technology	Technology, such as stock identification methods allows information to be obtained by individuals in a short period of time on specific factors.	Local technology allows some specific information to be available, such as where stocks are migrating. Intensive use of resources over a long period of time (instead of western technology) provides opportunities for obtaining information.
Institutional Arrangement	A wide variety of individuals obtain information used by a central office for decision-making	Loose arrangement of individuals, all of whom are resource users and live in the area, obtain information. Decision-making (eg. institution of licensing system) carried out by local politicians elected by the same resource users.

4.3 The Traditional Salmon Management System Today

4.3.1 Key Concepts in Traditional Management and Their Evolution

Two key objectives of the management of natural resources are regulation of *who* can use a resource and *how much* of it individuals can use. This was accomplished in the pre-contact era in the following ways, each of which has been carried over to some extent into the modern era.

1. *Catch restriction.* Interviewees confirmed repeatedly that people traditionally only took what they needed from the salmon resource. This appears to be a vague type of catch restriction, yet, interviewees frequently would qualify this by stating specific numbers that would be acceptable for a family. Thus, the limitation appears vague but, in practice, specific limits probably existed. In general, harvests in the pre-contact era were limited by catch per unit effort (an indicator of efficiency) (Pinkerton and Weinstein 1994).

   Evidence of use of this type of catch restriction in the modern era is complicated by the fact that the market economy makes limits based on need more difficult to estimate. Further, St'át'imc today fish much less than their ancestors did, in general. This research did find, however, in anecdotes and comments, that people who caught large amounts for sale were, at times, talked about in negative ways and accused of using the money for things they did not need.

2. *Exclusion of outsiders.* Specific rules of access to salmon existed for different groups of people (Romanoff 1992). Today, most people perceive access by outsiders as a serious problem. Outsiders, it is felt, do not follow rules of keeping the rocks clean, take large amounts of salmon, and are not interested in maintaining local traditions. One interviewee

recognizes a right of access for a larger group of people, provided that they do not take large amounts and that they follow local rules.

3. *Rock ownership*. Many fishing rocks, and particularly the most valuable ones for obtaining fish for the full length of the season, were owned and inheritable. Sharing access to rocks was compulsory, as were asking the owner's permission to use a location, and using rocks according to traditional rules. However, the individual who owned the rock did most of the fishing at that site. Today, many rocks are still identified by community members as belonging to a specific individual. Frequently, however, people made comments such as "today anybody can use a rock", suggesting that the previous restrictions are now more relaxed.

4. *Technological restriction*. Most fishing was done by dip net, set-net, or gaff hook in the pre-contact era which may have limited the efficiency of harvest, particularly on the Fraser mainstem. Traps were used only for salmon smolts and a season restriction was placed on that harvest. Today, the gill net is used in the spring when abundance is relatively low. The use of gill nets at the productive six-mile and Bridge River rapids fisheries is strictly limited by the availability of suitable sites. People do catch sockeye with gill nets at other sites, such as the Cayoose Creek traditional fishing area on the Fraser where the water is calmer. The dip net and set-net are the primary technologies used at the six-mile and Bridge River rapids sites today.

5. *Preservation requirement*. At times of large runs, salmon could not be processed as fast as they could be caught. Today, this is still the case, even though many people use the "cowboy" method of drying fish in which the fish is held together only by the tail (see

figure 13) (Kennedy and Bouchard 1992). Freezing and canning have become popular today with the result that fishing is limited less by the rate of cutting and more by the size of people's freezers, the number of people to help carry fish, and the distance from the fishing rock to the road.

6. *Season restriction.* Two periods of restriction of fishing were observed. The Early Stuart sockeye run was not fished, according to two interviewees. The season on salmon smolts was also restricted to the first two months of their migration. After that they were considered not good for eating (Kennedy and Bouchard 1992). Today, younger St'át'imc do not appear to follow the restriction on the Early Stuart run, and sockeye smolts are not harvested at all.

4.3.2 Comparing Indigenous and State Management Systems

Table 4.2 compares the activities of the Department of Fisheries and Oceans and the traditional and modern St'át'imc for each of the management functions listed in section 1.1.4 above.

Table 4.2 Comparison of DFO and Traditional and Modern St'át'imc Management in Study Area

Management Function	Department of Fisheries and Oceans	Traditional St'át'imc	Modern St'át'imc (Bridge River Community)
Logistical harvesting decisions, such as licensing, timing, location, and vessel or gear restrictions	Licensing system in place, timing, location and vessel and gear restrictions for commercial fishing. Restrictions on gear and timing for the Food Fishery near Lillooet in the past.	Location, timing restrictions.	Licensing system in place; restrictions on location, potential for gear restriction, some restriction on timing.

Table 4.2 cont'd

Harvest allocation decisions	No allocation decisions made within the local Native fishery.	Allocations based on rock ownership and kinship. Sharing of rocks promoted equity.	Harvest allocation exists, but it is not strict in most years. Limits use by outsiders to some extent.
Protection from habitat or water quality damage by other water resource users	Through courts.	Ethic of concern for the river and the salmon. More specific rules may have existed.	Through inquiries and panels; local land use planning through physical development plans.
Enforcement of regulations or practices guiding harvesting logistics, allocation, and resource protection	Fisheries officers in local office.	Taboos and norms enforced through social sanctions.	Community members hired by the community Administration reinforces social norms about fishing.
Enhancement and long-term planning	Artificial spawning beds and hatcheries in past.	Enhancement and planning could have taken place through local clan heads or divisional chiefs.	Efforts to establish a hatchery limited by funding; Cayoose Creek community administers Seton spawning channels for DFO.
Broad policy decision-making	At senior levels within the Department.	Local headship divisional chiefs.	Through locally elected Councils.

4.4 Changing Technology and Access

4.4.1 Increased Access by Outsiders at Xwisten

Before the twentieth century, access to fishing rocks was by foot or horseback. Thus, many people, during the pre-contact era and into the first part of this century, fished close to home: Fountain and Pavillion communities on the east Bridge River Rapids, the Lillooet community at "old bridge" or on Seton Lake, Shalath community on Seton Lake and Portage Creek, etc. During the second half of this century, however, the automobile became common and getting to the fishing rocks was no longer a problem. Instead, the distance between the road and the fishing rocks was the major barrier to be overcome.

Access at the west Bridge River Rapids poses a particular concern because of current automobile use (see figure 11). The road here is close to the river and public and private rocks are within easy walking distance. The Bridge River Administration has had many more problems with people from outside the community taking large amounts of fish than has any other community. In contrast, east Bridge River Rapids reportedly has better fishing, yet it has very little problem with outsiders because of the one mile steady uphill hike from the river to the road. The east Bridge River Rapids site is used extensively by Fountain and Pavillion community members for drying fish or packing up with horses.

4.4.3 Local Response to Changing Access at Xwisten

The Bridge River Administration responded to the access issue by installing a licensing system, available to members of the St'át'imc for twenty dollars a season, which allows license holders to pack out fresh salmon. Outsiders may be allowed onto the rocks, space permitting, or they may be asked to leave. In order to further limit fishing, the Administration also prohibits removal of *fresh* salmon on the weekends during the summer. Thus, fish caught on weekends must be cut and dried at the Bridge River site. A Bridge River member patrols the area to ensure care of rocks, safe practices, and enforcement of the licensing system. Patrols also help control theft of nets and fish.

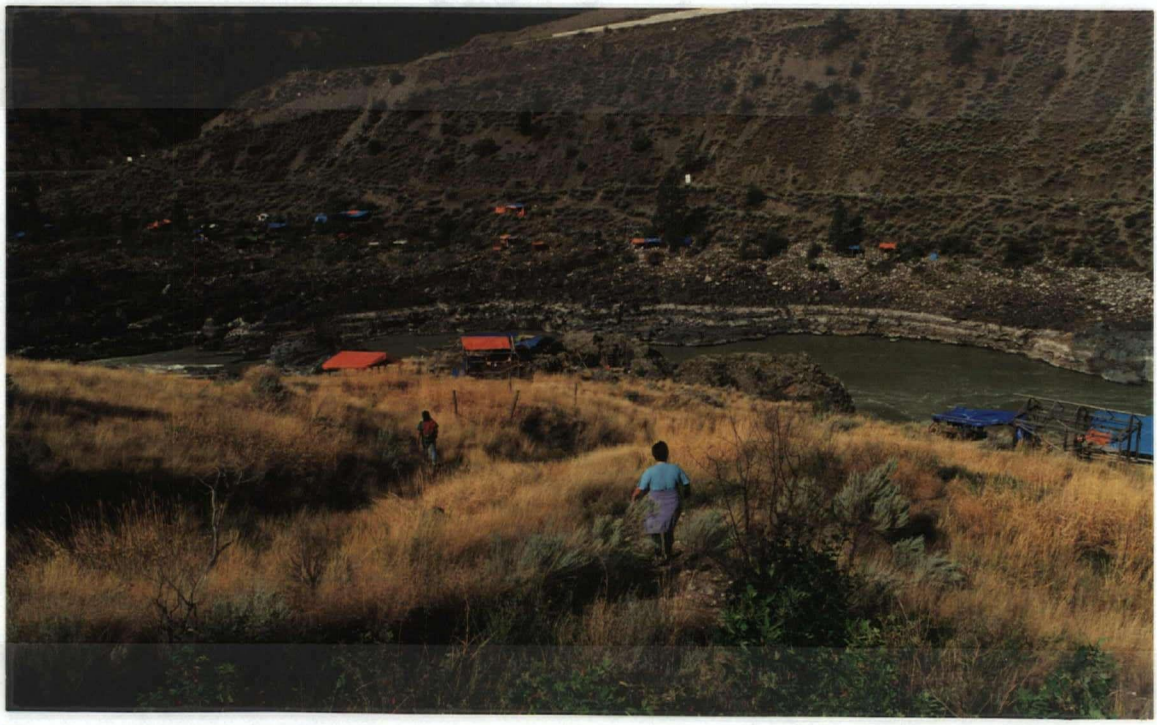

Figure 11. Six-Mile Fishing Site
Bridge River fishing site is visible on the opposite side of the river. People use tarps for fishing racks today instead of branches.

Figure 12. Cutting Salmon for Air-Drying
Salmon must be sliced to ensure complete drying and prevent infestation by maggots. Salt and pepper are also used to keep flies away.

Figure 13. Two Methods of Cutting Salmon: With and Without the Back Intact.
The method which leaves the back intact wastes less fish. It is, however, more difficult and time-consuming.

Figure 14. Desmond Peters (Sr.) in front of an Ishkin (subterranean house) in Progress.
Desmond and his nephew are building this ishkin on the site of a previous one, and collecting artifacts as they proceed.

> Comprehension is neither an arbitrary act [subjective] nor a passive experience [objective], but a responsible act claiming universal validity (Polanyi 1964, xiii).

5. IMPLICATIONS AND CONCLUSIONS

5.1 Barriers to Using Indigenous Knowledge

Previous chapters touch on some of the barriers to using indigenous knowledge of salmon in a modern context. Chapter 2 addresses this from the perspective of the literature while Chapter 4 suggests these barriers in the context of comparing western scientific and indigenous knowledge in this case. The sections below clarify the barriers to a wider use of indigenous knowledge identified in this study. The barriers are interrelated but are categorized into four types for clarity: methods and form, institutions, relations among groups, and change in the region.

5.1.1 Methods and Form

5.1.1.1 Methodological Inertia and Knowledge Form

A review of the type of information available on salmon stocks in the study area shows that data are collected by DFO personnel using established methods which do not include talking with local people. On the one hand, new data are sought which is compatible with what already exists. This is manifested in the current AFS co-management agreements, where local people are gathering data, but not from elders or long-time fishermen about stock changes and quality. Information is collected primarily from all fishermen about catch size, data which fit readily into catch size, gross escapement, and net escapement data generated by DFO. The current trend appears to be toward getting local people to do what DFO formerly performed, if not as comprehensively as is done presently. AFS funds have gone predominantly to communities that

have signed agreements with DFO and, thus, the pressure to adopt the current model of research may be substantial because of the financial awards.

A second aspect of methodological inertia is an extension of the first: for "practical" reasons knowledge has become synonymous with production of quantifiable data. Collecting and processing large amounts of data over a very large area is easier with numerical data. Numbers allow biologists and policy-makers to "say something" even if the numbers reveal almost nothing about ecological processes. Numbers which may show vague or even unidentifiable trends unless presented in certain ways are still easier to collect, process, and analyse than qualitative information about fat content in salmon or snow under trees in summer. Yet, the second *type and form* of information can be useful in ways that the numbers are not. This type and form of information can forecast trends which are not yet clearly discernible or indicate reasons for both large and small scale phenomena.

5.1.1.2 Perceived Lack of Legitimacy

Perceived lack of legitimacy of indigenous knowledge among some groups is probably one of the most significant barriers to use of indigenous knowledge in this case. This attitude was not expressed by any individuals in this study (none was questioned on this point). However, the perception that western science is vastly superior to indigenous knowledge is so ubiquitous and has been discussed in the literature on indigenous knowledge to such an extent, that the perception of indigenous knowledge by scientists (and policy-makers) is briefly discussed here.

Gieryn (1983) depicts science and other forms of knowledge as engaged in a competition for legitimacy and funding. However, another aspect of the relationship between scientific and indigenous knowledge is that scientists are not rewarded for researching indigenous knowledge.

Fisheries scientists may actually perceive that research on indigenous knowledge reduces their productivity as scientists (Finlayson 1994). Competition between scientists prevents practitioners from doing anything that is perceived to threaten their productivity as scientists.

One of the differences between western scientific and indigenous knowledge is that the former has access to many social mechanisms for legitimizing information. This is mostly because this knowledge is backed by universities, conferences, and journals, and by boards and politicians through research grants. Both those within these institutions and the public frequently judge the quality of research based on credentials such as the lab they work in, amount published, or university they are associated with. In contrast, local knowledge has none of these large scale social mechanisms reinforcing it and deeming it legitimate to scientists, politicians, or the public. The flip-side of this is, of course, that local knowledge has a lot of legitimacy among local people, who sometimes marvel at the naiveté of official science and scientists.

5.1.2 Institutions

5.1.2.1 Low Priority Management of Mid-Fraser Stocks

An apparent lack of commitment to stock preservation on the Mid-Fraser is a substantial barrier to use of indigenous knowledge. Local knowledge, in the present case, could be useful in helping maintain and enhance local stocks, in addition to providing general habitat and migration information relevant to Upper Fraser stocks. The depleted state of stocks, instead of attracting greater resources, seems to have resulted in the area being ignored. At the same time, both reduced access to migrating fish and large commercial markets compared to downriver fishers and the fact that turbulent waters on the main-stem in the Lillooet area limit use of the gillnet, reduce the St'át'imc fishers' ability and incentives to severely impact salmon on the mid-Fraser mainstem.

These factors, again, could explain the lack of management attention given this area relative to the Lower Fraser.

The low priority status of the mid-Fraser is evident by 1) the small amount of salmon research in the area, 2) the lack of active management of sockeye stocks and 3) low budget allocation under the AFS to the area. Greater management effort is necessary in the mid-Fraser in order to maintain and enhance stocks. Further, the lack of attention to spawning stocks in the Lillooet area does not foster co-operation. Local people, in this case, perceive that Fisheries and Oceans was negligent in protecting local stocks in the middle of this century. The continued lack of management attention to this area does not foster an appropriate atmosphere for co-operation in management. On the other hand, if more efforts are made to protect local stocks, which involve recognition of local capabilities and traditional authority, they will likely be well received because of the strongly expressed economic and spiritual importance of salmon to the people.

5.1.2.2 Organizational Structures

Organizational structures in the Lillooet area concentrate most of the research activity connected to DFO in the regional office in Kamloops and the office in New Westminster. This centralization can be a barrier to support of local activities, such as recognizing and gathering knowledge from local people.

The local capacities for data generation and the formation and enforcement of regulations aimed at maintaining salmon runs are not currently supported or widely utilized by government agencies. Local "on the rocks" patrolling is not government-supported. This is despite the potential benefits to salmon management of monitoring outsiders and prohibiting the removal of fresh salmon on weekends.

5.1.3 Relations among Groups

5.1.3.1 Inter-community Relations

Inter-community relations do not appear, yet, to be at the point where a clear consensus exists on the place of traditional rules and authority. In this case, the authority of the Bridge River Administration on their fishing rocks was not universally accepted by the neighbours of the Upper St'át'imc. Thus, the extension of that authority into data gathering and analysis may be challenged when the knowledge generated conflicts with the interests of other Nations.

5.1.3.2 Distrust of Government Fisheries Activities

Distrust of government fisheries activities exists, due to past interactions between Fisheries and Oceans managers and the Upper St'át'imc community. Local people recall, with great clarity, the restrictions on fishing which appeared to them to coincide with releases of fish through Hell's Gate. They perceive that the information necessary to do this was obtained with their assistance. Small infractions, such as offering a taste of salmon to a non-First Nations friend or holding a first-salmon ceremony on a non-fishing day were met with what were perceived to be extremely harsh repercussions. Thus, co-operation between fishers and government personnel in salmon management and research into indigenous knowledge by state salmon managers is likely to be met with some skepticism and reluctance at first.

5.1.4 Change in the Region

5.1.4.1 Cultural Change

Cultural change has resulted in some lifestyle changes. Most significant here are that fewer people camp at the rocks, and that less time is spent fishing because less fish are taken and because more people have full-time (non-subsistence) jobs. These represent reduced

opportunities for the acquisition, discussion, and transfer of indigenous knowledge. Significantly, the interviews didn't indicate that individuals observe the salmon less while catching and processing fish. However, people indicated that traditions including traditional rules are waning among some young people, probably because people have less time for fishing and spending time with elders in general and especially at the rocks. Cultural change may also be partially based on the aboriginal population decline at the time of European contact and a loss of knowledge which may have occurred at that time. Finally, many sources point to the experience of residential schools in which children were housed outside of their home communities and taught by nuns and priests. Residential schools prevented the passing of native culture to younger generations in many cases and contributed to the loss of aboriginal languages.

Political will within agencies external to the local community must be generated in order to use local management capabilities and indigenous knowledge to a greater extent. However, the tasks of preservation and adaptation of local tradition will fall to the community. Today, people work at full-time jobs and do not engage in some of the traditional practices. (Responding to this, the Cayoose Creek community allows employees two weeks off during the summer for fishing, fruit canning, and hunting.) Story-telling, net-making, the full variety of salmon cutting techniques for drying, and rules of the rocks are not carried on to the next generation in this century to the same extent as they probably were in previous ones. This is because fewer salmon are being caught and people spend less time on the rocks, compared to the previous century. Thus, the community is turning to classroom-type settings and to the fishing licensing system to maintain and teach traditions. (The licensing system also specifically controls outsiders.) The Bridge River formal licensing system brought gains in terms of reinforcing local authority and encouraging traditional practices (eg. by encouraging drying on weekends). The traditions of

story-telling and experiential learning are not as prevalent today; these are harder to maintain than traditional rules, or even practices like net-making. Yet, they are probably significant in generating data and maintaining the philosophical structure which helps people integrate data. Thus, a significant task for today's administration and community leaders will be to find ways to adapt and support local traditions such as experiential learning and story-telling to circumstances today.

5.1.4.2 Environmental Change

Environmental change is, clearly, an impediment to the use of indigenous knowledge derived from years of contact with an environment. The Bridge and Seton River systems have both changed to the degree that elders now have a good deal of knowledge about what *used* to be. Without the resource, obviously, indigenous knowledge is no longer directly applicable to resource management. That knowledge may be used to help understand the change that occurred or how the depleted resource could be restored. However, the specific information on the resource is gone with the resource.

Another aspect of ecological change is the impact of environmental pollution on salmon stocks. Several elders expressed concern about the effect of oil spills and other contaminants on the fish. Elder Rose Whitley further identified the negative effect of pollution on the salmon as the main limitation to the productive use of indigenous knowledge.

If indigenous knowledge is valuable (as this study argues for the present case and many other studies argue in other cases), that knowledge is itself a resource, or a form of "cultural capital" (Berkes and Folke 1992a,b). Cultural capital refers to institutions and knowledge relevant to resource management which derive from a particular social and/or cultural situation

and which include local resource management systems and indigenous knowledge. In the same way that human-made and natural capital must be preserved, so must cultural capital.

One of the consequences of environmental change is that it contributes to the loss of information that might have been used to manage it and other nearby resources. When a salmon stock decreases, people may, either voluntarily or through prohibition imposed from outside, no longer use it. This reduces the capacity for generation of knowledge about that stock, its habitat, and other aspects of that environment. Environmental degradation not only reduces natural capital, it may also reduce cultural capital. Resource managers can recognize situations in which cultural capital, that is, a developed local capacity for generating knowledge and carrying out other management functions exists. These systems could then be given special consideration in environmental decision-making.

5.2 Analysis

5.2.1 Perspectives on Indigenous Knowledge

This study asks what indigenous knowledge is available in the study area and how it compares to western scientific knowledge. The research identifies several specific areas of local knowledge of salmon in this case. Three interrelated perspectives on this knowledge are suggested by this study.

5.2.1.1 Indigenous Resource Management is the Product of Accumulated Knowledge

The traditional Upper St'át'imc salmon management system is the product of years of reliance on the salmon resources. The management system was built up over time and is the result of many years of interaction between the salmon and the Upper St'át'imc people. (Recall that indigenous knowledge may be considered a process of "trial and error"--Dewalt 1994;

western scientific knowledge involves a similar process of choosing between alternative hypotheses.) The result of this process is a set of rules, ethics, beliefs, philosophy and facts which shape that interaction.

Rules and beliefs in a management system result from a type of knowledge. More precisely, they are the result of years of accumulated knowledge. Thus, rules, such as the determination of fishing quotas based on need ("take only what you need") or transcendence of the subject-object duality by showing respect for salmon, should not be seen as merely interesting cultural phenomena. Instead, these rules should be seen as indicative of accumulated ecological and social knowledge. How these rules could be adapted to modern circumstances within the majority culture should be considered by state resource managers, politicians, resource users, and the public in general.

5.2.1.2 Indigenous Knowledge is the Product of Interaction with the Environment

A second perspective on indigenous knowledge is that it is the result of intensive and extensive interaction with the environment. (This overlaps with the accumulation of knowledge discussed in 5.2.1.1; these are differentiated here to clarify the main issues.) In contrast, DFO data are frequently obtained by researchers who spend little time in the area. This is the result of "professionalization" of the knowledge process. The potential result is a narrower range of variables recorded and a reduced likelihood of recording anomalies, compared to information collected by a researcher who spends almost all of his or her time in the study area.

5.2.1.3 Indigenous Knowledge is Contextual

The third perspective on indigenous knowledge is the importance of context. In western science, quantification fulfills at least two purposes: to clarify and support theory (Kuhn 1982)

and to allow for the impersonal transmission and rapid production of information (Shepherd 1993). The history of western science confirms the latter point: the demise of the narrative as a form of scientific writing and the adoption of mechanized observation and standard techniques and instruments have occurred with the expansion of communication technology and the use of variably-skilled labour to increase scientific productivity. In general, researchers maintain close contacts within a narrow field; however, most of the actual activity is carried out by technicians and graduate students. (Shepherd 1993)

Quantification and objectivity have become "technologies" for dealing with distrust (Porter, quoted in Shepherd 1993). On the other hand, use of context or relationship, is a "technology" used within indigenous knowledge systems. Analyses of who the researcher is, what has been the past experience with him or her, what were the particular influences on that individual at the time she or he was making observations, what are the particular skills of that individual, etc. contribute to the development of indigenous knowledge.

Indigenous knowledge in the case tends to be qualitative, tends to be diverse, and takes a diverse range of factors into account. Data collected by DFO in this case tend to be quantitative, definitive (rather than conjectural), and comparable (both in form and quality) over large distances. In the absence of context, there is quantification and objectivity.

5.2.2 Recommendations for Using Indigenous Knowledge

5.2.3.1 Potential Benefits

The most common argument against using indigenous knowledge in a broader context is that that use would not be feasible or cost effective. Increasingly, however, governments *will* be pressured to recognize and use local knowledge as part of current directions toward increased

local involvement in natural resource decision-making. State resource managers will benefit from an understanding of local knowledge to the extent that it helps them better understand the basis for positions local harvesters put forth.

The potential gains from using indigenous knowledge will not be considered rational until a general understanding exists within state agencies (and beyond that), that use of indigenous knowledge can be cost effective. Harvesters gather information while they catch and process fish. This alone can make use of indigenous knowledge cost effective. Western scientific knowledge is very powerful in describing some aspects of salmon populations and their habitat. However, knowledge fulfills multiple functions in a resource management system. Local knowledge *may* not provide the (elusive) precision necessary for international negotiations. However, it can assist in defining overall goals. It can further be useful in involving the public and maintaining an stewardship ethic towards the resource. Indigenous knowledge can also be used to back up, verify, or question data obtained by state agencies or even "hunches" of state managers. These are all very rational and even essential components of natural resource management.

5.2.2.2 Principles for Using Indigenous Knowledge in Modern Resource Management

Fourteen principles are defined here for successfully using indigenous knowledge in modern resource management.

1. Oral use of the aboriginal language, especially in association with traditional activities, supports the continuity of indigenous knowledge systems.

2. Preservation of indigenous knowledge depends on its active use. Writing down facts and other components of a knowledge system is not sufficient to maintain a dynamic entity based on oral communication.

3. Recognition and support by external agencies of traditional use and management of fish resources is highly compatible with use of indigenous knowledge in a modern context. Few incentives exist to share knowledge when traditional management authority or aboriginal fishing rights are not fully recognized and affirmed.

4. Indigenous knowledge is best *collected and analyzed* by community residents, and preferably by residents fluent in the aboriginal language.

5. Collection and analysis of indigenous knowledge is best *administered* by a group of elders and other knowledgeable community members. Administration includes identification of the purpose, scope, potential participants, and interviewers and supervision of the work. It also includes making decisions about the final outcomes of the work.

6. Information needs for managing the resource are best defined by both the First Nation community and state resource managers.

7. Research on indigenous knowledge is facilitated by the recognition that specific facts, beliefs, philosophies, and rules, are all related to a knowledge system. Examination of beliefs and rules and their potential applicability to a modern context is a legitimate use of indigenous knowledge.

8. Collection and use of indigenous knowledge is facilitated through provision of training for community members in working with elders in formal settings and in the ideological, technological, and institutional components of the western scientific system of knowledge and resource management.

9. Training for government data gatherers in working with elders and other community members in gathering knowledge will facilitate use of indigenous knowledge in a modern context.

10. Recognition of the value of elders' contributions and adherence to principles of fairness in the collection and analysis of indigenous knowledge will facilitate exchange of information and its use in a modern context. Collection and analysis of indigenous knowledge may include providing material compensation, in addition to ensuring that the knowledge provided is clearly used to further local goals.

11. Fora should allow for exchanges between elders and government biologists. These would facilitate factual exchange and foster a greater appreciation of indigenous knowledge by western-trained biologists.

12. Supervision of the use of indigenous knowledge in a state resource management agency is best made by elders, together with a community advisor or a community liaison department. Scientists may perceive little reward in investigating indigenous knowledge (Finlayson 1994). They may regard pursuing indigenous knowledge as potentially hazardous to scientific productivity and using traditional knowledge as difficult because of its intractability. Community advisors or a community liaison committee could facilitate the exchange of information between local and state organizations. The goal of these bodies would be to help communicate information while avoiding the process whereby information can be stripped to its bare (numerical) bones to facilitate data management and communication.

13. Indigenous Knowledge Centres set up in local communities and staffed by elders and other community members can facilitate collection and use of indigenous knowledge. These could supply both specific and general information for internal and external needs. The Centres would provide opportunities for elders and western-trained biologists to exchange information. Contacts would be maintained to all state resource management agencies through the Centre.

14. Shifting responsibility for data collection down towards local offices would provide greater opportunity for exchange between elders and western-trained biologists. Devolution of responsibility for data collection can save money. These funds could be directed to elders, to facilitate their participation and aid in collecting and using indigenous knowledge.

5.3 Further Research

The conclusions of this study are tentative and must be substantiated by further research on the relationship between indigenous and western scientific knowledge. In general, studies are required on the generation and communication of knowledge within each of the Department of Fisheries (or other state agency) and the Upper St'át'imc (or other community engaged in traditional subsistence activities). More specifically, the following studies should be given a high priority.

1. Investigation of how people who provide knowledge can control its use and prevent its misuse will facilitate use of indigenous knowledge in a modern context. The irony that knowledge of First Nations peoples was used in the expansion of European peoples and

cultures and the subsequent reduction in access to resources is not lost on elders and may serve as a cautionary remembrance.

2. The compatibility of new technologies, such as Geographic Information Systems with indigenous knowledge warrants study. Management activities in local communities can be, and is being, aided by new technologies. However, the effect on the indigenous knowledge system may not be positive.

3. Research is required on the use of information which is often collected by local people. This information includes parasite load, sex of catch, and approximate indicators of oil content, average fish size, run size, quality of flesh and general habitat condition, including water quality. What these factors indicate about the state of the habitat and salmon stocks should be investigated.

4. The extent to which information could be exchanged among First Nations and how this could be facilitated in order to obtain understanding over a larger region requires investigation. First Nations could cooperate to establish "institutes" of indigenous knowledge. The question of how this knowledge could be studied and communicated deserves attention.

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Appendix I

Interview Questions

1. At what age did you go down to the fishing grounds?
2. Who could use the fishing rocks in previous times?
3. Was this different for different rocks?
   Who had priority?
   Which outsiders could come to fish? How did you make sure that they would follow the same practices as your own people? Which people were considered outsiders (nation, village, etc.)?
4. How did people know when to start fishing and when to stop fishing for the season? (Was it different for different species?)
   who decided, what was their position (did they fish)?
5. How did people know how many fish to allow to proceed upstream (to spawn or for other reasons)?
6. Which fish were preferred?
   for taste, preservation, ecological, technological reasons?
7. How did fish get distributed in a family or a village?
8. Were efforts made to protect the spawning areas, keep the river clean or maintain areas free for passage of the salmon?
9. What changes have you seen in the fish stocks?
   Are there runs that used to come here that do not anymore?
   When did these stop coming?
10. What is your explanation for why they stopped coming?
11. How did people identify the different stocks that came up the river? How were the different stocks grouped--was it on the basis of timing and species, or were other factors involved?
    Do you know if people have been able to identify the different stocks that come up the river?
    Were different stocks fished differently?
12. Have you or anyone else attempted to discuss the changes you have noticed with DFO or any other agency?
13. Do you know of any stocks that could be increased?
14. What fishing practices that your parents and their parents practiced do you think would be valuable/important for using today?
15. How would you like to see the fishery change in the future?
16. How was knowledge of the fishery passed on to the children?

Appendix II

List of Elder Interviewees

Maggie Adolph
Tommy Adolph
Carl Alexander
Louie Bob
Bill Edwards
Aggie James
Tommy James
Mrs. Jimmy
Lillian Link
Ed Napoleon
Mary Napoleon
Desmond Peters, Sr.
Mary Peters
Ceda Scotchman
Jimmy Scotchman
Rose Whitley

Interviews with non-elders are listed in the references section above.

(CD in the text of this paper indicates the interviewer, Coral deShield.)