Counting on their Migration Home: An Examination of Monitoring Protocols and Saanich First Nations' Perspectives of Coho *(Oncorhynchus kisutch)*, Chinook *(O. tshawytscha)* and Chum *(O. keta)* Pacific Salmon at Goldstream River and Saanich Inlet, Southern Vancouver Island, British Columbia

by

Roxanne Paul
B.Sc., University of Victoria, 2000

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of

MASTER OF SCIENCE

in Interdisciplinary Studies

SUPERVISORY COMMITTEE

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ABSTRACT

Records of abundance of salmon that return to their natal spawning stream (escapements) are important indices that can assist with monitoring, conservation, and management of a salmon population over time. On their own, however these data reveal very little about the habitat, ecosystem and human communities that salmon encounter on their journey from freshwater to sea and back again. This research examines monitoring protocols for Goldstream River salmon stocks (coho, chinook and chum Pacific salmon). It includes and reaches beyond biostatistics from stream surveys to gauge First Nations' artisanal fishing activities at Goldstream River and Saanich Inlet as well as their commercial chum fishing endeavours in Saanich Inlet on south Vancouver Island, British Columbia. Methods included summations of major themes from interviews on traditional ecological knowledge (TEK) shared by local Saanich First Nation fishers whose families have lived in the communities around Goldstream River and Saanich Inlet for more than 200 years. Analyses of Goldstream salmon escapements for the period 1932 to 2004 and native harvest statistics of chum caught from Saanich Inlet between 1982 and 2004 are integrated with results from analysis of TEK research undertaken for this project. Key recommendations arising from the results of this research are: stream habitat restoration in response to loss and degradation of salmon-bearing streams;

modification of stream survey procedures to measure for morphological and physiological attributes including indicators of the health of Goldstream salmon; monitoring and eliminating sources of pollution to Saanich Inlet waters; implementing precautionary measures to ensure that overfishing of Goldstream salmon and shrimp in Saanich Inlet does not recur; and safeguarding naturally abundant Goldstream chum populations at the river. Under current management of the Goldstream chum fishery, the maximum carrying capacity (K) or target escapement of chum that the Goldstream River spawning grounds sustain is 15,000. Based on population assessments as well as physiography and ecosystem dynamics, I infer that Goldstream River's K for its natural chum population is between ~16,000 and 18,000; ~1,500 for the mixed stocks of natural and hatchery enhanced coho; and ~50 for chinook (based on the river's naturally occurring populations between 1932 and 1973) or ~385 enhanced chinook (based on the returning population from 1975 to 2002 since hatchery enhancement took place). A co-management relationship exists between Fisheries and Oceans Canada (DFO) resource managers and the Saanich First Nations bands (Saanich Tribal Fisheries councilors). Improvements to communication, collaboration and information sharing between DFO resource managers, Goldstream hatchery operators and Saanich First Nations with regards to decisions made about Goldstream salmon stocks are, however, necessary. In this thesis, I propose a model with recommendations for compatible fisheries management goals and techniques including adaptive management and ecosystem-based management to address this problem.

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EXAMINING COMMITTEE
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CHAPTER 1 - INTRODUCTION: RATIONALE FOR GOLDSTREAM SALMON MONITORING RESEARCH

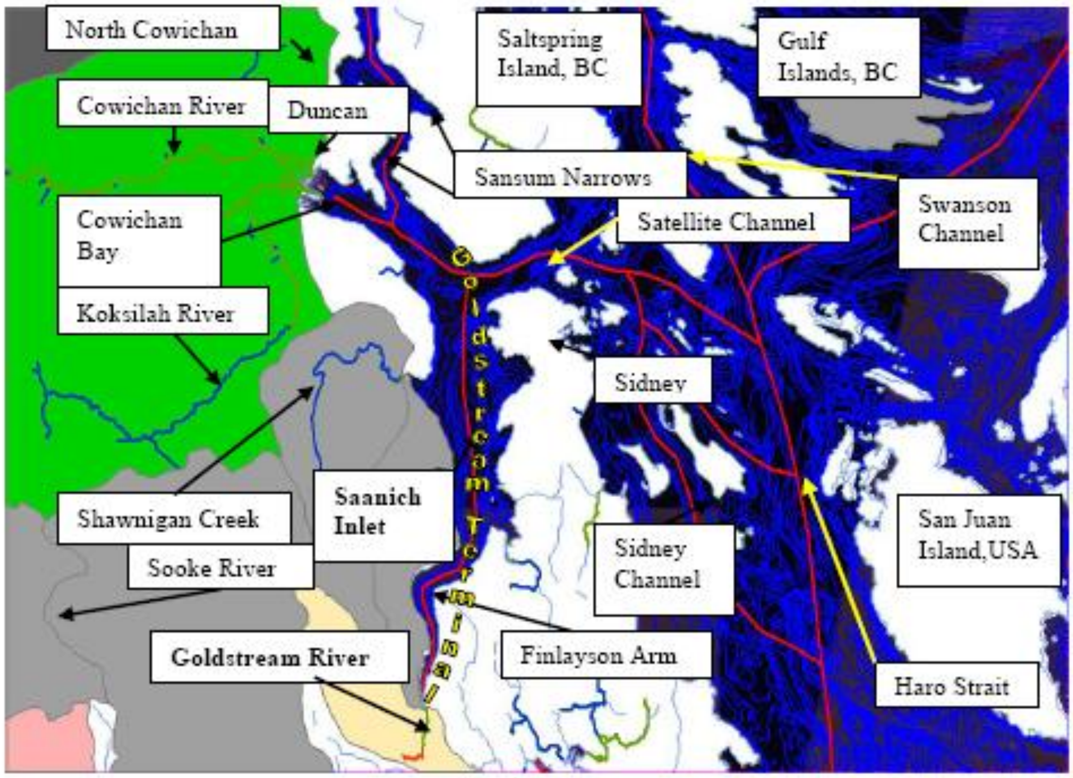
1.0 <u>Introduction and Background to the Study</u>

Three species of Pacific salmon – coho (*Oncorhynchus kisutch*), chinook (*O. tshawytscha*) and chum (*O. keta*) – migrate through Saanich Inlet to access Goldstream River, along the southern coast of Vancouver Island, as a spawning stream (Figure 1). These salmon have enormous cultural, nutritional and economic value for people of the Saanich First Nation who continue to fish for salmon at Goldstream River and Saanich Inlet. The salmon are also valued in the adjacent tidal water sport fishery and the offshore commercial fishery. Goldstream River salmon are genetically distinct from any other anadromous salmon population. As shown in this study, there are ongoing concerns over the long-term viability of the Goldstream salmon, including unexplained fluctuations in their populations (DFO 1999a 1999b, 1999d, 2001c, 2001d, 2002d, 2004b, 2004c, 2004d, 2004e, 2006a, 2006b).

1.1 <u>Research Goals and Objectives</u>

This research was undertaken in the interest of contributing to wild salmon conservation and future sustainable fisheries management planning. I hope that my findings will be useful to those working towards protecting, sustaining and enhancing the Pacific salmon fishery. The purpose of this research was to examine Goldstream salmon population trends in order to determine if, and how, historical and current records of salmon populations and Saanich First Nations' fishers' traditional ecological knowledge (TEK) about the salmon can effectively contribute to improving monitoring protocols for assessing annual returning populations of wild coho, chinook, and chum salmon at Goldstream River and Saanich Inlet.

Figure 1. Watersheds and Salmon Migration Routes Leading to Saanich Inlet



(Base Map and Thematic Layer Source: Community Mapping Network 2006) N

Legend

- Coho Distribution Zones
- Chinook Distribution Zones
- Chum Distribution Zones
- Ocean
- Salmon Migration Routes
- Goldstream River Watershed
- Cowichan River Watershed
- Sooke River Watershed

The ultimate goal was to assist in conserving, protecting and sustaining wild and natural salmon stocks[1]. A further objective was to develop a framework that addresses the complexities of monitoring and assessing salmon stocks and managing the local salmon fisheries. To that end, this study adopted an adaptive management, co-management and traditional management systems approach toward assessing returning salmon populations. The methodology for this research involved the integration of two emerging knowledge systems relevant to monitoring salmon and salmon fisheries: quantitative methods creating time series graphs from annual escapement[2] (Appendix A); and native harvest statistics; and social science methods yielding indigenous knowledge and perspectives of the Goldstream salmon fisheries.

Data gathering for this study was carried out over one field season (2002). Methods included stream surveys to learn how escapement data used in this study (DFO 1932-2004) are collected, and interviews with Saanich fishers about their traditional and current salmon fishing methods, and about the Goldstream salmon. In addition to these two research methodologies, I used the logistic growth model to determine the rate of population increase of Goldstream salmon. I also conducted a catch-per-unit-effort (CPUE) analysis with the limited data available to illustrate its function as a monitoring tool for Saanich fishers[3].

[1] ‘Salmon stocks’ and ‘wild’, ‘natural’ and ‘hatchery’ salmon are defined in Appendix A.
[2] Salmon escapements are records of abundance of (wild or hatchery-raised) adult salmon that escaped capture by inshore, offshore or freshwater fisheries, as well as freshwater or marine wildlife predators during their migration from freshwater to sea and back again and were identified at their natal spawning ground (Appendix A).
[3] A catch-per-unit-effort (CPUE) of the modern Saanich Inlet chum fishery operated by Saanich First Nation bands was originally proposed for this project. Due to inconsistencies in catch and effort data, a statistically meaningful CPUE analysis and measure of sustainability could not be attained and so the CPUE data and results are intended only as an example of the merits of CPUE analyses.

1.2 Thesis Framework

In Chapter 2, the geography and ecology of the Goldstream River salmon habitat and populations are described based on my review of the literature and personal observation. Chapter 3 presents an overview of current salmon management practices; salmon enhancement of Goldstream coho and chinook stocks; Fisheries and Oceans Canada's (DFO's) administration of the Saanich Inlet chum surplus fishery; and an overview of Saanich and other First Nations' perspectives of salmon and coastal fisheries. Both science and social science methods were used to address the complex question of salmon populations and monitoring protocols. Chapter 4 summarizes relevant literature about the contributions of traditional ecological knowledge and western scientific knowledge to wild salmon conservation and includes the topics of past and present fishing activities, ecological relationships, conservation practices of First Nation fishers, wildlife population assessments, mixed stocks of wild and enhanced salmon, native harvest statistics and wild salmon monitoring and management efforts. Chapter 5 presents methods used in the study, including field monitoring of returning salmon populations, population assessments from escapement records, analysis of native harvest statistics, and interviews with Saanich fishers. Results from these different approaches are reported and analysed in Chapter 6, and the findings are discussed in Chapter 7, in relation to the goals of this research. Chapter 8 presents recommendations and conclusions emerging from the study.

CHAPTER 2 - HABITAT AND NATURAL HISTORY OF GOLDSTREAM SALMON

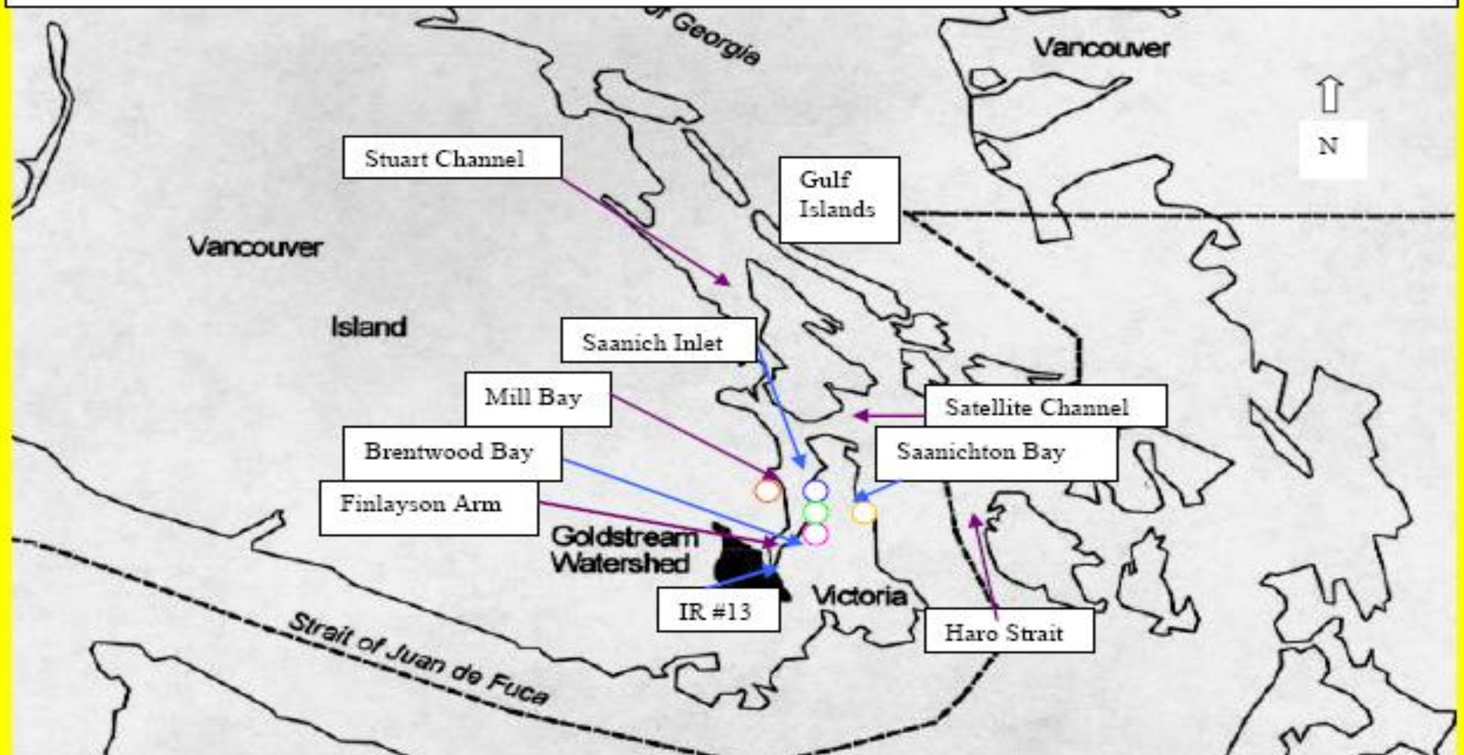
2.0 Study Sites: Saanich Inlet and Goldstream River Watersheds

The migratory route of Goldstream salmon consisting of Saanich Inlet and Goldstream River watersheds is referred to as the Goldstream terminal (DFO 1978-2004) (Figure 1). Saanich Inlet is a temperate marine fjord on the southeastern tip of Vancouver Island located on the west side of the Saanich Peninsula extending approximately 21 kilometres north of Goldstream River. Goldstream River flows into Saanich Inlet, and both the river and the inlet are important traditional fishing localities for the Saanich First Nations (Figure 2.1).

Saanich Inlet has unique oceanographic characteristics related to particulars of inflow of ocean and freshwater sources, ocean currents, low vertical mixing and a high level of algal or phytoplanktonic primary production of single-celled diatoms and dinoflagellates (Table 2.1) (VENUS 2004). These features influence the salmon populations' path of migration, as well as their supply of oxygen and food throughout the inlet (e.g. zooplanktonic crustaceans such as copepods and krill).

The Goldstream watershed is located at the head of Saanich Inlet (Finlayson Arm) about 15 km NW of Victoria. Environmental conditions and human use (summarized in Table 2.2) can affect fall season salmon runs. Precipitation, and storage and diversion of water affect the hydrology of Goldstream River, and impact water

Figure 2.1 Location of Saanich First Nation Bands (Base Map from: Bocking et al. 1998)



Saanich First Nation Bands

○ **Tseycum** ○ **Pauquachin** ○ **Tsartlip** ○ **Tsawout** ○ **Malahat**

- Members of all 5 bands use the small 4.8 hectares of reservation land located at the mouth of Goldstream River, referred to as Indian Reservation or IR #13 (Department of Indian Affairs and Northern Development 2006)

Table 2.1 Characteristics of Saanich Inlet (Bornhold et al. 1996: 4; DFO 2002a; Gargett et al. 2002:2; O'Connell 1997:106; WLAP 1995).

Cartographic Coordinates/ Geographic Location	Latitude: 48º 36' 29" N Longitude: 123º *28'* 41" W South of Saltspring Island and Sansum Narrows, West of Sidney (Figure 1)
Total Watershed Area	400 km²
Surface Area	65 km²
Length and Width	26 km by 0.4 km to 7.6 km
Sill Depth (at mouth of Inlet)	70 m
Maximum Depth	225 m
Source of Ocean Water Inflow	Satellite Channel (fed by Swanson Channel and Haro Strait)
Sources of Freshwater and Sediment Inflow	Cowichan River in the winter and northeasterly Fraser River in the summer; also Goldstream River and Shawnigan Creek
Water circulation	Inverse estuary (ocean water inflow in upper layer, super saline water outflow in lower layer); low vertical mixing (driven by winds and tides) most years
Primary Production	High; a major spring algal bloom, followed by several sporadic mini-blooms in the summer and fall months
Characteristics of Benthic Environment	Anoxic benthic waters, sediments accumulate undisturbed over time
Saltwater transport	Southerly oceanic saline waters are transported to the inlet and flow into the brackish headwaters of Finlayson Arm, which flows into the Goldstream River estuary at the river's mouth (Figure 1)

Table 2.2 Characteristics of Goldstream River Watershed (BC Fisheries 2001; BC Ministry of Forests 1999a, 1999b; Bocking et al.1998; CRD 2003a; CRD 2006)

Geographic Location & Ecological Features	Latitude: 48º 29' 00" N. Longitude: 123º 33' 00" W at river's mouth. 15 km NW of Victoria (Figure 2.1). Part of the Vancouver Island Forest Region (Nanaimo Lowlands Physiographic Region). Within the warmer, drier Coastal Douglas-Fir Biogeoclimatic Zone (ranging from sea level to 100 m elevation in the adjacent forested riparian area that extends from reach 1 to 4 along the river) and within the wetter, cooler Coastal Western Hemlock Biogeoclimatic zone in areas extending from sea level to 200 m elevation and higher (e.g. forested area adjacent to upper reaches 5 to 8 of the river) (Figure 2.2). The upper portion of the watershed is part of the Greater Victoria Water District, a designated conservation area.
Length	12.5 km
Area	40 km^2
Stream Flow Direction	Southeasterly (coming from the southeast)
Stream type	Third Order Stream (formed by the joining of two First Order streams in the drainage basin which forms a Second Order stream whose tributary joins to the main stream, forming a Third Order stream) (Christopherson 1994:420).
Annual Precipitation	Averages 800 mm regionally, mostly in form of rain, heaviest in winter months (Nov-Mar), lowest in autumn (Aug-Sept)
Surficial materials	Tills of varying depth (primarily with a sandy loam matrix), colluvium, exposed bedrock
Water Management	Dams were constructed at the outlets of Goldstream, Lubbe and Butchard lakes between 1892 and 1914 and were upgraded in 1995 to meet seismic standards. Water released from the lakes is diverted into Japan Gulch Reservoir water supply system near the Goldstream salmon hatchery. The Capital Regional District Water Department (CRDWD) maintains minimum flows to Goldstream for salmon fishery enhancement. Waterflows in excess of requirement pass down Goldstream River, north into Finlayson Arm. CRDWD used to divert water from Goldstream and one of its tributaries, Waugh Creek to provide Greater Victoria with ~20% of their water supply until 2003 when the Sooke dam was raised and began providing 100% of the water supply to area residents. Goldstream system reservoirs now provide only backup storage water for use during drought conditions, annual routine maintenance or emergencies when water cannot be supplied from Sooke Reservoir (CRD 2006).

levels critical for supporting fall salmon spawning runs. In 2003, for example, hatchery workers at Goldstream River observed “hundreds” of chum dying in the estuary and unable to access spawning grounds upstream due to critically low water levels (McCully P. pers. comm. 2003).

The lower, 5 km salmon-bearing portion of Goldstream River watershed is within Goldstream Provincial Park, which is less than 100 to 180 m in elevation above sea level, and is lined by hills and sharp cliffs. I used this same lower Goldstream field site that hatchery volunteers use to do the annual escapement enumeration of salmon that is described in the Methods chapter. This stretch of river is about 3 km long, extending from the mouth of the river at Reach 1, upstream to Reach 4 where the hatchery-counting fence (salmon trap) and the Water Survey of Canada Gauge Station are located (Figure 2.2).

Salmon returning to Goldstream River pass through Reach 1, near the mouth of the river, and either remain there or migrate further upstream to spawn in Reaches 2 and 3. All three reaches surveyed are quite shallow and are primary salmon habitat assessed as having high habitat value (Bocking et al. 1998). Channel stability is important for salmon spawning grounds. Degradation from erosional processes such as bank erosion causes deposition of fine sediments over the riverbed, which can destroy salmon redds (spawning sites in gravel). Bank erosion may also reduce channel stability by lowering the riverbed or changing the riverbed slope (Brye et al. 2004; Parkyn et al. 2005; Payne and Lapointe 1997). Most of Reach 1 of Goldstream was assessed as having mostly ‘good’ quality salmon spawning gravel. Overall quality of spawning gravel in both the upper parts of Reach 1 and Reach 2 further upstream, however were rated as only ‘fair’ (Bocking et al. 1998) (Appendix B).

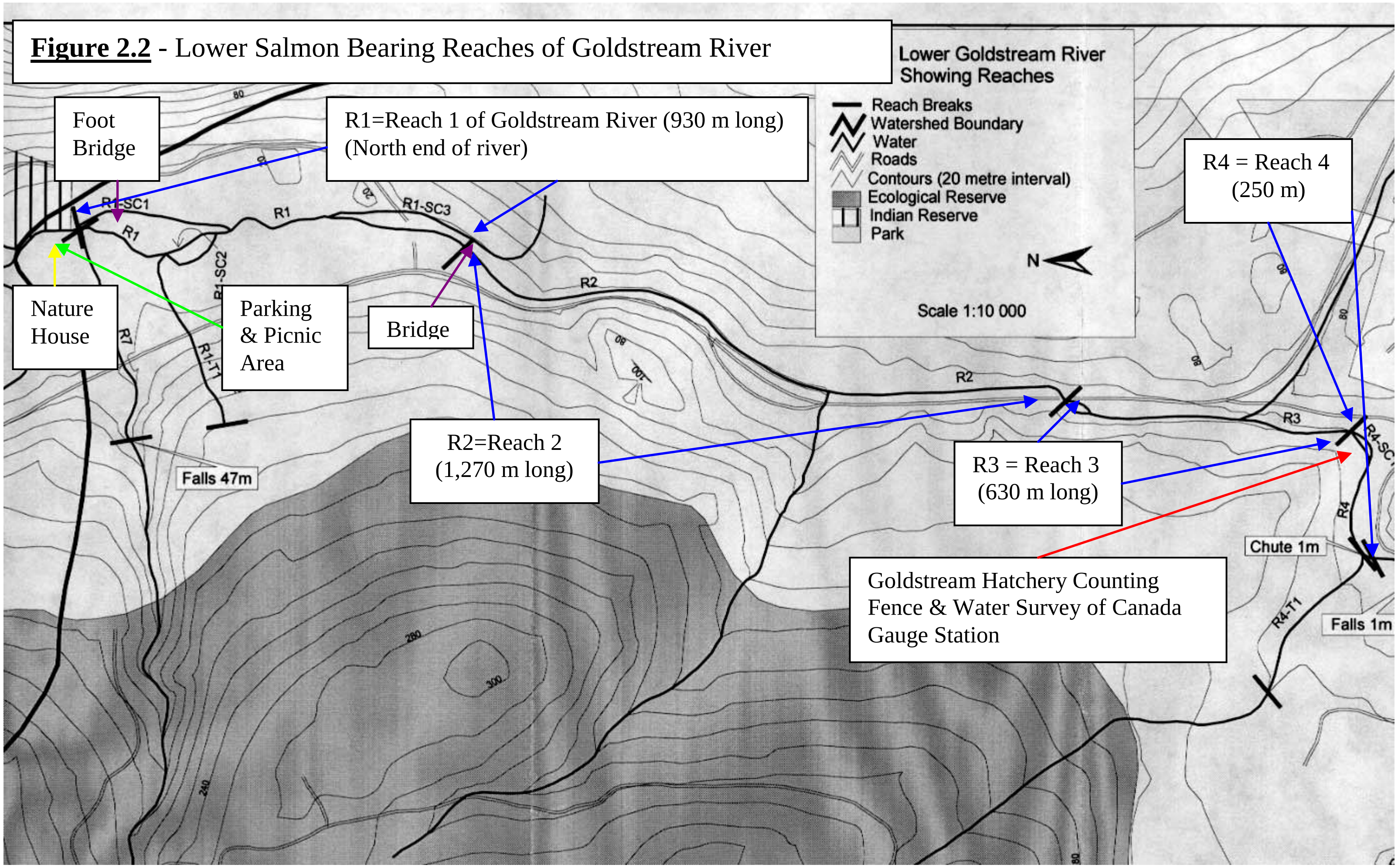


Figure 2.2 - Lower Salmon Bearing Reaches of Goldstream River

Study Site Escapement Survey Area - Reaches 1 - 3 = 2.83 km (Bocking et al. 1998: Insert)

The Goldstream watershed currently consists of mixed canopies of western redcedar (*Thuja plicata*), red alder (*Alnus rubra*) bigleaf maple (*Acer macrophyllum*) and Douglas-fir (*Pseudotsuga menziesii*) with salal (*Gaultheria shallon*), sword fern (*Polystichum munitum*) and red huckleberry (*Vaccinium parvifolium*) comprising some of the dominant under story species (Bocking et al. 1998). Goldstream acquired its name from Peter Leech who found gold-bearing gravel in the river in 1858. A small gold rush ensued from 1863 to 1864 when about 300 men worked along the river in search of gold (Akrigg and Akrigg 1998). There is scientific evidence from Saanich Inlet sediment cores that the woodlands surrounding Saanich Inlet were dominated by cedar, western hemlock and Douglas-fir (characteristic of old growth forests) 2,000 years ago (Heusser 1983). Tunnicliffe (2000) found that the ratio of western redcedar (characteristic of mature forest) to alder (a first colonist in riparian habitat) in this region has changed from 3:2 in 1865 and 1918 to 1:4 in 1935, with the presence of alder more than doubling between 1900 and 1970 (after Heusser 1983).

Prior to road and dam construction and logging activities in the mid and late 1800s and from 1938 to 1995, (when the Greater Victoria Water District lands at Goldstream were designated as an ecological reserve and logging activities were terminated), the riparian zone was dominated by coniferous trees that characterize old growth forest of the coastal Douglas-fir zone. That habitat includes coastal Douglas-fir, Grand fir (*Abies grandis*) and Western redcedar (Pojar et al. 2004). The shrub layer is dominated by dull Oregon-grape (*Mahonia nervosa*), salal, oceanspray (*Holodiscus discolor*), and trailing blackberry (*Rubus ursinus*). The underlying herb layer consists of Broad-leaved starflower (*Trientalis borealis* ssp. *latifolia*), sword fern and bracken fern (*Pteridium aquilinum*). Oregon beaked moss (*Kindbergia oregana)*, electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) and step moss (*Hylocomium splendens*) comprise the dominant species in the moss layer in old-growth forests of this type (Green and Klinka 1994).

The ecological integrity of Goldstream River habitat is critical to the perpetuation of healthy Goldstream salmon populations and of the Saanich First Peoples' salmon fishery. More detailed physical descriptions characterizing the salmon spawning habitat within the Goldstream survey area are listed in Appendix B.

2.1 Life History Patterns of BC Coho, Chinook and Chum Pacific Salmon

The various names of the Goldstream salmon, including the Saanich language terms, are listed in Appendix C. Pacific salmon species, including the Goldstream salmon (coho, chinook, chum), are anadromous, hatching in fresh water, migrating to the ocean where they spend most of their adult lives, and returning to freshwater to spawn. After spawning, the adults die and the fertilized eggs remain in the gravel spawning beds until they hatch and the young fry salmon emerge from the gravel beds into the river, then swim downstream to the estuary, and then into the saline ocean waters as smolts. The lower salmon-bearing reaches of Goldstream River are shown in Figure 2.2. A summary of life history characteristics of the Goldstream salmon, including amount of time they spend in the river prior to their migration to saline waters, is provided in Table 2.3 below. More detailed life histories and ecologies of the three Goldstream salmon species follow [4].

[4] There are no records of pink (*Oncorhynchus gorbuscha*) or sockeye (*O.* nerka) salmon populations for Goldstream River.

Coho spawn later than chinook or chum, from late October and early November until late December and early January. Eggs remain in the gravel until spring or early summer (See Table 2.3 for approximate number of eggs laid per female). The fry spend one year growing in freshwater, then as smolts they swim out to sea. Many remain close to shore throughout their marine lives, others move out to deeper ocean waters. Coho spend between six and 18 months at sea before returning to their natal freshwater stream. Average adult weight is 4 kg (Baxter 2000:21) (Table 2.3). Salmon returning to freshwater after only one year at sea are also called grilse. This is true of chinook and chum as well, but coho are the species that most commonly return from sea within just one year. Upon returning to freshwater, the coho migrate upstream diurnally, leaping out of the water frequently and moving quickly through rapids or

Table 2.3 Life History Characteristics of Goldstream River Salmon
(Baxter 2000; Candy and Quinn 1996; Harvey and MacDuffee 2002)

Salmon Species	Average Spawning Age	Spawning Season	Average Adult Fork Length[5]	Average Adult Weight	# Eggs Laid/ Female	Average Age of Fry at Ocean Migration/ Smolt Stage
Coho	3 yrs old	Nov-Jan	55 cm	4 kg	> 5000	12 months
Chinook	3 yrs old	Oct-Dec	80 cm	16 kg	< 4000 - >14,000	< 3 months
Chum	5 yrs old	Sept-Dec	65 cm	5 kg	2,000 - 4,000	< 1 week[6]

shallow riffles during spawning peaks. They usually remain out of sight in deeper pools or shady areas under streambanks when resting and are therefore more difficult to see from the streambank than chum or chinook. Coho are known to have a seasonal

[5] Tip of nose to fork of tail fin.
[6] Chum fry swim to estuary immediately after emerging from gravel and migrate from estuary to sea after a few weeks.

competitive advantage over other salmon, which spawn in earlier autumn; coho females tend to dig up and destroy existing redds to lay their own eggs (Baxter 2000). Coho can travel further upstream to spawn than chum, because they are able to leap over obstacles which chum cannot. Coho do not generally migrate as far inland as chinook, however, and tend to select finer gravel in which to dig redds (Harvey and MacDuffee 2002). Coho die within approximately two weeks of entering freshwater to spawn (Baxter 2000).

Chinook (also known as “Spring” or “King” salmon) spawn at Goldstream from about mid October to December. Eggs remain in the gravel until spring or early summer. The fry then travel downstream to the estuary right after emerging from gravel redds and spend about three months growing in freshwater before swimming out to sea. The smolts remain in sheltered coastal waters during summer before migrating northward to deeper ocean waters. Most chinook spend about two and a half years at sea and remain within approximately 1000 km of their natal river. They return to spawn at ages three to four although males tend to be younger than females, commonly returning to freshwater as two-year-olds (Baxter 2000; Healey 1991). Average weight of males and females is about 16 kg (Table 2.3) though weights of 45 kg are not unusual (Harvey and MacDuffee 2002:100). Chinook are the largest but least numerous of the Pacific salmon, with many spawning populations estimated at less than 1000 spawners (Baxter 2000:21; Harvey and MacDuffee 2002:100). Chinook spawn in tiny tributaries, streams or main river channels and die between approximately 4 and 25 days after spawning (NOAA 2005).

Chum spawn between September and December. Eggs hatch in the gravel in the spring and the alevins, which feed on their yolk sac, remain in gravel beds for about a month, then emerge as fry and travel downstream to the estuary immediately. The fry spend about three months growing in brackish waters of the estuary before swimming out to sea as smolts in the summer (between May and August). Juveniles remain in nearshore, sheltered coastal waters over the summer before migrating out into deeper ocean waters within about 35 km of the coastline in autumn and early winter as adults. Chum will spend between two and a half and four and a half years at sea before returning to their natal river. The average weight of an adult male or female chum is 5.4 kg (Baxter 2000; Hicks 2002 in Harvey and MacDuffee 2002:99) (Table 2.3). Chum migration from the estuary of the river to spawning grounds upstream is cued by increased water flow. They are strong, fast swimmers (maximum swimming speed of 3.05 m/s with short burst speeds of 4.6m/s) but they do not leap, are reluctant to enter long-span fish ladders and their migration distance upstream is stopped by the first significant barrier. Chum enter freshwater, spawn and die within three to 11 days (Baxter 2000: 28; Rawding and Hillson 2003:23).

2.2 BC Salmon Fisheries as Predators within the Salmon Food Web

It is evident that BC coho and chinook stocks declined from the 1970s through to 2005 (as is detailed in section 2.3). The resulting decrease in commercial and recreational Pacific salmon fishing opportunities negatively impacted the economies of BC's coastal fishing communities (BC WLAP 1995, 1996; Copes 1998; DFO 1998, 1999a, 1999c, 2001d, 2002d, 2004a, 2004c, 2004d; Edwards and Glavin 1999; First Nation Panel on Fisheries 2004; Haggan 2000; Haggan et al. 2003; Morrell 1989; Walters 1995). This predator-prey dynamic between humans and salmon exemplifies the importance of salmon in human societies and economies, which exists in addition to their role as keystone species[7] in marine and aquatic ecosystems. Under the current commercial salmon fishery regime, humans as predators take proportionately three to 20 times more Pacific Coast salmon than non-human predators (e.g. bears, wolves, eagles and seals) consume in a natural multi-predator, predator-prey relationship (Reimchen in: Harvey and MacDuffee 2002:96).

In addition to providing a direct source of food energy for a range of predator and scavenger species, salmon play a key role in aquatic and terrestrial ecosystems as sources of nutrients for tree growth in the riparian zone[8] and in many other parts of the food web (Bilby et al. 2003; Helfield and Naiman 2001; Hocking and Reimchen 2002; Honea 2005; Naiman et al. 2002; Reimchen 2001; Sucre et al. 2005). Salmon are a keystone species in the southern Vancouver Island coastal ecosystem and are also providers of substantial amounts of nitrogen (~ 23%) contributing to the growth rate of trees and shrubs within the riparian zone (Helfield and Naiman 200:2403). The continuance of abundant returns of Goldsteam salmon spawners (or escapements) to their natal river is therefore very important to the Goldstream riparian ecosystem as well as to human and non-human predators.

2.3 Population Trends in BC Wild Salmon Stocks

Stocks of wild salmon in BC have declined dramatically from their original numbers since large-scale commercial fishing began at the turn of the 20th century (Morrell 1989; PFRCC 1999; Pinkerton and Weinstein 1995; Wood 2001; DFO 2002d).

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[7] Keystone species is defined by Power et al. (1996:609) as "a species whose effect is large, and disproportionately large relative to its abundance".

[8] Isotopic analyses demonstrate that trees and shrubs near spawning streams derive ~ 22-24% of their foliar nitrogen (N) from spawning salmon (Helfield and Naiman 2001:2403).

Gresh et al. (2000) document a 70% to 90% reduction of adult salmon escapement to coastal North American river systems, at least in Wasington, Oregon and California, since 1890. Public interest groups, scientists and fisheries managers and other researchers have been advising the public about potential effects of over-fishing and habitat destruction upon BC wild salmon stocks for decades (Coward et al. 2000). The decline in BC salmon stocks was most apparent to commercial, recreational and First Nation fishers, fisheries managers, scientists and researchers by the 1970s and through the 1990s. In 1998, an independent panel of scientists informed DFO that unless meaningful action was undertaken immediately, the BC wild salmon resource could suffer a collapse from which it might never recover (NRDC 2001). Fisheries managers have since reported that BC salmon stocks are in a state of crisis (Copes 1998; DFO 1998, 1999a, 1999b, 1999c, 2004b, 2004c, 2004d; Fisheries Renewal BC 1998; Harvey and MacDuffee 2002; Walters 1995). This decrease in salmon stocks led to federal initiatives for conservation management (e.g. fishing restrictions and salmon enhancement), which targeted those stocks with the most severe population declines.

It is difficult to assess the details of the long-term decline of the BC west coast salmon runs because reliable data on the status of many stocks are unavailable. Lack of reliable, consistent data from stock assessments (such as mortality abundances along inshore terminals) was also a problem for the Newfoundland and Labrador (northwest) Atlantic cod (*Gadus morhua*) runs that collapsed in 1992 (Neis et al. 1996, 1998). Scientists have found that 43% of Canada's 9,662 west coast anadromous salmon and trout stocks could not be assessed due to absence of reliable data (Slaney et al. 1996). Of the 5,507 stocks for which reliable data were obtained, results showed that 142 west coast stocks have disappeared over the last century, 624 are at high risk of extinction, 78 are at moderate risk and 230 are of special concern. Habitat degradation from logging, urbanization and hydroelectric power was cited as the main reason for the 142 west coast salmon and trout extinctions (Slaney et al. 1996). Escapement data for Goldstream salmon stocks do exist for the period 1932 to 2004 and my findings from analyzing these data are included in the results of this thesis. Possible reasons for the emerging patterns I observed relating to Goldstream salmon stock escapement data are relayed in the discussion of this thesis.

BC salmon catches were lower in the five-year period from 1996 to 2001 than at any time 50 years prior to that (1951 to 1996). The number of stocks contributing to the 1996 to 2001 catches also declined, with stocks shifting from many diverse runs to fewer strong runs (PFRCC 1999; Wood 2001), resulting in part from hatchery enhancement of salmon populations.

Goldstream salmon fall within the BC South Coast, West Coast Vancouver Island (WCVI) and southern Strait of Georgia salmon stock categories assigned by DFO (DFO 1999b, 1999, 2001d, 2002d). According to DFO stock assessments, South Coast BC coho stocks, Southern Strait of Georgia coho and chinook stocks and WCVI chinook stocks dropped to “seriously low” population levels from the 1970s to the 1990s and at the beginning of the 21st century. By 1999, coho salmon populations had decreased below long-term averages more drastically than other BC salmon species (Baxter 2000; DFO 1999c, 1999d). These stocks remained at low abundances in 2005 but were projected to increase slightly in 2006 (DFO 2005c).[9]

[9] Though conservation efforts are in place, WCVI coho and chinook stocks are not listed as species at risk under Canada’s Species at Risk Act (Baxter 2000; DFO 1999; Environment Canada 2005).

Due to high mortality rates at sea over the 25-year period leading up to 1999, WCVI and southern Strait of Georgia coho and chinook stocks were subjected to intensive conservation measures (Copes 1998; DFO 1999d). Efforts to restore these declining coho and chinook populations include enhancement programs implemented under DFO management plans such as the hatchery coho and chinook stock enhancement initiative in place at Goldstream River.

WCVI coho and chinook stocks appeared to be generally increasing in 2003 (DFO 2004d). Southern Strait of Georgia coho returned in low abundance due to poor marine survival in 2004. However WCVI coho returned in higher abundances and limited fishing opportunities for wild coho were anticipated and permitted in tidal waters, including Saanich Inlet, for the 2005 fishing season (DFO 2005c, 2006a, 2006b). Several south coast (of the BC mainland and of Vancouver Island) coho stocks were depleted and expected to have low returns in 2006 (SeaChoice 2006). Chinook stocks remained strong in 2004 and were projected to return in high numbers in 2005 (DFO 2005c). Though expected returns were mixed, some WCVI (as well as Fraser River and Georgia Strait) chinook stocks were projected to be poor (SeaChoice 2006). WCVI chum stocks were assessed as poor to average (ranging from below average to near average) in 1999 and were projected to remain between these two status categories in 2003 (DFO 2002d). WCVI chum were reported to be generally returning in good, strong numbers in 2003 (DFO 2004d), and were projected to return at average to above average numbers in 2005 (DFO 2005c) and 2006 though according to SeaChoice (2006) data is lacking.

CHAPTER 3 - THE GOLDSTREAM RIVER FISHERY

3.0 Management of Goldstream River Salmon

Saanich Peninsula and the area around Saanich Inlet are within the traditional territory of the Saanich First Nation people (Claxton and Elliott 1994; Jenness 1938; Mos et al. 2004). For many generations, the families of the North Saanich (Tseycum and Pauquachin), South Saanich (Tsartlip and Tsawout) and the Malahat (who live on the west shore of Saanich Inlet) have fished coho, chinook and chum stocks in Goldstream River, the waters of Saanich Inlet, and adjacent straits (Figure 2.1). Chum, being the most abundant salmon species returning to Goldstream River were and are a major food resource, harvested each year from mid or late October to early December. The administrative body responsible for managing the fishery resources of the Tsartlip, Tsawout and Pauquachin bands, including Goldstream River and Saanich Inlet salmon stocks is Saanich Tribal Fisheries. The Tseycum and Malahat bands manage their fisheries independently but in consultation with Saanich Tribal Fisheries. Saanich First Nations' management of Goldstream salmon is discussed further in Chapter 6 (Results).

The hatchery at Goldstream River is called the Howard English Hatchery (herein Goldstream hatchery). Goldstream River is a modern day example of a mixed salmon stock fishery (wild and enhanced salmon stocks inhabiting the same spawning habitat). Hatchery stocks originated from wild coho and chinook brood stocks indigenous to Goldstream. DFO officers and Goldstream hatchery technicians manage Goldstream River to a 15,000 total population "carrying capacity" (or target escapement) of chum (see Appendix A for definitions). This annual figure was determined by DFO in 1985 (DFO 2001b). It represents the optimum abundance of adult chum spawners that the river can sustain and was put in place to prevent overspawning (additional chum digging up existing redds and destroying fertilized eggs of salmon that have already spawned, which can result when too many chum enter the river), and to prevent population declines of chum, which may occur if too few chum return to the river to spawn. If for example, 50,000 Goldstream chum entered Saanich Inlet and were migrating towards Goldstream River to spawn, DFO would allow a total of 35,000 chum to be fished from Saanich Inlet once 15,000 chum reached the river. Another function of the chum target escapement is to allow enough spawning gravel space in the river to maximize the abundance of natural[10] coho and chinook stocks that can spawn. This strategy is in keeping with DFO's current goals for coho and chinook stock enhancement at Goldstream River. Goldstream is also referred to as an indicator river by DFO as there are plans to monitor the Goldstream hatchery contribution of coho and chinook salmon (also referred to as indicator stocks) caught or observed at sea or upon their return to freshwater (DFO 1932-2004, 2002b; McCully P. pers. comm. 2002; Till 2005). (Further details about enhancement follow in this chapter.)

DFO issues an "Excess Salmon to Spawning Requirement" (ESSR[11]) communal, commercial fishing license to Saanich Tribal Fisheries as well as the Tsecyum and Malahat bands on an annual basis (DFO 2001a, 2001b). These licenses have permitted Saanich First Nation bands to catch and sell chum returning to Saanich Inlet and have been issued to both purse seine[12] and gillnet fishing vessels[13] contracted by Saanich

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[10] Natural salmon: Any salmon produced in the natural environment as a result of natural reproduction. A natural salmon could be either wild or the progeny of hatchery parents that spawned in the natural environment. It is impossible to distinguish a natural and wild salmon by field observation alone.

[11] ESSR is referred to as both 'Excess Salmon to Spawning Requirement' and 'Escapement Surplus to Spawning Requirement' in the Canadian fisheries literature (e.g. in DFO reports).

[12] Purse seine pelagic fishing vessels use a net that encircles salmon in midwater sea depths (~ 100 to 115 m in the deepest waters of Saanich Inlet) with a net that was on average 366 m long, 15 m deep and large enough to catch 20,000 salmon in one set. The seine net is then drawn into a pouch and reeled up on deck (WCVIAMB 2001).

Tribal Fisheries over the past 23 years (1982 to 2005). This fishery is only supposed to be permitted after 15,000 chum enter Goldstream River which, as shown in my results, has not always been the case. Two seine and one gillnet vessel currently receive this ESSR fishing license (DFO 2004e). (Further details about this fishery follow in this chapter.) Saanich Tribal Fisheries as well as the Tseycum and Malahat bands also fish chum from Saanich Inlet for "Food, Social and Ceremonial" (FSC) purposes, once target escapement is met (DFO 2001b). No other commercial (seine, gillnet, troll, trawl or weir) salmon fishing was permitted in Saanich Inlet between 1982 and 2005 however prawn and shrimp traps are still permitted. DFO managers and Saanich Tribal Fisheries council members recently agreed, however, that 80% of future chum salmon caught in Saanich Inlet would be allocated to the Saanich Nation (Pauquachin, Tseycum, Tsartlip, Tsawout and Malahat bands) for their ESSR fisheries (Figure 2.1). The other 20% of chum in Saanich Inlet will be allocated to commercial fishing vessels (other than those contracted by Saanich Tribal Fisheries, the Tseycum or the Malahat bands) in the form of ESSR licenses (Jacks V. pers. comm. 2004).

Goldstream River Park visitors are limited to rod and reel catch and release of all salmon species in Goldstream River and its tributaries during the fishing season and this fishery is managed by the BC Ministry of Environment's Fish and Wildlife Branch (BC Ministry of Environment 2006; DFO 2004b, 2006b). The use of fish weirs for catching salmon in BC coastal rivers was abandoned in accordance with DFO's Fisheries Act (forbidding the use of any barricade or obstruction in non-tidal waters) in the early

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[13] Gillnet vessels in deeper waters use buoyed and anchored nets suspended at surface or midwater sea depths from vessels ranging 10 to 13 m long. Nets may span 30 to 75 m with a mesh size of 130 mm for salmon fishing. Nets run horizontal to the seabed and perpendicular to the path of the salmon so incoming fish will get their heads but not their bodies through the mesh (WCVIAMB 2001).

1900s (Harris 2001). As I will discuss in the results, Saanich First Nations retain and exercise their aboriginal rights to fish any salmon they catch for their FSC purposes at Goldstream River and Saanich Inlet.

Prior to the moratorium on commercial and sport coho salmon fishing in the 1960s, there were 300 to 400 boats (operated by native and non-native sport fishing outfitters and Saanich fishers fishing for FSC purposes) fishing mostly for coho salmon in Saanich Inlet each day of the fishing season (Jacks V. pers. comm. 2004). Boat sizes ranged from 5 m long canoes using purse seine nets or troll hook and line gear, ~ 10 to 20 m long motorized troll or purse seining vessels, and 10 to 15 m long gillnet fishing vessels (FIGIS 2001; UBC Fisheries 2006; WCVIAMB 2001). The subsequent decline in coastwide Pacific coho salmon stocks triggered the closure of the coho commercial fishery in the inlet, and this has remained in effect for approximately 40 years (~1965 to 2005) (DFO 2001c, 2002d, 2004c).

The decline of Pacific coho and chinook salmon stocks to critically low levels in recent years (1985 to 2005) is due in great part to commercial over-fishing of these stocks at sea, as well as their popularity with anglers as prized sports kill fish (Copes 1998; DFO 1999a, 1999d). DFO conservation officers have enforced annual moratoria on fishing coho and chinook at Saanich Inlet over the past 20 years (1985 to 2005) and are currently managing coho and chinook as “species of special concern” (DFO 2006a). Recent fishing restrictions and conservation efforts include limiting recreational (or sport) fishers to a maximum catch of 2 coho[14], non-retention of chinook and 4 chum by

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[14] In 2005, coho fishing was restricted to only 2 hatchery marked coho, this changed to a maximum of 2 coho, only one of which may be wild, in 2006.

using barbless hook and line gear. The daily sport catch limit for all Pacific salmon species from tidal and non-tidal water combined is 4 (DFO 2006a, 2006b, 2006c). Closures and elimination of licenses to other commercial salmon fishing (e.g. trawling and non-native commercial kill fisheries) in Saanich Inlet have been in place since 1912 so as to protect the recreational fishery (DFO 2006b; WLAP 1995).

DFO also funds coho and chinook stock enhancement programs as part of its overall salmon conservation effort. These programs involve incubating fertilized salmon eggs and rearing then releasing the fry to nearby freshwater environments, a practice carried out in salmon spawning streams throughout the province. Hatchery enhancement has been promoted as an effective restoration strategy that could increase declining salmon stocks at their natal spawning grounds. However, as will be reviewed in Chapter 4, there are some concerns over mixing of hatchery-raised and naturally spawned salmon in the same spawning grounds. Coho enhancement activities such as incubation and introduction of coho transplanted from other systems began at Goldstream in 1974 (Bocking et al. 1998). DFO officials and hatchery technicians continue to enhance coho, and now also chinook stocks at Goldstream, but at time of writing [2006] had not attempted to augment naturally occurring chum populations at this site. Hatchery volunteers perform annual direct count surveys, also known as visual surveys or soft counts, that estimate total numbers of live coho, chinook and chum salmon returning to the Goldstream spawning grounds from October to December. As reported in the Methods chapter of this thesis, I participated with these surveys in 2002.

3.1 Goldstream River Salmon Enhancement

Adipose and ventral fin clipping, coded wire tagging (CWT) (implanting 1 mm long metallic wires into the nasal cartilage of 5 cm to 7.5 cm long smolts), and release of hatchery raised coho and chinook stocks, has been undertaken through the DFO Salmon Enhancement Programs (SEP) since 1991 (DFO 1998; pers obs. 2002). Goldsteam hatchery-raised chinook salmon that are released at Goldstream River are not currently tagged (McCully P. pers. comm. 2003). The hatchery coho are marked to assist with estimating the hatchery contribution to the general salmon population, and to provide corresponding recommendations for fisheries management, hatchery production strategies, experimental design, and international negotiations (Nichols and Hillaby 1990:1). In particular, hatchery coho marking is carried out to determine the hatchery contribution to declining stocks of wild southern Strait of Georgia and West Coast Vancouver Island (WCVI) coho salmon (McCully P. pers. comm. 2003).

There are currently many more hatchery-raised than wild or naturally spawned coho and chinook in Goldstream River (Bocking et al. 1998; DFO 2002b), with a ratio of hatchery-raised to wild stocks of approximately 9:1 (DFO 2002c; McCully, pers comm. 2002). Some of these hatchery fish are released at Goldstream and other sites where salmon enhancement programs are in place (e.g. Craigflower, Noble, Tod and Colquitz Creeks) (Goldstream Volunteer Salmonid Enhancement Association [GVSEA] 2001; Till 2005). The remaining 10% wild brood stocks of coho and chinook returning to Goldstream are at high risk of being extirpated by the domestically raised, hatchery stocks returning to this spawning site. Notably, DFO officers identify hatchery salmon as “wild” stocks after the second generation of hatchery raised salmon spawn at the river

(DFO 2002b, 2002c). Goldstream chum, on the other hand, have retained 100% of their natural genetic lineage (GVSEA 2005; Mc.Cully P. pers comm. 2002).

3.2 Saanich Inlet Chum Surplus Fishery

DFO uses fisheries management units to delineate the fishing areas where Saanich First Nation (Tsartlip, Tsawout, Tseycum, Pauquachin and Malahat bands) are entitled to fish salmon for commercial and communal cultural purposes, which includes their food fishery (DFO 2001:6). These designated areas include Saanich Inlet and part of Goldstream River (within DFO Fisheries Management Area 19), from the bridge over the river in Goldstream Provincial Park to a location at the estuary 1.6 km downstream (DFO 2001; Friedlaender and Reif 1979: A25 and A28) (Appendix D). Once the target escapement is reached at Goldstream River, the Saanich Peoples' fishing crews (of Saanich Tribal Fisheries, Tseycum and Malahat) are permitted to fish chum in Saanich Inlet and around the Saanich Peninsula[15] under the specifications of the annual ESSR chum fishing license (DFO 2001a, 2005b).

3.3 The State of the Saanich First Nation Salmon Fishery

Saanich First Nation people have fished salmon from Goldstream River and Saanich Inlet since pre-European settlement times (Bocking et al. 1998:3), and have continued to rely on fresh and dried salmon as a staple source of protein year round (Elliott 1990; Mos et al. 2004; Simonsen et al. 1995: online). The Saanich, like other First Nations of the BC coast, have expressed a general dissatisfaction with how

[15] This area under discussion lies within the DFO management Subareas 18-6, 19-4, 19-5, 19-6, 19-7, 19-8, 19-9, 19-10m 19-11 and 19-12.

enforcement of DFO's conservation laws has impacted their traditional fishing practices (Morrell 1989; Nuu-chah-nulth Tribal Council 1998; Richardson and Green 1989). There is also a perceived lack of consultation by DFO managers with BC's coastal First Nations about the management of their salmon and other fisheries (Edwards and Glavin 1999; Elliott 2003; Macleod 1989; Walters 1995).

Until the 1950s, Saanich people obtained much of their food from the waters of Saanich Inlet by fishing for direct family subsistence or working as wage labourers in commercial fisheries. Saanich elders recall times past when they knew exactly when the chum salmon were returning to Saanich Inlet because they could hear the killer whales coming into the inlet feeding upon them (Simonsen et al. 1997: 111). This era is remembered as a time of plentiful fish and food when there was little poverty. Unfortunately, once the fisheries became licensed, and opened up to fishers from outside the Saanich First Nation community in the 1950s, "Native people were displaced and no longer able to compete" (Sampson 1996 in Simonsen et al. 1997:36). As detailed earlier, however, non-indigenous sport fishers are now restricted to catch and release salmon fishing at Goldstream River, and to daily limits of 4 salmon from Saanich Inlet per person.

As well as direct losses of salmon through overfishing, increased pollution of Saanich Inlet poses a threat to Goldstream salmon that are migrating through the inlet, and to the health of the Saanich people. Salmon (*Onchorhynchus* spp.), herring (*Clupea pallasi*) and eelgrass plants (*Zostera marina*) have all significantly declined in conjunction with increased pollution of the Saanich Inlet marine ecosystem where these interdependent species once thrived (WLAP 1995). A common perception amongst Saanich people is that oil leakage from freighters may be polluting beaches in

Brentwood Bay, and that most of the inlet's marine resources, most notably salmon and shellfish, are in steady decline (Simonsen et al. 1995). Further studies show that fecal coliform in nearshore areas may be the primary contributor to pollution of beaches, shellfish, eelgrass and juvenile fish in local embayments (e.g. Tod Inlet and Brentwood Bay) where water circulation is lowest (WLAP 1996).

Despite the long-term risks and impacts of overfishing and pollution, Saanich people continue to exercise their rights to fish salmon at Goldstream River and Saanich Inlet. Saanich Peoples' rights "to fish as formerly" are set out in the 1852 Douglas Treaties signed by those First Nations referred to then as the South Saanich tribes (which are the bands now referred to as Tsartlip and Tsawout and the Malahat band who are descendents of the South Saanich Tribes) and North Saanich tribes (now called the Pauquachin and Tseycum bands). The Douglas Treaties stated that Saanich people would "retain their hunting and fishing rights on unoccupied lands" (Madill 1981: 9; Province of BC 200; Union of BC Indian Chiefs 2003) (Figure 1.1). DFO officially acknowledges First Nations' rights to "food fisheries," reconfirmed through the Sparrow case Supreme Court ruling (Supreme Court of Canada 1990; Usher 1991: 21), by overseeing the Aboriginal Fisheries Strategy (AFS) program, which applies "where DFO manages the fishery and where land claims settlements are not in place" (DFO 2000a: 5). Food fisheries recognized by the program entitle First Nations to fish for FSC purposes in certain fisheries management areas. Commercial sale of those fish is not, however, officially permitted or legalized under the AFS agreements (DFO 2000a).

CHAPTER 4 – MANAGEMENT SYSTEMS AND ASSOCIATED ISSUES

4.0 The Nature of Traditional Ecological Knowledge

The United Nations Environment Programme's (UNEP) signatories to the 1997 Convention on Biological Diversity called for recognition, protection, and promotion of indigenous knowledge (UNEP 1997). The application of indigenous ecological knowledge (herein termed traditional ecological knowledge or TEK) in biodiversity conservation initiatives is gradually gaining more widespread acceptance as it is becoming increasingly recognized that science alone has proven insufficient in alleviating loss of biodiversity and other issues of environmental degradation facing society today (Brodnig and Mayer-Schoenberger 2000; Flett et al. 1996; Garvin 2001; Mackinson 2001; Nigel et al. 2003; Turner 1997; Turner et al. 2000).

Native fishers, for example, hold extensive, long-accumulated local knowledge about distribution patterns, morphology, behaviour and life cycles of fish, as well as overall productivity of fishery resources, which they apply to the harvest, use and management of those resources (Berkes 1999). A prominent definition of TEK referred to by many researchers on the subject (Huntington 2000; Kimmerer 2000, 2002; Notzke 1995) has evolved from the work of Fikret Berkes (1993, 1995, 1999): Traditional ecological knowledge is "…a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living things (including humans) with one another and with their environment." (Berkes 1999:8). Kimmerer (2000:9) identified TEK as being "…born of long intimacy and attentiveness to a homeland," and noted that TEK can arise "wherever people are materially and spiritually integrated with their landscape." Mauro and Hardison (2000) described TEK as "…rational and reliable knowledge that has been developed through generations of intimate contact by native peoples with their lands" (Mauro and Hardison 2000 in Kimmerer 2002:433). It was also described as the "intellectual twin to science" (Deloria 1995 in Kimmerer 2002:433), though the formal acceptance of TEK into traditional, western scientific research has often been met with resistance (Berkes 1999; Bill et al. 1996; Howard and Widdowson 1997; Salmon 1996). In the case of the Saanich indigenous salmon fishery, and as will be shown in my results, the Saanich tribal chiefs, elders and fishers hold longstanding and extensive knowledge about salmon ecology, methods that protect and respect salmon and salmon habitat, salmon fishing practices, and conservation.

Prior to the 1900s, First Nations used fish nets of various types (e.g. seine, gillnet and hand-held dip nets) made from spun fibres harvested from stinging nettle plants (*Urtica dioica*) to catch salmon in streams and at sea (Newell 1993). First Nations' fishing technologies used prior to the 1900s included adjusting fish net mesh sizes, using hand carved, steam bent gaff and bentwood hooks (made of yew wood, deer bone barb and cedar wood lashing) and spears carved from pine wood (Newell 1993). Fishing technologies probably also included considerations and methods for targeting the species, run, size and gender of the fish in accordance to what they believed would sustain future fish populations (Berkes 1999).

Some natural resource managers and biologists have taken a dismissive attitude to TEK and the possibility of its integration with Scientific Ecological Knowledge (SEK) in the past (Johannes 1989). Howard and Widdowson (1996, 1997) negatively critiqued TEK research established by Berkes and Henley (1997) who integrated First Peoples' knowledge within their scientific research (Berkes 1977, 1979, 1989; Henley et al. 2002a, 2002b). Howard and Widdowson (1997:47) stated that TEK's cultural context and spiritual component "…prevent us from exposing fraudulent claims behind T(E)K research". They asserted, "Scientific methodology is based on vigorous testing of hypotheses. Validity depends in turn, on the efficacy of the tests used, and can therefore be reevaluated at a later date" (Howard and Widdowson 1997:46). These authors, however, did not conduct any applied, scientific methods (as Berkes and Henley did). They did not provide any bona fide data, results or offer evidence about real or potential drawbacks inherent to methodologies that have been used to integrate traditional ecological knowledge with western scientific paradigms and were therefore unable to scientifically prove or disprove their assertions. Instead, these writers insistently concluded and recommended that the scientific community should reject the integration of traditional ecological knowledge and scientific ecological knowledge outright. In contrast, Colorado (1988:49) proposed a balanced approach to the integration of traditional ecological knowledge and western scientific knowledge (WSK). She defined the term 'integration' as referring to "a blending of research efforts, not the domination or extension of ideological control by one culture's science."

Traditional ecological knowledge differs from scientific ecological knowledge in many ways. The main difference is that traditional ecological knowledge is derived from direct observations of a given locality over several to many generations, and consists of a holistic, open approach that may include social, political, ecological and spiritual components. By contrast, western scientific ecological knowledge is derived from direct, relatively short-term observations of organisms from a range of sites, and involves a more deductive, quantitative, and biological context (Berkes 1999; Kimmerer 2000). Both approaches provide legitimate means by which to understand ecosystems and biodiversity conservation. Traditional ecological knowledge may strengthen western scientific knowledge by providing historical and spiritual insights about the natural environment that are passed on orally from one generation of First Nations people to the next or contribute new ecological concepts learned and methods practiced and passed on by the next generation of First Peoples. Scientific ecological knowledge may contribute extensive, reliable, comparative data and rigorous mathematical, statistical and ecological models, or new technologies for measuring and analyzing information. Convergence of traditional ecological knowledge and scientific ecological knowledge may be useful in resolving multi-stakeholder conflict situations concerning protection of animals and biodiversity conservation (Peirotti and Wildcat 2000:1333). For example, research that blends traditional ecological knowledge and scientific ecological knowledge methods that address the question of the status of an animal population (such as Goldstream coho) will yield recommendations for protection of the species and its habitat that integrate cultural fishing rights and activities and provide greater insight to a greater diversity of stakeholders (e.g. First Nations people, fishers, fisheries officers and managers, marine planners and biologists) than conclusions based on either traditional ecological knowledge or scientific ecological knowlege research could do on their own. The following sections demonstrate how integrating traditional ecological knowledge with scientific ecological knowledge can complement, enrich, and strengthen conservation science, monitoring and research.

4.1 Integrating Traditional Ecological Knowledge with Scientific Ecological Knowledge to Assess and Monitor Fish Stocks

Traditional ecological knowledge acquired by fishers that is specific to fish species, stocks, populations and commercial and non-commercial fisheries is sometimes referred to as fisher's ecological knowledge (Johannes et al. 2000). Makinson and Nottestad (1998) proposed that the combination and utilization of traditional ecological knowledge (or fishers' ecological knowledge) with available scientific data is urgently required in the midst of our uncertainty about fish stocks. Johannes (1978) illustrated how knowledge of Paulan fishers in Micronesia surpassed the base of the scientific understanding of fish stocks. Despite potentially biased perceptions of resource abundance and of their own impacts upon fish stocks, most fishers know a lot about fish distribution and behaviour. Much of this knowledge is based not only on individual observations and experiences, but also those of parents, grandparents and others they have been fishing with (Makinson and Nottestad 1998:483).

Fishers' livelihoods depend upon acquiring knowledge that ultimately optimizes fish catch and minimizes effort (Neis et al. 1996, 1999). Interviews with fishers can elicit important information about fish behaviour and fishing practices. Fishers tend to closely observe environmental features or ecological attributes that are linked to fishing success such as:

> …seasonal movements, habitat preferences, feeding behaviour and abundance dynamics; as well as those physical attributes that affect fish distribution, the performance of gear and fishing time: wind direction, currents, water temperature and clarity, bottom characteristics and local assemblages structures as well as gear fouling (Neis et al. 1996 in Mackinson and Nottestad 1998:483).

Other common observations yielded by fishers include population distribution, body morphology and presence or abundance of mature females returning to spawning grounds (Hutchings 1996). Catch rates reported by fishers from the same site over time may help identify local changes in fish abundance (Hutchings and Myers 1994).

Catch-per-unit-effort (CPUE) analyses, (e.g. using number of fish caught per fishing vessel per day), are also sometimes used for estimating the population of a stock

(Neis et al. 1999). Cross-checking CPUE data with data from those from other fish stock surveys is also useful for assessing localized fish abundance and for monitoring populations (Moller et al. 2004).

As shown in this thesis, the integration of fisher's ecological knowledge with scientific ecological knowledge can improve our information base about the status of fish populations such as the coho, chinook and chum Pacific salmon populations harvested by Saanich First Nation fishers at Goldstream River and Saanich Inlet.

4.2 The Importance of Traditional Ecological Knowledge in Identifying Changes to Fisheries and the Coastal Environment

In the late 18th century, crown officials of the British Empire imposed social, cultural and political displacement and assimilation policies upon First Nations people that were carried forward and put into effect by Canadian government officials post confederation (after 1867). Policies promoting displacement and assimilation are those that effectively denied Aboriginal people access to their traditional territories and include the establishment of colonial schools that undermined the ability of aboriginal people to pass on their traditional language, knowledge, and cultural practices. These policies have fragmented much of the empirical knowledge of ecological relationships held by diverse indigenous groups but this specialized knowledge persists on reservations and in traditional communities (Indian and Northern Affairs Canada 1991; Indian Residential Schools Resolution Canada 2006; Kimmerer 2000).

Reports from the oral history of the Nuu-Chah-Nulth First Nation who reside on the west coast of Vancouver Island further illustrate the importance of traditional ecological knowledge contributions to our understanding of past BC ecosystems. Though previously unknown to ecologists or historians, past BC ecosystems supported bluefin tuna (*Thunnus thynnus*) whose populations have subsequently been extirpated in this region (Haggan 2000). This oral testimony was, subsequently, further supported by archaeological evidence (Crockford 1994, 1997), which confirmed the former existence of a bluefin tuna fishery along BC's Pacific coastline.

One of the major changes impacting Saanich Peoples' traditional fishing practices since the 1950s is the imposed restriction of land access to the coastal shoreline. Other impacts observed by Saanich people include:

1. Pollution of the water bodies and lands around Saanich Inlet.
2. Human encroachment in the form of development, resource extraction, and general invasion of privacy at sacred places and in other traditional-use areas.
3. Lack of employment due to loss of subsistence activities within the inlet and other activities such as a viable commercial fishery (Simonsen et al. 1995)

A Saanich First Nation fisher interviewed during the Bamberton Project consultations (1995) stated that he was fishing Saanich Inlet at least every second day in the summer of 1994 but failed to catch any salmon. "This never occurred in the past when salmon and other fish species were plentiful" (Smith in Simonsen et al. 1995). This fisher's testimony of former and current fishing experiences supports the results from Simonsen et al.'s interviews with Saanich People: that external human encroachment and commercial developments have caused major impacts to the coastal environment around Saanich Inlet since European settlement. These impacts have caused a decline in opportunities for the Saanich First Nation people to pursue their traditional and modern fishing practices in Saanich Inlet and at Goldstream River.

Saanich First Peoples bore witness to the pollution of the Saanich Inlet marine ecosystem, caused in part by commercial development of their traditional fishing places. They began noticing changes in marine life due to pollution in the inlet in the 1950s and attributed the decline in the health of the marine ecosystem to adverse effects from sewage, urban run-off and run-off from pesticides and fertilizers flowing into the inlet from agricultural lands (Bruce I. pers.comm. 2005; Duerden 1996:4; Simonsen et al. 1997). At that time, Saanich Inlet was under great strain from water contamination, however, none of the Goldstream salmon species had yet been assessed under conservation guidelines or been recognized as species of concern by DFO or any other governmental or legislative body. This underscores a point made by Wilder et al. (1999:58) who surmised that we could do great damage to an ecological system "without actually endangering a species, by fundamentally altering the habitat or the system itself." Tracking the fecal coliform content and point and non-point sources of pollution in the water over time are important means by which to measure the inlet's pollution levels (BC Ministry of Environment 2001; CRD 2003b). It is also advisable to consult with, listen to and learn from coastal First Peoples whose ancestors lived around Saanich Inlet before Eureopean settlement times. This is important because the First Nations communities should be consulted about pollution monitoring activities and because they may be able to contribute extensive knowledge about the effects that pollution and overfishing have had on their traditional fishing waters during their own and their ancestors' lifetimes.

Research on integrating fishers' ecological knowledge in fish biology and fisheries management suggests that one of the main failures of former fisheries management systems has been the exclusion of the dynamics or behaviour of the fishers (e.g. frequency, location and target of fishing effort) as an essential consideration of the system (Freire and Garcia-Allut 1999; Hilborn et al. 1995). As noted, Saanich people hold important ecological knowledge about the state of the marine ecosystem and fish populations comprising their past and current subsistence and commercial First Nation fisheries at Goldstream River and Saanich Inlet. This knowledge results directly from generations of Saanich First Nations families' dependence upon a wide, complex and interconnected variety of food items obtained through unique, localized subsistence practices within the coastal habitat within which they live (Mos et al. 2004). As demonstrated in the results of this thesis, the retention of local subsistence practices (e.g traditional chum fishing practices in Saanich Inlet and Goldtream River) and traditional ecological knowledge is also directly linked to the ecosystem integrity and biodiversity of coastal and marine habitat encompassing the Saanich Peoples' homelands. Saanich First Nations' salmon fishing patterns and dynamics were included as part of the natural system (here, the Goldstream terminal salmon migration route) upon assessing past and present salmon populations for this research and are reported in the Discussion chapter.

4.3 Conservation Practices as Traditional Ecological Knowledge of Canada's Indigenous Peoples

Traditional ecological knowledge incorporates conservation practices passed on from many generations of indigenous people who were life-long fishers. Alcorn, (1993:425) stated that: "…the commitment of indigenous peoples to conservation is complex and very old." Among the many examples of First Nations communities that have developed conservation practices and limited their fishing efforts to conserve fish stocks, are the Cree People of northern Canada (Anderson 1994; Berkes 1993; McGoodwin 2002). Chisasibi Cree fishers used short, intensive fishing cycles at various fishing sites to a specified catch-per-unit of effort (CPUE) threshold level, also known as pulse fishing. In this case, biodiversity conservation (rotation of fishing areas) was an indirect effect of maintaining the general productivity of the fish habitat (Berkes 1993:154). Berkes (1977, 1999) also observed Cree fishers allowing fish to escape, and exercising careful restraint from fishing in designated sanctuaries holding plentiful supplies of their main target fish stocks to prevent depletion of those stocks.

The Vuntut Gwich'in in the Yukon, Northwest Territories historically controlled the size and number of the fish they caught by determining fish net mesh size, and adjusting length and number of nets according to the quantity required for that family's fish preserves for the winter (Sherry and Myers 2002). Fish harvest levels for the Gwich'in and other First Nation communities are also controlled by numerous rules adhered to in the form of traditional knowledge practice and belief, territory systems and prohibitions against waste (Gottesfeld and Johnson 1994:459; Sherry and Myers 2002).

Conservation and resource management in small-scale traditional societies are commonly undertaken for the benefit of individuals, families and future generations (Healy 1993 in: Williams and Baines 1993:23). A community's self-interest in the management of local resources does not, however, imply that their conservation practices will be ineffective. Parties engaged and invested in attaining healthy and plentiful fish stocks are more likely to take active steps towards restoring and protecting the population into the future. In the case of Goldstream River and Saanich Inlet, generations of Saanich fishers have diligently practiced their trade and shared and passed on their accumulated knowledge about their artisanal salmon fishery for probably thousands of years. This form of passing on of accumulated knowledge has existed "for centuries before marine biology emerged as a discipline. Moreover, there are many times as many such fishers as there are marine biologists" (Johannes 1993 in: Williams and Baines 1993:144). In her concise review of fishing peoples and societies, McGoodwin (2002:6) also underscored that self-management practices of many localized fishers show distinct regard for "sound biological-conservationist principles." This type of practice is also exercised by Saanich fishers and is reported in my Results chapter.

4.4 Incorporating Traditional Ecological Knowledge with Wildlife Assessments

Scientific investigations that also make use of traditional ecological knowledge are likely to be particularly successful. The literature consulted on the topic provided important guidance about effective methods for documenting traditional ecological knowledge, including knowledge about local wildlife, fisheries and related topics (Berkes 1977, 1979, 1989, 1993, 1999; Berkes et al. 2000; Healy 1993 in: Williams and Baines 1993; Huntington 2000; Neis et al. 1999; Usher and Wenzel 1987; Usher 2000). Two main aspects of traditional ecological knowledge of value for scientific knowledge are: 1. local people's specialized knowledge of the environment frequently makes them the most appropriate guides and advisers to assist scientists wishing to locate particular organisms and resources and, 2. traditional ecological knowledge can be a "useful tool for compiling inventories of elements of local ecosystems" (Healy 1993 in: Williams and Baines 1993:25). TEK can provide important data in the survey work aspect of environmental research in biological sciences. TEK is a system of communicating knowledge about governance and systems of proprietorship as well as knowledge about local ecosystems within a human community.

4.5 Monitoring Wild and Hatchery Enhanced Pacific Salmon

Population and Behavioural Dynamics of Enhanced and Wild Pacific Salmon Stocks

Canada's Salmonid Enhancement Program (SEP) has been experimenting with the planting (or release) of all life stages of hatchery-reared fish in rivers and streams to increase natural production and enhance natural populations of anadromous salmon (Winton and Hilborn 1994). Major genetic pollution of a population may occur when the quantity of hatchery salmon begins to outnumber the quantity of wild salmon returning to a natal freshwater system where enhancement procedures are in place (Fedorenko and Shepherd 1986). Waples and Do (1994) studied effects of mixing wild and hatchery salmon populations in the Pacific Northwest. They concluded that although hatchery enhancement may temporarily improve population demographic problems, enhancement could also cause genetic and harvest changes to a population that could subsequently lead to its extinction once (or if) salmon supplementation were to stop.

Nickelson et al. (1986) compared natural spawning times of hatchery-raised and wild Pacific coho salmon returning to the same spawning stream in Oregon, Washington. Results showed that hatchery coho had a tendency to spawn substantially earlier than the wild strains. Quinn et al. (2002) found that hatchery coho and chinook whose ancestral lineage was linked to the Lake Washington basin had been spawning earlier since the 1950s (for chinook) and the 1960s (for coho) due to inadvertent selection at three Washington State hatcheries. It has also been found that random planting of hatchery stocks may effectively reduce natural production. For example, earlier spawning times of hatchery stock resulted in incubating eggs in the stream being exposed to fall freshets and bed movement resulting in increased overall mortality of coho (Nickelson et al. 1986; Lichatowich et al. 1999). Hatchery coho exhibited intrinsically lower ocean survival rates in early years of their life stages compared to wild coho smolts, which had comparatively higher ocean survival rates (Nickeslon 1986; Pearcy 1992). Pearcy and Fisher (1988) reported that wild Pacific Oregon coho smolts migrated further north than Pacific Oregon hatchery stocks. Further studies reported observations of hatchery-raised coho progeny displaying weaker territorial behaviour than wild salmon progeny (Norman 1987; Utter et al. 1993). Once released in the wild, cultured stocks may also demonstrate poor concealment behaviour, inept foraging behaviour and habitat utilization, and strong aggression, resulting in greater expenditure of energy, and placing them at greater risk of predation (Currens et al. 1997; Hesthagen et al. 1995; Hindar et al. 1991; Maynard et al. 1995, 1996). In addition, research on Oregon steelhead trout (another anadromous salmonid) demonstrated that, for this species, hatchery-raised fish that entered into natural production areas and reproduced with wild steelhead produced offspring with lower survival rates than their purely wild counterparts (Chilcote et al. 1986; Kostow 2004; Reisenbichler and McIntyre 1977). These studies provide empirical, scientific evidence that there are significant differences in life-history patterns and behaviours of hatchery-raised, naturally spawned, and wild salmon stocks (See Appendix B for definitions of terms).

McGie (1980) assessed relationships between hatchery coho salmon transplants and adult escapements in Oregon coastal watersheds. His research concluded that planting of domesticated hatchery coho stocks into natural production areas did not increase total salmon production. In fact, research at other sites showed that harvesting mixed stocks of hatchery and wild salmon (as is done by Saanich First Nation fishers at Goldstream River and Saanich Inlet), led to over-harvest, decline and extinction of wild populations (Flagg et al. 1995; Wright 1993). Reimchen (2000) found that black bears (*Ursus americanus*) in an old-growth watershed (Moresby Island, Haida Gwaii, BC) were eating a greater proportion of spawning chum males (than females), which may lead to a greater range of male spawners for any single female (predator-induced polygamy) and increase the genetic variance of the fertilized eggs of salmon. Assuming this premise for Goldstream salmon, the absence of bears within the salmon-bearing reaches of this watershed's mature forested area (that now regularly accommodates high numbers of park visitors) has probably resulted in a reduction in genetic diversity of fertilized eggs of Golstream chum.

It is important to take into account that information about the status of salmon stocks in one river system may not be applicable to another as each river system and its stocks, and hatchery operations, are unique. Winton and Hilborn (1994), however, provided some interesting insights about supplementation of chinook at four different hatcheries with the same overarching enhancement program goals, operating in British Columbia river systems. They provided synopses of hatchery operations in two coastal (Snootli and Kitimat Creeks) and two interior (Quesnel and Spius Creeks) systems. The DFO Salmonid Enhancement Program's goals for hatcheries (including the Goldstream hatchery programs administered by DFO) are to increase harvest and enhance, preserve and rehabilitate natural stocks in a cost effective manner. The authors found that while each of the four hatcheries had experimented with different spawning, rearing and releasing strategies, none had ever monitored natural stock survival or escapement (nor had any other Canadian Salmonid Enhancement Program stock supplementation hatcheries) (Winton and Hilborn 1994). The importance of accounting for effects, or potential costs and benefits, of hatchery fish interactions on natural stocks was simply not a consideration within the SEP hatchery operations framework. Although the goal of the hatcheries was to increase harvests in the Canadian commercial and Georgia Strait sport fisheries, numbers of chinook salmon caught continued to decrease from the period 1978 to 1989 (Winton and Hilborn 1994:11) with the hatchery chinook salmon contribution generally declining from 1983 to 1987. This was a period when enhanced chinook stock releases were expected to contribute in quantities enabling increase of the total catch. The authors concluded the chinook SEPs did not appear to be “markedly” contributing to increased chinook harvests (Winton and Hilborn 1994:11).

The studies cited above indicate that Pacific salmon stock enhancement has not increased salmon production, but instead has contributed to mismanagement of a mixed stock fishery in which the wild population component is over-fished, has had its genetic diversity substantially reduced, and even brought to extinction. Furthermore, hatchery managers have failed to implement monitoring strategies for measuring natural stock survival, escapement, or effects of hatchery fish interactions with wild brood stocks (also called demes).

Assessments of Salmon Escapement Records from BC’s Central and North Coasts

Habitat destruction (logging, damming, road construction agriculture and urbanization), enhancement programs, commercial fishing and the introduction of cultured fish resulting in a mixed stock fishery (wild and enhanced) are all factors that can lead to reduced escapement and genetic diversity of wild salmon (Kostow 2004; NRC 1996; Slaney et al. 1996; Wood 2001).

Escapement enumeration is the main method used to measure, assess and monitor salmon stock returns and to determine and allocate annual allowable salmon harvest yields. Thomson and MacDuffee (2002) assessed salmon escapements from DFO's salmon escapement database system (SEDS). The data they used for conducting assessments represented estimates of annual abundance of salmon spawners that returned to their natal streams in DFO statistical management areas 3 to 10 within the north and central coast of BC. BC 16 reports are official records of annual stream survey field reports collected from sites where surveying and monitoring occurred, and are archived in DFO office files. The salmon escapement database system accessed by Thomson and MacDuffee contains DFO's salmon escapement data (from BC 16 reports) dating from the 1950s to present. These data are limited in their ability to disclose important trends in salmon population (or deme[16]) survivorship, in part because commercial logging, fishing, and watershed development were already extensive throughout most of BC's coastal salmon habitat by the 1950s when the database was initiated (Thomson and MacDuffee 2002:71).

There are over 1000 freshwater ecosystems (drainage basins) supporting more than 2500 runs of salmon on the north and central coasts of BC (Thomson and MacDuffee 2002:18). Efforts to survey and estimate abundances of sockeye, coho, pink and chum escapements (1950-1999) have fluctuated over time. The greatest reduction in enumeration effort for north and central coast coho occurred in 1999. Only 2% of all central coast coho systems had reliable coho escapement data between 1950 and 1999. Sockeye had the second poorest enumeration record, followed by chinook, pink and chum (Thomson and MacDuffee 2002:74). DFO monitoring efforts (escapement surveys) were evidently focused on the most commercially important stream runs.

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[16] See Appendix A for definitions of 'spawner' 'population', 'deme'.

Monitoring efforts neglected the importance of smaller streams and tributaries that are vital to the survival of many salmon demes; the ecological role of salmon; and the importance of these smaller runs to First Nations' food fisheries.

The authors also found that, due to the limitations of the escapement database, only 10% of the salmon rearing streams, rivers and tributaries with escapement data (biased towards larger, more productive runs) had reliable salmon escapement data (Thomson and MacDuffee 2002:74). After assessing the status of salmon based on data from indicator systems that did have reliable data, the authors determined that central coast coho have been declining since the 1950s. No reliable status could be provided for the north coast as only 14 of 891 systems had been reliably surveyed. North coast coho catches have been declining since the 1970s, and all coho systems were deemed critical in the 1980s, yet none of the indicator systems were surveyed in the 1990s. High exploitation rates (60 to 80%) combined with poor escapement data caused extensive overfishing of coho coastwide. DFO finally issued fisheries restrictions on coho catches in 1998 and the data from 2000 and 2001 demonstrated improvement in some systems. DFO reported that fisheries restrictions and improved ocean survival in conjunction with the 1998 ocean regime shift explain the increase in 2000-2001 coho returns (PFRCC 1999). Thomson and MacDuffee (2002:80) cited poor sampling as a potential barrier to assessing coho returns and status, however, warning that habitat changes in logged watersheds and declining productivity in headwater streams may also have affected wild north coast coho runs.

To summarize, 56% of indicator system chinook runs on the north coast were assessed as "very depressed" (less than 40% of spawner target escapement was met) and 22% were categorized as "depressed" (40% to 79% of target escapement was met).

Commercial catches of central coast chinook have declined significantly since the 1970s, but escapement goals are still falling short. Bella Coola, a system enhanced by hatchery fish, is the only central coast indicator system that met its target chinook escapement goals in 1990 and 1991 (Thomson and MacDuffee 2002: 81). Pink salmon were the healthiest species within the central coast salmon indicator systems, while 75% of chum indicator systems were classified as "depressed" or "very depressed". North coast indicator chum systems declined in the 1980s and 1990s at a time when harvest levels (for Areas 3 and 4) were above average. Only one north coast chum system met its escapement target in the 1990s with preliminary data from 2000 and 2001 showing no change to this condition. All indicator chum systems on the central coast (within Areas 9 and 10) were classified as "very depressed" in the 1990s, and limited sampling in several areas hindered the possibility to make adequate assessments of improvements or declines in central coast chum returns (Thomson and MacDuffee 2002:80-81).

Sockeye on the north and central coasts were classified as "depressed" or "very depressed" in 73% of the indicator systems. Two of the north coast indicator systems showed some improvement from 1991 to 2001 while the status of central coast sockeye remained 'very depressed' despite fishing reductions. Eight out of 18 sockeye systems on the north coast met their target escapement goals, whereas none of the indicator streams on the central coast met theirs (Thomson and MacDuffee 2002:81). Central coast sockeye are not recovering and fishing pressure, habitat loss, global warming influences and/or marine conditions continue to threaten the status of these stocks. Thomson and MacDuffee (2002:77) acknowledged that many small runs of sockeye used to contribute significantly to local First Nations fisheries, and that they were once important to the commercial fishery, and recommended that the status of these runs be assessed.

4.6 Use of Native Harvest Statistics in Assessing Fisheries' Sustainability

Usher and Wenzel (1987:145) defined native harvest statistics as counts, or estimates, of the quantity of a particular species of fish, or wildlife, by category taken in a specific area by a specific group of native people during a specific time period. The authors reviewed and assessed two common types of native harvest data – administrative and monitoring records, and special-purpose studies. The existing body of information on native harvest data can be used to recreate a meaningful historical statistical series for biological as well as socio-economic research purposes (Usher and Wenzel 1987). The native harvest data from the Excess Salmon to Spawning Requirement (ESSR) licenses and the BC 16 reports containing Goldstream River coho, chinook and chum escapement data that I used for this project were categorized by Usher and Wenzel (1987:146) as "administrative and monitoring data." These data can be used to monitor harvesting trends and as potential indicators of fish abundance. ESSR native harvest statistics can be used for conducting catch per unit effort (CPUE) analyses of First Nations' commercial and/or communal salmon fisheries (as exemplified in the Results chapter). CPUE analysis using native harvest statistics can be an indicator of salmon abundance and harvesting trends but is not a very precise measurement tool for research and management. CPUE will be described in greater detail in Chapter 6.

4.7 Wild Salmon Monitoring and Management Efforts

Co-management

Joint stewardship and applied resource management practices built on First Nations' rights to fish (and to harvest other natural resources), is commonly referred to as cooperative management or "co-management" (Berkes and Henley 1997; Berkes et al. 1991; Notzke 1995; Pinkerton 1989). Co-management as defined by the Royal Commission on Aboriginal Peoples involves "institutional arrangements whereby governments and Aboriginal [and sometimes other parties] enter into formal agreements specifying their respective rights, powers, and obligations with reference to the management and allocation of resources in a particular area" (RCAP 2:666 In: Berkes and Henley, 1997:29).

In the *Haida Nation v. British Columbia* (Ministry of Forests) 2004 case decision, the provincial and federal governments were imposed with the legal duty to undertake 'meaningful consultation' with First Nations when conduct may adversely affect existing or potential Aboriginal rights or title. According to legal counsel of the BC Aboriginal Fisheries Commission, "(M)eaningful consultation should also translate into greater inclusion and actual substantive participation by First Nations who are involved in co-management relationships with DFO and to provide incentive for those who aren't" (Braker and Company Barristers and Solicitors 2006).

Numerous case studies highlight strengths and weaknesses, successes, trials and tribulations resulting from co-management efforts between federal (or state-level) and First Nations (or local-level) authorities (Berkes 1999; Confederacy of Nations 2004; DFO 2001b, 2005a; First Nations Panel on Fisheries 2004; Gitxsan Chief's Office 1998, 2006; Notzke 1995; Pinkerton and Weinstein 1995; Robinson 2001). For a comprehensive, case-by-case listing, refer to Notzke's analysis in "A New Perspective in Aboriginal Management: Co-management" (1995). Schrieber (2001) emphasized that lack of attention to local concerns is the dominant contributor to biological and social crises in fisheries. The flow of social and economic benefits from the fishery back into the community is integral to power-sharing and meaningful co-management arrangements with government fisheries managers (Schrieber 2001).

The Gitxsan's Selective Surplus Salmon Fishery, similar to that of the Saanich First Nation Excess Salmon to Spawning Requirement (ESSR) fishery, is a legalized, commercial sale fishery entered into by agreement between and co-managed by DFO fisheries managers and the First Nation band councilors (DFO 2005a; First Nation Panel on Fisheries 2004: 28; Notzke 1995; Pinkerton and Weinstein 1995). The joint agreement enables and permits harvest and sale of fish, in addition to the Gitxsan's rights to fish for Food, Social and Ceremonial (FSC) purposes, as is the case with the Saanich Peoples' fishing rights. These agreements (both for the Gitxsan and Saanich First Nations) were developed in part as fishers began exploring options for conducting more selective fishing methods in order to target enhanced or plentiful stocks, and rebuild depressed wild stocks that had been over-harvested in mixed-stock fisheries (Gitxsan Wet'suwet'en Watershed Authority 1998; Pinkerton and Weinstein 1995:66; Taylor 2003).

The ESSR communal fishing license of the Gitxsan allows Native fishers a commercial harvest of Babine River sockeye salmon in river waters once the enhanced sockeye stocks reach a target escapement at Babine River (subject to changes in fisheries management plans) (DFO 2005a; Pinkerton and Weinstein 1995:66). The Gitxsan perform catch-surveys using standard sampling surveys of CPUE and total effort and have trained a number of their people in salmon population monitoring and management methods and in the operations of the traditional fisheries management system. The Gitxsan have since published their current catch monitoring methods and data, spelling out sample size, methods, and confidence limits (reliability) “making (itself) accountable to scientific and political scrutiny” (DFO 2005a; Pinkerton and Weinstein 1995:65; Taylor 2003). Regional DFO staff interviewed in 1995 stated that the Gitxsan catch monitoring system was “as good as you can get at this point without excessive expenses which would only improve the data a little more” (Interview with DFO field staff 1995 in: Pinkerton and Weinstein 1995:65). This co-management situation between Gitxsan and DFO was ongoing at the time of writing (Pinkerton E. pers. comm. to Turner, N.J. July 2006). In 2004, chief negotiatior of the Gitxsan Hereditary Chiefs, Elmer Derrick, was confident that the Gitxsan would be able to reach an understanding on the allocation, management, protection and enhancement of salmon and stated that: “What we do want is to co-manage our territories, and the resources within those territories, for the benefit of the Gitxsan and for the Crown, too” (BC Treaty Commission 2004:47).

The theory behind the ESSR fisheries is that they give the highest possible catch per unit of effort, using the most effective gear available by season and area, and purposefully concentrate on aggregations of the most efficiently exploitable fish (Berkes 1999; DFO 2005a; Pinkerton and Weinstein 1995; Pinkerton E. pers. comm. 2002; Taylor 2003). From the literature reviewed, the Gitsxan’s Babine River ESSR sockeye fishery appeared to be one of the most successful examples of a co-management effort established and maintained between DFO and a BC First Nations community. Robinson (2001) referred to the Gitxsan’s experiences, problems, prospects and approaches with building co-management partnerships for the Skeena River salmon fishery as a useful model for addressing and resolving native title issues in Australia. The efficiency of the Gitxsan's ESSR sockeye salmon fishery is also an important case study because it closely parallels the co-management initiative between DFO and the Saanich Tribal Fisheries regarding Goldstream River chum stocks and the ESSR chum fishery in Saanich Inlet.

Adaptive Management

Another resource management framework, which carries some advantages for integrating First Peoples' Traditional Ecological Knowledge regarding wild salmon conservation, is "adaptive management" (Berkes 1999). Links between TEK and adaptive management outlined by Berkes (1999:126) include: "learning-by-doing, a mix of trial-and-error and feedback learning, and social learning with elders and stewards in charge". In his experience with the James Bay, Ontario Cree fishing system, Berkes observed that in the Cree system, research and management were synonymous. They also assume that they cannot control nature or predict yields; they are managing the unknown, as is characteristic of adaptive management. In light of his research findings, Berkes (1999) proposed that adaptive management be considered a "rediscovery" of traditional management. The synchrony between research and management of fishery resources characteristic of adaptive management also exists in the Saanich First Nations' fishery management system. This is evidenced in the interview results and discussion of this thesis (Chapters 6 and 7).

According to a review of case studies, ecosystem resilience or possibility for restoration of resilience of ecological components of the ecosystem and flexibility of existing power relationships among stakeholders comprising the social component of the management system are attributes of successful adaptive management institutions (Gunderson 1999). According to Walters (1997), lack of data on key processes that are difficult to study and differences in ecological values are key barriers to successful administration of adaptive management institutions. Pinkerton (1999) identified distrust and resistance of management agencies and lack of broadly organized political support as additional barriers to successful implementation of adaptive management efforts in BC fisheries. In adaptive management, all parties are actively learning (Berkes 1999; Gunderson 1999; Johnson 1999; Lee 1999; Pinkerton 1999; Walters 1997). Uncertainty about relationships among ecological and social components, user response to management, and abundance of the natural resource are inherent to natural resource management; therefore, elements of risk and ambiguity must be embraced when engaging in adaptive management processes (Johnson 1999).

Ecosystem Management

The Coast Information Team (CIT), consisting of representatives from the Province of BC, First Nations, local governments of BC's Central and North Coasts and non-government organization reached consensus on a definition of ecosystem-based management that is equally applicable to southern Vancouver Island interests. In April 2001, the Coast Information Team defined ecosystem based management as:

> …an adaptive approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities. The intent is to maintain those spatial and temporal characteristics of ecosystems such that component species and ecological processes can be sustained, and human well-being supported and improved (CIT 2001).

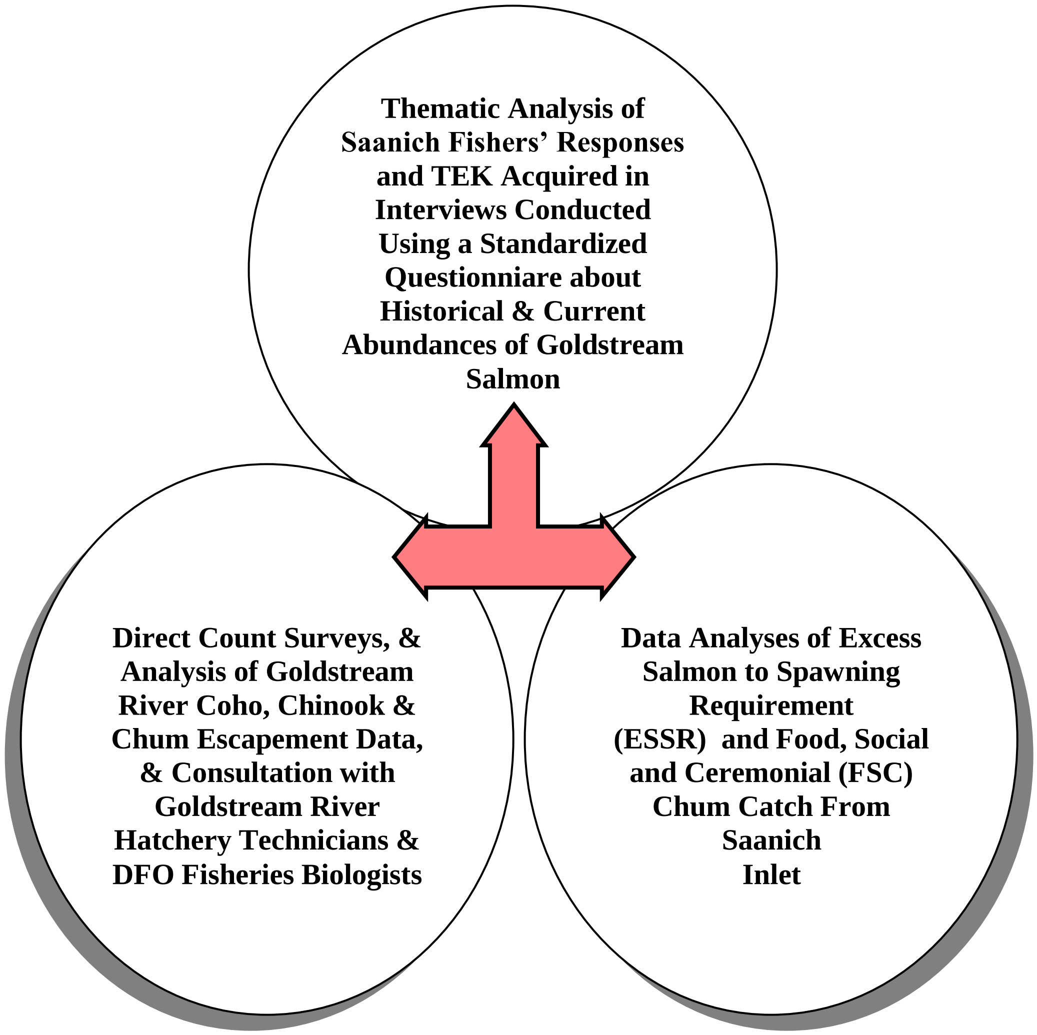
The First Nation Panel on Fisheries (2004:2) has since listed an ecosystem approach to management as a top priority in their vision for BC fisheries. The literature on ecosystem based fisheries management showed a trend in recommendations to simultaneously adopt a precautionary principle (e.g. preventing fishing in areas where the status of and impact upon the ecosystem is unknown). Ecosystem based management integrates an adaptive management approach enabling flexibility in the face of changes in ecosystem and community dynamics. It is holistic in nature and avoids command and control pathways to resource management (CIT 2001; Larkin 1996; Olsson and Folke 2001). In practice, ecosystem-based management includes effective, efficient time and resources applied to monitoring of ecosystems and ecosystem resources such as individual species (Olsson and Folke 2001).

CHAPTER 5 – METHODS

5.0 Overview of Methods Used for this Research

I used both qualitative and quantitative research methods in this study of Goldstream salmon stocks monitoring. Traditional Ecological Knowledge (TEK) was brought out from interviews with Saanich fishers and combined with analyses of salmon abundances returning to their natal stream (Goldstream coho, chinook and chum escapements) as well as abundances of chum salmon caught from Saanich Inlet (native harvest statistics). Thematic analysis of traditional ecological knowledge from interviews and analyses of fish stock data (scientific ecological knowledge) are each based on separate knowledge claims and each imparts partially different information (Usher 2000). Neither the qualitative nature of traditional ecological knowledge, nor the quantitative data of salmon catch or escapement could, independently, sufficiently inform us about the status of Goldstream salmon stocks. An interdisciplinary research approach, blending science and social science methods was therefore undertaken to address the question of how escapement counts contribute to Goldstream salmon monitoring protocols. This approach was undertaken in order to generate an inclusive and well-rounded picture of the monitoring protocols and conservation practices in place for the Goldstream salmon and of the Saanich First Nation fishers' perspectives of these. This chapter describes the quantitative methods (direct fish counts, time series graphing, three year rolling averages and assessment of biostatistics) and qualitative methods (interviews, transcription and analysis of traditional ecological knowledge reported) used for this research. My integrated research approach (Figure 5.1) may be used in conservation biology, ecology and other life science projects.

Figure 5.1 Integrated Research Approach for Monitoring Wild Salmon Stocks at Goldstream River and Saanich Inlet, Southern Vancouver Island, B.C.



5.1 Interviews with Saanich First Nation Fishers

Background

Traditional ecological knowledge (TEK) of fishers, also referred to as fisher's ecological knowledge (FEK), of the Saanich peoples' salmon fishery, was documented through collaboration with Saanich First Nation fishers. Saanich fishers were asked to share their knowledge and perspectives about the Goldstream and Saanich Inlet fishery in semi-directed interviews that ranged in duration from one to four hours. A standardized survey research instrument was created for conducting these interviews. The overarching goal of the questionnaire was to document knowledge and life experiences of Saanich People who have fished these waters for subsistence purposes over several to many years. The survey was also designed to obtain qualitative and quantitative information about Saanich fishers' observations of coho, chinook and chum salmon over time (Appendix E).

I applied to the University of Victoria Human Research Ethics Committee to undertake interviews for this research. The questionnaire and Participant Consent Form designed for conducting interviews with Saanich fishers were submitted in this application. The application was approved and a Certificate of Approval was obtained, allowing me to recruit and interview participants for this project for the period of July 26 2002 to July 25 2003 (Appendix F).

Interviewees were selected on a chain referral basis to identify key informants rather than a random sampling of the community as this is a recommended approach when undertaking research involving traditional ecological knowledge (Huntington 2000). Experienced fishers referred by their peers, were asked to participate in a face-to-face interview with me. Dr. Nancy Turner who had worked with him previously referred the first interviewee (Earl Claxton Sr.) to me. Three subsequent participants assisted with guiding the selection process by using peer selection, referring other fishers and offering their contact information for the purposes of the study. All fishers referred by other expert fishers were interviewed until no new names came up. A total of seven fishers were interviewed (Appendix G).

Upon reading, understanding and signing the Participant Consent Form, each interviewee provided me with permission to tape-record the session and use the information within this master's thesis (Appendix H)[17].

Interviews were subsequently transcribed *ver batim* as closely as possible. Each participant received a copy of the transcript of his own interview, and was asked to review the transcription for accuracy, completeness, and approval. Participants were asked again for approval to use their interviews in my thesis and if they would like the audiotape of their interview archived with either the Saanich Native Heritage Society or the Saanich Adult Education Centre library at the Saanich Tribal School located at 7449 West Saanich Road, BC.

The relevant results from the interviews are presented both as part of the thematic analysis procedure, and as separate topics in my results chapter.

Thematic Analysis

Thematic analysis is commonly used to categorize qualitative information (e.g. from interviews). It allows for the translation of statements from interviews (qualitative

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[17] On occasion participants asked that information discussed be left off record. In these instances, the tape recorder was shut off until the person expressed that they would like to resume the interview for the purposes of the research.

data) into quantitative data. It is a process of encoding qualitative information by using a series of codes or flags such as particular themes. A theme is a pattern found in interview responses that will describe and organize the possible observations and may be extended to interpret aspects of the phenomenon. Boyatzis (1998:4) described thematic analysis as a useful tool for "…systematically observing a person, an interaction, a situation, an organization, or a culture." Thematic analysis assists in communication between positivistic science and interpretive science (Silverman 1993). It can bridge or translate methods and results into forms accessible to readers from different fields, orientations or traditions of inquiry (Silverman 1993). Thematic analysis is a good methodology to use with interviews regarding TEK within a First Nation community, as it is useful for analyzing individual and shared responses to questions within the questionnaire.

Thematic analysis of interview transcripts was undertaken in order to encode qualitative information (TEK) and document dominant, emerging themes regarding Saanich Peoples' past and present salmon fishing experiences at Goldstream River and Saanich Inlet. Transcripts were reviewed to identify, organize and systematically observe recurring topics and/or details (e.g. varying attributes of fishing effort over time), emerging from participants' qualitative and quantitative responses to the questions posed in the survey (Boyatzis 1998; Silverman 1993). Themes were coded by using different symbols for identifying each theme. Depending on participant responses, a topic raised from a question in the research instrument such as 'change in size and configuration of salmon over time', may or may not result in a predominant theme upon analysis. In this research, the theme (e.g. former fishing methods) is the unit of coding and the Saanich First Nation fisher is the constant unit of analysis. If a recurring theme was identified in the responses of most of the participants, it was considered a major theme.

The descriptive and quantitative themes that were generated from thematic analysis of interviews are tabulated in Chapter 6. This process enabled me to systematically identify, list, describe and examine Saanich First Peoples' observations, interactions and cultural relationships with salmon. It also provided a structural framework from which to observe Saanich Peoples' past and present circumstances with the wild salmon fishery at Goldstream River and Saanich Inlet.

Limitations, Assumptions and Advantages of Non-random Chain Referral Participant Selection and Thematic Analysis

A limitation of the non-random chain-referral approach to selecting interview participants was that the total resulting number of participants (here n=7) was probably not a statistically robust subset of the total Saanich First Nation fishing population. In addition, all interview participants were men however women have also traditionally participated in the fishery. There are no census or other statistics reporting the number of Saanich People who have fished Goldstream River or Saanich Inlet for salmon throughout their lives so the ratio of Saanich fishers interviewed to the total number of Saanich fishers could not be determined. The participant selection process did, however, ensure that only experienced fishers were recruited for interviews.

A limitation of thematic analysis is that summation of interviewee responses can result in loss of depth and context of First Peoples' knowledge (Stevenson, 1998). Categorizing dominant themes from interviews (Table 6.1) however, allows an overview of large amounts of qualitative data.

5.2 Escapement Enumeration

Purpose of Escapement Surveys

Escapement enumeration is the process of estimating abundance of salmon completing their life cycle at their natal freshwater habitat[18]. I conducted Goldstream escapement enumeration for this project in consultation and in conjunction with Howard English hatchery technicians and DFO salmon biologists during the Fall 2002 salmon run season (Appendix I). Two to three surveyors conducted these annual salmon stock counts at Goldstream River once a week on the same day each week from Wednesday, September 25 to Wednesday, December 4, 2002. This work was undertaken in order to determine how escapement data were obtained and recorded in DFO's field report files (DFO BC 16 reports) (DFO 1932-2004). Annual escapement counts build upon existing baseline data and enable observation and comparison of ocean survival trends of individual salmon stocks at a particular site (or between a number of sites) over time. These data serve as points of reference and measurement for ongoing wild salmon stocks monitoring and scientific study. Escapement data also provides researchers with updated information for preparing annual forecasts and prescriptions for wild salmon conservation strategies.

Surveyors used two or three pocket-sized manual counters, wore stream waders and used waterproof notebooks and pencils for recording field notes.

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[18] Escapement counts acquired from enumeration surveys are sometimes referred to as soft counts because they are best estimates or approximations of the total number of salmon returning to their natal river to spawn.

Visual Survey Procedure

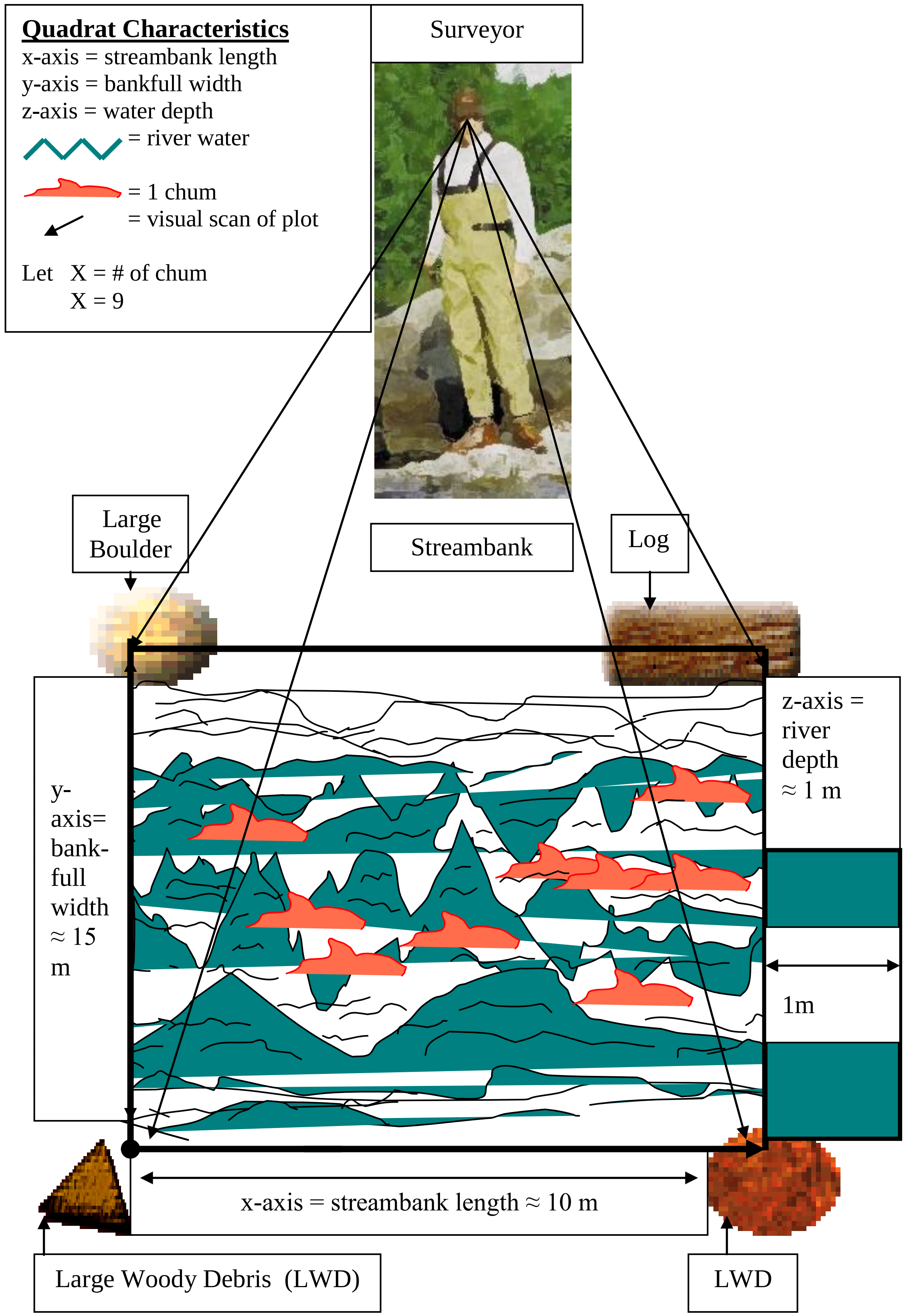
The four salmon spawning reaches of Goldstream River that comprise this study site (reaches 1 to 3) were visually surveyed during a 2.8 km stream walk. The stream walk involved hiking through the river's adjacent riparian zone (Table 2.2) and wading through shallow river currents (~ 2.5 cm to 60 cm in depth) on gravelly, spawning ground waters. Surveyors scanned spawning ground waters along the riverbanks (used as parallel transect lines) and within the bankfull width[19] (used for perpendicular lines to those of the riverbanks) that formed the quadrat.

Quadrats varied in length and size and were visually outlined on site. Surveyors used the bankfull width (the distance from one side of the stream bank to the other) and the distance between two points identified on each side of the stream to demark a visual quadrat. Four objects used for visualizing a quadrat are, for example, a tree and boulder on one side of the river, and a shrub and piece of large woody debris across the bankfull width. The four markers indicate the plot within which stream waters were surveyed for salmon abundance (escapements) (Figure 5.2).

Surveyors stood at a point along a transect line (the streambank of their quadrat) and used their counters to record the total number of live salmon (of the species that they were responsible to count during that stream walk) that they observed within their quadrat, then moved downriver to plot and examine another quadrat. Each consecutive plot was delineated and surveyed within about 5 minutes when counting in the river and about 10 minutes when traversing the woods along the riverbank.

[19] Bankfull width: The width of flow within a stream channel that is just contained with the channel banks; Commonly known as the distance perpendicular to streamflow between the limits of terrestrial vegetation on both sides of the stream (BC Ministry of Forests 2001:1).

Figure 5.2 Quadrat Formed for a Visual Survey of Adult Chum at Goldstream River



These quadrats were established approximately every 10 m where observation of river waters was possible until the full 2.8 km stretch of river was surveyed and all salmon migrating upriver or spawning at the river were counted. During my field season in 2002, I was trained by an experienced stream surveyor and hatchery volunteer named Art Inglis who has conducted weekly counts of Goldstream salmon for several years. Surveyors are trained to identify each of the salmon species present (coho, chinook and chum), to calibrate their field of vision within four ocular distance intervals, to mark out each quadrat surveyed, to be visually aware of and alert for all migrating salmon within the reach of river surveyed and were careful not to recount the same salmon in two or more separate quadrat plots along the length of the river. Weekly counts or estimates of salmon captured, roughly, the total number of salmon returning to the river as is done in a population census (complete count) (Thomas et al. 2004). The general movement of migrating salmon is from downriver to upriver therefore surveyors counted the salmon from upstream to downstream, in a northbound direction (beginning at the terminus of Reach 4 and moving towards Reach 1). This was done in an effort to reduce the chance of recounting the same salmon twice in one day.

Escapement enumeration was conducted at 10 to 15 elevated observer checkpoints at heights ranging from approximately 2.5 m to 13 m above water surface level throughout Reach 3, and for about half the length of Reach 2 (totaling ≈ 1.5 km of river length). Quadrats surveyed from those observer points (located about 1.3 km upstream from the mouth of the river) enabled clearer observation of those deeper water pools where coho typically prefer to rest. The remainder of Reach 2 and Reach 1 (which is ≈ 1.3 km) was surveyed using quadrats at lower elevations, along the riverbank or within river waters (at eye-level of the observer, or ≈ 1.5 m to 2 m above water level).

Each weekly stream survey took approximately two to three and a half hours. It was common for one person to survey Reach 1 (930 m in length) upstream to downstream while another one or two people surveyed Reach 3 (630 m long) and travelled downstream to Reach 2 (1, 270 m). After Reaches 1 through 3 (totalling 2.8 km) had been surveyed (Figure 2.2), all surveyors met at the terminus of Reach 1 where the road bridge and picnic tables are located (~ 930 m from the mouth or estuary of the river). At that point, we tallied our weekly escapement counts for coho, chinook and chum salmon, then returned to the hatchery and reported them to the bookkeeper.

The bookkeeper recorded weekly escapements at the Goldstream hatchery over the two and a half month salmon run season. Final tallies of observed escapements were reported to the Goldstream River Nature House and to DFO offices in Nanaimo and Victoria at the end of the salmon run season. A DFO officer subsequently checked over escapement survey field reports, accompanying field notes and calculations for general accuracy of information. Final tallies of salmon counts were then recorded in a database for storing annual escapement records and were filed as BC 16 reports in DFO offices in Victoria and Nanaimo, BC. DFO then makes these data accessible for external research purposes (e.g. via the Fish Wizard website on the internet). Copies of the BC 16 files containing salmon escapement counts for Goldstream River from the period 1932 to 2004 were obtained for this study [20].

Limitations, Assumptions and Advantages of Goldstream River Salmon Survey

The salmon counts were limited by a number of factors. Environmental conditions such as murky waters resulting from the release of tannins from autumn

[20] These archives were collected from the DFO office located at 4250 Commerce Circle, Victoria, BC.

leaves that fell into the river made it difficult to see past the surface of the water on some occasions and at some locations within the stream survey circuit. Since coho preferred to remain hidden in deep, dark pools of water or under rocks and riverbanks, they were more difficult to observe from the stream bank and individuals that remained invisible would have been missed. Coho and chum that were counted one week may have been recounted for the same survey the following week because their senescence period is about two weeks. This was probably not the case for chinook counts however as their senescence period after spawning is about 2 days (Baxter 2000; Morbey et al. 2005; NOAA 2005; Rawding and Hillson 2003).

Escapement reports represent estimates of all salmon returning to their natal river. In practice, however, the procedure yields a rough estimate of all visible salmon encountered and accounted for during a period of three to four hours, once a week during the fall spawning season (September to December). It is important for scientists and/or researchers to understand how salmon escapement data are collected so that inherent margins of error in estimation of salmon abundance can be recognized.

Coho, Chinook and Chum Escapements (1932 to 2004)

Records of Goldstream River coho, chinook and chum escapement were retrieved from Fisheries and Oceans Canada's (DFO's) stream survey reports (filed as DFO BC 16 reports) for all years on record (i.e. the period 1932 to 2004). Escapement counts recorded from 1932 to1959 stream surveys were categorized under very wide numerical ranges, which were coded alphabetically in stream inspection logs. More recent live counts (1960 to 2004) of returning salmon were conducted using more precise enumeration methods (DFO 1932-2004). I composed detailed metadata descriptions for all the salmon escapement data gathered from Goldstream River stream inspection logs dating from 1932 to 2004 (Appendix J).

Processing Escapement Data with a Three-Year Rolling Average

Escapements from stream inspection log sheets were entered into Microsoft Excel (©2001) database spreadsheets to create frequency tables of discrete data for each salmon species. The purpose of plotting the escapement data was to graphically illustrate a time-series distribution for identifying and analyzing significant or noteworthy fluctuations in numbers of coho, chinook and chum salmon returning to Goldstream River spawning grounds over the past 70 years. Three-year rolling average intervals (e.g. averages for 1932-1933-1934, 1933-1934-1935, 1934-1935-1936, etc.) were logged in order to smooth out arbitrary fluctuations within the 1932-2004 dataset. Graphs were constructed with time plotted on the X-axis and three-year averages of escapements plotted on the Y-axis. This was done for each of coho, chinook and chum salmon escapement data. Moving averages effectively smooth out arbitrary, local fluctuations in raw data.

Saanich Tribal Fisheries' Saanich Inlet Commercial Chum Catch Dataset

Saanich Tribal Fisheries' total allowable catch of chum varies annually depending on the "excess" number of chum (escapements) that successfully completed their return migration to Goldstream River spawning grounds. Managing Pacific salmon stocks on the basis of a target escapement goal is also known as a constant-stock-size strategy (Hilborn and Walters 1992: 453). Once the annual escapement target of 15,000 chum salmon are accounted for in the river, harvesting activities as outlined and agreed to within the annual Excess Salmon to Spawning Requirement (ESSR) chum-fishing license are permitted in the inlet (DFO 2001b). DFO collects and files data from annual ESSR chum catch in collaboration with the Saanich Tribal Fisheries council. Total harvest of Saanich tribal commercial, communal salmon in Saanich Inlet has been recorded since 1982. The last record of total chum catch available from DFO files in the winter of 2005 was from the 2002 ESSR fishing season. There was no ESSR fishery in 2003 or 2004.

Population Characteristics Based on Coho, Chinook and Chum Escapements

I determined the carrying capacity (K) for coho and chinook based on observed population increases and decreases of the escapement data from 1932 to 2004. (As noted in Chapter 3, DFO has already determined the carrying capacity of chum at Goldstream River to be 15,000.)

I then solved for the rate of population growth (r) for three separate time intervals (1932 to 1944, 1944 to 1973 and 1973 to 2002) for each of the Goldstream salmon stocks based on their individual carrying capacities. The logistic growth rate was determined by using Pierre Verhulst's (1838) logistic growth model, which is based on the theory that population growth is limited and may depend on population density (Cox 1996:173).

$$r = \frac{dN/dt}{N\left(\frac{K-N}{K}\right)}$$

r = Rate of population change over time
dN = Change in population
dt = Change in time
K = Carrying capacity

I also deciphered the maximum total area of riverbed each salmon species would occupy in the spawning reaches (Reaches 1, 2 and 3) of the river if each stock had reached its maximum carrying capacity for the river during spawning season (October to December). I did this to find out if there is enough spawning habitat to accommodate the maximum carrying capacities proposed for Goldstream coho, chinook and chum stocks at this river.

5.3 **Saanich Inlet Excess Salmon to Spawning Requirement and Food, Social and Ceremonial Chum Fisheries Data Processing**

Chum catch data from annual ESSR fishing licenses issued for Saanich Tribal Fisheries Saanich Inlet commercial fishery between 1982 and 2002 and from their Food, Social and Ceremonial (FSC) chum catch for the 25 year period from 1978 to 2002 were collected from DFO fisheries managers for this research project (DFO 2001a, 2001b). These data were input into a spreadsheet database (Microsoft Office Excel Program © 2001) and modeled into a 20-year time series graph with a three-point moving average applied to them. These graphs were also used for comparing trends in Saanich Inlet chum catch against trends in coho, chinook and chum salmon escapements from the same time period (1980 to 2002).

Example of a Catch per Unit Effort (CPUE) Analysis

Catch per unit effort (CPUE) was proposed for this project because of its potential for measuring the fishing activity and sustainability of the Saanich First Nation's ESSR and FSC chum fisheries in Saanich Inlet. Contiguous ESSR and FSC data for the total number of chum caught (the measure for catch) per number of days fished in a year (the unit of effort) for the period 1994 to 1996 were used for the CPUE for this study.

CHAPTER 6 - RESEARCH RESULTS

6.0 Introduction to Research Results

Important findings and major themes that emerged from analysis of interviews with Saanich fishers are provided in this chapter. Results and analysis of three-year rolling averages of Goldstream River escapement data, Excess Salmon to Spawning Requirement (ESSR) and Food, Social and Ceremonial (FSC) biostatistics are also presented. The catch per unit effort (CPUE) data and results for the period 1996 to 1998 are included at the end of this chapter.

6.1 Interviews with Saanich Fishers

The Saanich Nation comprises the communities of Tsartlip, Tseycum and Pauquachin on the west side of the Saanich Peninsula and the Tsawout on the east side as well as the Malahat on the west bank of Saanich Inlet (Figure 2.1). The total on-reserve population of these communities is approximately 2250 (Aboriginal Canada Portal 2006; Department of Indian Affairs and Northern Development 2006; Mos et al. 2004).

The traditional ecological knowledge (TEK) component of this project consisted of the insights voiced by Saanich fishers relating to the cultural and environmental aspects of the Goldstream and Saanich Inlet salmon fishery. The peer selection recruitment process of participants resulted in interviews with seven experienced Saanich fishers including six from Tsartlip and one from Tsawout[21]. Six of the seven participants agreed that they would like the tapes of their recorded interviews archived

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[21] This method was used to identify specialized fishers and did not aim to or result in equal representation of the total Saanich First Nation population.

with either the Saanich Native Heritage Society or the Saanich Adult Education Centre library located at the Saanich Tribal School grounds at 7449 West Saanich Road, BC (Appendix E and G).

The Saanich fishers interviewed conveyed valuable traditional ecological knowledge including descriptive, biological information about morphology, physical characteristics, the food web, feeding behaviour and migration patterns of Goldstream salmon as well as alterations to salmon habitat they have observed and their own conservation and restoration efforts at Goldstream River and Saanich Inlet over time. They also relayed knowledge about their former and current fishing practices and technologies used to fish salmon. Some observations of size and abundance of salmon caught, and accounts of relatives' fishing experiences were recorded during the interviews. Some notable quantitative and qualitative descriptions of cultural fishing practices at these sites were also documented in this process and are reported in the following sections.

In general, according to those interviewed, Saanich salmon fishing opportunities have markedly declined over the past 150 years or so. Some of the reasons for this are eradication of many small, local salmon-bearing streams due to road construction, pollution, and overfishing of salmon and shrimp (a primary food source for salmon).

Habitat Loss

In the 1870's, the province (BC Department of Lands and Works) paved over several tiny but ecologically significant salmon streams (or creeks) that flowed through East Saanich into Saanich Inlet. The creeks were probably fragmented by wooden culverts (in the 19th century) and eliminated (completely filled in with gravel and debris)[22] to provide road access to the Saanich Peninsula. At the time, (1873), road development was protested by the Saanich People. The Saanich First Nation, collectively, wrote official letters to petition the provincial government's plans for further road development through the Saanich First Nations' lands in both East and South Saanich (BC Archives 2003). However, East and West Saanich roads (which intercept the Tsartlip, Pauquachin and Tseycum or North and South Saanich bands' lands) were eventually built despite the Saanich Nation's opposition to the process. "They blasted some rock…in Fairmont…they cut off that stream that goes down our way so as the water won't flow up that way. That was about 1940" (Claxton Sr. E. pers. comm. 2002). Patricia Bay Highway, which intercepts the Tsawout band's lands in East Saanich, was built in 1960 and then widened in 1970 (Tsawout First Nation Band 2006; Wikipedia 2006a).

Substances that are deleterious to salmon spawning and rearing habitat in local creeks or streams include: large and small deposits of rock and soil debris from rock excavation (blasting) that occurred during highway road construction in Saanich in the 1870s, around 1940 and in 1960; and deposits from gravel, asphalt and concrete rubble that were used to pave roads in the 1940s and 1960s (Arizona Department of Transportation 2004; Statistics Canada 1999). This assortment of construction debris was probably either directly deposited by road builders or indirectly deposited by rain and downslope gravitational movement from the construction sites to nearby streambanks and waters. This in turn would have caused bank erosion, siltation and

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[22] The summation of construction and existence of wooden culverts and filling in of streams to build roads in the 1870s was derived from literature about California, and New Zealand (State of California 1995; Victoria University of Wellington 2005). No detailed information from BC sources was found for the 1870s era of highway roads construction and engineering.

nutrification of stream water at those times in recent history. In addition, the introduction of clay, concrete or steel culverts during the 1940 road construction activities in Saanich fragmented the connectivity of the stream habitat, created barriers to salmon migration pathways and altered the pressure and flow of water where the culverts were placed (Arizona Department of Transportation 2004; Hoel and Short 2006; Statistics Canada 1999).

Saanich Inlet tributaries are important habitat for anadromous salmon (Elliott J. pers. comm. 2002; Simonsen et al. 1995: online; Simonsen et al. 1997). "The coho spawn in little streams…they just seem like ditches to some people" (Elliott J. pers. comm. 2002). The elimination of numerous small streams through East and West Saanich on southern Vancouver Island has disrupted the Saanich Inlet ecosystem by cutting off, fragmenting and altering the direction of surficial and groundwater flow to local creeks and streams. "So when they put in the…West Saanich Road, it started to knock off all those streams, change their direction" (Elliott J. pers. comm. 2002). Elliott observed that these roads acted as physical barriers, forcing coho salmon to reroute their migration path and subsequently attempt to dig redds (spawning nests) and lay eggs in inhospitable aquatic environments where spawning and rearing of juveniles could not occur (e.g. the banks of the inlet). The roads and culverts also blocked nutrients originating from those streams from flowing into Saanich Inlet to nourish the shrimp and other marine organisms that subsisted upon them.

> …Those are the streams that are feeding our Inlet and they're feeding the coho. That's what they are there for. They eat those [*nutrients*] and whatever comes out of those streams, that is their food. And, it is also feeding the young salmon, the ones that are just coming out of the stream…. (Elliott J. pers. comm. 2002).

John Elliott, Earl Claxton and other Saanich fishers recalled their elders teaching them that Saanich Inlet was a nursery and important feeding ground for wild salmon migrating through and feeding on the then plentiful food sources within it (Claxton Sr. E. pers. comm. 2002; Elliott J. pers. comm. 2002).

…My dad always said that this, Saanich Inlet is a nursery for salmon. That's the way he described it…. They come here, they are born, the little [*salmon smolts*] feed, they grow up here and then they leave and they go up… anything to do with fishing is lessening it (Elliott J. pers. comm. 2002).

The Shrimp of the Inlet

A notable decrease in shrimp has taken place in Saanich Inlet since those roads were built throughout the reserve (Elliott J. pers. comm. 2002). John Elliott and Joe Bartleman (pers comm. 2002) expressed that the decrease of shrimp in the region is likely due to increased commercial shrimp fishing and pollution in the inlet. The continuance of the commercial shrimp (and prawn) fishery[23] that was established as a test fishery in Saanich Inlet in 1999 is increasing the demand for shrimp and causing further decline to the shrimp population (Bartleman J. pers. comm. 2002). Shrimp are a major prey for salmon so a declining shrimp population may be a contributing factor to the subsequent decrease in size and abundance of salmon and other fish stocks that used to pass through Saanich Inlet in the thousands (Claxton Sr. E. pers. comm. 2002; Elliott J. pers. comm. 2002). This has negatively affected the livelihoods of Saanich fishers dependent on fishing declining numbers of salmon, shrimp, and other fish in the Inlet for their food (Elliott J. pers. comm. 2002).

[23] Prawns are large shrimp and all licenses for shrimp fishing in BC nearshore Pacific Ocean waters fall under the legislation of the 'Prawn and Shrimp License' designation issued through DFO.

John Elliott (pers. comm. 2002) dissected the stomachs of recently deceased salmon at Goldstream River to determine what they had been eating. He found mostly shrimp in the stomachs of these salmon, indicating that shrimp is a main part of the diet of the salmon feeding in Saanich Inlet prior to migrating upriver (to Goldstream River spawning grounds).

Conservation Practices of Saanich First Nation Fishers

The Saanich were aware of the necessity to control and limit their fish catch. Earl Claxton Sr. (pers. comm. 2002), for example, was careful to teach his grandchildren about conserving the fish: "*My grandchildren are the ones that like to go and catch the fish…but I always say don't get anymore than about 30, even 30's too much.*" Earl Claxton leads field trips for children attending kindergarten to grade eight classes at the Saanich Tribal School and shows them how to fish Goldstream River salmon in the least wasteful ways. He also teaches them not to catch more than is needed for their families' winter supply of chum during the fishing season.

Joe Bartleman (pers. comm. 2002) and his family (of the Tsartlip band) have fished Goldstream River and Saanich Inlet for over 200 years. They especially like to fish grilse coho salmon, which were caught in the inlet at approximately 30 cm long[24]. The coho grilse were a main part of the Saanich Peoples' food fish but have subsequently been eliminated from their diet due to coho fishing restrictions over the past 15 to 20 years. "*I must have been in my early 20s last time I ever went out for*

[24] Michielsens et al. (2006) define grilse as: " Salmon that return after one winter at sea."

those, because they closed it completely, and when it reopened again, we could still take them at 12 inches, and I resisted" (Bartleman J. pers comm. 2002). Bartleman has witnessed a decline of coho returning to Saanich Inlet feeding grounds first-hand over the past twenty years. His testimony illustrated that even during times when DFO reopened coho fishing in Saanich Inlet, he exercised restraint from his traditional coho fishing practice in the interest of protecting future generations of coho salmon. A similar conservation ethic was evident from the interview with Tsartlip Chief, and lifelong fisher, Simon Smith (pers comm. 2002). "…for the chum, our People believe these are ready to spawn so they don't want to catch them…eggs are something our People like too and we do believe in conservation, we won't fish them if we believe there isn't enough in the river." Earl Claxton, Joe Bartleman and Simon Smith's accounts of their families' fishing practices illustrated that Saanich fishers are cautious of the quantity of salmon that they fish and that conservation is a well-ingrained and intrinsic part of their fishing practices.

Changes to Saanich Peoples' Salmon Fishing Efforts

In the past (prior to the 1950s), traditional, rotational fishing practices maintained the general productivity and abundance of Goldstream salmon stocks. Joe Bartleman spoke of his parents' experiences with rotation fishing of chum at Goldstream River (between 50 and 70 years ago).

> I think we had more of a demand on the resource at that time, as there were always different families in that stream doing their fishing at different times. It was never all of us there at once. We couldn't possibly leave them enough room. But, because there was all that rotation, and with all these people taking fish out of the stream, we could allow more than 17,000 (*chum*) because we were taking them as they come in. (Bartleman J. pers. comm. 2002)

Over the past 50 to 70 years, there has been a transition in fishing effort from traditional, rotational family fishing practices which entailed catching more salmon at the river to a modern commercial seine boat (chum) salmon fishery taking place in Saanich Inlet.

> But now they come out from the boats out here in the Sound, there, we guesstimate the amount they catch, and we guesstimate about all the schools that are sitting in the Bay (*Saanich Inlet*)" (Bartleman J. pers. comm. 2002).

In these modern fishing times (e.g. 2000 to 2005), there are guardians on duty on board the seine vessels that fish the Saanich Tribal Fisheries ESSR chum fishery in Saanich Inlet each year. Guardians monitor abundance of salmon caught and estimate abundance of salmon present in the inlet during spawning season (Smith S. pers. comm. 2002). (See Saanich Tribal Fisheries section later in this chapter for further context regarding the Saanich First Nation's fisheries management practices.)

Changes to the Goldstream River Salmon Stock Fishery

Six out of seven fishers confirmed that Goldstream has historically been a predominantly chum salmon-bearing stream. As noted previously, today, Goldstream River is a mixed salmon stock fishery providing spawning habitat for enhanced coho and chinook stocks as well as naturally spawning chum. Five of the seven fishers expressed concern that hatchery enhancement of coho and chinook to higher levels than the stream's natural, historical populations could negatively impact its wild chum populations (Appendix A). In addition, two out of seven fishers relayed that Goldstream coho and chum were smaller in length, girth and weight than they were when they fished them in the past. John Elliott (pers comm. 2002), for example, observed that the coho he caught in Saanich Inlet in the past two years were about the same length but a lot thinner (~2 lbs lighter) than the ones he caught in the previous 40 years.

The following table describes the predominant themes that emerged from the interviews with Saanich fishers (Table 6.1). The first column reports recurring themes expressed by all seven Saanich fishers. Information specific to Goldstream River and Saanich Inlet (the second and third columns) are summaries of detailed examples that characterize the major theme, provided by the majority (4 or more) of project participants. Some of the findings, and quotes representing the themes presented in this table include accounts of observations (TEK) passed down from elders, relatives or other Saanich fishers.

Table 6.1 Major Themes from Interviews with Saanich Fishers

Theme	**A. Findings Specific to Goldstream River**	**B. Findings Specific to Saanich Inlet**	**Example Quote**
1. Observations and experiences regarding changes to the (aquatic) environment	i. Width of river reduced and restricted partially due to encroachment of park's recreational facilities such as the picnic area (paved area with picnic tables) at the river's edge (terminus of reach 1).	i. Pollution in Saanich Inlet. ii. Development eliminated several streams flowing into Saanich Inlet.	1.B.i. "We can't go out and get the fresh fish we used to get…because of pollution. We got some food from the sea (*Saanich Inlet*) not very long ago, about a month ago…and we ate it and my wife and I both got sick. What's in that fish? Pollution caused that." (Morris S. pers. comm. 2002)
2. Fishing practices a.) Fishing practices and technologies used from pre-European settlement times to the 1960s	i. Set up fishing and smoking camps near riverbeds (Oct.-Dec.). ii. Started fishing at the mouth of the river and moved their way upriver to the top (so that they were not taking all the fish from the same place). iii. Fished at night.	i. Canoes docked at the beach along the Brentwood Bay shoreline. ii. Fished near the mouth of Goldstream River and in the inlet waters throughout the Saanich Peninsula. iii. People fished with their families all day and at night.	2.a.) A. i-iii. "They (*elders*) had a way of knowing when it was time for the fish to go up (*Goldstream River*). There was times when they would spend two nights overnight…catching and smoking (*salmon*)…There used to be a big smokehouse there… maybe 30-40 feet long (9-12 *m* long) …10-12 feet high (3-3.5 *m* high). It was only recently that they took it down…(*about 10 years ago)…*

Theme	A. Findings Specific to Goldstream River	B. Findings Specific to Saanich Inlet	Example Quote
2. Fishing practices a.) Fishing practices and technologies used from pre-European settlement times to the 1960s (continued)	iv. Wooden shafts, gaff hooks, spears, nettle fibre fishing nets, dip-nets, stakes and weirs were handmade (e.g. dip-nets were made from boughs bent into 0.5 to 1 m diameter circles, bound with tree sap and twine with a 1 to 1.5 m long bough handle attached (Smith S. pers. comm. 2002). Stakes and weirs were used for stakes luring; a 2.5 - 3.5 m wide net, with 2 - 7 kg weights keeping it submersed below water was secured by 8 cm wooden posts driven into the riverbed to keep the net in place. The net trap ran across half the width of the river at ~ 45º angle to the riverbank and lured salmon to one side of the stream for catching (Bartleman J. pers. comm. 2002). v. Chum were caught and cured (cut, salted and laid out in containers to dry overnight) or staked and hung to dry under a canopy in the sun and wind.	iv. Canoes or wooden boats using hook and line or net fishing. Beach seine net fishing, rod and line as well as spear fishing salmon from the shoreline (for family, cultural and communal Food, Social and Ceremonial as well as small-scale trade and sale purposes). Gillnet, seine and troller (hook and line) boat fishing of coho, chinook and chum (for family cultural and communal Food, Social and Ceremonial as well as trade and small scale commercial sale). People used to catch many more chum in Saanich Inlet by: seine net, troll (using 65-90 m of wire line and 4.5 kg cannon balls for trolling), canoes mounted with line or net, and by spear fishing in the past than they do now. (Salmon species not specified.)	They used to smoke the fish right there.” (Morris S. pers. comm. 2002)

Theme	**A. Findings Specific to Goldstream River**	**B. Findings Specific to Saanich Inlet**	**Example Quote**
2. Fishing practices a.) Fishing practices and technologies used from pre-European settlement times to the 1960s (continued)	They were also smoked by hanging over burning alder at the campsite by the river.[25] Salmon were then piled in layers and bundled with rope, or strung together on a rope line. vi. Salmon transported from the river by canoe, rowboat (or other boat) horse and buggy, and in later years (early to mid 1900s) by car. vii. Mostly chum caught in river.	v. Salmon were stored in wooden boxes or crates on the boat. Once freezers were kept at home (~ the 1930s), fishers kept salmon they caught on ice in boxes on board the boat. vi. Crates were stored on the beach overnight. Salmon could be left in crates overnight and carried home or transported by horse and buggy up to the mid 1900s and by car thereafter. vii. Caught chum, coho and chinook.	See quote 2.a.) A. i-iii. on previous page.
2. Fishing practices b.) Recent fishing practices and technologies used (1960s-present)	i. Gaff hooks, spears, dip-nets, weirs, (for stakes luring), used for salmon fishing during day or nighttime fishing trips. Salmon then strung together on a rope, pulled downriver and transported home where they smoke or airdry the fish.	i. There are currently 1-4 seine boats (contracted by Saanich Tribal Fisheries) fishing chum during a 10-day fishing season (Oct); fish are loaded onto a truck, and delivered to the home residences of Saanich First Nations people living in	2.b.) B.i. "Our band gets a truckload of fish, and we get about 4 fish each-each family-not very much. We just got 4 fish about a week ago. They're supposed to bring another load…We used to have our own boats go out and catch the

[25] Hard or dry smoking hardens and dries the salmon and it can be eaten at once after smoking or stored over winter as dry food. Cold or half-smoking half cooks the chum, adding alder wood smoked flavour to the fish, which can be vacuum-sealed and stored in a freezer for winter food supply. Smoked salmon can also be transported to a cannery, jarred in its own salmon oil and kept in dry storage for a winter food supply and refrigerated (once the compressed-sealed jar is opened. Salmon caught for ceremonial purposes (some ceremonies require one male and one female salmon) are hard-smoked (Smith S. pers. comm. 2002).

Theme	**A. Findings Specific to Goldstream River**	**B. Findings Specific to Saanich Inlet**	**Example Quote**
2. Fishing practices b.) Recent fishing practices and technologies used (1960s-present) (continued)	ii. Bring home chum caught from the river raw (in cedar boxes or other containers) and freeze them; or bring them to a local smokehouse; or smoke them at a smokehouse built on their residential property where they are cured (cut, salted, laid out to dry overnight, staked, hung, then cold or hard-smoked by cooking them over burning alderwood).	the Tsawout, Tseycum, Pauquachin and Tsartlip villages.	fish for our people (*until about 1998*) but…they (*Saanich Tribal Fisheries*) went in the hole (*bankrupt*) and they had to sell that boat." (Morris Sr. I. pers. comm. 2002)
2. Fishing practices c.) Changes in fishing technologies used to fish salmon (1940s to present)	Since the 1940s, synthetic fibre fishing nets, line, hooks, weights, rods and knives have usually been purchased at department stores rather than hand-made. Nets, lines and twine (used for binding gaff hooks to fishing poles) were woven from stinging nettle plant stems in the past. Hooks, weights, poles, spears, knives and axes, (to chop cedar, alder or other trees for fishing poles and firewood), used to be made of carved stone and cedar.	Seine fishing used to be done from cedar canoes by drifting cotton nets with mesh sizes adjusted to the size of salmon they wanted to catch. Since ~1940, metal and fiberglass seine boats with synthetic nets and 110 - 130 horsepower (hp) gasoline powered motors were used to fish chum; or 5 -7 hp motor if coho or chinook fishing as they are slower swimmers. Wire for seine bough poles, barline, cannonballs, spoons, other lures, flashers, buoys and weights for 3 spool lines are attached to both sides of the vessel.	2.c.) B. "When I was a kid (*in the 1940s*), we didn't have… any sort of an engine to get around with. We had oars…if you had a canoe and paddles you were quite well off … insofar as your ownership of the canoe…my grandfather made me a canoe." (Claxton pers comm. 2002)

Theme	A. Findings Specific to Goldstream River	B. Findings Specific to Saanich Inlet	Example Quote
2. Fishing practices d.) Spiritual ceremonies and beliefs about salmon	Saanich people bring their children to Goldstream to teach them about their heritage and ancient connection to the river so that the younger generation will feel connected to the stream and learn and pass on the spiritual beliefs their parents and elders learned (e.g. the salmon have a species name and a prayer name that Saanich People use to honour and respect the salmon and which reflects their beliefs of gathering food; and, how to fish without needlessly wasting or injuring the salmon; and, how to fish in a way that will protect the next generation of salmon).	Chum (annual abundances of which are detailed later in this chapter) and a small number of coho salmon (e.g. 1 male and 1 female for one of the [unspecified] annual longhouse ceremonies) are caught from Saanich Inlet by Saanich Tribal Fisheries' fishers for their Food, Social and Ceremonial purposes (Smith S. pers. comm. 2002). This catch is used for communal, cultural celebrations and longhouse ceremonies such as potlatch, naming and blessing ceremonies.	2.d.) A. "We always bring … along … our elders who were there first, and before we even start to fish (*Goldstream River*), we'll say a prayer together to honour the fish, and we thank for our food." (Elliott J. pers. comm. 2002)
3. Traditional knowledge of salmon ecology and biology	i. Sockeye and pink salmon are not endemic to Goldstream. Salmon are sensitive to pollution and the smell of the river.	i. Observed changes in salmon populations over time (fewer coho, chinook and chum to be caught in Saanich Inlet).	3.A.ii. & B.ii. "They (*the salmon*) wouldn't go into Goldstream…It is becoming so contaminated, they can't even put their nose in that river. There is something wrong when the fish won't go into their creek. They try, they

Theme	**A. Findings Specific to Goldstream River**	**B. Findings Specific to Saanich Inlet**	**Example Quote**
3. Traditional knowledge of salmon ecology and biology (continued)	ii. Observed changes in salmon population dynamics over time (fewer salmon returning to the river now than in the past). Pollution from oil leaks from boats in the inlet and overfishing of salmon (especially coho and chinook) at sea/offshore.	ii. Observed changes in salmon migration behaviour over time – Feeding habitat and migration paths have changed (i.e. coho are no longer using their former migration routes to spawn in local creeks; naturally spawned juveniles no longer feed in local creeks in the abundance that they used to; fewer salmon return to Saanich Inlet from local creeks or remain in the inlet after migrating from Goldstream River (probably due to pollution in the inlet in recent years) though the inlet was commonly used by salmon as nursery and feeding grounds. - Overfishing of all salmon (especially coho and chinook) offshore. -Shrimp is a main food of salmon. - Salmon are staying at greater depths in the water column. - Adult salmon returning to Saanich Inlet are smaller.	can't do it, but they have to spawn. So they look for another little place to go and spawn. They do spawn but their eggs won't hatch." (Claxton Sr. E. pers. comm. 2002) 3. A.ii & Bi."Fish have gotten smaller than previous. The coho seem to be on average now about 8 lbs (*3.6 kg*), and we'd catch the ones that were 18 lbs (*8.2 kg*) before, it was a lot of them. 12 lbs (*5.4 kg)* would be a big fish (*in the past*), usually about 10 lbs (4.5 *kg*) is big now." (Bartleman J. pers. comm. 2002) 3. B.ii. "Salmon in Saanich Inlet have gone deeper. We used to catch them in the top 6 feet (*1.8 m*) of water. In the last 10 years, we've had to use line to catch them around 190 to 200 feet (*58 to 61 m*) below the surface." (Bartleman pers comm. 2002)

<u>Theme</u>	**A. Findings Specific to Goldstream River**	**B. Findings Specific to Saanich Inlet**	**<u>Example Quote</u>**
4. Salmon conservation, restoration and stewardship efforts by Saanich Peoples	i. Refraining from harvesting river stocks (including adult coho, coho grilse and all species of salmon eggs/roe). ii. Restoring riparian zone by: planting native vegetation along streambanks to improve salmon spawning and rearing habitat and to decrease erosion processes in wetlands, along streambanks and in creek beds; removing invasive vegetation such as Himalayan Blackberry, English Holly and English Ivy. (Wetland stewardship viewed as a part of fishery conservation efforts- Saanich people partake in streamkeepers and wetland keepers projects in Saanich.) iii. On-going in-stream salmon population surveying.	i. Refrain from fishing coho. ii. Fish excess chum in Saanich Inlet to reduce effects of overspawning in the river. iii. Keep log of abundance of chum caught in Saanich Inlet for the ESSR and FSC chum fishery and report total annual catch to DFO officers.	4. A.i. “There are three runs of salmon….the first one is all males…my ancestors used to say… you take all the fish you want there …The second run, you take what you want … they’re mixed in, half and half there, females and males...the third run…you leave alone. That’s the last one…you don’t catch that run. That ensures your river.” (Cooper E. pers. comm. 2002)
5. Changes resulting from federal fisheries’ (DFO) management of Goldstream salmon	i. Grants from DFO to augment coho and chinook place the natural chum population at risk. The river has historically been a	i. Representatives of the Saanich First Nations have attended meetings with DFO in which they have expressed that	5. A.i. & B.i. “We’re negotiating our fishing with DFO all the time because they don’t believe we still have the

Theme	**A. Findings Specific to Goldstream River**	**B. Findings Specific to Saanich Inlet**	**Example Quote**
5. Changes resulting from federal fisheries (DFO) management of Goldstream salmon (continued)	predominantly chum-bearing stream with very few coho and chinook. Prioritizing coho and chinook stocks will compromise chum habitat. ii. The river is now managed as a tourist attraction - Goldstream River is poorly managed (*the park, river waters and salmon fishery).* - DFO swung the river to the other side (*southwesterly*), away from the reserve, (*reason not specified*) and employed Saanich people to assist with that project. - Several Saanich people were also employed (by DFO) to build trails. This led to increased access, traffic and tourism to the river. iii. There has been too much enhancement of salmon species not originally using this river.	they can no longer eat fish from the inlet due to pollution. They can no longer live off of the fish the way they used to because the polluted fish and seafood (salmon, codfish, octopus, crab, clams and shrimp) makes them ill. ii. Commercial salmon fisheries should not be allowed in Satellite Channel or Saanich Inlet until the freshwater target escapement for the (chum) salmon is reached. DFO was however, allowing a commercial chum fishery in Satellite Channel (in Oct. 2002) before the Cowichan River escapement target (of 110,000) was met. This is a double standard and gives the impression that DFO is using a strong hand with the Saanich First Nation over the Cowichan First Nation in their acts and regulations (Smith S. pers. comm. 2002).	total rights that we tell them we do (*to fish as formerly under the Douglas Treaty*).” (Smith S. pers. comm. 2002) 5.A.i. & B.ii. “You have to protect that second run (*of chum*) and if you’re going to open up the Saanich Inlet to harvesting once they reach 15,000 (*target escapement*), they (DFO) are not protecting that second run.” (Bartleman J. pers. comm. 2002) 5. A.i-iii. & B.ii. “I really believe that they (*DFO*) have been trying to push this stream to become a coho stream rather than a chum stream.” (Elliott J. pers. comm. 2002)

Attributes of Saanich Fishers' Fishing Efforts Over Time (1940s to 2002)

It cost a fisher approximately $2,500.00 (for spools of wire for the bough poles, bar lines, cannonballs, hoochies, flashers and gas) to operate a hook and line fishing boat (in Saanich Inlet) each fishing season (Cooper E. pers. comm. 2002). Using this financial estimate as a benchmark, a 10-day ESSR chum fishery in Saanich Inlet (now done by seine and gillnet fishing boats) costs Saanich Tribal Fisheries approximately $250.00 a day to operate a boat and equipment and this does not account for fishers' wages which are paid out in cents per pound of salmon caught and sold at the market value price of a given fishing season (See Figure 6.4 for the total ESSR chum catch from 1982 to 2004).

In the past (prior to 1960) Saanich fishers caught on average 120 fish each during a 9-hour fishing trip and each person made a total of 12 trips to Goldstream River over the three-month long fishing season to provide for a seven-person family. This supplied the Saanich People with approximately 1440 salmon a year per family. According to the fishers interviewed, the average weight of chum salmon caught in the past and present (between the mid-1940s to 2002) ranged from about 3.6 to 6.8 kg. A conservative weight of 4.5 kg was selected from this range in order to estimate annual intake of salmon per person (by weight). This amounted to each person receiving and consuming just over 200 salmon or about 930 kg of salmon a year (or 2.5 kg of salmon per person a day, year round). More recently (1960 to present), total averages reported for 9-hour fishing trips made three times per fishing season, has yielded a total of under 200 salmon per four-person family per year. This amounts to an allocation of just under 50 salmon (or 220 kg of salmon) per person annually or just over 1/2 kg of salmon per person a day, year-round. These estimates were derived from fishers' responses about the number of annual fishing trips made to Goldstream River, the duration of each trip, the quantity of salmon caught per trip and the number of people in the family to feed with the total annual catch (Appendices E, G and H).

Traditional Ecological Knowledge of the Goldstream Salmon Run

By listening to their elders, some Saanich fishers have learned to recognize environmental cues that signal the timing and abundance of the upcoming season's Goldstream River salmon run. Earl Claxton Sr. (pers. comm. 2002) recalled his mother (Elsie Claxton) teaching him that seasonal stages of local plants indicate the timing of the (Goldstream) salmon run: "My mother said that when the Spiraea or the Oceanspray (*Holodiscus discolor*) is in full blossom, it is time for you to go out there and get ready for the salmon run… When the Spiraea is just starting to turn brown, it is time to set up your (*fishing*) camps." Earl's mother also passed on to him the knowledge that extremely low tides occur when the moon is full.[26]

Emmanuel Cooper (pers. comm. 2002) also spoke of environmental indicators about abundance and timing of the salmon run which he learned from his ancestors: "If there are a lot of fir cones on the (*Douglas*) fir tree in the Springtime, you know there is a big salmon run coming…When blackberries are ripe, [*these berries were assumed to be those from the trailing blackberry bush* {*Rubus ursinus*}*that is native to BC*], you

[26] Salmon tend to gather near estuaries to feed during spring tides when river and ocean floor sediment is disrupted due to upwelling caused by the moon's magnetic pull on the water when flood and ebb tidal currents are strong. This phenomenon occurs for two to three days before and after the full (or new) moon because the disruption of gravel and sediment uncovers and transports smaller organisms out of the river to the estuary and near-shore saltwater environments where salmon swim in to feed upon them (DFO 1996; Stowe 1996).

know the salmon run is coming down." These ecological indicators guided the timing of Saanich peoples' salmon fishing activities over many generations.

A little known fact is that there are two runs of chum salmon at Goldstream River. "The first run in October, are longer, skinnier. They are leaner. The fat is burned off them. The lean ones are really good for smoking. The fat ones (*from the second run around November*) are purely for sport (Bartleman J. pers. comm. 2002).

Difficult Experiences with Fishing in Goldstream Park

Three of the Saanich fishers interviewed relayed that DFO conservation officers as well as visitors to Goldstream Park expressed discontent and reprimanded them for conducting their traditional spear and gaff fishing in public view near or within Goldstream Park over the past twenty years or so (Bartleman J. pers. comm. 2002; Claxton Sr. E. pers. comm. 2002; Cooper E. pers. comm. 2002). The park encompasses all three salmon-bearing reaches of the river. However only Reach 1 (from the mouth of the river to the bridge about 1 km upstream) is made accessible to the public with paths and bridges within the park. The fishers who were reprimanded by the conser_Olvation officers and members of the public about their fishing have since decided to fish in waters further upstream (Reaches 2 and 3), out of sight from the visiting public's view.

Saanich Tribal Fisheries

The committee of Saanich People who have become officially known as Saanich Tribal Fisheries was originally a group of family representatives that would gather together on a voluntary basis to work out any problems that surfaced regarding fisheries. Today, Saanich Tribal Fisheries consists of a formal body of three community leaders voted in by the Saanich First Nation to serve their communities and to work towards making the most informed decisions that they can. Saanich Tribal Fisheries has regular meetings with elders and people who fish for the four bands (Bartleman J. pers. comm. 2002).

In the past, Saanich fishers could travel by canoe to sell or trade salmon they caught in Saanich Inlet for tea, sugar, flour, bread and other products in coastal communities of British Columbia and the United States. Current federal and international trade, fisheries and immigration laws now delimit the range in which Saanich fishers can travel to catch, trade or sell salmon. Salmon caught in Saanich Inlet was sometimes brought as a gift or for trade when people were visiting relatives or other members of local tribes. Saanich fishers also used to sell salmon caught in the inlet to the market in the town of Sidney or along the side of West Saanich Road. The money from the sale of the salmon was used for purchasing fishing gear, food, and anything else they needed for the next fishing trip (Claxton Sr. E. pers. comm. 2002).

Salmon fishing in Saanich Inlet has been federally regulated and intermittently closed to commercial fishing since 1912. Salmon are still caught by Saanich fishers at Goldstream River, primarily to feed themselves and their families. The Saanich Tribal Fisheries' ESSR chum (in place since 1982) and the Saanich First Nations' FSC chum fisheries have taken priority over any other salmon fishing (e.g. commercial sports fishing) in Saanich Inlet since the 1960s. Saanich Tribal Fisheries is entitled to sell only the salmon caught from the ESSR chum fishery in Saanich Inlet. Saanich fishers expressed concerns that current DFO laws prevent them from selling the salmon they are entitled to catch in Saanich Inlet, their traditional fishing waters. Saanich Tribal Fisheries, the Malahat and Tseycum ESSR chum licenses prohibit retention of any other salmon (i.e. coho or chinook) from the inlet. A requirement of the Saanich First Nations' ESSR chum fishery (co-managed by DFO and Saanich Tribal Fisheries) is that all profits from the sale of those salmon be placed into fisheries related programs for Saanich Tribal Fisheries (Bartleman J. pers. comm. 2002; Claxton Sr. E. pers. comm. 2002; Smith S. pers. comm. 2002).

It was tradition for heads of families to safeguard traditional ecological knowledge about river, estuarine and ocean stewardship, including the presence (or absence and relative abundance) of salmon and other environmental considerations pertinent to Goldstream River and Saanich Inlet waters. This history (like an almanac but not recorded) is passed on orally during social gatherings and may take on religious and spiritual contexts important among families within the four Saanich villages. Such information is sometimes used for predicting when a good salmon run will occur and may be passed on when one or more families take fishing trips together. Joe Bartleman (pers. comm. 2002) relayed that: "Before immigration laws and fisheries restrictions, Saanich fishers used to rotate fishing areas much more frequently." Fisheries management protocols for Goldstream River salmon were quite different prior to the time when DFO fisheries restrictions and management regimes came into place at Goldstream River and Saanich Inlet.

The modern Saanich Tribal Fisheries council of the 1980s arose from the necessity to bring the Saanich First Nation communities together to communicate to DFO that "…the Saanich people need (*the salmon*) and are going to get together to fish the surplus chum in Saanich Inlet…and (*that they*) are the ones to do the job" (Bartleman J. pers. comm. 2002). Saanich Tribal Fisheries used to have their own licensed commercial boat to fish salmon in Saanich Inlet. Due to high costs of maintaining the boat, the license and boat were sold in 1989 (Bartleman J. pers. comm. 2002; Morris Sr. I. pers. comm. 2002; Smith S. pers. comm. 2002).

Under current Saanich Tribal Fisheries management practices, equal numbers of salmon (4 salmon per family or household) are distributed to the Saanich people of Tsartlip, Tsawout and Pauquachin two or more times a year. (The Tseycum and Malahat bands have their own vessels that fish, sell and distribute chum independently of the Saanich Tribal Fisheries). Some of these salmon (i.e. chum) are from Saanich Inlet, whereas some sockeye are caught, transported and delivered to families of the Saanich bands from other fishing locations such as the mouth of the Fraser River or Sooke River (Bartleman J. pers. comm. 2002; Claxton Sr. E. pers. comm. 2002; Cooper E. pers. comm. 2002; Morris S. pers. comm. 2002). Saanich Tribal Fisheries, the Tseycum and the Malahat bands can also catch chum in Saanich Inlet for their FSC purposes each year during the salmon run season (October to December). This fishery is entitled to the Saanich above and beyond the ESSR chum fishery in Saanich Inlet, which occurs annually during the salmon run season once the 15,000 chum target escapement goal has been met at Goldstream River.

In recent years (1989-2004), Saanich Tribal Fisheries has contracted a fishing boat captain and crew that lease seine vessels to carry out the ESSR chum fishing in Saanich Inlet. Salmon caught in the ESSR chum fishery are usually sold to buyers in Vancouver, BC. However if the Canadian market is full, then they will sell them to Washington State buyers[27]. Buyers take inventory of the quantity of male and female

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[27] The contractors may bid and win the contract at 10 cents per pound of salmon for example and be paid by the sale of those fish on the market. STF will earn the remaining profit to put back into funding for STF. For example, if the ESSR chum were sold for 15 cents a pound, STF will earn 5 cents for each pound of salmon sold.

chum purchased (from the seine vessel conducting the ESSR), but Saanich Tribal Fisheries does not. Any profits gained by the ESSR fishery are used to fund Saanich Tribal Fisheries' management needs including the administering of funds for ongoing surveying, guardianship and conservation work at Goldstream River and Saanich Inlet. Annual funds from Saanich Tribal Fisheries' ESSR fishery goes towards paying a fishing guardian who oversees the fishing activity on the seine vessel in Saanich Inlet while the ESSR chum fishing is being conducted, as well as to funding a shore patrol that monitors the salmon at Goldstream River. This includes employment of a night shore patrol whose job is to make sure that people do not illegally fish the river for salmon roe or coho to sell on the market. Stream surveyors are hired to carry out direct counts of coho, chinook and chum salmon stocks 24 hours a day, 7 days a week during the salmon run season. Other stewardship activities such as creation, maintenance and protection of salmon-bearing arms or reaches at Goldstream River are also funded by Saanich Tribal Fisheries (Bartleman J. pers. comm. 2002; Claxton Sr. E. pers. comm. 2002; Cooper E. pers. comm. 2002; Morris Sr. I. pers. comm. 2002).

Saanich Tribal Fisheries' shore patrol may ask fishers how many salmon they caught at Goldstream River and keep record of those accounts. This is not always an accurate count because if Saanich people fishing at the river do not wish to relay that information that is considered their right (Smith S. pers. comm. 2002). Saanich Tribal Fisheries takes inventory of the chum caught in Saanich Inlet and provides that information to DFO each year. DFO is now requesting more detailed counts of salmon at Goldstream River, so Saanich Tribal Fisheries has hired counters to do that and report it, which costs additional funds (Smith pers comm. 2002).

Recently, there has been some uncertainty about the quantity of chum in Saanich Inlet that are Goldstream chum and the number of chum that are Cowichan River chum that are caught by fishers from each of the bands. Saanich Tribal Fisheries has addressed this issue by cost sharing chum-tagging efforts in Saanich Inlet with DFO and having DNA tests done to determine which salmon are from Goldstream and which are from Cowichan River (Bartleman J. pers. comm. 2002). Saanich Tribal Fisheries also pays for any necessary consulting work (e.g. scientific research about the native fishery) from the sale of chum from the inlet.

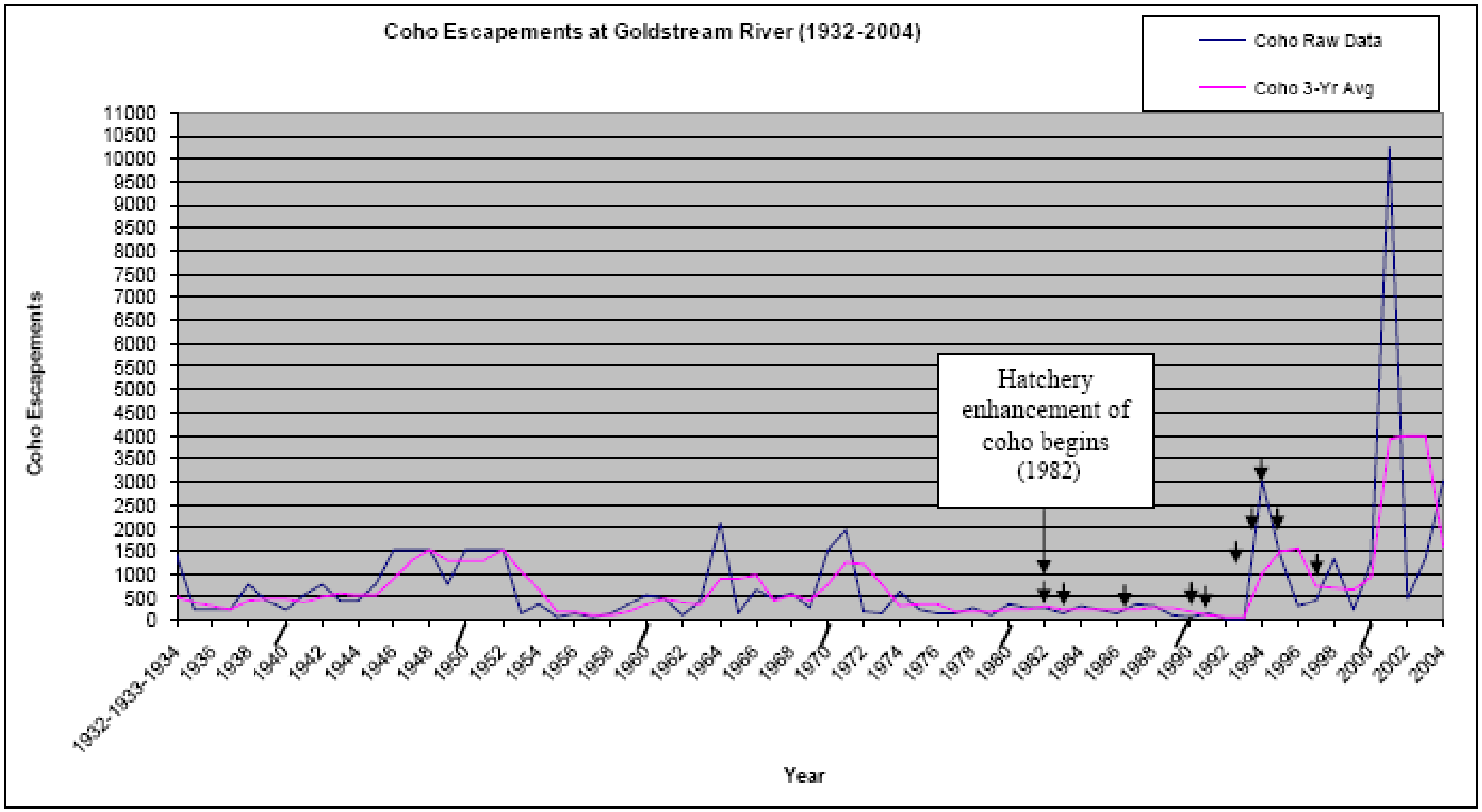
6.2 Results from Goldstream Salmon Biostatistics

This section relays results from graphing three-year rolling averages of Goldstream coho, chinook and chum escapements spanning the time-period from 1932 through 2004 (DFO 1932-2004). Three-year rolling averages of Saanich Inlet Excess Salmon to Spawning Requirement (ESSR) and Food, Social and Ceremonial (FSC) native harvest statistics graphed for the period between 1978 and 2003 (or the earliest to latest time periods available) are also reported (DFO 2001a, 2001b). A catch-per-unit effort (CPUE) analysis is also included at the end of this section.

Less than 500 coho per year returned to Goldstream River between 1932 and 1940 (Figure 6.1)[28]. Coho returned in abundances greater than 500 from 1942 to 1952

[28] Raw data for coho escapements for 1932 (=500 coho), 1933 (=500) & 1934 (=400) were added together resuling in a count of 1,400 coho for the period 1932-1933-1934. The raw data for 1932-1934 were grouped together in Figure 6.1 so that the 3-year average time-series data could be illustrated in alignment with the raw data intervals showing coho escapements for the period 1932-2004.

Figure 6.1 Coho Escapement Trends at Goldstream River from 1932 to 2004



↓ = Major El Niño event (1982 to 1983, 1986 to 1987, 1990 to 1995 and 1997 to 1998

Note: See Table 6.2 for a list of all El-Niño years from 1932-2004. La Niña events (ocean cooling that often follows El Niño events) impacted eastern north Pacific waters 1988 - 1989 and less strongly 1995 - 1996 but are not known to affect the Pacific waters or salmon populations included with this study (Cayan and Webb 1992; NOAA 2006). The El Niño events (ocean warming) listed above are referenced from: Beamish et al. 1999; Mysak 1986: NOAA 2006.

Table 6.2 – El-Niño Years on Record for 1932 to 2004 (Stormfax Inc. 1996-2002)

1932-1933	1939-1940	1940-1941	1941-1942	1946-1947	1951-1952
1953-1954	1957-1958	1963-1964	1965-1966	1969-1970	1972-1973
1976-1977	1977-1978	1982-1983	1986-1987	1991-1992	1992-1993
1994-1995	1997-1998	2002-2003	2004-2005		

(ranging from 100 to 1500 coho in the raw data tables) and form a sigmoidal (or S-shaped) curve with an apparent 1,500 coho carrying capacity at its tail end (in 1952). Annual coho population averages went below 500 again (ranging from 50 to 500) from 1965 to 1969 and 1972 to 1993. A logistic growth[29] curve is apparent at the end of each of those periods. 1964 was an exceptional year as 2,100 coho escapements were reported (prior to incubation or hatchery enhancement initiatives). 1970 and 1971 escapements brought averages up as well when counts of 1,500 and about 1,900 coho returned in 1992[30]. A major population increase followed from 1992 to 1994 with escapements surpassing 1,000. Coho decreased below 1,000 per year from 1995 to 1998 then surged to a rolling average of over 3,900 per year in the years between 1999 and 2001 at which time a J-shaped curve can be seen, which indicates a period of population growth without restraint. This is followed by a decline to just over 1,500 coho per year between 2002 and 2004.

Less than 500 coho returned to Goldstream River nearly 60% of the time between 1932 and 2004. Lower oscillating numbers of coho returned from 1953 to 1958 following the tail end of the logistic growth curve (1950 to 1952). Historical

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[29] A logistic growth curve models population behaviour in which the initial stage of population change is approximately exponential (marked by a J-shaped curve); then, population growth slows as competition arises (e.g. more coho are caught at sea), then at the upper limit to the number of individuals the environment can support (the carrying capacity of the river), population growth stops (UBC 1998; Wikipedia 2006b).

[30] Hatchery enhancement of Goldstream coho began in 1982.

escapement trends for the 70-year period leading up to the coho population dieback that occurred between 2002 and 2004 indicate that the river's maximum carrying capacity (K) for spawning coho may be approximately 1,500 coho annually.

Using the logistic population growth model[31], standard deviation of the population as the measure for population variation (Triola 1995) and assuming this carrying capacity (K) of 1,500 coho (as a prospective target escapement for the river), the rate of population change (r) for Goldstream coho from 1932 to 2004 is as follows:

- For the period 1932 to 1944, annual rate of population change for coho salmon was
  r = 5.02%

- From 1944 to 1973 (prior to hatchery enhancement of coho)
  r = 7.79%

- From 1973 to 2002 (prior to, during and following coho population enhancement at the Goldstream hatchery which began in 1982)
  r = 64.54%

Goldstream coho increased at the highest rate from 1973 to 2002, the period during which hatchery enhancement of coho was initiated at the river (Figure 6.1).

There were less than 25 chinook per year at Goldstream from the 1930s to the mid 1960s though no data were logged for 24 of the 30 years between 1932 and 1962 (Figure 6.2, Appendix J). Three-year averages show less than 50 chinook annually between 1962 and 1993; however, 100 chinook were observed in 1994. Fewer than 50 chinook annually returned between 1995 and 1999. The original escapement count was 75 (before the 3-year rolling average algorithm was applied) for the year 2000, just prior

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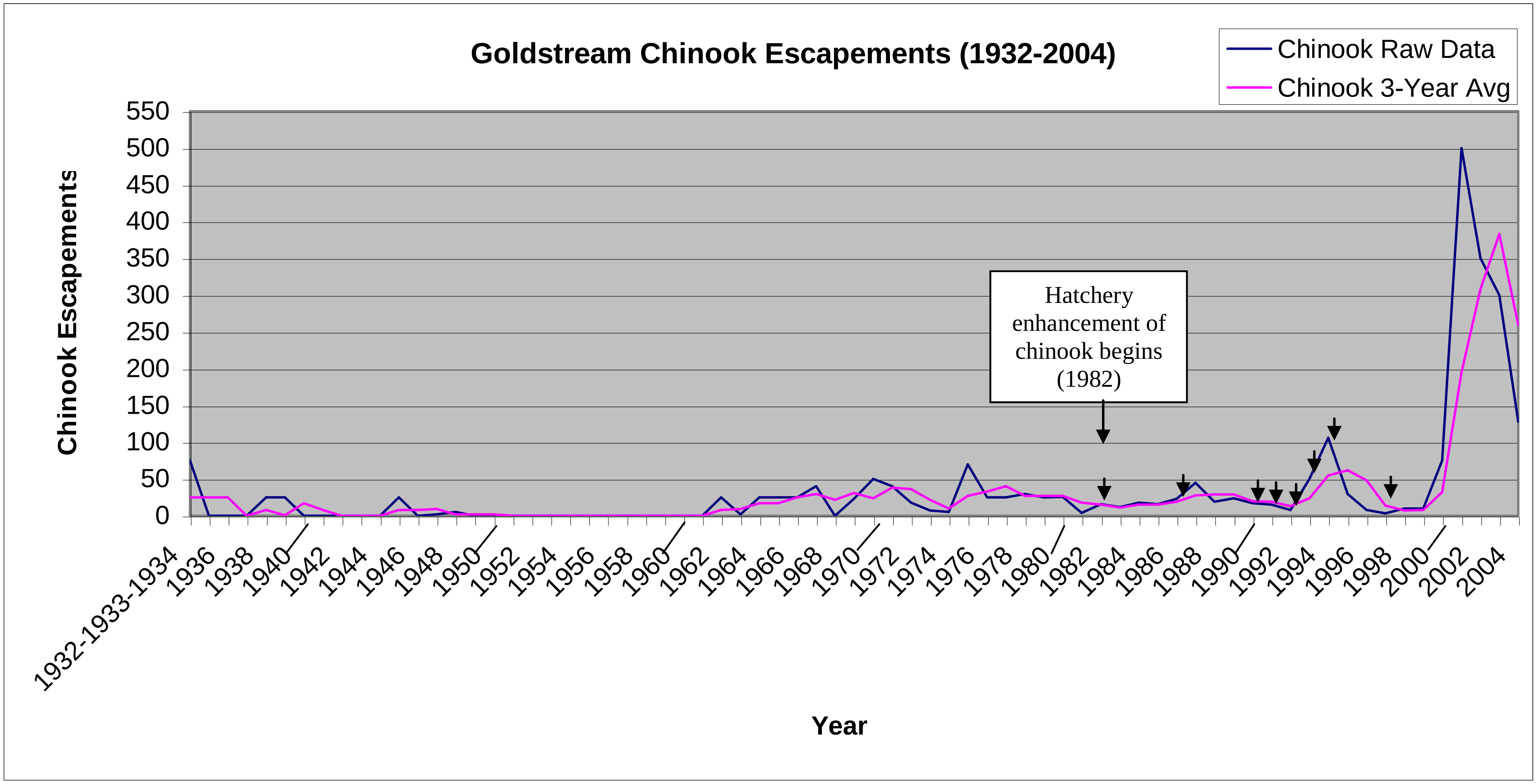
[31] dN/dt=rN(K-N/K) where N is the number of individuals at outset of time interval, dt is per unit time, r is the rate of population change or per capita growth rate and K is the carrying capacity (Cox 1996).

Figure 6.2 Chinook Escapement Trends at Goldstream River from 1932 to 2004



▼ = Major El Niño event (1982 to 1983, 1986 to 1987, 1990 to 1995 and 1997 to 1998) to a major population boom that occurred between 2001 and 2004 with counts ranging between about 130 and 500 in the original dataset.

These data show that recent hatchery enhancement efforts have resulted in a rapid increase in chinook abundance, which greatly surpasses historical population levels at this site. About 50 or fewer chinook returned to this river system approximately 84% of the time between 1962 and 2004 (the period for which consecutive annual chinook enumeration records exist). Chinook have only exceeded an average annual return of 50 about 14% of the time over the 72-year period between 1932 and 2004, all of which occurred over the past twelve years, since 1992 averages. It is therefore difficult to estimate a chinook stock carrying capacity for the river. Approximately 50 individuals appeared to be the best target escapement for chinook based on natural, historical populations (e.g 1932 to 1973). The recent chinook population boom (for the period 2001 to 2004), which followed approximately 20 years of Goldstream chinook stock hatchery enhancement efforts, however, shows exponential population growth (in the form of a J-curve) that peaked at a count of 383 chinook (for 2001 to 2003 averages), then dropped to 259 (in three-year averages) the following year (2002 to 2004 averages). This more recent trendline shows that a target of approximately 385 individuals may be used as a more current baseline maximum carrying capacity for gauging changes in the population and monitoring hatchery enhanced chinook stocks at this site.

I used the same intervals as I did previously with coho for the chinook escapement dataset, assuming a carrying capacity (K) of 50 chinook for the 1932 to 1944 (12 year), 1944 to 1973 (29 year) and 1973 to 2002 (29-year) period intervals. The logistic population growth and limitation model equation yielded a rate of population change (r) of:

r = 15.36% a year for chinook salmon for the period 1932 to 1944

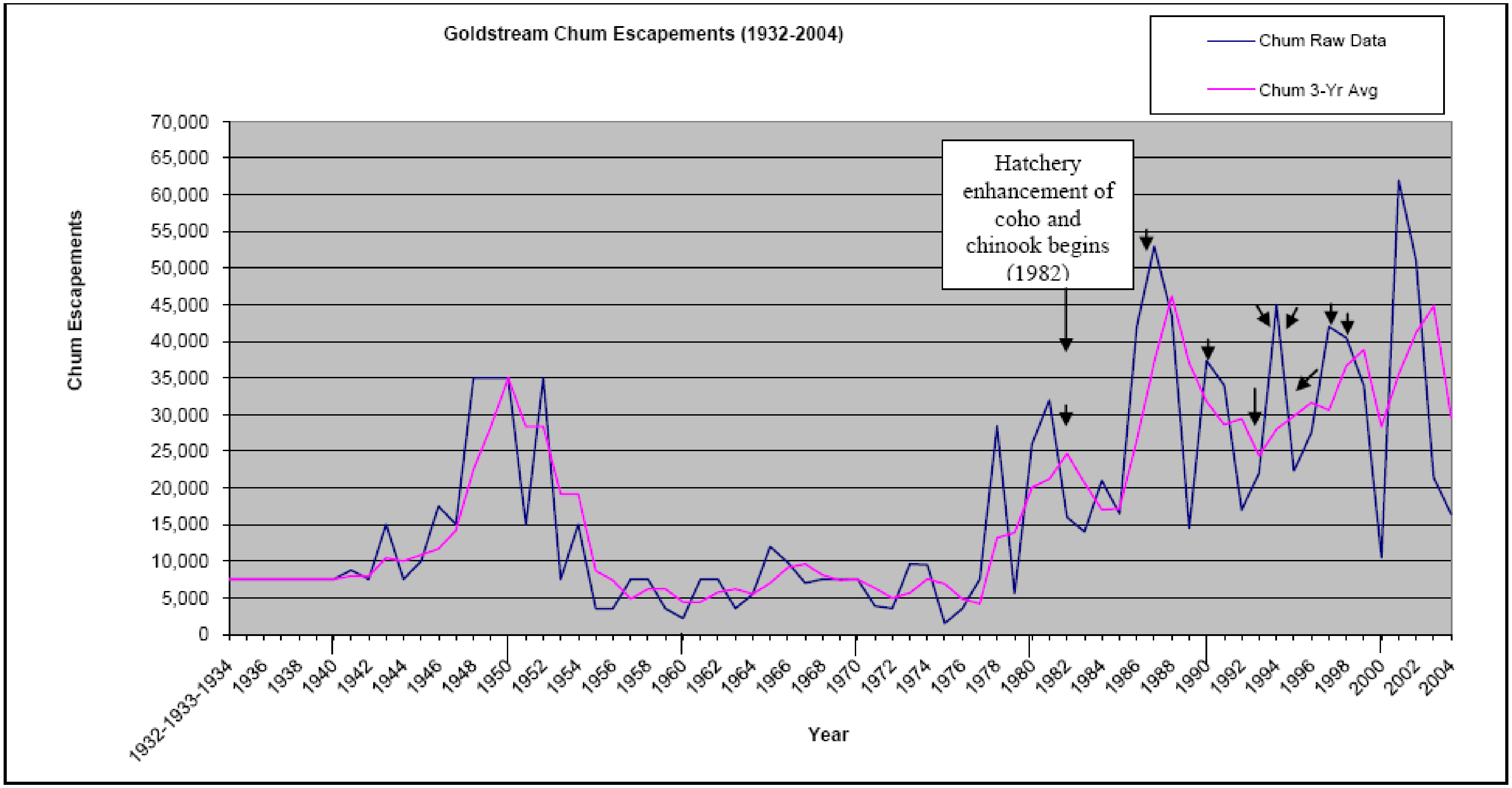
r = 4.16% from 1944 to 1973 (prior to hatchery enhancement of chinook),

r = 4.65% from 1973 to 2002 (just prior to, during and following chinook population enhancement at the Goldstream hatchery which began in 1982).

If the K for chinook was set at 380, which I proposed could be used as a modern baseline K for the period 1973 to 2002 alone, the rate of population growth (r) for 1973 to 2002 is comparatively smaller (than 4.65%) at 4.08% (Figure 6.2 and Appendix J).

Chum abundance at Goldstream River fell below the assumed 15,000 target escapement goal between 1932 and 1942 with a sudden increase occurring within the system between 1942 and 1948, followed by a crash between 1949 and 1955 (Appendix J, Figure 6.3). The system received relatively low but stable chum returns of less than 10,000 individuals, at about two-thirds the current maximum carrying capacity between1952 and 1975. Three major population booms occurred between 1975 and 2004. Escapements escalated between 1975 and 1980 then decreased between 1980 and 1983. Thereafter, chum returns soared from the 1982 to 1984 rolling average of 17,000 to the 1986 to 1988 return of 46,000 chum, more than 3 times the current carrying capacity. The ensuing decline from 1989 to 1996 is indicative of chum returns ranging from as low as 14,000 (in 1989) and as high as 45,000 in 1994. Another incline shows overall increase from 1995 to 1999, then a steep dip in returns appears again as a result of only 10,500 chum returning to the river in 2000. The highest annual return of chum on record for this site totaled 62,000 and occurred in 2001. This was followed by

Figure 6.3 Chum Escapements at Goldstream River from 1932 to 2004



▼ = Major El Niño event (1982 to 1983, 1986 to 1987, 1990 to 1995 and 1997 to 1998) another big return of 51,000 chum in 2002. The 2002 to 2004 rolling average reveals a subsequent decrease in returns averaging 29,600 chum.

Total escapements have fallen below the 15,000 Goldstream River chum carrying capacity three times since 1980[32]. Before 1980, Goldstream River chum counts remained below the current 15,000 target escapement for about 33 years (1932 to 1942 and 1952 to 1975), which is just over 45% of the total 72-year period time between 1932 and 2004. These stocks have not been enhanced by the hatchery at this river, however overall abundance of chum has far surpassed historical levels in recent years (i.e. 1975 to 2002) as discussed in Chapter 7.

Using the same intervals as I did for coho and chinook and assuming the carrying capacity (K) of 15,000 chum (determined and assumed by DFO for annual Goldstream chum fisheries management) the rates of population change for Goldstream chum are as follows:

r = 2.55% a year for the 3-year rolling averages of chum salmon from 1932 to 1944.

r = 9.74% for the period 1944 to 1973 (prior to hatchery enhancement of coho and chinook).

r = 52.97% for the period 1973 to 2002 (just prior to, during and following coho and chinook population enhancement at the Goldstream hatchery which began in 1982),

The Goldstream chum population generally increased at relatively slow rate from 1932 to 1944, then declined between 1944 and 1973 (a 29-year period) however the population growth rate for that period was much higher (at r = 9.74%). The population

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[32] The first record of Saanich Tribal Fisheries fishing Goldstream River ESSR chum in Saanich Inlet on file is for the year 1982.

increased at an exceedlingly fast rate of 52.97% for the 29-year interval from 1973 to 2002, which includes the period following coho and chinook enhancement at the river from 1982 to 2002 (Figure 6.3). Figures 6.1, 6.2 and 6.3 show that overall Goldstream coho, chinook and chum stock averages have all generally increased from 1932 to 2002. The rates of growth reported above show that the rate of population generally increased from 1932 to 2002 as well.

The length and width of each of the three salmon-bearing reaches (Reaches 1, 2 and 3) of Goldstream River divided by the carrying capacities (K) for each of the coho, chinook and chum stocks listed above yields the area of spawning habitat that would be used by each of these species at their maximum capacity (K). Coho and chinook use mostly Reaches 2 and 3 and chum use mostly Reaches 1 and 2 of the river to spawn (pers. obs.). Assuming equal distribution of each salmon species at their proposed maximum carrying capacities (K) at the river:

Reach 1 (12, 834 m^2) + Reach 2 (18,284 m^2)
= 31,116 m^2 per 15,000 chum
= 2.1 m^2 of riverbed per spawning chum at maximum capacity

Reach 2 (18,284 m^2) + Reach 3 (8,460 m^2)
= 26,744 m^2 per 1,500 coho and per 380 chinook
= 14.2 m^2 spawning habitat per coho and chinook inclusively[33].

(See Appendix B for descriptions of spawning habitat including spawning gravel quality at Reaches 1 to 3 of Goldstream River.) As shown above, chum salmon have approximately 2 m^2 while coho and chinook have about 14 m^2 each in which to spawn at maximum carrying capacity (K). (Further assessment follows in the Discussion chapter.)

[33] Source of length and width measurements of Goldstream River from Bocking et al. 1998

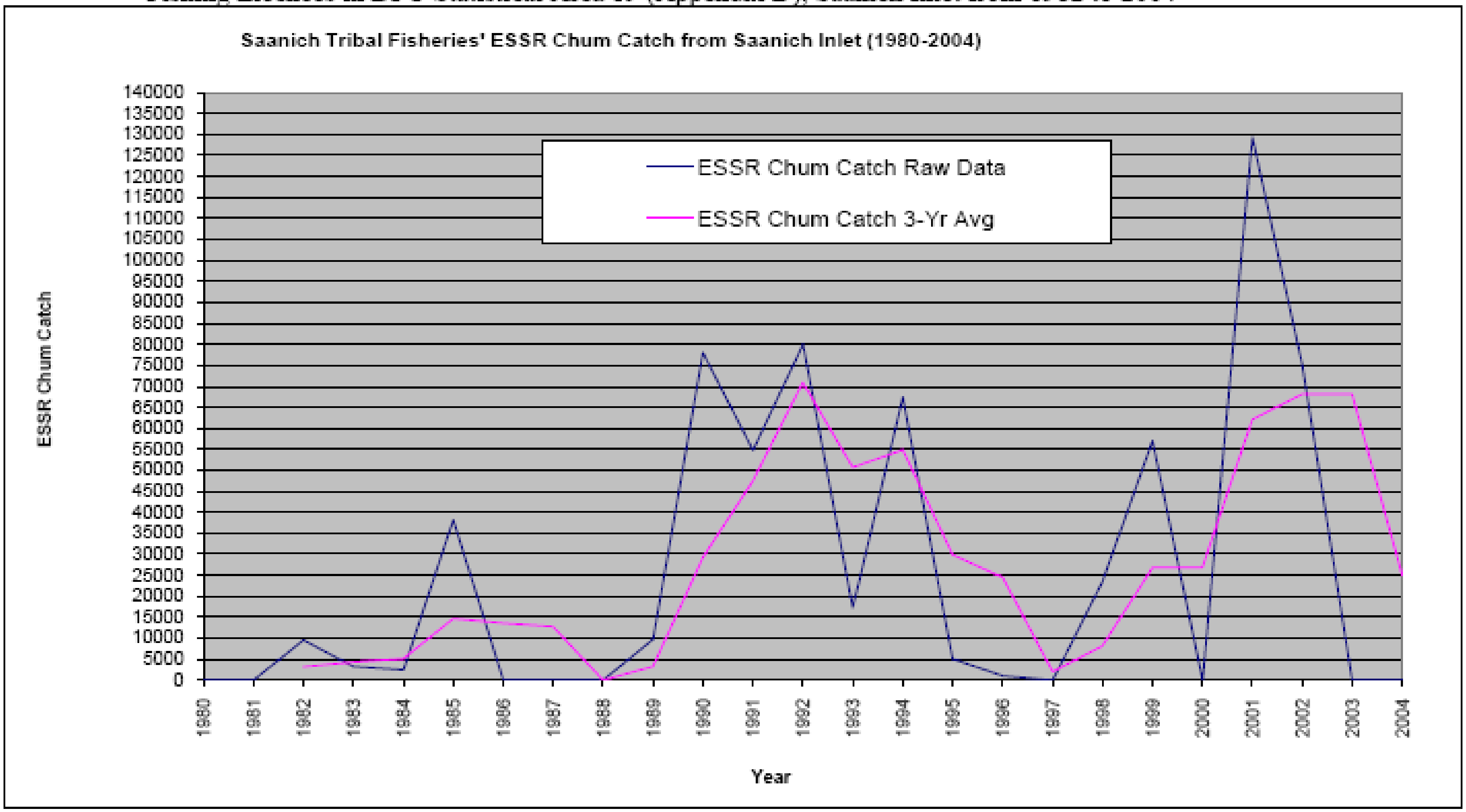
The ESSR chum fishery has been fished by Saanich Tribal Fisheries in Saanich Inlet since its inception in 1982 but was closed to fishing intermittently in seven different years (1986 to 1988, 1997, 2000, 2003 and 2004). Average annual catches peaked twice over the 24-year period from 1982 to 2004 (Figure 6.4). The first major increase occurred between 1990 and 1994, the lowest catch being 17,260 chum in 1993 and the highest being 80,000 in 1992. The second wave of increased chum catch years began with 57,000 chum caught in 1999 and ended in a catch of about 75,030 in 2002. The highest ESSR chum catch on record is for the year 2001 when approximately 129,300 chum were fished from Saanich Inlet.

The ESSR is permitted to Saanich Tribal Fisheries once 15,000 chum reach Goldstream River. Comparison of ESSR and escapement records show three years when fewer than 15,000 chum returned since 1982 (the inception of Saanich Tribal Fisheries). Table 6.3 shows the abundance of chum fished from the inlet by Saanich

Table 6.3 Saanich Inlet Chum Catch in Comparison to Escapement Years when Chum Approached and Surpassed Carrying Capacity at Goldstream River (DFO 1932-2004, 1982-2002, 2001a, 2001b)

Year	Escapement Goal	Goldstream River Chum Escapements	Chum caught in Saanich Inlet ESSR fishery	Chum caught in Saanich Inlet FSC fishery	Saanich Inlet Chum (potentially) overfished
1983	15,000	14,000	3,250	3,600	1,000
1989	15,000	14,500	9,750	5,125	500
2000	15,000	10,500	0	0	0
2003	15,000	21,400	0	60	-6,400
2004	15,000	16,400	0	No Data	0

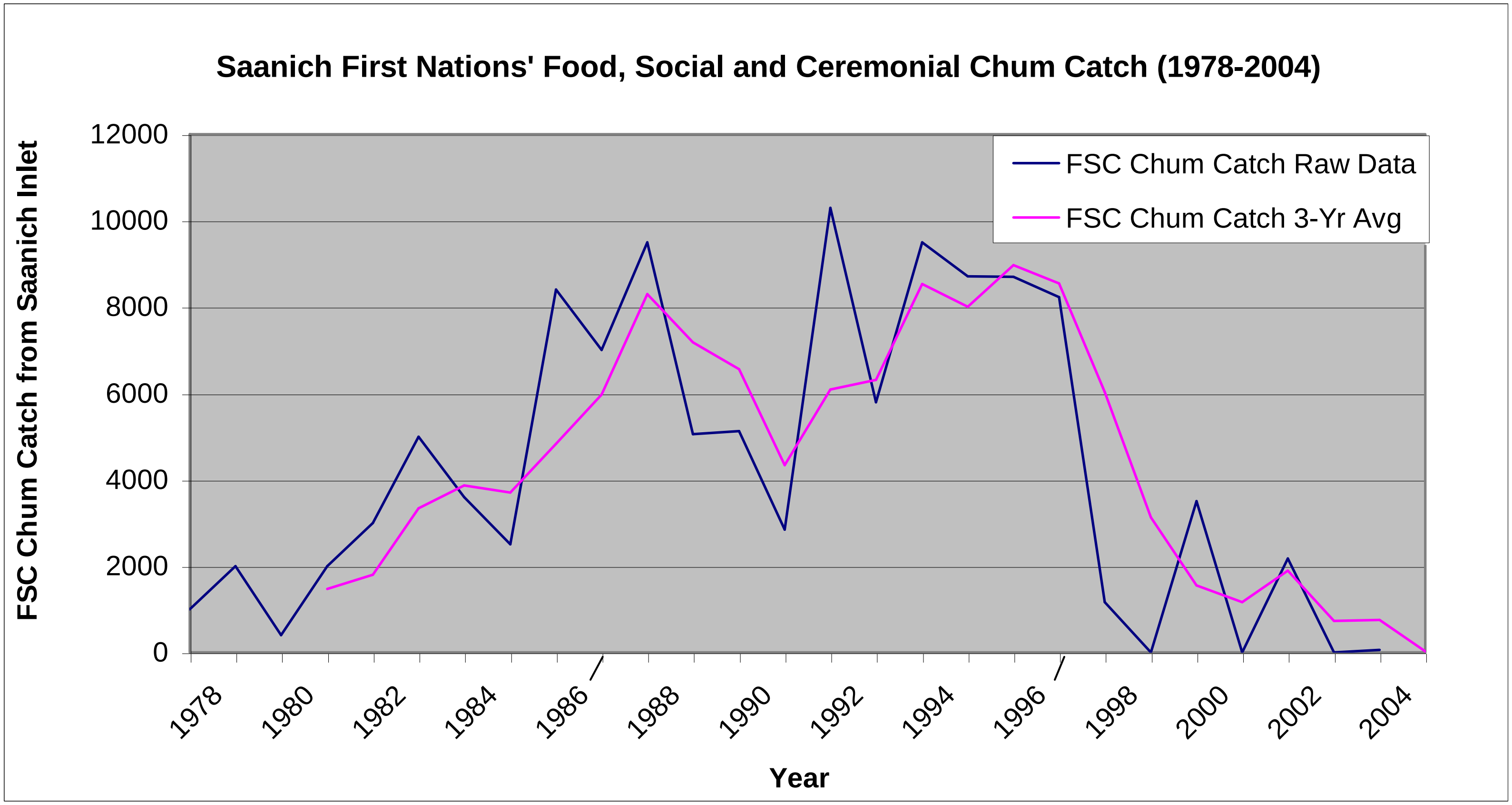
Figure 6.4 Abundance of Chum Saanich Tribal Fisheries caught with Excess Salmon to Spawning Requirement Fishing Licences in DFO Statistical Area 19 (Appendix D), Saanich Inlet from 1982 to 2004



Tribal Fisheries when escapement counts approached and surpassed the 15,000 chum target escapement goal. The number of overfished chum reported indicate the abundance of chum caught in the inlet that would otherwise have migrated to the mouth of Goldstream River or been available as prey for other predators in the ecosystem such as otters, sea lions, seals, otters, bears and seagulls.

In 1983 and 1989, thousands of chum returning to Goldstream River were removed by chum fishing activity in Saanich Inlet before the established escapement goal of 15,000 chum was reached (6,850 and about 14, 880 chum respectively). In contrast, only 10,500 chum returned to Goldstream in the year 2000 (4,500 chum below target escapement) and no chum fishing activity (ESSR or FSC chum fishing) took place in Saanich Inlet that year. Chum escapements were above target goals by about 6,400 and 1,400 in 2003 and 2004 respectively yet no ESSR chum fishing took place in either of those years and only 60 chum were fished for the FSC fishery in 2003. The trendline for Saanich First Nation FSC chum catch from Saanich Inlet shows two major periods of catch increase followed by periods of significant decline (Figure 6.5). FSC chum catches increased steadily from 1,470 chum in 1977 to 1979 to approximately 8,300 chum in 1985 to 1987 averages. Catches declined to just over 6,550 in 1987 to 1989 and dropped again to just over 4,440 in 1988 to 1990. The FSC fishery rebounded when a sizeable increase to just over 8,500 chum were caught between 1991 and 1993, then fluctuated between 8,000 and 9,000 chum until the period average for 1995 to 1997. A significant decrease in catch ensued for the seven-year period between 1997 and 2004 with average catches below 4,000 in 1996 to 1998 and below 2,000 from 1997 to 2004,

Figure 6.5 Saanich Peoples' Food, Social and Ceremonial Chum Catch from Area 19, Saanich Inlet from 1978 to 2004



ranging from no catch in four of those seven years (1998, 2000, 2002 and 2004) to 3,500 (the highest total annual catch for this seven-year period) in 1999.

There were four dominant phases of increase and three prevalent stages of decline in total chum catch from 1979 to 2002 (Figure 6.6). Total Saanich Inlet chum catch (ESSR and FSC chum catch combined) mostly increased between 1978 and 1986 with the three-year average catch of 1,800 in the period 1979 to 1981 increasing more than eleven times in six years to over 21,000 (for the period 1985 to 1987). Chum catch remained below 10,000 from 1987 to 1989, then soared to around 33,590 from 1988 to 1990, and continued to increase over time, peaking at about 77,220 in the period 1990 and 1992. Catches remained above 20,000 over the next four years, as illustrated by the steep, continuously declining trendline for the period 1990 to 1994, (with the exception of a slight increase from 1991 to 1992 averages). The decline continued until 1995 to 1997 when only about 8,000 chum were caught. Catches increased to above 20,000 in 1997 and 1998 averages, more than doubled to approximately 64,000 in the 1999 average total, then almost doubled again to about 124,240 for the period 2000 to 2002.

Overall, total chum catch increased between 1979 and 1981 (1,800 chum caught) and 2001 to 2003 averages (about 124,270 chum caught). The same is true of chum escapements with the exception of the periods 1981 to 1983, 1982 to 1984 and 1983 to 1985 when average escapements (approximately 20,670, 17,000 and 17,170 chum respectively) were generally lower than those reported for 1979 to 1981 (21,200 chum escapements) at the inception of the ESSR fishery (Figure 6.7).

Figure 6.6 Total Saanich Inlet (Area 19) Chum Catch (Excess Salmon to Spawning Requirement and Food, Social and Ceremonial Catch Combined) from 1979 to 2002

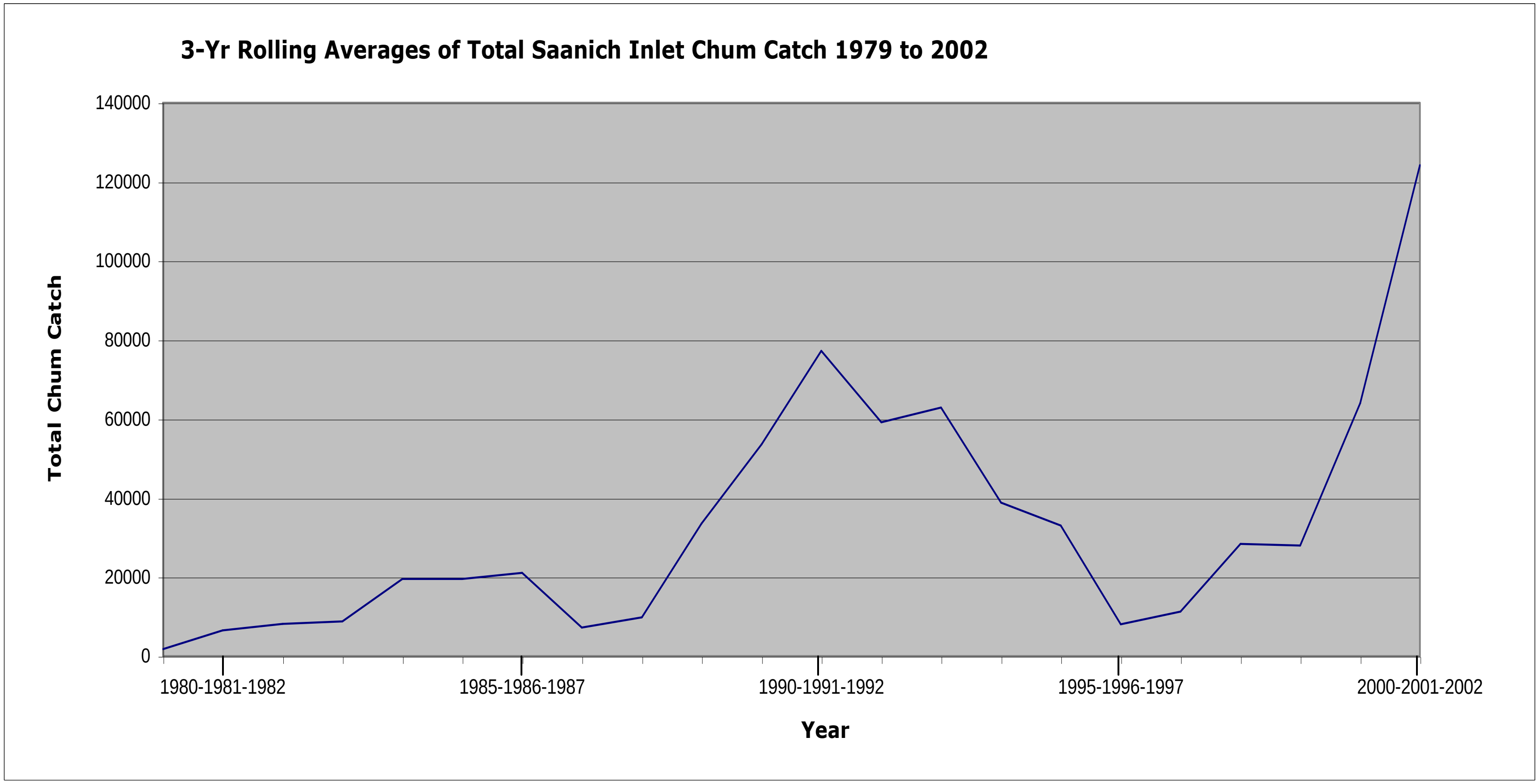
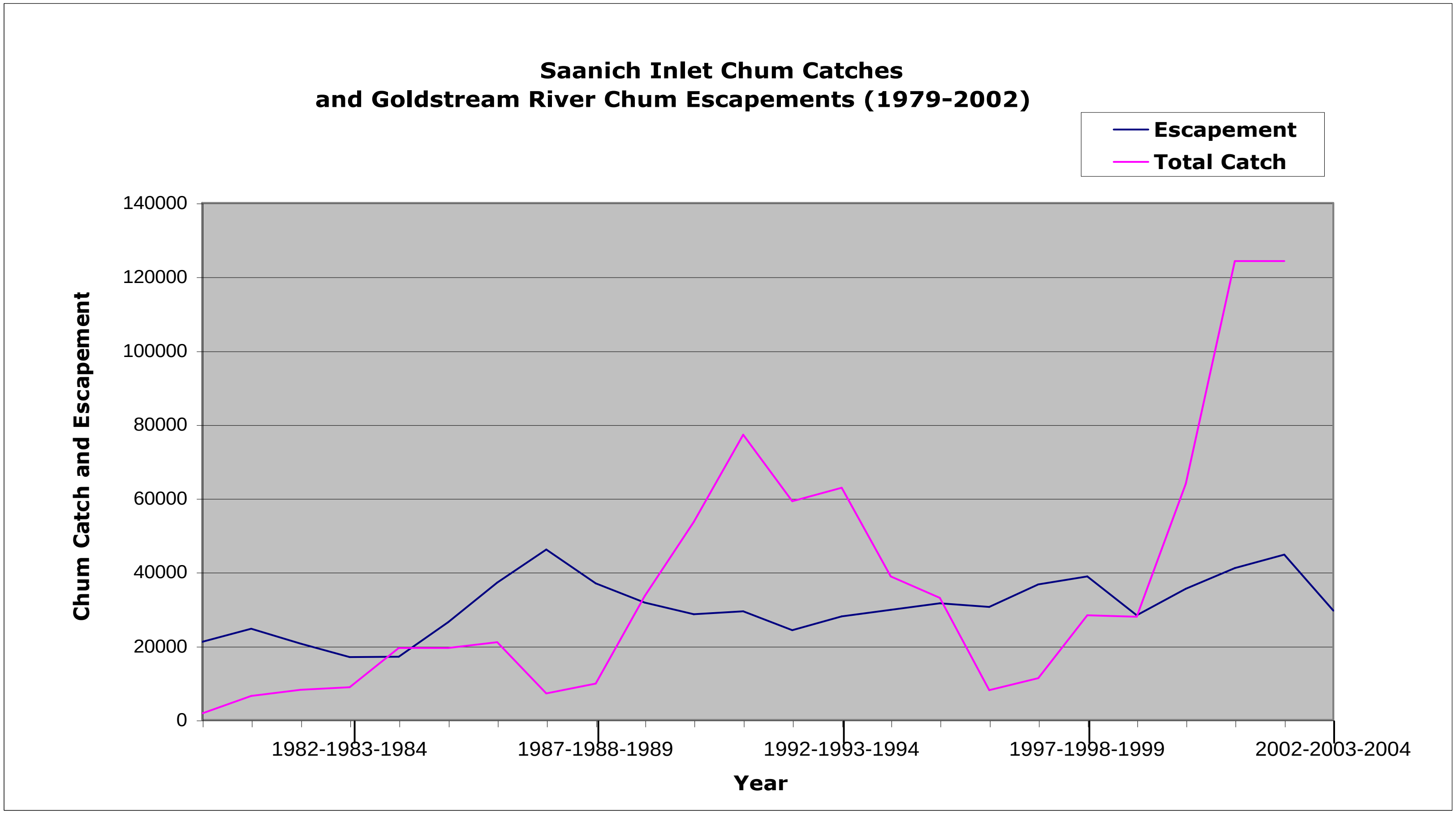


Figure 6.7 Abundance of Chum Salmon Caught in DFO Area 19, Saanich Inlet in Comparison to Chum Escapements at Goldstream River between 1979 and 2002



Total escapements have been as low as 8,000 (in 1979) and as high as 62,000 (in 2001) over the past 25 years (1979 to 2004) while total harvest has been as low as 0 (in 2000 and 2004) and as high as approximately 85,800 chum (in 1992). In years when very few escapements returned to the river, the otters and seagulls as well as the Saanich First Nation fishers would have had fewer salmon upon which to feed. The bacteria and plants that benefit from the remains of salmon carcasses in the watershed would also have had less nitrogen available to them in those years.

Table 6.4 shows that total chum catch increased nine times (blue cells) and decreased five times (yellow cells) within seven timeline intervals of 5000 chum escapements for the period between 1979 and 2004. There is no apparent, emerging pattern of total chum catch increasing, decreasing or being managed solely in direct connection with reports of escapement abundance for the 25 years for which data was available.[34] I used purple cells to highlight notable differences in total chum catch abundance in relation to escapements in the same (or relatively close) numeric intervals. For example, there were no chum caught in 2004 when there were 16,400 chum escapements but there were approximately 85,800 chum caught in 1992 when there were 7,000 escapements (8,000 fewer chum than the 1,500 target escapement). Years that I highlighted in yellow in Table 6.4 depict times when total catch decreased from the previous year(s) in an escapement interval. Years that I highlighted in blue represent those years when total catch increased from the previous year within that escapement interval.

Table 6.4 shows that there was a lot of variation between escapement and total catch between years. It also illustrates that closer monitoring of the chum fishery on an

Table 6.4 Total Chum Escapement and Total Saanich Inlet Chum Catch (1979 to 2004) (DFO 1932-2004, 2001a, 2001b)

Escapement Range	Total Escapement	Total Catch	Year
10,000-14,999	10,500	0	2000
	14,500	14,881	1989
	14,000	6,850	1983
15,000-19,999	16,400	0	2004
	17,000	85,814	1992
	16,500	46,600	1985
	16,000	14,600	1982
20,000-24,999	21,400	60	2003
	22,300	13,750	1995
	22,000	26,760	1993
	21,000	5,000	1984
25,000-29,999	25,400	60,509	1999
	27,500	9,264	1996
	26,000	2,000	1980
30,000-34,999	34,000	65,000	1991
	32,000	3,000	1981
40,000-44,999	40,500	23,441	1998
	42,000	1,165	1997
	45,000	76,076	1994
	43,500	5,050	1988
	42,000	7,000	1986
50,000-54,999	51,000	241,235	2002
	53,000	9,500	1987

Table Coding

--- Total catch decreased over time (Year column)
--- Total catch increased over time (Year column)
--- Notable change in total catch in relation to escapements within and between intervals

* Each escapement interval lists annual escapement alongside total annual chum catch in chronological order from most to least recent year on record (i.e. 2004 to 1981).

[34] Intervals with only one or with no escapement years on record are omitted from the table.

annual basis could better protect the chum population returning to Goldstream by ensuring that at least 15,000 chum return to the river. Chum counts surpassed the carrying capacity (K) of 15,000 established by DFO by 1,000 or more for 20 of the 23 years listed in Table 6.4. In 1991, 34,000 chum returned to Goldstream River and 65,000 chum were caught in Saanich Inlet whereas ten years prior in 1981, 32,000 chum returned to the river but only 3,000 were caught in the inlet. In 1983, total escapement was 14,000 (1,000 chum below the target escapement goal) and total catch was 6,850 whereas in 1986, total escapement was three times that of 1983 at 42,000 chum while total chum catch was only 7,000 (only 150 more total chum caught than in 1983). These data demonstrate that under the current 15,000 chum target escapement Saanich Tribal Fisheries could have harvested 28,000 more chum than they did for commercial and community fishing purposes in Saanich Inlet in 1986 as set out in the ESSR fishing licenses under DFO regulation. A comparable dynamic occurred in the system in 1996 when total chum catch in Saanich Inlet was around 9,260 and escapement was 27,500. Nine years prior, in 1987, there was a similar total catch of about 9,500 chum when escapements were reported at 53,000 chum, almost two times that of 1996 (Table 6.4). This shows that Saanich Tribal Fisheries could have caught 12,500 more chum in 1996 and 38,000 more chum from Saanich Inlet in 1987 for either their commercial ESSR chum fishing or FSC purposes. The abundance of chum that returned to Goldstream in those years should have provided a surge of nitrogen to the river and riparian zone ecosystem and increased salmon prey abundance available for other species such as seagulls, bears, and river otter.

Examining Saanich Inlet ESSR chum catch alongside Goldstream chum escapements for the period 1982 to 2004 revealed several inverse relationships (Figure

6.8). For example, ESSR chum catch averages increased from 3,200 to 14,650 between 1980 and 1983 while escapements decreased from 24,670 to 17,170 (just 2,000 over the 15,000 chum target escapement). In contrast, ESSR catch decreased from 13,570 to 0 while escapements escalated from 26,500 to 46,170 in 1984 to 1986 averages. Also, the ESSR catch progressively increased from 3,250 to 70,900 chum between 1987 and 1990 while escapements decreased from 37,000 to 29,450 during the same time interval.

ESSR catch and escapements increased (from 50,650 to 54,870 and from 24,330 to 28,000 chum) simultaneously between 1991 and 1992. Chum escapements then increased slightly from 29,770 to 30,600 between 1993 and 1995 while the ESSR fishery underwent a sizeable decrease in three-year average catches from 29,870 to 2,030 chum. Escapements remained over 26,000 averages (undergoing two periods of increase and decrease ranging from 26,812 to 44,800 chum) from 1996 to 2002. During that time, the ESSR fishery increased continuously and markedly from a catch of 8,158 in 1996 to approximately 68,120 in 2001. The ESSR chum fishery then decreased (to 25,011) in 2002 at the same time that escapements dropped from 44,800 to 29,600 in 2001 to 2002 rolling averages.

Figure 6.9 illustrates that the Saanich First Nation's FSC chum fishery underwent two discernable waves of increase between 1978 and 2003. The first wave coincides with a period of increase in chum escapement between 1983 and 1986 (three year rolling averages). The second increase in FSC catch occurred between 1989 and 1994. Chum escapements were on the rise again during this time with the exception of

Figure 6.8 Three-Year Rolling Averages of Saanich Inlet Excess Salmon to Spawning Requirement Chum Catch in Area 19, Saanich Inlet and Escapements Returning to Goldstream River from 1980 to 2004

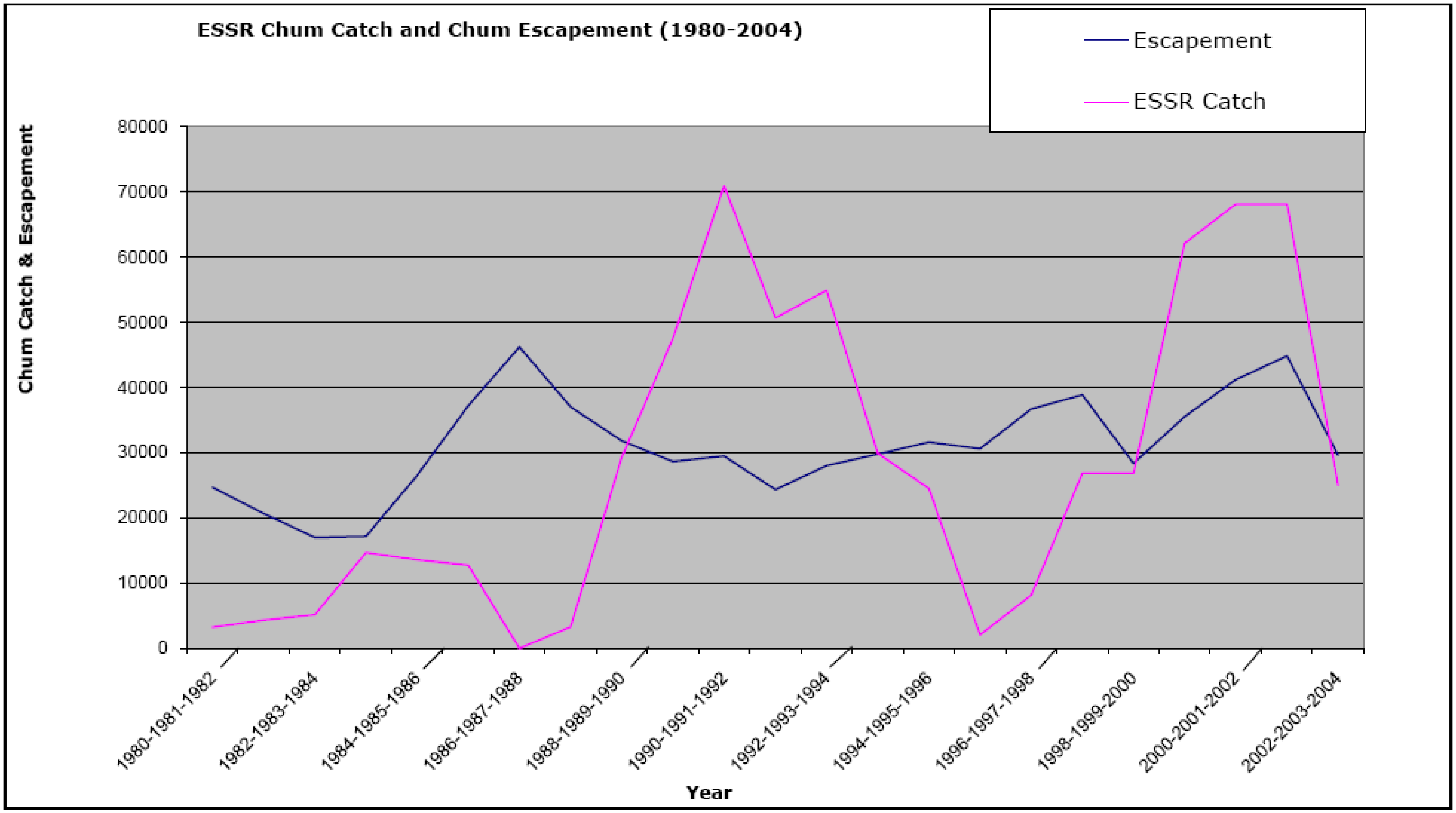
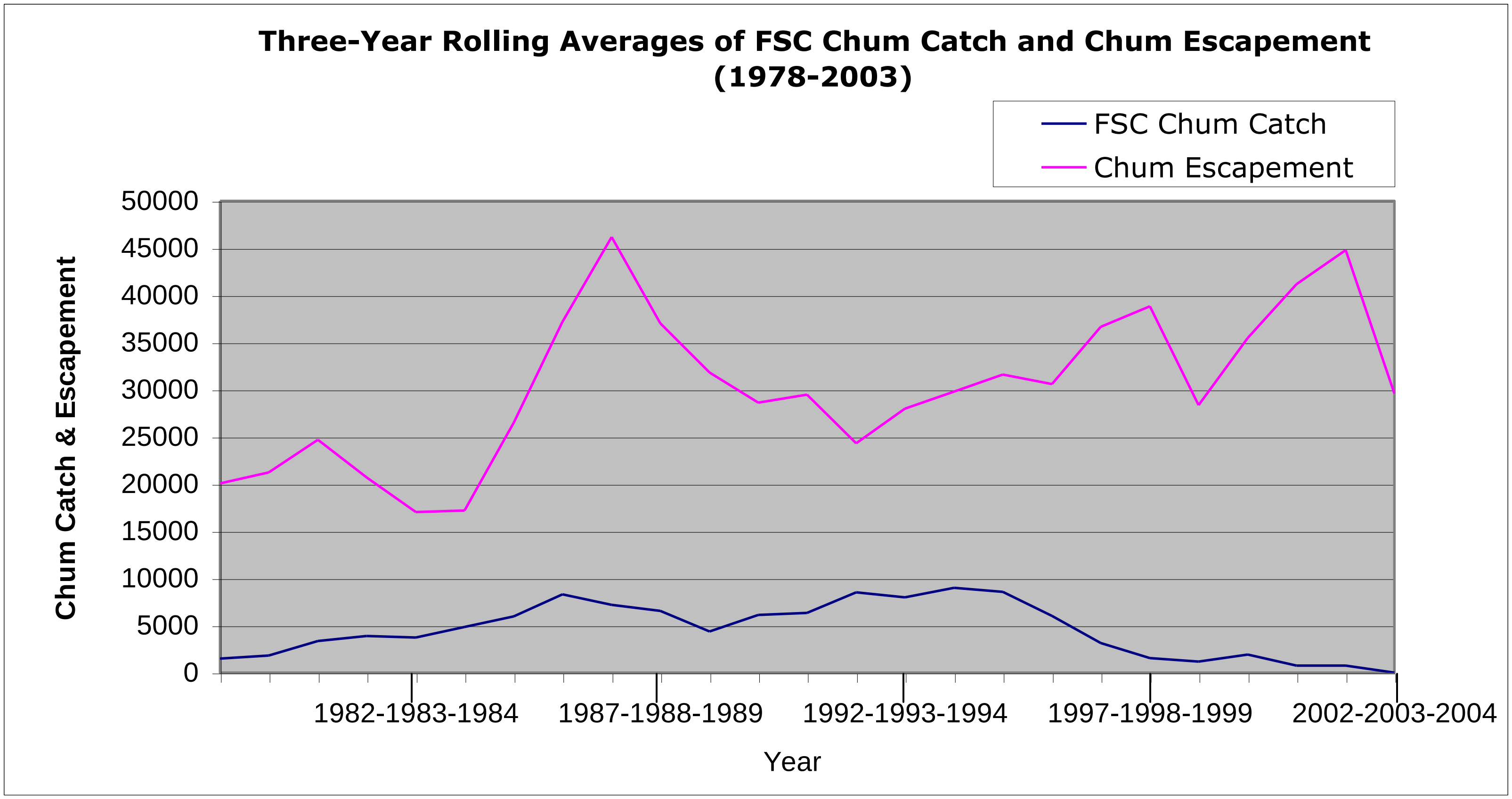


Figure 6.9 Three-Year Rolling Averages of Food, Social and Ceremonial Chum Catch in Area 19, Saanich Inlet in Comparison to Chum Escapement at Goldstream River from 1978 to 2003.



the 1991 three year rolling average when a sudden decrease of 5,000 chum escapements from the previous year (to around 24,330 chum) is evident. FSC chum catch has, on average, remained below 9,000.

Escapements fluctuated between a low of about 17,000 and a high of about 46,170 chum and FSC chum catches range between a low of 20 and a high of 8,970 for the same 25-year period. FSC catches began to decline in 1985 and 1986 (from 8,300 to 7,180 averages) while escapements were soaring towards their highest point (from approximately 37,170 to 46,170) in those same years. The decline in FSC chum catch for that period persisted until 1988 to 1990 when only 4,340 chum were caught and during which time escapements also progressively declined to a 1988-1990 average of about 31,790 chum.

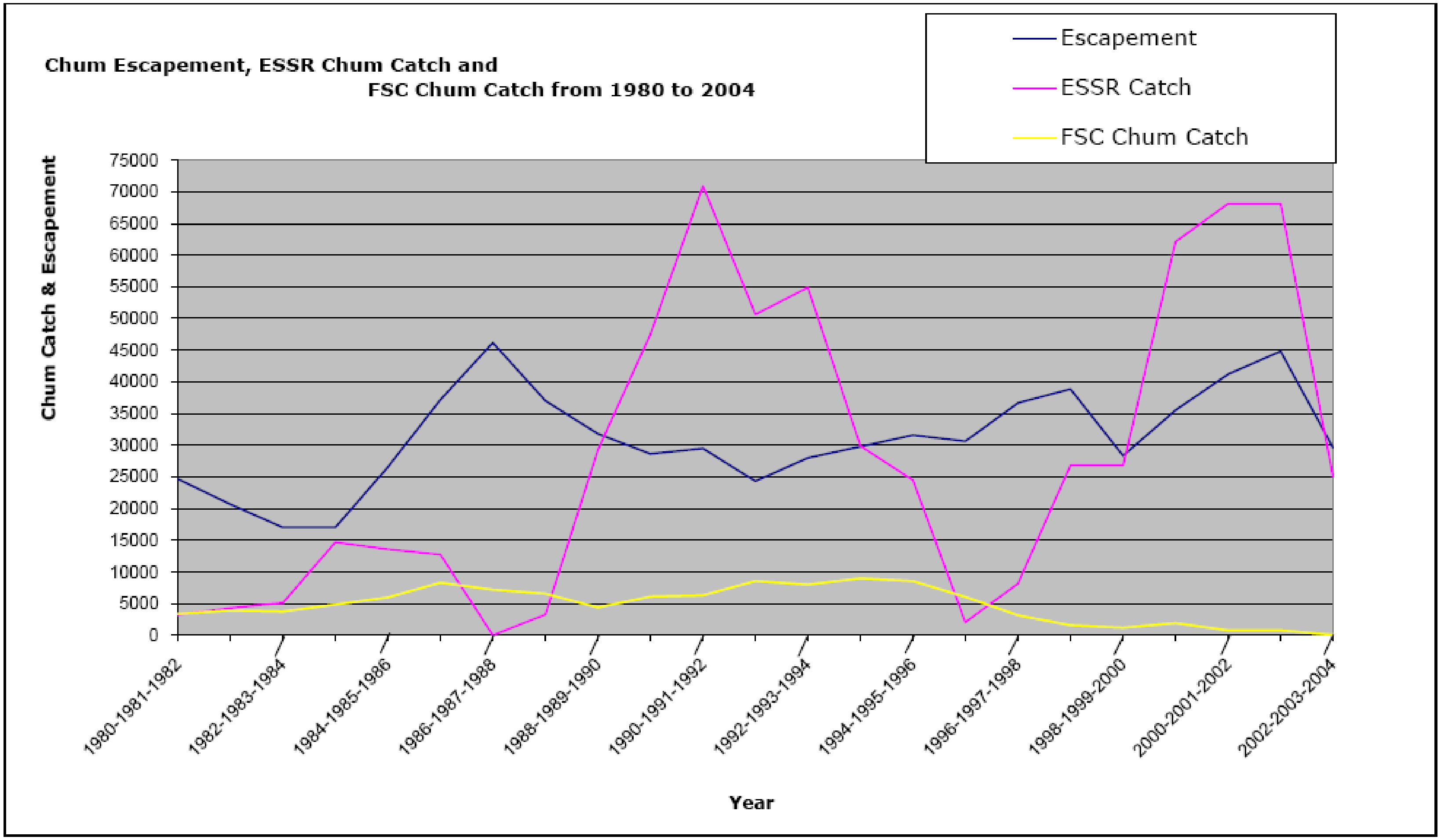
The most interesting trendline resulting from examining FSC and escapement data concurrently is the most recently recorded one spanning from 1996 to 2001 when FSC chum catch decreased from just over 3,000 to 20 while escapement (and thus fishing potential) increased and fluctuated between 30,000 and 45,000 chum (Figure 6.9).

Between 1980 and 2004 chum escapements fluctuated between 17,000 and 46,000, and remained above 28,000 from 1992 to 2002 (i.e. 1992 to 1994 through to 2002 to 2004 averages inclusively). ESSR chum catch was highly unstable ranging from 0 to 79,000 over the same 24-year period. ESSR catch increased from 8,500 between 1980 and 1985 to 79,000 from 1986 to 1991. There were more than 52,800 ESSR chum caught from 1992 to 1997 and over 41,300 taken from 1998 to 2002.

Several short-term intervals of both negative, inverse and parallel or positive relationships exist between the Saanich Inlet ESSR chum catch and chum escapement datasets spanning the period 1980 to 2002: ESSR chum catch in the inlet increased while chum escapement to the river decreased (1988 to 1990); the ESSR fishery decreased while chum escapement increased (1983 to 1986 and 1992 to 1993); parallel relationships occurred when both ESSR chum catch and the river's chum escapement counts increased (1995 to 1997 and 1998 to 2001) and decreased (2001 to 2002) at the same time. These data showed that annual chum catch does not consistently increase or decrease in direct relation to annual increase or decrease in chum escapements (i.e. there is not a consistent, positive or negative correlation between these two datasets) (Figure 6.10). There was however a continuous, parallel relationship between ESSR chum catch and escapement from 1998 to 2002 when both these indices for Goldstream chum abundance increased and then decreased simultaneously over time. FSC chum catch in Saanich Inlet remained below 9,000 during that same 24-year period (1980 to 2004).

FSC chum catch generally increased in years when escapement increased for most years on record up until 1996. FSC also took on a pattern of increased catch in periods when ESSR chum catches were decreasing though this pattern was not the case when the ESSR fishery crashed in 2002. FSC chum catch averages dropped and remained below 2,000 in 1997 to 2001 averages though escapement and ESSR catches increased (Figure 6.10). Another interesting observation resulting from examining ESSR, FSC and chum escapement data together is that no ESSR fishery occurred in 1986, 1987 or 1988 when escapements were very high at 42,000, 53,000 and 43,500 respectively, and the number of FSC chum caught was 7,000, 9,500 and 5,050 for those same years. (These latter results are derived from the original datasets without the three-year average algorithm applied to them.) The three-year average for 1986 to 1988 FSC chum catch was relatively high at around 7,180. By contrast the total average FSC

Figure 6.10 Goldstream River Chum Escapement and Saanich Inlet Excess Salmon to Spawning Requirement and Food, Social and Ceremonial Chum Catch Three-Year Rolling Averages from 1980 to 2004



catch for the period 1978-2003 was 4,280. There was no ESSR chum catch from 1986 to 1988 though escapements for that period averaged approximately 46,170 chum (which is 16,440 units higher than the 29,730 average escapements for 1978 to 2003). Total average ESSR chum catch for the whole 1978 to 2003 timeline was comparatively much higher, at around 25,060.

Catch per Unit Effort of Chum in Saanich Inlet (1994 to 1996)

Catch per unit effort or CPUE (a measure of abundance of salmon caught per number of days, hours or fishing excursions) is a useful tool for fishers to use to determine how time-effective their fishing practices, vessel, crew and gear are in relation to abundance of fish they catch for food or for selling. Data retrieved from DFO archives and field reports as well as Saanich Tribal Fisheries' native harvest statistics were used to produce CPUE results for Saanich Tribal Fisheries' ESSR and FSC Saanich Inlet chum fisheries. Table 6.5 shows total ESSR and FSC chum catch, and number of days Saanich Tribal Fisheries employed a seine fishing vessel for the three consecutive years for which these data were available on record (1994 to 1996).

Table 6.5 Data for Saanich Tribal Fisheries CPUE of Chum from 1994 to 1996 (DFO 2001a, 2001b)

Year	**Gold - stream Chum Escape-ment**	**Saanich Inlet ESSR Chum Catch**	**Days Fished in Saanich Inlet**	**Fishing Boats**	**ESSR Chum CPUE** (Effort in days)	**Saanich Inlet FSC Chum Catch**	**Days Fished in Saanich Inlet**	**FSC Chum CPUE** (Effort in days)
1994	45,000	67,355	8	2 seine	8,419	8,713	1	8,713
1995	22,300	5,044	6	1 seine	841	8,700	8	1,088
1996	27,500	1,036	2	1 seine	518	8,226	8	1,028

Saanich Tribal Fisheries caught more than 8,000 chum per day in both the ESSR and FSC fisheries in 1994. That amounts to over 16 times more chum caught per day in the ESSR fishery and more than 8 times more chum caught per day in the FSC fishery than in 1996 (Table 6.5). This is defensible under current management however, as the 1994 chum escapement was more than three times over the established 15,000 chum salmon carrying capacity (DFO 2001a, 2001b).

No data on number of fishing days or number and type of fishing boats (effort) was found for FSC chum catch for the more recent period of 1997 to 2004[35] however, FSC catch averages decreased sharply from about 1,560 to 750 chum during that time. The decline in FSC chum catch from 1997 to 2004 indicates that there is either much less success or much less effort with the Saanich Tribal Fisheries' pursuit of chum for FSC purposes than there was in the period 1980 to 1996 when FSC catch was much higher.

There was no data for fishing effort for the Saanich Tribal Fisheries' ESSR chum catch for the period 1980 to 1993 or 1997 to 1999. However, 2 to 3 seine vessels and 1 gillnet fishing boat were used for an average of 15 days each year in 2001 (when 68,120 chum were caught) and 2002 (when about 25,010 chum were caught), resulting in about 3,100 chum per fishing day [36]. By contrast, the ESSR chum catch ranged from 3,330 to 70,900 between 1980 and 1996 (using 1 or 2 seine vessels between 1992 and 1999). Though effort is not exactly known, the 1980 to 2004 data indicate that overall, there were two periods of very high and two periods of very low total catch of chum per unit of annual effort (number of days spent fishing by seine or gillnet vessel). A discussion of

[35] There was no FSC chum fishery in Saanich Inlet in the years 2000, 2002 and 2004.

the estimated costs and benefits of running a seine vessel for the ESSR chum fishery is provided in Chapter 7.

6.3 Summary of Main Findings

Alteration to the coastal landscape including loss of streams and wetlands from construction of roads and urban development and the redirection of Goldstream River water flow as well as pollution of Saanich Inlet from sewage and oil leaks from boats are some of the main concerns Saanich fishers expressed about the Goldstream River and Saanich Inlet ecosystems (Table 6.1). Saanich fishers interviewed were concerned about the established Goldstream coho and chinook hatchery and DFO fisheries managers altering Goldstream River from its original state as a chum-bearing stream to one that accommodates sport and commercial fishery interests by augmenting coho and chinook populations. All fishers interviewed expressed dissatisfaction with DFO fisheries management of the river and inlet and did not think that fisheries officers had consulted with them appropriately or sufficiently about past decisions regarding administration and management of their salmon fishery.

Traditional, rotational fishing practices exercised by families fishing at Goldstream River and Saanich Inlet have declined over the past 70 years. Prior to the 1960s, Saanich fishers made on average 12 trips to Goldstream River per fishing season and caught about 1,400 salmon per family per year or 206 salmon per person per year. From 1960 to 2002, by contrast, fishers caught about 196 salmon per family per year or 49 salmon per person per year, which is roughly 25% of what they used to catch from the river. Most of the Saanich Peoples' salmon fishing in Saanich Inlet is currently undertaken by the Saanich Tribal Fisheries council, which hires a captain and crew with a seine vessel to fish the ESSR commercial chum fishery. These salmon are both sold on the market and delivered by truck to Saanich First Nations households in all four villages (Tsartlip, Tsawout, Tseycum and Pauquachin). This modern fishery service helps those who are unable to fish but does not provide incentive for the current generation of Saanich youth to learn how to fish, or to acquire the cultural knowledge associated with salmon fishing. All proceeds from the Saanich Tribal Fisheries' ESSR chum fishery sales are put towards fisheries programs including monitoring and stewardship activities at Goldstream River and Saanich Inlet (e.g. employing fisheries guardians to monitor fishing activity on board the ESSR fishing vessel, escapement surveying at the river, and restoring river channels and local creeks on the peninsula or tributaries of Goldstream where salmon can spawn and alevins can feed.) In recent years, the ESSR chum fishery has increased yet the FSC chum catch has decreased (Figure 6.10). This is beneficial for the perpetuation and development of Saanich Tribal Fisheries' stewardship and monitoring projects, which are funded by the profits from the ESSR fishery. This trend is, however, also problematic for the Saanich community especially if the number of FSC chum caught in future years is less than the number of salmon requested for food for social and ceremonial gatherings.

There was a general increase in the population of all three salmon stocks (coho, chinook and chum escapements) that returned to Goldstream River between 1932 and 2004 (Figure 6.1, 6.2, 6.3). The maximum carrying capacity (K) of coho at Goldstream River is 1,500. K for chinook was 50 for the period 1932 to 1973 and 380 for the period 1973 to 2002 (Figure 6.2 and Table 6.6). K for chum is 15,000. At K, each chum uses about 2 m^2 of riverbed as spawning ground in reaches 1 and 2 of the river. Coho and chinook would have access to about 14 m^2 of spawning habitat each if both species were at their proposed carrying capacities (Table 6.6). Chum were overfished in Saanich Inlet in 1983 and 1989 when fishing occurred prior to the river having met its 15,000 escapement target. Low fishing activity in the inlet relative to river escapements occurred in 1981 when only 3,000 chum were caught in the inlet and chum abundance at the river exceeded the current carrying capacity at more than double the target abundance (32,000 chum). This trend is observed again in 1987 when 9,500 chum were caught in the inlet and 53,000 chum returned to the river. Chum fishing activity increased from about 1,500 to 77,200 between 1979 and 1990 then declined substantially to about 8,050 in 1995 averages and increased markedly again to 124,240 in the year 2000 (Figure 6.6). Overall, FSC chum catch has clearly declined over the past ten years while the ESSR chum fishery has generally increased (Figure 6.10). Between 1994 and 1995, CPUE notably decreased for both the ESSR and FSC chum fisheries (Table 6.6).

Table 6.6 Carrying Capacities and Population Change Rates of Goldstream Salmon (Derived from equations applied to escapement data [DFO 1932-2004].)

Salmon Species/ Years	**Carrying Capacity (K)**	**Rate of Population Change (r) 1932-1944**	**r 1944 to 1973**	**r 1973 to 2002**	**Spawning habitat (m^2) per salmon At K**
Coho 1932-2002	1,500	5.02%	7.79%	64.54%	14
Chinook 1932-2002	50	15.36%	4.16%	4.65%	14
Chinook 1973-2002	380	N/A	N/A	4.08%	14
Chum 1932-2002	15,000[37]	2.55%	9.74%	52.97%	2

[37] 15,000 chum K was determined by DFO. All other calculations in Table 6.6 are my own.

CHAPTER 7- DISCUSSION

7.0 Introduction and Overview

Collectively, the voices of the Saanich fishers interviewed for this project provided a distinctive contribution of traditional ecological knowledge in the form of oral testimonies rich in history, and respect for the land, people, resources, cultural, social and spiritual traditions. Fishers shared their knowledge of Goldstream salmon, the salmon habitat and the fishery, as well as traditional and modern fishing methods. The following discussion of interview results elaborates on topics presented in the previous chapter (Results). This section discusses the five major themes resulting from thematic analysis of interviews with Saanich First Nation fishers: ‘observations and experiences regarding changes to the (aquatic) environment’, ‘cultural practices’, ‘salmon ecology and biology’, ‘salmon conservation, restoration, and stewardship efforts’ and ‘changes to federal fisheries management (DFO) of Goldstream River salmon’. These areas under discussion are key variables for biodiversity and sustainable harvesting considerations and Saanich fishers’ discussions about these topics provided a useful qualitative lens with which to examine monitoring protocols for coho, chinook and chum Pacific salmon at Goldstream River and Saanich Inlet.

The descriptive results from interviews with Saanich fishers provided some insights about how and why changes in salmon abundance and conservation efforts came about over the past 130 years or so (since road construction began in East Saanich in the 1870s). The major changes to the landscape, physiography, quality of the river waters, the inlet waters, salmon abundance, enhancement and migration patterns, the salmon food web and adjustments to Saanich fishers’ fishing methods and conservation practices relayed in my Results chapter are important local observations which are not immediately apparent to those engaged solely with population assessment, monitoring, enhancement and other salmon conservation initiatives at local and regional scales. These environmental indicators are not discovered or monitored by natural scientists on a frequent basis. Researchers engaged with salmon population monitoring at Goldstream River, Saanich Inlet and beyond may find it useful to learn how historic changes to the local landscape and aquatic environments measure up alongside historic changes in salmon abundance at the river (from 1932 to 2004).

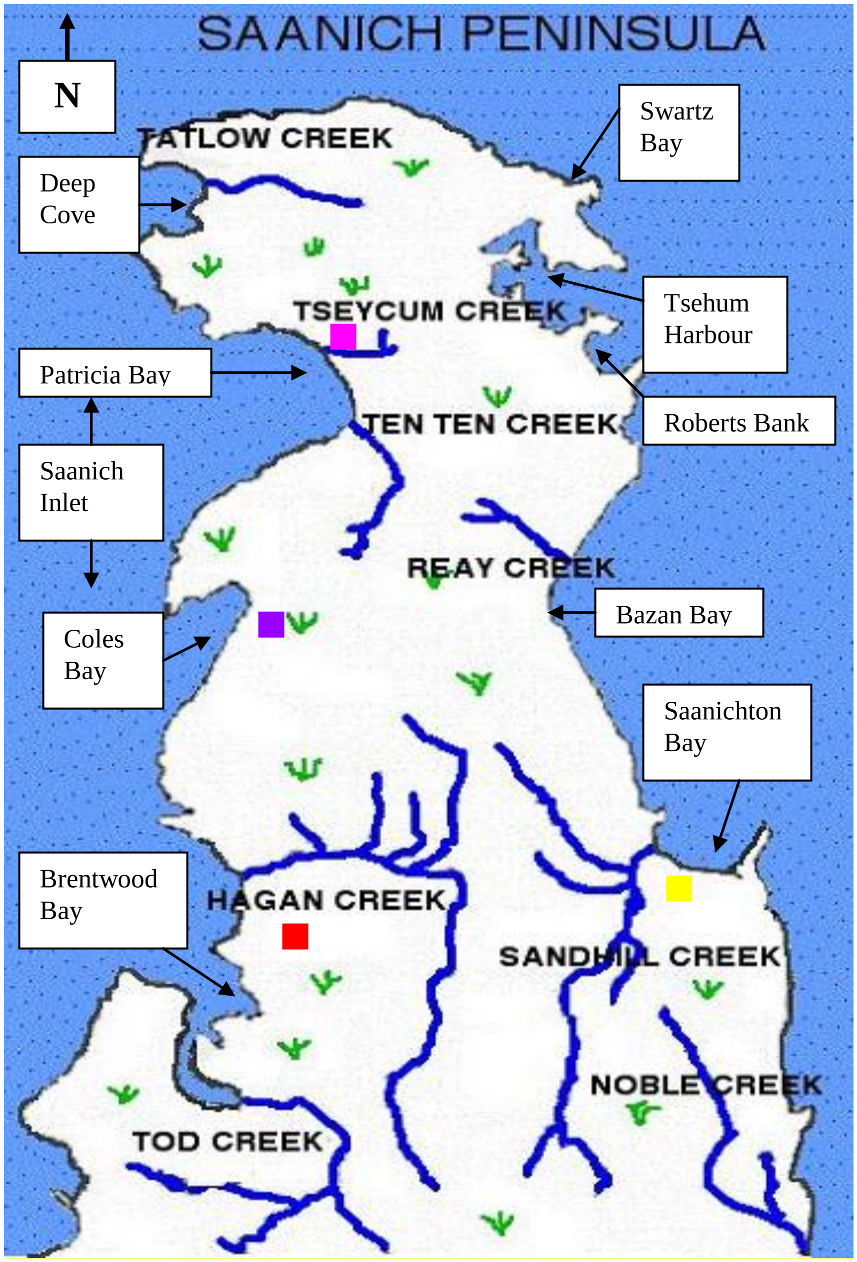
7.1 Discussion of Interview Results

Loss of Creeks Impacts Saanich Inlet

As illustrated by the testimonies of Saanich fishers in the results, elimination of streams throughout the Saanich region has disrupted the Saanich Inlet ecosystem and salmon populations. Further loss of creeks in this region will negatively impact salmon and their habitat. This in turn may result in further reduction in the local wild salmon stocks available to Saanich First Nations for Food, Social and Ceremonial (FSC) purposes or for commercial sale.

Tod and Hagan creeks located on the southwest side of the Saanich Peninsula, and Ten-Ten, Tseycum and Tatlow creeks located along the northwestern shores of the Saanich Peninsula all drain directly into Saanich Inlet, the saltwater environment from which Goldstream River salmon feed and where Saanich People fish (Figure 7.1). These creeks are an important component of the Saanich Inlet ecosystem and are important to the health of the salmon and to the Saanich People as well. These freshwater bodies carry microinvertebrate and macroinvertebrate plankton and other food sources (such as

Figure 7.1 Saanich Peninsula Creeks along the South Coast of Vancouver Island, BC



(Peninsula Streams Society 2004)

<u>Saanich First Nation Place Names</u>

Tsartlip	Pauquachin
Tseycum	Tsawout

juvenile herring, another anadromous pelagic fish) as well as dissolved minerals and nutrients consumed by salmon. Goldstream salmon feed on small planktonic crustaceans such as decapods, especially shrimp, such as pandalid shrimp (*Pandalidae*), euphausiids such as krill (*Euphausia pacifica*), and mysids such as opossum shrimp (*Mysis relicta*) at Saanich Inlet. Adult salmon will also feed upon juvenile salmon, usually of other species (e.g. adult coho and chinook will prey on juvenile chum salmon) (Fresh et al. 1981; Kaczynski et al. 1973; Pearsons and Fritts 1999). Juvenile chum and coho prey on gammarid amphipods (*Gammarus palustris*), harpacticoid copepods (*Harpacticoida*) and isopod crustaceans (Feller and Kaczynski 1975; Washington State Department of Ecology 2006). Goldstream salmon, in turn, provide a regular source of protein and fatty acids (including omega-3) to Saanich Peoples' diets and comprise 42% of all marine meals they consume (Health Canada 1995; Mos et al. 2004).

The remaining creeks that continue to flow through Tsartlip, Tseycum, Pauquachin and Tsawout lands are at risk of further degradation from urbanization and associated impacts such as non-point source pollution (Claxton J. pers. comm. 2002; Simonsen et al. 1995). Pollutants emitted from fertilizers and pesticides used on local farmlands for example, are absorbed through the soil matrix and transported to the streams by rain and underground water systems.

Using Goldstream River as an outdoor laboratory for conducting research, a knowledgeable Saanich fisher dissected several deceased salmon during spawning season and discovered that shrimp was the major prey of salmon passing through Saanich Inlet to return to their natal river (Elliott J. pers. comm. 2002). Saanich fishers are noticing a decline in abundance of shrimp, another one of their Saanich Inlet marine food sources, and as noted, a major prey for chum and other salmon. This decline in shrimp populations was attributed to loss of creeks from urban and road development and to an increase in commercial shrimp fishing in the inlet. As noted in Chapter 6, Saanich fishers have explained that Saanich Inlet was a nursery and important feeding ground for salmon feeding on plankton and shrimp. Any further loss of creeks, or failure to restore and protect existing creeks along the Saanich Peninsula in Central and North Saanich districts, will likely result in further diminishing the amount of planktonic food prey available to the salmon. It is foreseeable that the increase in commercial shrimp fishing, occurring since 1999 (DFO 2000b, 2001d), will further contribute to the decline in shrimp size and abundance available for salmon to feed upon in Saanich Inlet, the historical nursing grounds of Goldstream River salmon stocks (Bartleman J. pers. comm. 2002; Morris Sr. I. pers. comm. 2002). Lack of shrimp and planktonic food sources from streams could lead to salmon feeding less, becoming leaner, switching prey or switching migration routes. This is difficult to gauge given our limited understanding of the ecosystem dynamics of Saanich Inlet and Goldstream River. Based on their own research and observations, however Saanich fishers (Appendix E) identified particular fisheries management issues that should be addressed such as local stream restoration. These Saanich fishers demonstrated that there is a synchrony between fisheries research and management. This common thread between research and management is characteristic of adaptive management and indicates that this type of management is, on some level, inherent within the Saanich First Nation communities.

Saanich fishers made direct observations of cumulative impacts upon coastal and marine ecosystems caused by changes to the landscape and marine biodiversity (e.g. loss of streams and lowered abundance of shrimp or other sources of salmon nourishment, and redirection of water flow of Goldstream River). Adding provisions for measuring for salmon size and diet to the existing annual escapement survey procedures could assist with monitoring these impacts and changes to the marine ecosystem over time.

Saanich First Nation members should be invited to assist with drafting, coordinating and implementing these proposed changes to Goldstream salmon escapement surveys. Such an effort would be another step towards adaptive management, incorporating what is learned from experience to implement plans for improving existing management or monitoring methods. This process would also be another worthwhile step towards co-management, as it would assist hatchery technicians and DFO staff in charge of organizing and conducting escapement surveys and monitoring of salmon stocks at Goldstream River.

Saanich fishers' testimonies about the link between Saanich Inlet salmon and shrimp life cycles is comparable to Berkes' (1999:11) observations of Cree First Nations' fishing practices in James Bay, Ontario within the Chisasibi whitefish fishery in that: *"…extensive local knowledge existed on distributions, behaviour, and life cycles of fish simply because such information was essential for productive fishing, as any fisher knows, and was at one time essential to survival."* *In situ* observations of nearshore and freshwater fish populations combined with scientific knowledge of the fishery are integral for effective ecosystem-based management where harvesting of marine resources occurs on a continuous basis. A learning-by-doing approach to community-based salmon stocks monitoring evident with the Cree and Saanich people's respective fisheries bodes well for the adaptive management approach which, as I discuss later in this chapter, is essential for an effective management model for Saanich Tribal Fisheries and the Saanich communities.

Adaptive management proved very successful in the case of western Sweden's Lake Racken Fishing Association (LRFA) who restored spawning gravel beds and followed up with monitoring the lake's brown trout spawning grounds. An accident had occurred at a power plant upstream[38], causing siltation of spawning grounds and destruction of trout eggs after the restoration work had been done at the lake. Due to the knowledge they acquired during their work, however, LRFA fishers were able to quickly identify the effects of the accident and acquire the funds to restore the trout habitat (Olsson and Folke 2001). This case study exemplifies the effectiveness of fishers' experiential knowledge in helping to protect fish and fish habitat. The inclusion and perpetuation of experiential knowledge that local Saanich fishers have about the Goldstream salmon fishery should also be included when planning and implementing conservation and monitoring protocols for Goldstream salmon.

Conservation Initiatives of Saanich Fishers

Berkes (1999) described Cree First Nation People's self-imposing fishing gear restrictions and refraining from fishing their main target fish stocks at times. Results from thematic analysis (Table 6.1) demonstrated that these same overarching, fishery conservation strategies were employed by Saanich fishers who targeted coho and chum salmon at Goldstream River and Saanich Inlet over approximately the past 40 to 60 years (Bartleman J. pers. comm. 2002; Claxton Sr. E. pers. comm. 2002; Smith S. pers. comm. 2002). Deliberate restraint from exercising traditional fishing rights during times when coho stocks were replenishing contributed to conserving and protecting the coho

[38] No date listed but timelines in article indicate that the accident occurred between 1986 & 2001.

population. This type of effort provided Goldstream coho stocks with a greater chance for undisturbed, natural regeneration over time, and could replace enhancement as a wild coho population conservation and regeneration strategy. In many cultures, First Nation peoples' commitments to caring for their natural resources are deep-rooted (Alcorn 1993; Barsh 1982; Berkes 1999:152; Dwyer 1994; Gadgil et al. 1993; George 2003:73; Jones 1997:12). In the case of Saanich fishers, this moral commitment to conservation was manifested by their voluntary monitoring and control of coho and chum fishing, irrespective of coho fishing openings administered by DFO when stocks began to rebound, and despite their continuous cultural rights to fish for FSC purposes at Goldstream River and Saanich Inlet. This is a good example of how Saanich First Nations practice conservation at these two traditional fishing sites.

Changes in Traditional Saanich First Nation Fishing Methods

Saanich First Peoples have moved away from their original fishing practices. Fifty to 70 years ago, families caught their year's supply of salmon by travelling to Goldstream, camping and fishing together at the river, then smoking and preserving the salmon (Table 6.1). Families travelled by canoe in Saanich Inlet in search of food, where they caught chum and other fish from the inlet waters[39]. In recent years, families have received their salmon from the ESSR and FSC chum fisheries caught by seine vessel in Saanich Inlet.

The delivery of salmon to peoples' homes is helpful for those unable to access or attain the resource for themselves. This modern method of salmon catch and delivery,

[39] Harvesting also involved berry picking (e.g. for salal and salmonberries) and root vegetable digging (e.g. for camas bulbs) along the coast in late summer and duck, deer and seal hunting in the fall (George

however, reduced the need for families to travel together to fish for their own food in the inlet or the river. This change in salmon fishing practices and Saanich Tribal Fisheries' management could lead to loss of shared traditional ecological knowledge about salmon fishing methods as fewer people are actively engaged with the process of fishing for their or their family's annual supply of salmon. The loss of traditional ecological knowledge about salmon habitat and other environmental indicators previously learned and passed on among the people of the Saanich First Nation communities could subsequently lead to the erosion of intergenerational bonding and cultural ties between and among the Saanich families. This loss of knowledge, practice and belief about salmon and fishing could also prevent future generations of Saanich people from learning about fishing methods, conservation and stewardship efforts as well as their traditional and ongoing fishing rights at Goldstream River and Saanich Inlet. The perpetuation of traditional ecological knowledge about Goldstream salmon is very important for Saanich people because it is intricately connected to the current and future wellbeing of the Saanich First Nation culture.

Recent Changes to the Goldstream River and Saanich Inlet Salmon Fishery

The observed change to coho stocks' morphology (physical form and structure) over recent time (i.e. Goldstream coho generally becoming thinner in the past two years than approximately 40 years prior to that) serves as a point of reference for further salmon stock monitoring at these sites.

2003) probably allowed rotation or alternation of harvesting pressure for the then, more plentiful resources along the Pacific Coast.

Six of the seven Saanich fishers interviewed affirmed that Goldstream River has always (historically and currently) been predominantly a chum salmon-bearing stream. This corroborates the biostatistics that showed annual chum escapements far exceeding those of coho and chinook from the period 1932 to 2004. Most (five of seven) fishers expressed concern that the recent (1980s to present) enhancement of coho and chinook stocks will negatively affect the natural chum population. Further studies investigating for interspecific competition among species are required to determine if enhanced coho and chinook stocks are negatively affecting wild chum stocks. (See Chapter 8 for further recommendations.)

Major Themes from Interviews with Saanich First Nation Fishers

Table 6.1 summarized results from thematic analysis of interviews conducted with Saanich fishers. Participants' observations and experiences in relation to changes to the aquatic environment (Goldstream River and Saanich Inlet) included reduction in the river's width and restriction of the size, number and productivity of streams flowing into Saanich Inlet over the past 50 years, as well as the onset of pollution and sickness from eating fish from the inlet over the past 10 years (Bartleman J. pers. comm. 2002; Morris I. Sr. pers. comm. 2002; Morris S. pers. comm. 2002; Smith pers. comm. 2002). These environmental changes are directly linked to the health of the aquatic ecosystem and of humans. Accounting for these impacts in addition to fluctuating escapements of native stocks and total (chum) catch provides a more holistic picture with which to evaluate the fluctuating status of wild and enhanced salmon stocks than would be possible from examining escapement data alone.

Sub themes of fishing practices that emerged from interviews with Saanich fishers (past and recent changes to fishing practices and technologies) illustrated prevailing changes to Saanich First Peoples' traditional fishing practices over time. As noted, there was a shift from pre-European times (1800s) to the 1960s when families travelled to, fished and camped at Goldstream River overnight, and smoked their salmon at the smokehouse on site. Implements used for fishing such as gaff hooks and spears were formerly hand-made. Since the 1960s, fishers have stopped setting up fishing camps and smoking salmon at the river. Tourism at the provincial park area of Goldstream River (Reach 1) has increased (Figure 2.2). The smokehouse has been taken down. Saanich and Malahat First Nation fishers are permitted to fish the river for their Food, Social and Ceremonial purposes (Simonsen et al. 1997) (Appendix E): however only descendants of the families comprising these bands can fish in the river. Some park visitors, members of the public, media and park wardens who observed Saanich fishers spear fishing salmon at Goldstream River in the past expressed opposition to it (Bartleman J. pers. comm. 2002; Cooper E. pers. comm. 2002; Morris Sr. I. pers. comm. 2002). The management of the salmon-bearing reaches of Goldstream River as a tourist attraction for park visitors since its inception as a BC provincial park in 1958 (BC Ministry of Lands, Parks and Housing 1986) has inconvenienced, imposed upon and altered the fishing behaviour of Saanich fishers fishing at Goldstream River. In contrast, modern day amenities such as gaff hooks or dip-nets made from synthetic materials can now be purchased at department stores. Salmon caught at the river are now smoked at smokehouses in the communities of Tsartlip, Tseycum, Tsawout and Pauquachin First Nations, which accommodates fishers who do not have smokehouse facilities at their homes (Table 6.1). These modern adaptations are quite useful to fishers and probably save them considerable time and effort in catching and processing their salmon food but they are also disadvantageous because the opportunity to learn how to make one's own dip-net or prepare and hang their salmon for smoking is lost in the transition.

The practice of saltwater salmon fishing in Saanich Inlet has shifted away from families taking fishing trips in hand-carved wood canoes or crafted wooden rowboats to families purchasing and using fiberglass motorboats or seine vessels for fishing. Prior to the 1960s, it was common for many families to fish for salmon in the inlet from September to December. In recent years however (since the 1980s), the Saanich Tribal Fisheries owned and subsequently sold, then contracted a seine boat to conduct the ESSR chum salmon fishery in the inlet. Families very rarely will fish for salmon or other fish in the inlet anymore. This may be in part due to increased pollution and awareness of pollution in the inlet and a fear of becoming poisoned and sick from eating fish caught from the inlet (Morris Sr. I. pers. comm. 2002). The decline in salmon fishing activity in Saanich Inlet by Saanich Peoples could also be a result of lifestyle changes such as the option of purchasing salmon fillets from a local grocery store instead of having solely the option to catch fish from the inlet (which entails the additional requirements of killing, skinning and cutting the salmon). The fact that each family receives a number of salmon pieces caught by the Saanich Tribal Fisheries vessel and then delivered to their doors several times throughout the year may also be contributing to the decline in fishing activity at both Saanich Inlet and Goldstream River.

Conversations about salmon ecology and biology, another theme derived from interviews with fishers, revealed that fishers have observed changes in salmon behaviour over time such as selection of feeding habitat and migration paths at the river. Fishers also stated that there has been a decrease in abundance of salmon returning to the river in recent years (i.e. the past 50 years). Escapement data for Goldstream River salmon stocks indicated that fluctuations in abundance occur annually. This coupled with seasonal fluctuations in timing of salmon runs and abundance may account for why fishers believed they saw more salmon at the river in the past than they did recently (i.e. 2000 to 2002). Overall, however, salmon escapement (total abundance of salmon returning to the river) has increased over the past 50 years (Figure 6.1, 6.2, 6.3).

Fishers also stated that there were fewer coho, chinook and chum salmon to be caught in the inlet now (2002) than there were in the past (e.g. earlier on in the 50-year period during which they had fished). This discrepancy may in part be due to ongoing conservation measures that have led to coho and chinook fishery closures in Saanich Inlet over the past twenty years (since the 1980s). There never was a great abundance of chinook at the river: however escapement data showed that an overall increase in chinook to the river has occurred since the 1960s (Figure 6.2) probably resulting from both Goldstream chinook stock enhancement and fishery closures. The number of chum that may be caught has been much more closely monitored and controlled by the ESSR licenses in accordance with the target 15,000 Goldstream River chum escapement goal since 1980. This may be part of the reason for the majority perception that there has been a decrease in abundance of salmon to be caught in Saanich Inlet, though records of total catch for Saanich Inlet chum (or other salmon) are not available for any period prior to 1980.

Saanich fishers partake in a variety of conservation, restoration and stewardship efforts to protect salmon stocks and habitat (Table 6.1). These range from practical restoration activities (e.g. planting native vegetation along creek banks) to reporting abundance of salmon fished in the river and caught in the inlet, and exercising restraint from fishing their favourite foods (e.g. grilse) in order to protect declining BC coho populations. The former examples are characteristic of modern fisheries monitoring and management techniques whereas the latter conservation effort (restraint from fishing or rotating fishing effort) is characteristic of a traditional tribal fishery management practice. Some fishers engage in spiritual practices that include a prayer for the salmon as well as the ancestors and relatives of the salmon being caught for their food. This is a show of respect and appreciation of nature and emphasizes the cultural tradition and belief of fishing in the least harmful ways to the animal and its habitat.

Pollution in Saanich Inlet is reportedly contaminating the fish, seafood and shellfish in the inlet (Table 6.1). Pollution in the inlet comes mainly from non-point sources such as oil spills and leaks from boats and marinas, sewage from pleasure crafts and houseboats as well as runoff from agricultural and residential lands carrying carcinogenic chemicals from herbicides and pesticides (Simonsen et al. 1995; Spliid 2005). Consumption of these local food sources from the inlet is ascribed as cause of illness to fishers and their families. This is a health concern that was brought forward to Fisheries and Oceans Canada personnel. It is apparent that pollution is an important issue, which the Saanich First Nation community would like to see addressed and remedied. Another major concern regarding Saanich Inlet waters was DFO’s decision to allow non-native commercial harvesters access to the salmon fishery before the Cowichan River target escapement goal was met (year not known) (Table 6.1). This action led to disproportionate advantage and allocation of chum stocks to non-First Nations parties prior to First Nations and is contrary to the Aboriginal Fisheries Strategy (AFS). This is an important issue regarding equity, Saanich First Nations’ Douglas

Treaty rights to fish as formerly[40] and their legal entitlement to first priority (to fish for FSC purposes rather than commercially) over other uses of the resource (after conservation concerns have been addressed) as provided under federal fisheries legislation (DFO 2000a).

Costs and Benefits of Running a Seine Fishing Vessel

Using information gathered from interviews, a very rough estimate of the cost of operating a fishing vessel in Saanich Inlet is $2,500 per fishing season. The captain and crew are paid from the sale of the chum (e.g. 10 cents per pound of salmon sold). A total of 75,034 chum were caught in the ESSR fishery in 2002. Given an average weight of approximately 3.6 kg per chum salmon (assuming the lower end of the 3.6 to 4.5 kg average weight reported in results), then about 270,122 kg of chum were sold on the market. Assuming a market sale price of fifteen cents a pound and 10 cents a pound paid out to the captain and crew and 5 cents per pound returned to Saanich Tribal Fisheries (Smith S. pers. comm. 2002) the ESSR fishery earned about $27,000 (from which $2,500 is subtracted for vessel operation costs). The result from this example is that Saanich Tribal Fisheries would have profited $24,500 from their ESSR commercial chum fishery in 2002 (Smith S. pers. comm. 2002).

A requirement of Saanich Tribal Fisheries' ESSR fishery is that all profits be reported to DFO (DFO 2001b) and reinvested in the operational costs of the fishery, as well as training Saanich people to do surveying, monitoring, stock assessment, stewardship or related fisheries project work (Smith S. pers. comm. 2002). There was no

[40] The Saanich Douglas Treaty tribes are made up of the Tsartlip, Tseycum, Tsawout, Pauquachin and Malahat bands.

ESSR chum fishery and thus no profits for Saanich Tribal Fisheries in 2003 or 2004, so the approximate profit of $24,500 from 2002 (and any other compounded savings from previous years) would have been carried over for paying for operations and jobs listed above over the three-year period from 2002 to 2005. Given the above, it is apparent that job placement in stock assessment work is not providing stable revenue for Saanich First Nations over the long term. The income from the ESSR fishery does, nevertheless, provide a source of income, training and work experience that contributes to the improvement of monitoring protocols of Goldstream River salmon stocks at present.

Abundance of Salmon Caught at Goldstream River Over Time

As presented in my results, Saanich fishers reported catching less than one fifth of the quantity of salmon from Goldstream River (for food for themselves and their families) from 1960 to 2005 than they did in the period between 1930 and 1960. This may account for the majority perception of the fishers interviewed that there are far fewer salmon at Goldstream River than there were in the past. Escapement records do show a significant reduction in chum between 1948 and 1975 with annual returns of chum exceeding 15,000 for most years thereafter (Table 6.4). This perception of lower abundance of salmon returning to Goldstream River may be resultant of less fishing activity by Saanich First Nations since that time (1960), when escapements were low.

Discrete Indicators of Varying Salmon Morphology and Seasonal Spawning Times

Changes in salmon morphology include changes in girth, length and body mass of adult salmon returning to Goldstream over time. Only two fishers interviewed noticed changes in salmon morphology of coho and chinook returning to Goldstream River in recent years, compared to past runs.

There are two runs of chum salmon, the first run, in October, consisting of chum of smaller body mass than the second run, which are larger in body mass and valued as sports fish. The fact that there are two runs of chum, one smaller than the other may contribute to the perception that chum have decreased in size in recent years that fishers have caught them. If the fishers caught salmon in the later part of the season (the larger sized salmon of the second run) in previous years, then fished during the earlier part of the salmon run season (October) in latter years, for example, their impression would be that the salmon returning in recent years seem smaller than they had in previous years. It is difficult to cross-check or assess the validity or potential relationship between these two discrete findings as there are no detailed records about abundance of chum salmon for each of the two runs at Goldstream River nor are there records of variables measuring for proportional morphology for these escapements over time. This finding does however point to the possibility of the interruption or loss of traditional ecological knowledge about Goldstream salmon over time.

Nature's Indicators and Provisions for the Goldstream River Salmon Run

Some seasonal cues informed fishers about the time of year when they should begin collecting their fishing technologies and preparing to set up their fishing camps at Goldstream River. Saanich People have learned about the natural history of their home place from their elders through their stories (the passing on of traditional ecological knowledge). Saanich fishers learned that when oceanspray, also called 'Wild Spiraea' (*Holodiscus discolor*), a deciduous, woody shrub of the rose family, is in full-blossom and its creamy white flowers are just beginning to go to fruit and turn brown, and when the trailing blackberries (*Rubus ursinus*) have turned ripe on their thorny bushes in July, the (chum) salmon will soon be returning to the river. Saanich and Cowichan people historically used the wood from oceanspray to make salmon-barbecuing sticks and needles for weaving cattail camp and travel mats used for shading their canoes (Claxton and Elliott 1994:12; Pojar and MacKinnon 1994:78). Fishers have also learned that a great abundance of fir cones on coniferous trees (i.e. Douglas fir [*Pseudotsuga menziesii*]) in the spring season indicates that there will be a great abundance of salmon returning to the river that fall. First Nations people along the Pacific Coast used the wood from Douglas fir trees for making fire tongs, spear handles, dip-net poles and salmon weirs. The pitch was also used for sealing joints of gaffs and fishhooks and for caulking canoes and water vessels (Pojar and MacKinnon 1994:32). It is important to document the knowledge about the natural history of a place as well as the sustainable harvesting practices used to harvest food from the land and waters. This knowledge, when shared, illustrates the pathway from the past so that this generation and future generations may learn an appreciation for protecting their natural habitat, learning sustainable plant and salmon harvesting methods and making informed decisions about how to become stewards of their homelands and waters.

Saanich Tribal Fisheries

Prior to the onset of DFO fisheries laws, restrictions, regulations, licenses and policies coming into place at Goldstream River and Saanich Inlet, the salmon stocks were closely safeguarded by the heads of Saanich First Nation families who knew the inlet, the river, the fish and the coastal lands intimately. The ecological knowledge of these places would be passed on to other members of the community during harvesting and at social and cultural gatherings and events. These people would in turn become stewards of the river, the inlet and the fishery. One of the main changes in the fishery is that in the past, there was a lot more rotation of fishing, so that all the families would have enough room, enough time and enough salmon to fish. The knowledge from experienced Saanich First Nations who were managing the fishery was preserved and passed on in a more localized manner in the past when more families were fishing together in the inlet or camping at the river in groups. Saanich Tribal Fisheries arose out of the need for families concerned with fisheries issues to come together to address them collectively and, in more recent times, to address fisheries concerns with DFO.

Families do not fish the inlet or river as often as they used to, in part because of the closure of coho fisheries in Saanich Inlet and the onset of modern commercial vessels doing the salmon fishing and distributing the salmon to them. Another reason why Saanich People do not camp and fish at the river as much now as they did in the past is due to complaints from park visitors offended by witnessing Saanich People fishing in their traditional way by gaff hook, or spear or by using modern (synthetic) net poles, then clubbing the salmon on the head to kill them for their food. Fishers who do not wish to be bothered by offended spectators are likely to stop fishing at the river altogether (Bartleman J. pers. comm. 2002; Cooper E. pers. comm. 2002; Morris Sr. I. pers. comm. 2002). Visitors to Goldstream Park may not be aware of Saanich Peoples' traditional fishing methods and rights to fish for FSC purposes even though there are information signs posted in the park to educate the public about the Saanich Peoples' cultural fishing practices at the river. As noted earlier, the smokehouse that was formerly used by Saanich people at the river was torn down around 1992 (Morris Sr. I. pers.comm. 2002).

Prior to its removal, fishers used to invite park visitors to the smokehouse to demonstrate their traditional salmon fishing, cutting and smoking methods. These relatively recent changes to cultural fishing practices have probably resulted in fewer opportunities for experienced fishers to share their knowledge of the salmon and teach fishing methods that were formerly passed on from family to family and from one generation to the next over time. In 2005, however DFO Minister Geoff Regan announced the need to focus on First Nations' fishing opportunities and Goldstream River was identified as one of the places where this should occur (DFO 2005d).

Current Saanich Tribal Fisheries Management Practices

Saanich Tribal Fisheries works with DFO to provide records of their annual Excess Salmon to Spawning Requirement (ESSR) and Food, Social and Ceremonial (FSC) chum catch to assist with monitoring protocols (Figure 6.10). Saanich Tribal Fisheries has also worked cooperatively with DFO on other conservation and fisheries matters pertaining to Goldstream River and Saanich Inlet. For example, Saanich fishers have refrained from fishing coho from the inlet and the river when their populations were reportedly low province-wide, even though it is their cultural right to fish them (Bartleman J. pers. comm. 2002; Smith S. pers. comm. 2002). Though there is a lot of progress that could be made, I think that Sannich Tribal Fisheries provides a good example of how co-management between First Nations and DFO can occur. Saanich Tribal Fisheries also serves in addressing Saanich Peoples' interests, concerns, conflicts and disputes regarding fisheries matters such as salmon allocation, distribution and entitlements of external parties seeking access to the Saanich Inlet chum fishery. For example, when DFO decided to allow non-First Nation commercial fishers access to the

Saanich Inlet ESSR chum, Saanich Tribal Fisheries defended Saanich Peoples' commercial chum fishery (Smith S. pers. comm. 2002). The result was negotiations with DFO that led to the decision to allocate 80% of the future Saanich Inlet chum catch to Saanich people and 20% to non-Saanich First Nation fishers (DFO 2005d; Jacks V. pers. comm. 2004).

7.2 Discussion of Goldstream Salmon Fisheries Statistics

Goldstream Coho Escapements (1932 to 2004)

An examination of population patterns of the available time-series escapement data (1932-2004) lead to a suggested carrying capacity (K) of about 1,500 spawning coho per year. Recent observations revealed a tendency for WCVI coho to migrate from the west coast of Vancouver Island to the southern Strait of Georgia (perhaps due to the pursuit of more abundant food sources in those waters). Mature coho migrating through the southern Strait of Georgia are more likely headed to the Fraser River basin spawning grounds (DFO 2001). This change in migratory patterns of coho may have occurred due to the effects of the 1997 to 1998 El-Niño and may have contributed to the decline in coho escapement at Goldststream in 2002 (i.e. averages dropped from 3,990 coho in 2001 to 1,570 coho in 2002, which is just over the proposed carrying capacity) (Figure 6.1). Another noteworthy emerging pattern regarding target escapement or carrying capacity is that Goldstream has supported less than 500 coho approximately 60% of the time between 1932 and 2004. The time-series graph also illustrates that the most common and sustainable population of coho spawners at the river over the long term is probably about 500, which is a different target population than the maximum carrying capacity. The rates of population change (Table 6.6) show that coho stocks at Goldstream have increased at the highest rate between 1978 and 2004, during the time when hatchery enhancement of coho began. This indicates that overall, the enhancement of the coho population has been successful at this river.

The concept of a natural, historical carrying capacity for coho stocks (here, suggested to be about 1,500) would likely interest Saanich fishers because five of the seven fishers interviewed expressed concern that recent (DFO funded) enhancement of coho (as well as chinook) stocks will negatively affect the natural chum population that has historically outnumbered coho and chinook stocks. This is a legitimate concern as coho and chinook stocks are species of conservation concern province-wide, are an indicator stock undergoing stock enhancement at Goldstream and are generally more highly valued in both the cash economies of sport and commercial fishery sectors than chum salmon. It is therefore conceivable that future efforts and program funds by DFO to augment, monitor and protect coho and chinook stocks will take precedence over management efforts for sustaining, monitoring and protecting the existing natural chum population at the river which is highly valued by the Saanich people for their Excess Salmon to Spawning Requirement and Food Social and Ceremonial fisheries as well as for their intrinsic value to their culture and to Goldstream River (Table 6.1).

Chinook Escapements at Goldstream River (1932 to 2004)

Results from time series graphs of chinook escapements (1932 to 2004) corroborate Saanich First Nation fishers' assertions that Goldstream River was not a major chinook stream (Figure 6.2). The natural, historical carrying capacity of chinook at Goldstream (from 1932 to 2001) is 50 individuals. In the past few years (from 2001 to 2004) however, chinook stocks have risen more than nine times beyond historical levels of the previous 68 years to quantities ranging from about 195 to 385 individuals. The higher figure of 385 is a (maximum) carrying capacity, which I proposed based on average chinook escapements from 2001 to 2004 alone. This target escapement carries an element of uncertainty and risk because it is derived from escapements over a very short term. The Goldstream chinook escapement population should be monitored and considered carefully over the next few years before a target escapement for chinook is officially put into place. The main fisheries management issue to consider about selection of a carrying capacity or target escapement goal of 50 versus 385 chinook is: whether the enhanced population should take precedence over the chinook that would occur if the chinook were left to spawn naturally without the intervention of hatchery enhancement of the population. Target escapements and carrying capacity abundances are based on shifting fishing quotas both offshore (in international fishing waters) and nearshore (in inlets, channels and passes). Consequently, these data do not reflect the abundance of wild salmon that occurred at Goldstream prior to the onset of commercial fishing, logging, pollution, road and home construction as well as commercial and facilities developments that occurred around the mid 1800s.

As noted in Chapter 3, Goldstream River is being managed by DFO as an indicator river because the coho and chinook populations are being enhanced. The Goldstream coho are called indicator stocks because the enhanced stocks are tagged and fin-clipped annually (pers. obs.), which enables scientists to monitor the population through tag and recapture studies (Pacific States Marine Fisheries Commission 1997; SFEC 2004). Goldstream chinook salmon are also called indicator stocks because the population is being augmented at the hatchery. Chinook are not currently tagged, however which constrains monitoring of chinook to escapement surveys of mixed stocks (hatchery and wild stocks) at the river. This is problematic as there is no means by which to measure the hatchery contribution of chinook salmon to the total catch of offshore and nearshore (i.e. Saanich Inlet) fishing vessels or to the natural chinook stocks returning to Goldstream. It is also not possible to separate out and measure for possible impacts of hatchery and wild chinook upon coho, chum or other chinook salmon at the river.

Chum Escapements at Goldstream River (1932 to 2004)

Although chum stocks are not enhanced at Goldstream River, numbers of chum have actually increased over recent time (since 1975). Hatchery enhancement of coho and chinook stocks since the 1980s have apparently, therefore not as yet constrained the annual abundance of chum escapements (Figure 6.3; Table 6.6). Saanich First Nation fishers interviewed believed that there were fewer salmon returning to the river: however escapement records indicated otherwise. As noted in my results, Saanich People have not been fishing at the river as often in recent years compared to the past (i.e. they fished there nearly six times more often in the years before 1960) (Appendix E). This decrease in fishing activity over the past 45 years may be contributing to the increase in abundance of chum at the river that began in the 1970s and continued on up to 2004 (Figure 6.3). Chum escapement declines occurred at Goldstream and throughout much of the BC coast in 1952 and 1953. This is probably due in great part to a major expansion of chum fishing activity at that time (Reimchen, T.E. pers. comm. 2006). There may have been a delayed effect in the relationship between decreased fishing activity in the 1960s and the increase in Goldstream chum escapements after 1970 (given the average chum spawning age of 5 years) as at least two generations of Goldstream chum broodstocks would have returned to their natal river during that time; one in 1960 and one in 1965. (Figure 6.3;

Table 2.3). Though the perception of fishers is that there are less salmon to fish from the river, Saanich First Nations could have fished more (chum) salmon as a food source from the river than they did in recent years, with the exception of 2000, 2003 and 2004 when escapements were below the 15,000 target (Figure 6.3; Table 6.4).

The 15,000 chum target escapement put in place by DFO is intended to ensure that there are enough chum to secure the next generation of Goldstream chum to spawn at the river. This figure may not, however, accommodate other important ecosystem dynamics such as the role of salmon as a food source for eagles, bears and mink that forage in the river and the role of salmon carcasses in providing important nutrients to the river and its riparian zone. Closer monitoring of the chum population may ensure that enough chum return to the river and could also prevent an overabundance of chum from entering the river which is known to lead to overspawning, digging up of established redds and crowding among chum spawners. Chum escapements surpassed the currently established target escapement or carrying capacity (K) of 15,000 by 1,000 or more for 20 out of 23 years between 1979 and 2004 (Table 6.4). If closer monitoring of total chum escapement in relation to total chum catch had been done on an annual basis in the past, the Saanich First Nation could have accessed a thousand more to many thousand more chum per year for commercial or communal purposes than they did in most years between 1979 and 2004. More specifically, Saanich Tribal Fisheries could have fished about 276,500 more chum from Saanich Inlet over the past 25 years than they did.

Goldstream Salmon and El-Niño

El-Niño Southern Oscillation (ENSO) events are known to cause: increased sea surface temperatures in Pacific Ocean waters; change in salmon migration paths; salmon to migrate deeper into the ocean water column; and mortality of salmon (Appendix A; Beamish et al. 1999; Mysak 1986; NOAA 2006). Chum escapements recorded for 1982 and 1983 were very low compared to previous and ensuing years on record (Table 6.4). This may be linked to the major El-Niño event of 1982 to 1983, however other El-Niño events have occurred since then. Coho and chinook escapements were also low in 1982 and 1983 and while it is possible that these populations were impacted by the El-Niño in those years, the difference in population between those and other years on record for these species were not on average noteworthy. Chum escapements decreased in conjunction with El Niño events from 1986 to 1987 as well, and escapements for Goldstream coho, chinook and chum were all considerably lower during the major 1997 and 1998 ENSO than in the two-to three-year period leading up to that event (Figure 6.1, 6.2, 6.3; Table 6.4). The discussion of El-Niño events in relation to concurrent Goldstream salmon abundances opens the dialogue for considering natural events as causes for decreases in salmon populations along with anthropogenic causes such as overfishing, pollution, global warming and destruction of salmon habitat from urban developments such as road construction.

Goldstream Salmon Spawning Spaces

In the absence of competition for spawning habitat, hatchery and wild salmon breed freely. When competition for space is a factor however, reduced redd numbers, delayed spawning and increased egg loss through retention are reported (Flemming and Gross 1992). The number of spawning female fish produced in a given year is strongly density dependent on the (initial) number of females that lay eggs at the time of spawning (Elliott and Hurlsy 1998). The naturally occurring chum population has enough room to spawn at its maximum carrying capacity (K). Individual chum were, however, probably competing with each other for spawning space in years when chum escapements were between 35,000 (1948 averages) and 45,000 (1988 averages) (Figure 6.3). Coho and chinook (which are hatchery enhanced stocks) tend to migrate further upstream to spawn than chum and are therefore probably not frequently in direct competition with chum for spawning space (particularly when chum are at or below the 15,000 chum carrying capacity). Coho and chinook are probably not at risk of overspawning (digging up and destroying one another's gravel redds as a result of direct competition for space) as each has more than sufficient access to spawning ground space (14 m^2 each) in Reaches 2 and 3 of the river (Figure 2.2, Table 6.6).

Saanich Inlet ESSR Chum Catch (1982 to 2004)

Goldstream River chum fishery management and monitoring efforts have been improving over time as target goals are successfully met and fishing activity is curbed accordingly. Comparisons of ESSR catch and escapement data showed that Saanich Tribal Fisheries overfished chum in Saanich Inlet in 1983 and 1989 (2 out of their total of 22 fishing years on record from 1982 to 2004) (Figure 6.4; Table 6.4). The chum population was below its carrying capacity in the years 2000, 2003 and 2004. However no ESSR chum fishery occurred in those years and so local overfishing did not contribute to the decrease in the chum population in those years. The time series graph of annual native harvest statistics also indicates that Saanich Tribal Fisheries did not acquire any income from an ESSR chum fishery to fund and sustain conservation (shore patrol, stream surveyors), restoration (stream and wetland protection), stewardship (day and night river patrol personnel) or other fisheries related programs for three of the five years between 2000 and 2004 (inclusively). The facilitation and progress of these programs is entirely dependent on and vulnerable to unpredictable abundances of chum returning to Goldstream River and Saanich Inlet. The danger in the strategy of using ESSR funds to administer these programs is that when there are continuous, consecutive or closely intermittent years when fewer than 15,000 chum return to Goldstream, Saanich Tribal Fisheries is at risk of bankruptcy, and conservation, restoration and stewardship activities are at risk of being terminated, just when they are most needed.

Food, Social and Ceremonial Chum Catch (1978 to 2003)

Saanich Tribal Fisheries seems to be shifting away from fishing chum from Saanich Inlet for Food, Social and Ceremonial (FSC) purposes. A steep decline in FSC chum catch is apparent over the past few years (1997 to 2004) compared to previous years (1982 to 1997). This is probably due in part to unpredictable, oscillating salmon escapements at the river, Saanich Peoples' perception that there are fewer salmon returning to the river and the inlet, the pollution of the inlet and to an increase in or shift towards ESSR chum fishing activity which coincides with the decrease to the FSC chum fishery over recent time (Figure 6.5). This transition from FSC to ESSR chum fishing may represent a conscious shift in fishing effort implemented by Saanich Tribal Fisheries in order to economically sustain the costs of the ESSR chum fishery and other Goldstream salmon monitoring programs described earlier. This transition in fishing effort bodes well for increasing funds for the ESSR fishery and for stewardship and supporting fisheries projects in years when there is a sufficient abundance of chum to allow the fishery in the inlet.

The decrease in FSC chum fishing in the inlet, however, indicates that there are fewer salmon available for social events, ceremonies and feasts customary to Saanich People (Claxton and Elliott 1993; 1994). Some of the salmon stocks migrating through Saanich Inlet during the fall run fishing season are Cowichan River chum stocks and some are Goldstream River chum stocks: however some stocks migrate from offshore waters of the United States. Though unpredictable, this is an important factor to consider in regards to establishing fishing limits to prevent overfishing of chum stocks in Saanich Inlet (even after target escapements have been met at Goldstream River) because the 1985 Pacific Salmon Treaty between BC and the US requires that Canada and the US monitor, measure and ensure equity of southern Pacific Coast chum catch between these two countries (Pacific Salmon Commission 2005). Cowichan First Nations received their own ESSR chum fishery license in 2002 and caught 11,169 chum in Satellite Channel (DFO Statistical Management Area 18-located north of Area 19, the Saanich bands' fishing location) in that year while Saanich Tribal Fisheries caught just over 75,000 chum (DFO 1982-2004, 2002).

The Cowichan band's ESSR fishery is allowed once a considerably higher target chum escapement (110,000) reaches Cowichan River (DFO 2002). As many Goldstream chum enter Saanich Inlet by way of Satellite Channel, it is important that equitable abundances of chum remain available to the Saanich Inlet ESSR fishery as they are passing through the Cowichan bands' fishing waters. If annual chum catch and escapements continue to be recorded by both the Cowichan and Saanich First Nation bands, improvements and advances to monitoring of chum populations, catches and establishment of ceilings for maximum catch at Saanich Inlet and Satellite Channel

(Areas 19 and 18) may be attainable over time[41]. This step could occur by averaging total ESSR catch for each of Saanich Inlet and Satellite Channel over time and solving for a catch ceiling that can represent and enable equitable allocation of chum catch for the Saanich and Cowichan bands. The figure for annual ESSR chum catch ceilings could be determined from, for example, an equation that includes solving for the variables of total chum escapements at each of Goldstream and Cowichan rivers, total chum catch from the Saanich and Cowichan bands' ESSR fisheries, the bands' total on-reserve population and economic needs from the fishery.

Chum Escapement, ESSR and FSC Catch (1980 to 2004)

This research raises questions about whether relationships between Goldstream salmon escapement abundance and the two chum fisheries in Saanich Inlet are occurring randomly or whether they can be explained by fishing activity or fisheries management practices. Examining chum escapement, ESSR and FSC catch together allowed for observations and comparisons of parallel or inverse relationships between the two chum fisheries and chum escapements at the river (Figure 6.10). There is an apparent link between decreased chum fishing activity and an increase in adult chum spawners that have evolved from both the parent and offspring generations returning to the river.

Variables for Monitoring Saanich Inlet Salmon

Catch per unit effort (CPUE) analysis is used for gauging the abundance of fish caught for a given amount of energy (time and/or money spent by fishing vessel and

[41] According to Simonsen et al. (1997), Saanich Inlet was a traditional fishing place of the Cowichan as well as Saanich bands (which includes the Malahat band).

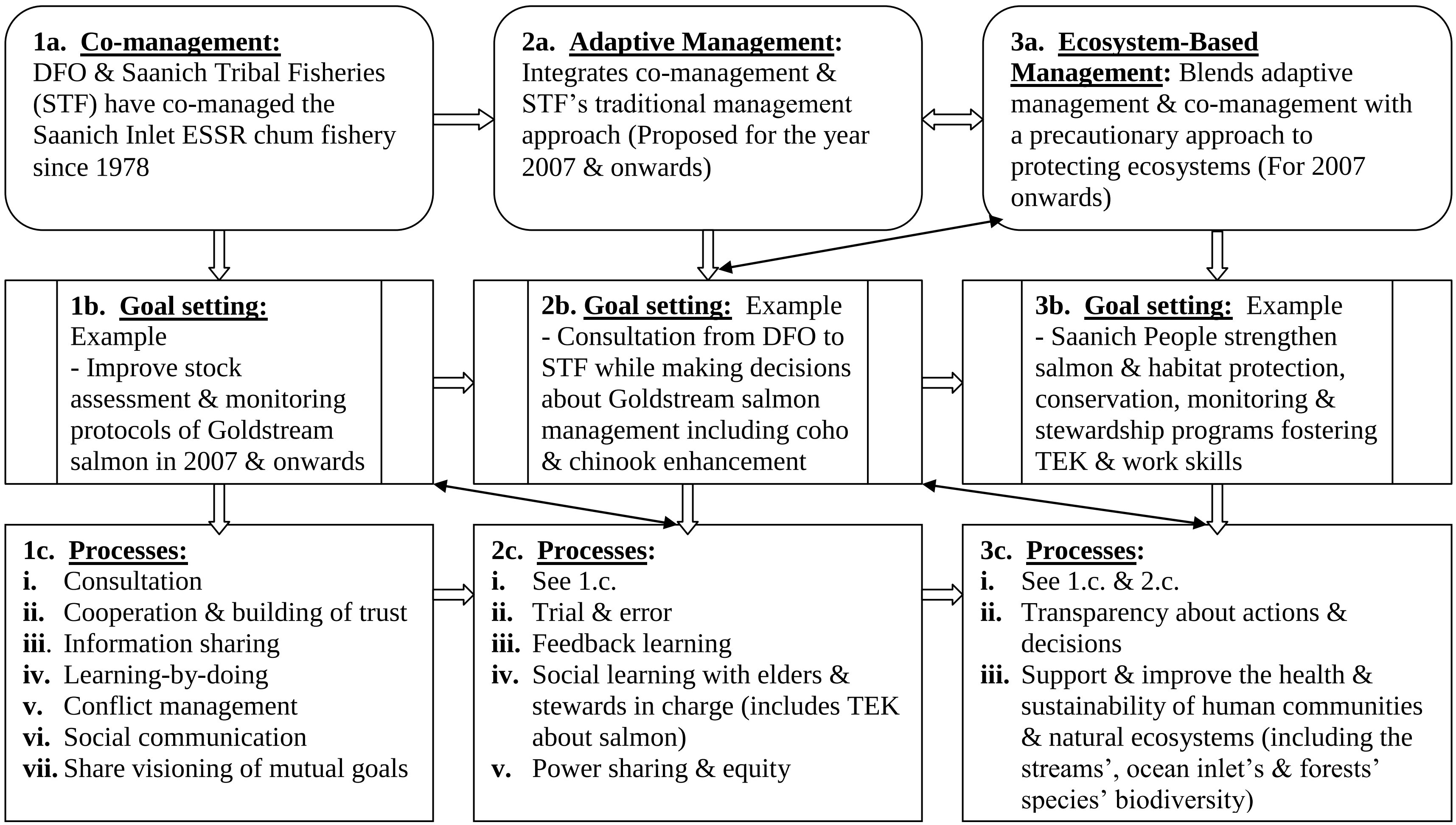
crew). The extent of CPUE depends in great part on how abundant the annual chum salmon run is at particular times when fishing occurs at particular fishing areas and how much effort the fishing vessel, captain and crew expend on fishing. Annual catch and effort data can assist with a posteriori accounting for costs of operating a fishing vessel during the fishing season. There was insufficient data to conduct a meaningful CPUE for Saanich Tribal Fisheries' ESSR chum fishery. Consistent annual data for monitoring salmon catch and fishing effort (e.g. reports of date, time, weather, accurate listing of location, tide, currents, net hours, numbers of fishers as well as gender, weight, number of chum and by-catch fish caught during each fishing trip) were missing for most years (1982 to 2004) for which there were records of Saanich Inlet ESSR chum catch. Recording and examining the abundance of (tagged and untagged) incidental coho and chinook bycatch caught during ESSR fishing trips in Saanich Inlet could also help with monitoring Goldstream coho, chinook and chum salmon stocks over time.

Integrated Fisheries Management of Goldstream Salmon Stocks

As noted in the results section, Saanich fishers expressed a number of concerns pertaining to salmon fisheries and conservation. Two of the main concerns were enhancement of salmon stocks at Goldstream River and lack of consultation from DFO regarding management decisions about Saanich peoples' traditional salmon resources. Councilors representing Saanich First Nations (or Saanich Tribal Fisheries) and DFO officers have worked together to negotiate license agreements for the ESSR chum fishery in Saanich Inlet and have co-managed this fishery since 1978. Given that a co-management work relationship already exists between these two bodies, the processes of consultation, cooperation and information sharing towards the mutual goal of improving stock assessments and monitoring protocols is certainly attainable through a more comprehensive co-management strategy that includes learning-by-doing (Berkes 1994). Conflict management or resolution (guiding conflicts towards constructive results) and social communication (creating meaning and enriching common knowledge in the face of change) are important features of any co-management endeavour (Borrini-Feyerabend et al. 2000:7-15) (Figure 7.2).

Learning-by-doing, collaborating and information sharing are active processes inherent to the adaptive management approach to fisheries management as well. In practice, the adaptive management approach should accommodate a mix of trial-and-error, feedback learning and social learning with elders and stewards in charge and would be designed to incorporate the traditional ecological knowledge of Saanich fishers, stewards and elders as in a traditional management system (Berkes 1999; Figure 7.2). In the adaptive management approach proposed in this model, Saanich People learn about the salmon resource from the perspective of their elders and gain cultural and ecological knowledge that is important for protecting their salmon and salmon fisheries. I propose this approach because I believe it would allow Saanich Tribal Fisheries to continue with and advance current fisheries projects while returning to the original concept upon which the council was founded: to gather together with elders, community leaders and stewards

Figure 7.2 Co-Management, Adaptive Management, First Nations' Traditional Resource Management and Ecosystem-Based Management for Goldstream Salmon Stocks Monitoring, Assessment and Management (Berkes 1999; Borrini-Feyerabend et al. 2000; CIT 2001)



of the lands and waters to discuss and work towards solving fisheries issues that arise within the community (Bartleman J. pers. comm. 2002).

Saanich fishers' concerns about a lack of meaningful consultation by DFO regarding decisions about salmon resources (including hatchery enhancement of coho and chinook stocks at Goldstream River) can be communicated with the knowledge and confidence that power-sharing and equity in the adaptive management approach of their fisheries is expected (Figure 7.2). In this schematic model, stakeholders[42] ultimately work collaboratively to collect data, monitor and assess naturally spawned and hatchery-enhanced salmon stocks returning to Saanich Inlet feeding grounds and Goldstream River spawning grounds.

Ecosystem-based management embraces adaptive management as well as some of the attributes of co-management such as transparency and willingness of each party to accept the others' philosophies (e.g. DFO accepting Saanich peoples' traditional ecological knowledge and fisheries management practices and Saanich People being open to considering science-based management recommendations). It has the additional goal of maintaining spatial and temporal characteristics of ecosystems such that component species and ecological processes can be sustained (CIT 2001); promoting restoration of the Goldstream salmon species to their most common, healthy or sustainable abundances over time, for example. Ecosystem based management also mandates that human well-being be supported and improved (CIT 2001) (Figure 7.2). For example, Saanich communities would continue benefiting from the development of

[42] Stakeholders: Those who have an interest in a particular decision, either as individuals or representatives of a group. This includes people who influence a decision or can influence it as well as those affected by it (Stakeholder Forum for Our Common Future 2002).

stewardship and monitoring programs including training and employment opportunities that are funded by the profits from the ESSR chum harvest sales. As illustrated in Chapter 4, a precautionary approach to fisheries management is often incorporated with ecosystem-based fisheries management (CIT 2001; First Nation Panel on Fisheries 2004; Larkin 1996; Olsson and Folke 2001). Precautionary measures for Goldstream salmon may include, for example; refraining from enhancing a population at levels not previously documented when its long term effects on an ecosystem are unknown; and prohibiting the harvest of stocks thought to be of concern due to declining numbers even if exact population parameters are unknown.

CHAPTER 8 – RECOMMENDATIONS AND CONCLUSIONS

8.0 Recommendations

Observations of aquatic changes and environmental impacts such as reductions or changes to the width of Goldstream River and its tributaries, reduced number and quality of streams flowing into Saanich Inlet and the onset of pollution in the inlet since the 1950s need to be documented and considered along with monitoring of fluctuations of escapement and total catch of coho, chinook and chum salmon at these sites over time. This will improve existing monitoring protocols, which to date only account for total abundance (i.e. catch and escapement) of salmon stocks. As it is difficult and probably impossible to accurately predict annual returns of chum, a good precaution would be to ensure a safeguard of 1,000 to 3,000 chum escapements beyond the current annual target goal of 15,000 chum. This will help with sustaining the next generations of wild chum stocks. Adding a moderate buffer to the existing target escapement of chum would increase the amount of nutrients entering the ecosystem for organisms (such as mink) and microorganisms (such as bacteria) that feed upon salmon and salmon carcasses. Increasing the abundance of chum salmon carcasses in the river would also increase the amounts of the element nitrogen entering the ecosystem[43], which in turn promotes the growth of plants and trees in the Goldstream River riparian zone (Helfield and Naiman 2001; Reimchen 2003). Promoting the growth of plants such as common lady fern (*Athyrium filix-femina [L.]Roth*) and deciduous trees such as red alder (*Alnus rubra*) along the Goldstream River streambanks (Bocking et al. 1998) reduces stream

[43] In the cycling of nitrogen, microorganisms feed on the flesh of decaying salmon or salmon carcasses, processing the nitrogen as they feed and releasing it when they die so that the nitrogen is transported through the river water, riverbed, streambanks and riparian zone soils and made available for uptake by grasses, plants, shrubs and trees (Reimchen et al. 2003).

bank erosion, which can lead to siltation and suffocation of fertilized salmon eggs. Growth of plant and tree foliage along the streambanks of salmon spawning waters also provides shade and refuge for salmon, especially coho, which prefer cooler, shadier waters. Shading from streamside vegetation also prevents stream waters from overheating which can lead to salmon mortality (Michalski et al. 2000; Slaney and Martin 1997).

For future analyses, protocols for counting and assessing returning salmon could be improved by modifying the stream survey methodology to incorporate records of physical characteristics of salmon such as gender, length, width, girth and weight as well as morphological indicators of health (such as open wounds, scars or disfigurations) and spawning behaviour to accompany the escapement data and current stream survey reports. This additional assessment would allow more effective identification of changes to the morphology and health of returning salmon over time, contributing to more refined baseline information for future decision-making regarding conservation of Goldstream salmon and salmon habitat. This might include decisions to curb fishing effort of certain stocks and restore or enhance spawning, rearing and feeding habitat. In addition, annual assessment of the stomach contents of deceased coho, chinook and chum salmon could provide an indication of the main prey of Goldstream salmon (e.g. shrimp, herring or other species they may have consumed from Saanich Inlet). Such studies could also determine whether or not one species (e.g. coho) is out-competing another species (e.g. chum) for the same limited food resources (e.g. nearshore herring and shrimp). Together with escapement data (annual abundance of returning stocks), this information could improve our current understanding and management of the Goldstream salmon stocks.

Additionally, repeated seasonal monitoring of salmon redds dug by each of the three salmon species spawning at the river over time would assist in gauging whether (enhanced) coho and chinook stocks are impacting or outcompeting natural chum populations at this site. The Saanich fishers believe this to be the case.

People of the Saanich First Nation communities should be consulted and invited to participate with drafting, coordinating and implementing these and other proposed changes that may occur to the current Goldstream River escapement enumeration and monitoring procedures. I suggest that monitoring efforts employed by Saanich Tribal Fisheries for recording total catch of Saanich Inlet chum could be improved if variables for catch and effort such as time, date, number of fishers, net hours, weight of salmon caught, bycatch, weather conditions, tides, currents and nautical chart or geographical positioning system coordinate readings of areas where fishing effort occurred were tabulated for each fishing event.

Further communication and consultation about the issue of mixed salmon stock management and the coho and chinook stock enhancement occurring at Goldstream River are required in order to address Saanich fishers' concerns with DFO fisheries management. Specifically, the Saanich are concerned that their traditionally important chum populations are being eclipsed by the enhanced coho and chinook. Studies monitoring for interspecies competition over spawning habitat at Goldstream River may clarify whether or not enhanced coho and chinook stocks place additional competition or stress on the naturally occurring chum population and/or between each of the enhanced stocks. Studies assessing relationships between coho, chinook and chum escapements at the river and availability or abundance of food prey in Saanich Inlet within the same fishing season may be helpful for determining whether enhanced coho and chinook stocks place additional competition or stress upon chum at Saanich Inlet feeding grounds. Saanich fishers deliberately restrained from exercising their traditional fishing rights during times when coho stocks were replenishing which provided Goldstream coho stocks a chance for natural, undisturbed regeneration over time and undoubtedly helped increase coho populations. This type of fisheries management practice could replace salmon enhancement as a coho and chinook population conservation and regeneration strategy.

DFO's decision in 2002 to allow priority to a non-First Nations commercial chum fishery in Saanich Inlet before either the Cowichan or Saanich Peoples' chum fisheries had begun, compromised and limited Saanich and Cowichan Peoples' access to their own natural and economic resources (Table 6.1). Though this decision occurred only for the 2002 salmon fishing season, it was one that was contrary to the constitutional rights of First Nations to have first priority over the Food, Social and Ceremonial fisheries (once conservation objectives have been addressed) as established in the *R*. vs. *Sparrow* case (DFO 2000a; Supreme Court of Canada 1990). This issue is complex and calls for open, trilateral discussion among the three parties concerned: DFO, commercial harvesters, and Saanich Tribal Fisheries. The management model I proposed in Figure 7.2 includes goals and processes for addressing issues and conflicts among parties with common interests in Goldstream River (and Saanich Inlet) salmon. This framework integrates adaptive management, co-management, traditional management and ecosystem-based management approaches. Processes include consultation, learning-by-doing, collaborative decision-making, a precautionary approach and flexibility with environmental and cultural changes in the monitoring, assessment and management of salmon stocks.

Recording CPUE variables such as time, date, total number, sex and weight of salmon caught (including any bycatch fish), weather conditions, tide, currents, number of net hours, type and number of fishing vessels and number of fishing crew members on board each vessel each fishing season would allow Saanich Tribal Fisheries to consider what their annual catch and profits are in relation to effort and costs expended in the ESSR chum fishery in Saanich Inlet over time. It would also be advantageous if the captain and crew operating the ESSR fishery vessel in Saanich Inlet accurately recorded the specific location, parameters (i.e. longitude and latitude, or Geographic Positioning System [GPS] coordinates) and water depth in which salmon were caught alongside the variables required for complete CPUE analyses over time as these data could be used to identify and track specific locations where the greatest abundance of salmon were fished in the past (e.g. over a five-year period). This would enable rotation of fishing pressure by seine and trolling vessels from heavily fished to less frequently fished areas and allow Saanich Inlet's ecosystem resources time to recover from the continuous, annual commercial troll and seine chum salmon fishing activities. Three-to five-or even ten-year rotations of fishing effort in fishing areas of Saanich Inlet along with the proposed 16,000 to 19,000 chum target escapement at Goldsteam River could also assist with preventing chum in Saanich Inlet from becoming overfished over the long term.

The Saanich Inlet ESSR chum fishery enables Saanich Tribal Fisheries to train and pay workers to work as guardians and surveyors. As noted in the discussion about costs and benefits of running a fishing vessel (Chapter 6), however, the work and income from the fishery is unstable. If a ten-year average of profits (e.g. 1995 to 2005 ESSR profits) were assessed, then a fixed annual fund could be put aside for training and employing guardians, surveyors and stewards. In addition, a monitoring program could be put in place that would allow individuals in the community to train and work at those jobs on a regular, annual basis (e.g. four months a year full-time and four to eight months a year part-time).

Saanich people are not fishing Saanich Inlet or Goldstream River with their families as much now as they did in the past. To remedy this, a portion of profits from the ESSR fishery could be allocated to sponsoring Saanich First Nations guided educational field trips to Goldstream River and Saanich Inlet to teach traditional fishing methods to children and adults interesting in learning about Saanich fishers' cultural ways, traditions, and heritage. Alternatively, ESSR funds could be put aside to sponsor and provide an incentive for families to participate in guided family fishing excursions to Saanich Inlet and Goldstream River. Finally, external funding is advisable for projects and jobs that facilitate monitoring of Goldstream salmon stocks, restoring and stewarding Goldsteam's tributaries, the other creeks running into Saanich Inlet and the wetlands of the Goldstream riparian zone, as well as for addressing and monitoring the problems with pollution in Saanich Inlet. Funding from external bodies such as DFO, the BC Ministry of Agriculture, Food and Fisheries or non-government environmental organizations such as the David Suzuki Foundation or the Sierra Club of BC would help

Saanich Tribal Fisheries and the Saanich People with carrying forward those jobs and projects in years when the ESSR fishery has poor profit margins or deficits or in the event of a 10-year lull in the ESSR fishery occurring, for example. This is a timely recommendation since DFO and Saanich Tribal Fisheries recently negotiated that 20% of the ESSR chum fishery in Saanich Inlet will be opened up and allocated to commercial fishers from outside the Saanich or Malahat First Nation (Jacks V. pers. comm. 2004).

8.1 Conclusions

More complete counts and assessments of returning salmon during escapement surveys can effectively contribute to improving monitoring protocols for Goldstream salmon. The baseline of data available about coho, chinook and chum abundance in Goldstream River spans a period of 73 years (1932 to 2004), and is useful for showing trends in changes in abundance of each of the three salmon species over this time period. These data are also useful when applied as a tool for measuring, monitoring and benchmarking ESSR and FSC chum fishing activity in Saanich Inlet. When used together escapement data (from 1932 to 2004) and native harvest statistics (from 1978 to 2005) can provide supporting information for determining whether chum fishing activity should be increased, decreased, or remain more or less constant in a five year life-cycle following a given escapement year. For example, if chum populations were below 15,000 in 2004, then fishing activity should be monitored so that a minimum of 15,000 chum make it through Saanich Inlet to Goldstream River in the 2009 salmon spawning cohort.

Salmon are an important indicator species for the Goldstream River and Saanich Inlet ecosystems and are culturally and economically important to the Saanich First Nation peoples. This research provides concrete suggestions based on interviews and documenting knowledge and perspectives of Saanich fishers, as well as examining existing population data and monitoring protocols for the three salmon species frequenting Saanich Inlet and spawning at Goldstream River (coho, chinook and chum), for improving the processes and effectiveness of monitoring, assessing and managing these stocks. Given that Saanich peoples have relied on salmon of Saanich Inlet and Goldstream River since time immemorial, probably thousands of years, and given that they have rights to fish these salmon as defined in the Canadian Constitution, they need to be even more closely involved as participants in monitoring, management and decision-making protocols affecting the salmon and their fisheries. Accordingly, I have presented in this thesis several recommendations that will improve their overall participation in salmon management. Ultimately, the addition of the Saanich fishers' knowledge and cultural practices to a true co-management situation will benefit the salmon populations and their habitats as well as the health and well being of the Saanich people.

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Appendix A - Glossary of Specialized Terms Used in This Thesis

1. Terms Relating to Salmon

Carrying Capacity: The maximal population size of a given species that an area can support without reducing its ability to support the same species in the future.

Catch-per-unit-effort: The catch of fish in numbers or in weight, taken by a defined unit of fishing effort.

Deme: Reproductive or breeding unit (spawning site) comprised of individuals who are likely to breed with each other (i.e. well mixed). A single population may include more than one deme and demes may be partially isolated from one another. Their partial isolation may or may not be persistent over generations. There will always be at least as many demes as populations.

Escapement: The quantity of sexually mature adult salmon (typically measured by number or biomass) that successfully pass through a fishery to reach the spawning grounds.

El Niño: El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe.

Enhancement: The application of biological and technical knowledge and capabilities to increase the productivity of fish stocks. It may be achieved by altering habitat attributes (e.g., habitat restoration) or by using fish culture techniques (e.g., hatcheries, production spawning channels).

Hatchery Salmon: A salmon whose parents were born in a hatchery or a salmon that has spent a portion of its life cycle in an artificial environment; Any salmon incubated or reared under artificial conditions for a part of its life. This definition does not distinguish between a salmon one generation removed from the wild and a salmon whose parents were highly domesticated products of the hatchery.

Native Harvest Statistics: Counts or estimates of the number of animals by category taken by a specific group of native people during a specific time period

Natural Salmon: Any salmon produced in the natural environment as a result of natural reproduction. A natural salmon could be wild (see definition below) or it could be the progeny of hatchery parents that spawned in the natural environment. It is impossible to distinguish a natural and wild salmon by field observation alone.

Population: Group of interbreeding salmon that is sufficiently isolated from other populations so that there will be persistent adaptations to the local habitat.

Salmonid: Fish of the family Salmonidae, including salmon and steelhead.

Spawner: Sexually mature individual, either male or female.

Stock: A group of salmon spawning in a specific stream at a specific season, which do not interbreed to a substantial degree with any other group of salmon. Several stocks linked by a low level of straying may constitute a metapopulation.

Wild Salmon: A salmon whose parents have spawned in the wild and has spent its life in the natural environment; Any naturally, spawned salmon belonging to an indigenous population. Indigenous means a population whose lineage can be traced back to 1800 in the same geographical area or that resulted from natural colonization from another indigenous population. This is a difficult definition to apply since we do not have continuous records of salmon populations going back to the 1800s. Its application is more appropriate in defining what is not wild rather than what is wild. For example, a hatchery salmon population introduced recently by humans to a creek would not be considered wild. Where there is doubt, a population should be considered wild unless there is clear proof that it is not.

1. Hydrology Terms

Cascade Habitat: A series of small steps, slides or falls characterized by a step height, <1m, 5-60º gradient and strong currents.

Glide Habitat: Shallow, slow flowing water section characterized by < 0.1m depth, 1-3º gradient, small currents and an unbroken and smooth waters surface.

Pool: A deep body of still or slow moving water, generally occurring in the main channel in an alternating sequence with riffles or runs. Pools are characterized by a depth >0.5m,where the stream widens or deepens and the current declines.

Reach: A homogeneous segment of a drainage network characterized by uniform channel pattern gradient, substrate and channel confinement.

Riffle Habitat: Shallow area of a stream, often separating pools, characterized by 0.1-0.3m depth, 1-3º gradient, moderate currents and an unbroken/unsmooth water surface.

Definitions adapted from: Brannon et al. 2005; Daily and Ehrlich 1992; Independent Scientific Group 1996; Lichatowich 2001; NOAA 2004, 2006; Northern Territory Department of Infrastructure, Planning & Environment 2005; Ricker 1972; Slaney & Zaldokas 1997; State of Oregon 2000; State of the Salmon Consortium 2006; Usher & Wenzel 1987; Waples 1991.

Appendix B - Summary of Habitat Descriptions of Reaches 1 to 3 Goldstream River, Salmon Escapement Enumeration Survey Area (Modified from Bocking et al. 1999.)

Habitat Descriptors	Reach 1	Reach 2	Reach 3	Total Reaches 1-3
Total Area (Reach length x Avg. bankfull width)	16,275 m^2	20,828 m^2	9,261 m^2	Range = 46,364 – 45,846 m^2 = 518 m^2; Mean = 46,105 m^2
Reach Length	930 m	1,270 m	630 m	2,830 m
Gradient	1.2%	1.4%	1.7%	Average = 1.4%
Salmon Habitat Length	735 m	1,327 m	564 m	2,626 m
Habitat Types (See Appendix B)	71.8% glide, 23.7% riffle, 4.5% pool	38.6 % glide, 54.8 % riffle, 6.6% pool	36.5% glide, 52.2% riffle, 8% pool, 3.2% cascade	Average = 49 % glide, 43.6 % riffle, 6.4% pool, 1% cascade
Average Bankfull Width	17.5 m	16.4 m	14.7 m	Average = 16.2 m
Average Wetted Width	12.7 m	11.7 m	13.4 m	Average = 12.6 m
Salmon Rearing Habitat Area (Habitat length x bankfull width)	12,255 m^2	21,763 m^2	9,261 m^2	Range = 45,846 m^2- 43,279 m^2= 2,567 m^2; Mean = 44,563 m^2
Average Water Depth	0.5 m	0.7 m	0.6 m	Average = 0.6 m
Volume of Salmon Habitat Waters (Salmon Habitat Length x Avg Bankfull Width x Avg Water Depth)	6,431 m^3 = 6,431,000 L	15,234 m^3 = 15,234,000 L	4,975 m^3 = 4,975,000 L	Range = *26,640* – 25,525 m^3 = 1,115 m^3; Mean = 26,083 m^3 = 26,083,000 L
Overall Spawning Gravel Quality	Good – 9% low, 64% medium, 27% high quality	Fair – 31% low, 59 % medium, 10% high quality	Fair – 38 % low, 56 % medium, 6 % high quality	Fair/Good- 26 % low, 60% medium, 14 % high quality

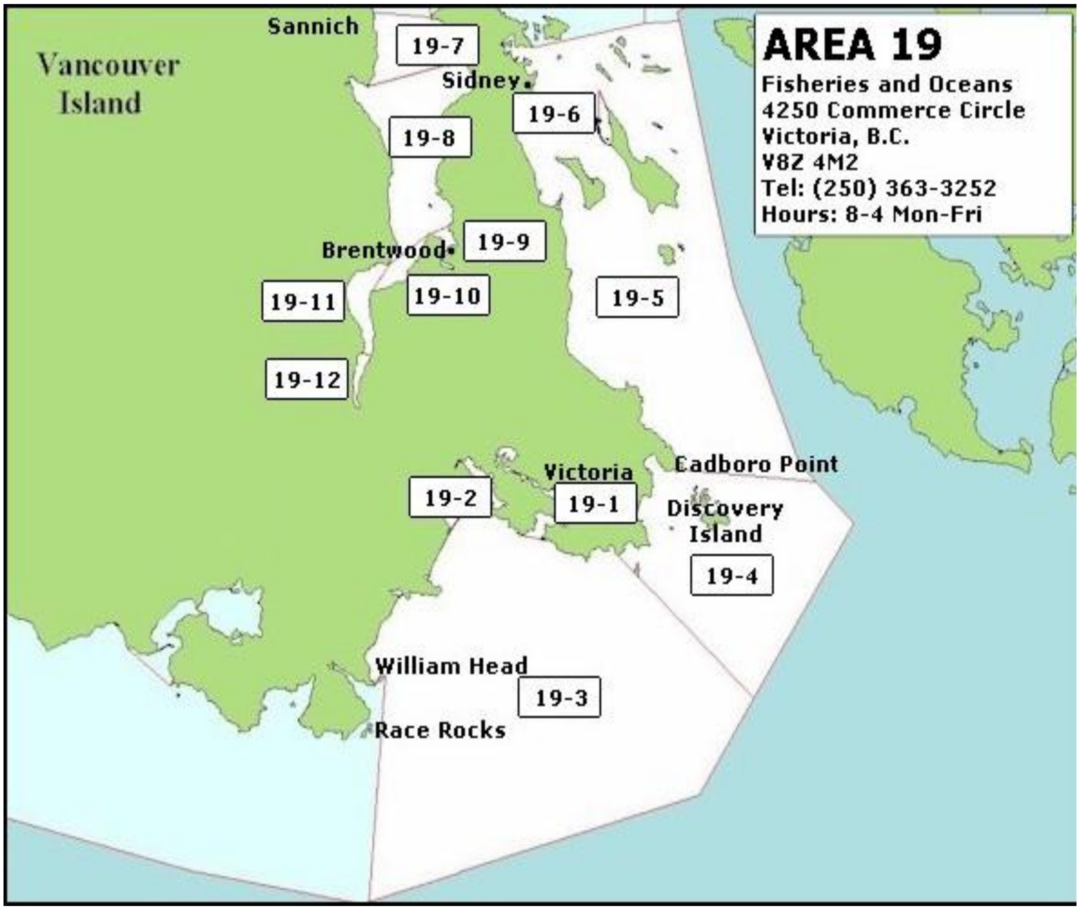
Appendix C - Common, Scientific and Saanich Language Names for BC Salmon Species (Baxter 2000; Claxton and Elliott 1994)

Common Name	**Vernacular Names**	**Scientific Name**	**Saanich Language Name** [i.]
Coho	Bluebacks, Silver	*Oncorhynchus kisutch*	ȾÁ,WEN
Chinook	Spring, King, Tyee	*O. tshawytscha*	STOKI
Chum	Dog, Calico	*O. keta*	QOLEW̱
Sockeye	Sukkai, Red	*O. nerka*	ȾEḴI
Pink	Humpback	*O. gorbuscha*	HENNEN

[i.] Saanich language salmon species names sourced from: Claxton, Earl Sr. and Elliott, J. Sr. 1994. *Reef Net Technology of the Saltwater People*. Brentwood Bay: Saanich Indian School Board.

Appendix D - Fishing Management Area 19 (Saanich First Nations' Fishing Area)

18.6 (located southwest of Pender Island)



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(DFO 2005b: online)

<u>Appendix E</u> - Saanich First Nation Fisher Interviewees

Bartleman, Joe. Tsartlip Elder. Goldstream River and Saanich Inlet fisher. Personal Interview. Standardized Survey Instrument. *Saanich Tribal Fishery Interview Questionnaire Transcript: Historical and Current Fishing Methods and Practices (at Goldstream River and Saanich Inlet).* 10 December, 2002. 848 Stelly's Cross-Road, Brentwood Bay, Saanich, BC.

Claxton, Earl. 2002. Tsawout. Cultural Historian and Researcher, Saanich Indian School Board. Goldstream River and Saanich Inlet fisher. Personal Interview. Standardized Survey Instrument. *Saanich Tribal Fishery Interview Questionnaire Transcript: Historical and Current Fishing Methods and Practices (at Goldstream River and Saanich Inlet).* 22 July, 2002. Language Centre – 7449 West Saanich Road, Brentwood Bay, Saanich, BC.

Cooper, Emmanuel. 2002. Tsartlip Elder. Goldstream River and Saanich Inlet fisher. Personal Interview. Standardized Survey Instrument. *Saanich Tribal Fishery Interview Questionnaire Transcript: Historical and Current Fishing Methods and Practices (at Goldstream River and Saanich Inlet).* 29 August, 2002. 7543 West Saanich Road, Brentwood Bay, Saanich BC

Elliott, John. 2002. Tsartlip. Linguist and Cultural Historian, Saanich Indian School Board. Goldstream River and Saanich Inlet fisher. Personal Interview. Standardized Survey Instrument. *Saanich Tribal Fishery Interview Questionnaire Transcript: Historical and Current Fishing Methods and Practices (at Goldstream River and Saanich Inlet).* 18 Sept., 2002. Language Centre. 7449 West, Saanich Road, Brentwood Bay, Saanich, BC.

Morris, Ivan Sr. 2002. Tsartlip Elder. Goldsteam River and Saanich Inlet fisher. Personal Interview. *Standardized Survey Instrument. Saanich Tribal Fishery Interview Questionnaire Transcript: Historical and Current Fishing Methods and Practices (at Goldstream River and Saanich Inlet).* 7 Aug., 2002. 45 Tsartlip Drive, Brentwood Bay, Saanich, BC.

Morris, Sandy. 2002. Tsartlip Elder. Goldstream River and Saanich Inlet fisher. Personal Interview. Standardized Survey Instrument. *Saanich Tribal Fishery Interview Questionnaire Transcript: Historical and Current Fishing Methods and Practices (at Goldstream River and Saanich Inlet).* 7 August 2002. Church Road, Brentwood Bay, Saanich.

Smith, Simon. 2002. Tsartlip Band Chief. Goldstream River and Saanich Inlet fisher. Personal Interview. Standardized Survey Instrument. *Saanich Tribal Fishery Interview Questionnaire Transcript: Historical and Current Fishing Methods and Practices (at Goldstream River and Saanich Inlet).* 30 October, 2002. Tsartlip Band Office. Stelly's Cross-Road, Brentwood Bay, Saanich, BC.

University of Victoria

Appendix F - University of Victoria Human Research Ethics Committee Certificate of Approval for Research and Other Activities Involving Human Subjects

University of Victoria - Human Research Ethics Committee

Certificate of Approval

Principal Investigator	Department/School	Supervisor
Roxanne Paul **Graduate Student**	**GEOG/ENVI**	**Dr. Michael Edgell** **Dr. Nancy Turner**

Co-Investigator(s):

Krista Roessingh, Undergraduate Student, Uvic

Title: **Assessing Historical and Current Abnudancies of Coho, Chinook and Chum Salmon at Goldstream River**

Project No.	Approval Date	Start Date	End Date
045-03	**24-Feb-03**	**26-Jul-02**	**25-Jul-03**

Certification

This is to certify that the University of Victoria Ethics Review Committee on Research and other Activities Involving Human Subjects has examined the research proposal and concludes that, in all respects, the proposed research meets appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Subjects.

J. Howard Brunt
Associate Vice-President, Research

This Certificate of Approval is valid for the above term provided there is no change in the procedures. Extensions/minor amendments may be granted upon receipt of "Request for Continuing Review or Amendment of an Approved Project" form.

Office of Vice-President, Research - UVic
Room 424, BEC - P.O. Box 1700
Victoria, BC V8W 2Y2

Tel: (250) 472-4362
Fax: (250) 721-8960
E-mail: ovprrc@uvic.ca

045-03 Paul, Roxanne

Appendix G - Saanich Fisher Interview Participants Recruited by Peer Selection

Saanich Fisher Interviewee	**Referred By**	**Date Interviewed/Length of Interview**	**Location**	**Signed Letter of Consent**
Earl Claxton Sr.	Dr. Nancy Turner	July 22, 2002 & July 26, 2002. 2 hours.	Saanich Tribal Language Centre. 7449 West Saanich Rd.	Yes
Emmanuel Cooper	Earl Claxton Sr.	August 29, 2002. 1.5 hours.	7543 West Saanich Rd.	Yes
Ivan Morris Sr.	Emmanuel Cooper	August 7, 2002. 1.5 hours	45 Tsartlip Dr.	Yes
Sandy Morris	Ivan Morris Sr.	August 7, 2002. 1.5 hours.	Omitted at request of participant	Yes
John Elliott Sr.	Earl Claxton Sr.	September 18, 2002. 2 hours.	Saanich Tribal Language Centre. 7449 West Saanich Rd.	Yes
Simon Smith	Emmanuel Cooper	October 30, 2002. 2 hours.	Tsartlip Band Office. 800 Stelly's Cross Rd.	Yes
Joe Bartleman	Earl Claxton Sr.	December 10, 2002. 3.5 hours.	848 Stelly's Cross Rd.	Yes

<u>Appendix H</u> - Interview Survey Guidelines and Questionnaire for Interviewing Saanich First Nation Fishers

<u>Re</u>: *Assessing Historical and Current Abundances of Coho, Chinook and Chum Salmon at Goldstream River*

Some of the topics to be discussed with you (the participant) are:

- Your fishing experiences at Goldstream: practices, protocols, traditions
- Your opinions about the different species of salmon (populations) that inhabit the Goldstream River
- Federal Fisheries restrictions and licenses
- Salmon lifecycles, optimal habitats
- Cultural importance of salmon to your people
- Importance of salmon to peoples' health
- Stories, or other information about salmon
- Learning about salmon; where did this knowledge come from?
- Opinions about hatcheries, fish farms, and wild salmon
- Your opinions about the current hatchery at Goldstream River.
- Your opinions about a potential future, Saanich, tribal chum hatchery at Goldstream River.

<u>Interview Questions</u>

1. Where/when were you born? Where did you grow up? What schooling have you had (Formal? Informal?)
2. How long have you been fishing?
3. Who taught you to fish? (Describe first fishing experiences)
4. What kind of fishing have you done?

5. Do you fish Goldstream River? (Yes, No, Sometimes, Have in the Past, My friends/relatives did)

6. Where at Goldstream River do you fish? (Did you fish at the mouth, estuary? Other? Saanich Inlet?)

7. What kind of fish have you caught at Goldstream River?

a.) Do you currently fish chum at Goldstream River?

b.) If yes, at what times of the year do you fish? How often do you make fishing trips? (e.g. ten times a month, 6 months a year)

c.) If yes, approximately how long is each fishing excursion you make (e.g. 6 hours a day)?

d.) What kind of fishing gear and equipment do you currently use to fish chum (and/or other stocks)? (What kind of methods and technologies do you use to fish?) Do you use a boat? What type of boat? Speed of boat (HP)? Cost of boat and boat maintenance costs? Gas costs? (*Relates to CPUE Analysis component of study.)*

e.) What is the relative size of the chum salmon that you catch at Goldstream? (e.g. Relative to past fishing experiences fishing chum? Length & width in feet or metres, weight in pounds or kilograms – current & past chum catches?) Catch male? Female? Or both?

f.) What is the relative condition of the chum that you catch at Goldstream? (e.g. Relative to past fishing experiences fishing chum? Are they hatchery or naturally spawned - was a clipped adipose fin noted? Healthy in size and configuration? Discoloured?)

g.) What is the approximate annual cost (in dollars) accrued to you in maintaining your current (chum) fishing practice (e.g. in modern fishing gear expenses, etc?)

h.) Do you keep record or inventory of how many chum and/or other salmon stocks you catch at Goldstream River when you fish?

i.) If so, can you tell me how, and why?

8. How many fish are caught per family per year (approximately)?

9. How are these fish processed?

10. Can you tell me a bit about your recollections of populations of fish: Good

years? Bad years? Fisheries restrictions?

11. Can you tell me a bit about your early memories about fishing, or about stories from the past you've heard from your parents, grandparents and others?

12. How important do you think salmon species diversity is for the Goldstream River system? (In your opinion, are the currently abundant chum - the threatened, but hatchery enhanced coho and chinook – and the less abundant sockeye and pink salmon species of equal value to the Goldstream River ecosystem?)

13. What do you think about the success of hatcheries and salmon enhancement? (Do you think current Federal salmon fisheries conservation management at Goldstream River is proper? Effective? Appropriate?)

a.) Did you fish coho prior to the coho enhancement initiative at Goldstream? (e.g. prior to establishment of the hatchery in 1982? Prior to incubation box culturing of coho at Goldstream in 1974?)

b.) Do you remember what the relative size of coho salmon that you (or your relatives or friends) caught at Goldstream River was? (e.g. Length & width in feet or metres, weight in pounds or kilograms?)

c.) Do you remember what the relative condition of coho salmon that you caught at Goldstream River was? (e.g. Were they hatchery or naturally spawned - did you note a clipped adipose fin? Healthy in size and configuration? Discoloured?)

d.) Do you remember what the relative size of chinook salmon that you caught at Goldstream River was? (e.g. Length & width in feet or metres, weight in pounds or kilograms?)

e.) Do you remember what the relative condition of chinook salmon that you caught at Goldstream River was? (e.g. Were they hatchery or naturally spawned - did you note a clipped adipose fin? Healthy in size and configuration? Discoloured?)

14.) Did your elders fish salmon at Goldstream River?

a.) If so, can you tell me approximately how long ago (in years), and how often (in months, weeks, days, hours)?

b.) If yes, can you tell me what methods and technologies (fishing gear and equipment) your elders used when fishing chum (coho, chinook) and other salmon stocks? (e.g. stakes luring, reef net fishing?)

15.) Did they keep any (historical) records of the quantity and species of salmon they fished?

a.) If so, how?

16.) Are you interested in the idea of compiling historical records of fishing practices employed by the Saanich First Nations fishers of Goldstream River?

17.) Any other information you would like to share?

(These interview questions are drafted for the purposes of gathering knowledge and information held by the Saanich First People's fishing community fishing salmon at Goldstream River and Saanich Inlet.)

<u>Appendix I</u> - Letter of Understanding Between Roxanne Paul and Fisheries and Oceans Canada

Date: Tue, 23 Jul 2002 11:11:48 –0400
From: MacDonaldRobe@pac.dfo-mpo.gc.ca
Subject: Goldstream River Salmon Study
To: rpaul@office.geog.uvic.ca

Roxanne:

Please consider this a letter of understanding between yourself and

the Dept. of Fisheries and Oceans. You may carry out your fish counts and

research, utilizing all areas, including the lower reaches of Goldstream.

Periodic up dates to this office on fish counts and a summary of your total

counts would be greatly appreciated by this office.

They can run, but they can't hide!

Robert (Bob) MacDonald / K-9 Chrissy
Fishery Officer/Dog Master
Victoria Field Unit
tel: 250-363-3252
fax:250-363-0191
4250 Commerce Circle
Victoria B.C.
V8Z 4M2

Appendix J - Metadata for Goldstream Salmon Escapements (1932 to 2002)

The salmon population estimation codes used by field observers for Goldstream River stream inspection forms from 1932 to 1959 were as follows:

A=1-50 B=50-100 C=100-300 D=300-500 E=500-1000 F=1000-2000 G=2000-5000 H=5000-10000 K=10000-20000 L=20000-50000 M=50000-100000 N=Over 100000

In addition to these run size estimation codes, 'Size of Run' was described qualitatively with a category of Heavy ("HVY."), Medium ("MED.") or Light ("LT.") from 1932 to 1984 (DFO 1932-1984) in stream inspection logs. No alphabetic-numeric population estimation range was provided for coho, chinook or chum categories at Goldstream River for 1932, the first escapement year on file in BC 16 reports. The 1932 salmon runs were recorded using categories of Heavy (coho), Medium (chinook) or Light (chum) with notes indicating that each of the runs were similar compared to the brood year stock runs, which are neither available nor evidenced qualitatively or quantitatively within the BC 16 "Report on Salmon Stream" archival records. Size of run is interpreted as either light, medium or heavy as compared to the run size pattern(s) for that species from previous years. For example, a 'C` (Lt) run refers to the 100-300 range listed above and is recorded as 100, the number occurring at the lower end of the range. A medium (Med) run in the 'H' (5,000-10,000 range) is recorded as 7,500, the number falling within the middle of the numeric range, and a 'K' (10,000-20,000) heavy (Hvy) is entered as 20,000 at the higher end of the range. Upon inputting these data into Excel spreadsheets, I took measures to be as consistent as the data, and previous field observer(s)' recorded notes allowed. Data input consistency was achieved by comparing and verifying 'light', 'medium' and 'heavy' counts within each of the alphabetically coded numeric ranges recorded for each year against those recorded from each of the previous years (pattern recognition). This process enabled me to transfer the descriptive, interval data from BC 16 reports from the years 1932 to 1984 to numerical spreadsheet format. This in turn allowed for more consistent categorical population estimation, analysis and comparisons.

In most cases, (except 1941, 1945 and 1946), when I entered escapement data that had previously been recorded with coded numerical ranges (e.g. H=5,000-10,000) with a medium (Med.)'size of run', I input 7,500 chum into the spreadsheet cell, assuming the middle number of the 5,000-10,000 range to be the most appropriate estimate for the year. Exceptions to this rule were made if a specific number or note comparing the run size to either the previous year or the brood year (3 or 4 years prior) was logged alongside the alphabetic code. For example, the chum run for 1941 was recorded as H, a heavy run, Larger than 1937-38 brood year. As chum runs for 1937 and 1938 were both recorded as H medium runs, the middle, upper range of the 5,000-10,000 H category (midrange between 7,500 and 10,000) 8,750 was input for the 1941 Goldstream River chum escapement total.

There is no record of any sockeye escapements in BC 16 reports from 1932 to present. It was noted that there is "no record of pink frequenting this stream" in 1934 (BC 16, 1934). Light runs of pink salmon were recorded in the "A" estimate number range (1-50) for October of 1938 and 1939 (BC 16, 1938:1939). Data from stream survey reports indicate that no pink salmon stocks have been observed or recorded at

Goldstream River for any year after 1939. I input the Pink salmon data into an Excel worksheet for statistical analysis however these numbers are too low and infrequent to produce graphical output and therefore will not be presented with results.

Chinook counts first appeared in Goldstream River BC 16 logs under the Estimate Number code B (50-100 range), LT. (Light run size) in 1934. Specific chinook counts first appeared on record, with "Two fish spawning" observed on Oct 27, 1947. (DFO, BC 16 file, 1947). No numerical notes of more specific counts were provided for chinook from 1949-1961 (no data), 1962-1966 (A-range), 1968 (no data), 1976-1977 (A-range) and 1979 (A-range). A more exact quantity of chinook ("40 pcs.") is recorded on the 1967 stream log in the Comments category, and 30 were recorded for 1978. All observations of chinook recorded from 1934-1984 were categorized as light sized runs (Lt.). For years when no data were recorded in BC 16 records, I input "no data" into the Excel spreadsheet cells. More exact counts of chinook were consistently recorded on file from 1980-2002, which I logged into Excel spreadsheets for the purposes of conducting the chinook escapement population estimation and analyses.

From 1960 onwards, numerical field notes appear progressively more specific (e.g. 2,200 chum, 500 chum and 0 data for chinook recorded), with these more exact numbers accompanying the numeric range estimates logged in the 'Total Number on Grounds' box, or the 'Comments on any Other Conditions Affecting This Stream' section of the inspection sheet. This pattern continued with the exception of 1962 and 1963 coho, and chum counts. The alphabetic-numeric range codes were used to record 1962 and 1963 coho and chum total estimates, as well as 1972, 1974, 1975, 1976, and 1977 chum estimates. 1980-2002 BC16 Annual Reports of Salmon Stream and

Spawning Grounds for Goldstream River have total numbers of coho, chinook and chum logged in using these more precise numerical estimates.

Use of light, medium or heavy run size was completely eliminated as a descriptive variable for salmon stream and spawning grounds log inspection forms in 1985. Use of alphabetized coded ranges was also completely eliminated in 1985 (BC 16 Reports for Goldstream River, 1932-2002). This latter change in logging population estimates occurred following a five-year period from 1980 to 1985 during which time more specific, consistent, annual, numeric, on-site counts accompanied each alphabetic range value logged for each ensuing annual record (DFO BC 16 Reports for Goldstream River 1980-1985). This transition of record keeping format improved upon previous escapement monitoring protocols. Total escapement estimates based on the common inspection log forms used from 1932 to 1980 could (for example) demonstrate a range between as many as 20,000 and 35,000 chum for an ‘L’ (20,000-50,000) category, with a light (Lt) run size description. Use of specific ratio numeric estimates (as was done from 1980 to 2002) are probably more precise indicators of the returning population than the former interval alphabetic numeric range value format used for estimating salmon populations from 1933-1980 allowed. The more current ratio numeric data on record from 1980-2002 are a marked improvement from the first available record (1932) when nominal descriptive values of light, medium and heavy runs were the sole indication of salmon run size.

(N.B.: The chum run estimate for 1934 was also described using solely the nominal "medium" run size descriptive variable. A specific interval numeric value of 500 coho, and 0 observed chinook were also logged on file for that year.)

Stream inspection reports for Goldstream River first listed "Optimum Escapement" of Goldstream River coho (750), chinook (100) and chum (15,000) in 1985. There is no further listing for optimum escapement on stream inspection reports from 1985 to 1992. In 1993 and 1994, optimum escapement numbers for Goldstream River salmon stocks reappear as follows: coho (1000), chinook (500), chum (15,000). The 1998 DFO stream inspection form ("Annual Report of Salmon Streams and Spawning Populations") relays optimum escapement of coho at 4,000, with no optimum escapement logged for either chinook or chum stocks. This was the last account of "optimum escapement" reported and filed with Goldstream River BC 16 archives at the Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, BC, and 4250 Commerce Circle, Victoria, BC, Fisheries and Oceans Canada offices.

From 1994 to 2005, volunteers working with the Goldstream Hatchery have undertaken direct count surveys of Goldstream coho, chinook and chum and submitted observed live salmon escapement counts to Fisheries and Oceans DFO offices in Victoria and Nanaimo for their BC 16 files. The survey takes place from the mouth of the river (the estuary) to the hatchery fish counting fence, about 2.8 km upstream. Some of the current reports in BC 16 files are recorded via e-mail correspondence with DFO fishery officers.

Escapement data for Goldstream River (1953-1999) compiled by DFO may be accessed through the Fish Wizard website, jointly operated by DFO and the BC provincial government (Fish Wizard 2001).