Pacific Fisheries Resource Conservation Council

Pacific Salmon Resources in Northern British Columbia and Yukon Transboundary Rivers

.

Prepared by
Mark Johannes

January 2011
Issued January 2012

Pacific Salmon Resources in Northern British Columbia and Yukon Transboundary Rivers.

Mark R.S. Johannes

For quotes and short excerpts from the material covered under "fair use", we recommend the following citation: Johannes, Mark R.S. 2012. Pacific Salmon Resources in Northern British Columbia and Yukon Transboundary Rivers. Vancouver, BC: Pacific Fisheries Resource Conservation Council. 70p.

For further information about this document and about the Pacific Fisheries Resource Conservation Council (PFRCC), contact:
Pacific Fisheries Resource Conservation Council
1682 West 7th Avenue, Suite 303
Vancouver, BC, Canada V6J 4S6
Telephone 604 775 5621
Fax 604 775 5622
www.fish.bc.ca
info@fish.bc.ca

Printed and bound in Canada

Table of Contents

Executive Summary

This is the fifth report in a series on Pacific salmon resources by the Pacific Fisheries Resource Conservation Council (PFRCC) describing the current state and the ability to assess and understand the status of salmon resources in British Columbia, the Yukon and Arctic. This report examines the wild salmon in Canadian portions of northern BC and Yukon transboundary rivers and focuses on the: (a) Stikine River, (b) Taku River, (c) Alsek / Tatshenshini River, and (d) Upper Yukon / Porcupine rivers. Each of these watersheds comprises a portion of estuary and lower river within Alaska U.S. territorial boundaries with headwaters located in Canada. The Unuk, Whiting and Chilkat rivers are also briefly discussed in this report, but have limited Canadian based salmon resources and few ongoing monitoring and assessment programs in Canada.

Information presented in this report is derived from Fisheries and Oceans Canada (DFO) and Alaska Department of Fish and Game (ADF&G) salmon spawning, catch and stock assessment records, reports from the Transboundary Technical Committee (TCTR) of the Pacific Salmon Commission (PSC), the U.S. and Canada Yukon River Joint Technical Committee (JTC), the Pacific Scientific Advice Review Committee (PSARC), the Canadian Science Advisory Secretariat (CSAS), and published technical references and literature and online published sources. Cross border mark-recapture estimates, catch and spawning counts are used to examine Canadian based salmon population status and trends in abundance. Most of the data are reported as numbers of salmon spawning in Canadian river and streams and are based on mark recapture assessments, weir and fence counts and visual survey estimates where available.

Unlike many other regions of BC, estimates of salmon catch and escapement for the upper Yukon, Alsek, Taku and Stikine river systems are based on very consistent methods with long time series records for specific index sites (i.e., fence or weir locations). Assessment and monitoring programs have been maintained through agreement based on the Pacific Salmon Treaty (PST) between the governments and Canada and the U.S (Gov. Canada, Gov. U.S. 2006) and the Yukon River Joint Technical Committee (JTC). Single annual visual or aerial surveys are often used to index spawning salmon. In these instances, the accuracy of these estimates of escapement is often unknown between sites and years. Efforts have been made to use estimates in this report which have been reported and published and are comparable between survey methods and years, but variations in salmon numbers presented may be accounted for by several sources over time and space including: salmon returns, spawner abundance, fishing harvest effort, climate and local and regional effects in freshwater and coastal habitats or site conditions, and changes in annual assessment and survey methods used to determine catch and spawner abundance.

The estimates used in this analysis are limited to local and regional watershed trends in wild salmon resources in Canadian waters and are not intended to represent changes in salmon stock specific production related to survival and mortality trends among various life history stages of salmon (e.g. egg to fry survival, marine survival of adult salmon, migration survival to spawning adult salmon). In many instances, few estimates are available for both harvest and escapement to examine trends in all or even specific salmon populations and stream systems in the entire watershed. In recent years, cooperative management between the Alaska Department of Fish and Game (ADF&G) and Fisheries and Oceans Canada (DFO) through the Pacific Salmon Treaty

(PST), have created abundance based assessment programs intended to derive species specific whole watershed catch and escapement estimates which can form the basis to predict salmon production.

Public interest and discussion on wild salmon is often focused on conditions and situations that are considered detrimental to the survival and success of salmon species. Many populations of salmon face declines in their numbers or survival rates through pressures from water and land development, population growth, habitat disturbance and destruction, and more wide ranging issues including climate variation and change. As a species, salmon continue to represent an irreplaceable link to human culture and society on the west coast of Canada and the Pacific Rim, and still remain resilient and diverse. This report is a compilation of information to document the long-term status and current trends of wild Pacific salmon in northern BC and Yukon transboundary watersheds.

Stock Status Summary

Most salmon stocks within the watersheds described in this report can be considered healthy compared to many other regions of British Columbia. In the northern region as a whole there is a greater mix of those stocks doing well and maintaining their productivity versus those needing enhancement or recovery.

The Yukon and northern transboundary Canadian salmon stocks are managed under an agreement with the U.S. through the Pacific Salmon Treaty. The Pacific Salmon Treaty through the Pacific Salmon Commission created the Transboundary and Yukon River Panels to manage shared salmon stocks. The Yukon River and the Transboundary Panels are serviced by Joint Technical Committees as science advisory groups comprising Canadian (BC and Yukon) and the U.S. (Alaska) fisheries managers.

Under the Alaskan state fisheries management system, the Alaska Board of Fisheries (BOF) adopts fishing regulations and eleven Fish and Game Advisory Committees across the state provide local annual review and input. Under state and federal U.S. law, subsistence use has the highest priority among consumptive uses for salmon resources. The federal U.S. management system is focused on rural subsistence use, while the state continues to manage all fisheries on all waters, except for when and where federal rules supersede. Thus, management of salmon fisheries in the Yukon and northern BC transboundary areas includes coordinating efforts between the U.S. and Canada for stocks originating in Canada and between ADF&G and the federal government for regulation of fisheries in Alaska with two regulatory and advisory group systems.

The review of stock status information and management plans for Yukon and northern BC salmon populations undertaken for this report leads the author to make the following observations:

- A simplified management system would enable more effective management of salmon fisheries and Canadian salmon, and improve stock status in the Yukon, Alsek, Taku and Stikine river drainages.

- The salmon fisheries in the Yukon and northern BC transboundary rivers are adaptively managed annually through use of lower river terminal sampling methods and assessment techniques to manage salmon fisheries for surplus production and harvest, based on target escapements to entire basins or watersheds. Surveys are completed annually to define the extent of salmon distribution, habitat quality and habitat use to assess habitat or stock related trends and status. Salmon stocks are not managed to preserve genetic diversity.

- There is a strong influence from enhancement / sea ranching (hatchery) in many populations including coho, chum and pink salmon in southeastern (SE) Alaska. In some cases, greater than 40% of the Chinook, chum and pink salmon harvested in Alaska were salmon raised through Hatchery Cost Recovery. At the same time, harvest management has generally provided more effective and lasting recovery results than enhancement in most of the region.

- Pink salmon stocks are not effectively monitored.

- Steelhead salmon stocks are not at all monitored.

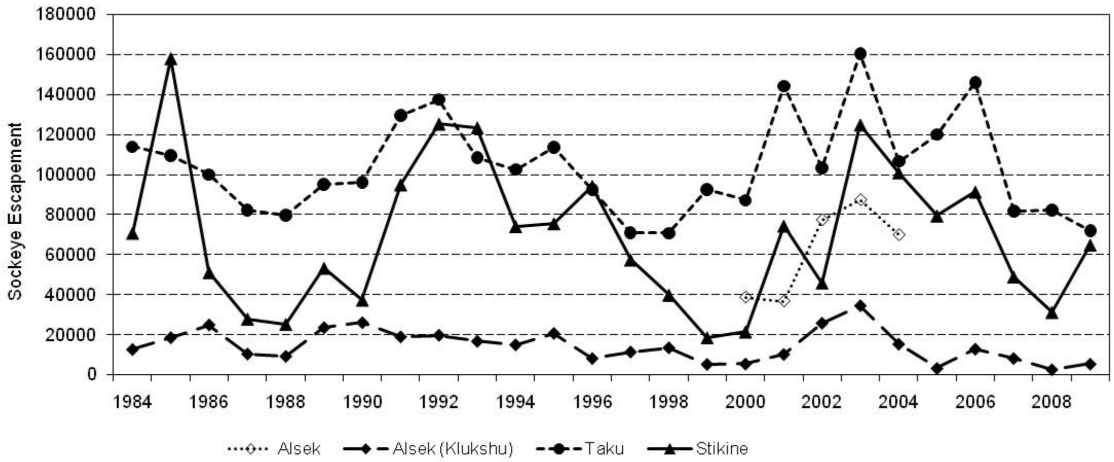
- There is limited scientific information, priority identification, or relevant information available to help protect the tranboundary region's most sensitive spawning and rearing salmon habitats and watersheds being exposed to major resource extraction project development and expansion – i.e. mining in Taku, Stikine, and Alsek, and placer mining regime in Upper Yukon, as well as hydro electric installations, coal bed methane projects, pipelines and transmission corridors.

- The conservation units and the profiles of genetic diversity and unique characteristics under Canada's Wild Salmon Policy continue to be poorly defined for many salmon species in Yukon and northern BC areas.

Data Summaries by Salmon Species

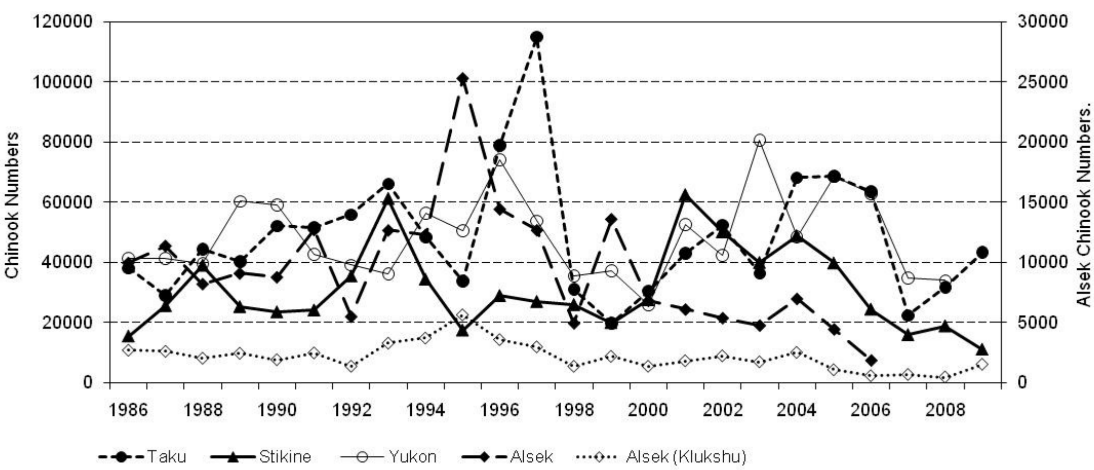
Sockeye salmon (*Oncorhynchus nerka*)

Figure A: Trends in whole system escapement or in-river abundance for sockeye salmon in northern BC and Yukon stocks.



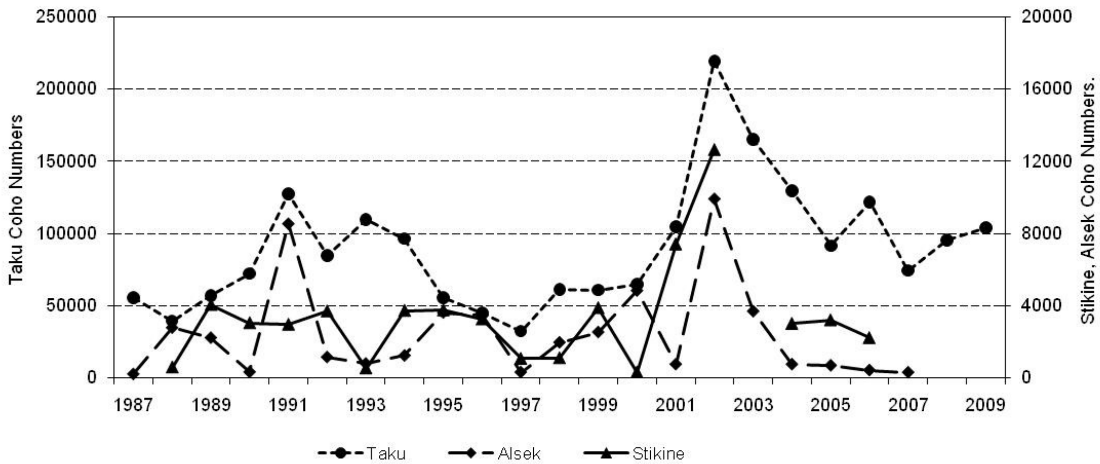
Chinook salmon (*Oncorhynchus tshawytscha*)

Figure B: Trends in whole system escapement or in-river abundance for Chinook salmon in northern BC and Yukon stocks.



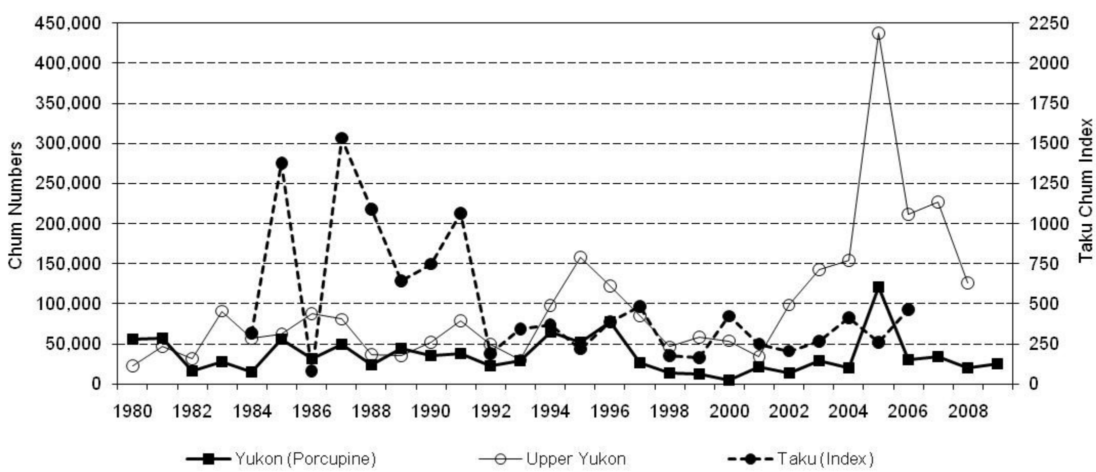
Coho Salmon (*Oncorhynchus kisutch*)

Figure C: Trends in whole system escapement or in-river abundance for coho salmon in northern BC and Yukon stocks.



Chum Salmon (*Oncorhynchus keta*)

Figure D: Trends in whole system escapement or in-river abundance for chum salmon in northern BC and Yukon stocks.



Introduction

The Pacific Fisheries Resource Conservation Council (PFRCC) has published four descriptions of Pacific salmon resources in: (a) southern BC (Fraser River, Strait of Georgia, west coast Vancouver Island and Okanagan River) (PFRCC 2002), (b) central BC north to the Nass River and Portland Canal (Riddell 2004), (c) Arctic BC and Yukon (Irvine et al. 2009), and (d) southern BC and the Fraser Basin (Labelle 2009). These reports are available from the PFRCC office or website (www.fish.bc.ca) and describe the current state of wild Pacific salmon resources in BC, Yukon and Northwest Territories

Here we present the next report in this series on the Council's overview on Pacific salmon, describing the current state of on the salmon resources in Canada originating from northern BC and Yukon transboundary rivers including the Yukon, Alsek, Taku, and Stikine rivers.

Pacific salmon are distributed throughout BC and the Yukon and represent thousands of populations (Foerster 1968, Groot and Margolis 1991, Augerot 2005). The PFRCC's intent with this report is to document and present an up to date reference for the northern BC and Yukon transboundary river salmon populations for general public and scientific interest and awareness. This report reflects a balance of observations to describe the past and present status and some of the details, management and monitoring of these Pacific salmon populations.

Wild salmon are an irreplaceable icon in western Canadian society and culture, and remain resilient and diverse species in nature. Salmon represent a living barometer of the conditions in the environment, and their habitat state and stock status often reflect potential anthropogenic impacts. Public interest and discussion on wild salmon often focuses on sudden changes and high-profile controversies that affect or potentially undermine salmon survival and success. Many populations of salmon face declining numbers or lower survival through impacts from multiple human and natural sources including water and land development, population growth, habitat disturbance and destruction, and more global issues including climate change and variation. This report is a compilation of information to document the long-term status and current issues of wild salmon in northern BC and Yukon transboundary watersheds including the Stikine, Taku, Alsek and Yukon rivers. The Council uses this information to provide a longer-term perspective on salmon populations and help identify potential issues and opportunities to benefit and conserve the resource.

This report presents information derived from Fisheries and Oceans Canada (DFO) and Alaska Department of Fish and Game (ADF&G) based on salmon spawning, catch and stock assessment records, reports reviewed and accepted by the Joint Transboundary Technical Committee (TCTR) of the Pacific Salmon Commission (PSC), the U.S. and Canada Yukon River Joint Technical Committee (JTC), the Pacific Scientific Advice Review Committee (PSARC), the Canadian Science Advisory Secretariat (CSAS), published technical references and online information sources.

The Pacific Fisheries Resource Conservation Council is completing and updating this series of salmon status reports to review and maintain a record on BC and Yukon salmon populations to help identify and understand wild salmon and habitat conservation issues. Along with these reports, the PFRCC provides a comprehensive website to review, discuss and comment on conservation issues associated with salmon populations in BC and the Yukon. Staff from DFO, PSC and ADF&G have provided valuable information and input as contribution to this report.

Report Description:
Pacific Salmon of Northern BC and Yukon Transboundary Rivers

This report is the fifth in the PFRCC's series on the status of salmon resources in BC and the Yukon. The first report is found in the PFRCC's 2001- 2002 Annual Report (PFRCC 2002) and includes the status of salmon resources in southern BC, the Fraser River, and the Okanagan River. The second report describes the salmon resources of central and northern British Columbia, monitoring programs, and current salmon issues in those regions (Riddell 2004). The third report describes the salmon recourse of the Arctic and MacKenzie Basin (Irvine et al. 2009), and the fourth report reviews the salmon resource in southern BC including the Fraser and Okanagan Basins (Labelle 2009).

This fifth report is limited in geographic scope to the major salmon producing Canadian portions of transboundary watersheds in northern BC and the Yukon (Map 1) and focuses on salmon stocks of the: (a) Stikine, (b) Taku, (c) Alsek / Tatshenshini and (d) Upper Yukon / Porcupine rivers. Each of these watersheds includes a portion of estuary and lower river within Alaska, U.S. territorial boundaries. The Unuk, Whiting and Chilkat Rivers are also northern BC and Yukon transboundary rivers, but have less abundant salmon stocks and habitats spawning or originating in Canadian waters. A watershed level description is presented for the Unuk, Whiting and Chilkat rivers, but salmon stock status information is either limited or not available for Canadian based salmon populations.

The first and fourth salmon status reports were organized on the basis of major geographic areas and represented different balances of species and issues. The second and third reports were organized by species over broader geographic areas, and then by geographic subsets of those areas. The northern BC and Yukon salmon report is again organized along major geographic areas as individual watersheds and by salmon species within major watersheds. The use of a watershed to organize salmon populations and issues is consistent with the salmon stock assessment, management and reporting under the Pacific Salmon Treaty (Governments of Canada and US 2006) and the TCTR for the Stikine, Taku and Alsek rivers (TCTR 2009, 2010) and the Upper Yukon through the Yukon Joint Technical Committee (JTC 2010) and reflect DFO's Wild Salmon Policy (WSP) (DFO 2005) and organization of salmon conservation units (Holtby and Ciruna 2007).

The data used in this report differ between watersheds, but are generally represented by salmon catch and escapement numbers from roughly 1970 to 2009. Most of the spawning escapement data are based on; (a) long term time series for a specific index salmon stock monitored by weir or fence counts, (b) cross border mark-recapture estimates of total run size in Canadian waters, (c) comprehensive US and Canadian catch monitoring and biological sampling and stock identification, and (d) single (annual) visual or aerial salmon spawner counts at specific index sites. These are often long term assessment and monitoring programs which undergo annual program review (e.g. Yukon fall chum - Bue et al. (2004); southeast salmon stocks – Woods (2007), Der Hovanisian and Geiger (2005), Bue and Hayes (2009), Borba et al. (2009)) to refine methods and then to advise based on stock size, enhancement issues or natural conditions.

Northern BC and Yukon salmon stock monitoring programs have some remarkable consistency in methods and level of effort over time, in part based on: (a) remote watersheds and limited access to many lakes and stream with local salmon populations, and (b) funding and management agreements between Canada and the US negotiated in the Pacific Salmon Treaty (Governments of Canada and US 2006, Jensen and Johnston 2005) to estimate salmon numbers and predict levels of shared surplus harvest used by fisheries biologists in southeast Alaska and Canada. However, the accuracy of any observation and estimate of salmon numbers or local / habitat based population status is often unknown unless quantified directly through counts at weir or fence sites, or mark-recapture techniques with estimates of statistical variance.

The data represented here are treated as the best measures or indices to establish time trends in salmon spawning population status and are summarized to represent the status of a salmon species status in the entire watershed. The analyses presented here use catch, migratory and spawning records where observations are considered the most consistent over time in method and level of effort and can be cited to technical reports as source documents. Data have been compiled from comprehensive annual reporting from the Transboundary Technical Committee for the Stikine, Taku and Alsek Rivers (Davidson 2009a, b, 2010a, b, Der Hovanisian and Geiger 2005, TCTR 2009, 2010) and salmon population aggregates and from the U.S. Canada Yukon JTC (JTC 2006, 2007, 2008, 2009, 2010). The status of salmon populations is summarized using detailed maps and plots to present time trends for observed data.

Note: The Council cautions the reader that the absence of recorded salmon spawner estimates or escapement values for a species in a stream, watershed and year may not indicate that the species does not use the stream, nor does it imply that a known population of salmon is considered lost or extinct. Observations of zero or null data may simply reflect that either stream surveys and observations for a salmon population do not exist or that survey frequency and area has varied or declined in recent years. In some instances a zero value has been used and recorded to reflect an observation of no spawning salmon in a specific stream. These observations are identified in the report where warranted.

The Council also notes that annual reports are published by the Pacific Salmon Commission and Yukon Joint Technical Committee (JTC) on these salmon stocks and present: (a) the review of annual management, assessment and enhancement data and activities for the transboundary salmon aggregates (Stikine, Taku and Alsek) and for the Yukon River, and (b) the Fisheries and Oceans Canada annual Integrated Fisheries Management Plan for each of the major salmon aggregates including: Stikine, Taku, and Alsek / Tatshenshini Rivers and Yukon River Chinook and chum salmon (DFO 2004 a, b, c, d and 2008a, b, c, d).

Study Area

The Stikine, Taku, Alsek and Yukon rivers are considered transboundary between Canada and U.S., with headwaters in northern BC and / or the Yukon and downstream flow from the coast mountain range into Alaska where they enter the Pacific Ocean (Map 1). The rivers are near the BC and Yukon communities of Telegraph Creek, Atlin, Haines Junction, Whitehorse, Pelly Crossing, Stewart Crossing, Dawson City and Old Crow. These watersheds are glacial and non-glacial in origin and include a diverse set of aquatic and salmon habitats including wide lower rivers, meandering main and off channels, lakes, wetlands, ground water channels, sloughs, and often clear headwaters. The Stikine and Alsek watersheds have very large areas of streams and lakes unavailable to salmon migration and spawning due to impassible barriers. The Taku and Yukon watersheds are largely accessible to wild Pacific salmon populations.

Pacific Salmon Treaty Background

The Pacific Salmon Treaty (PST) was ratified in 1985, and it provides a mechanism for joint Canada and US salmon stock assessment and management in the Stikine, Taku, Alsek and Yukon watersheds. Salmon management activities were identified in the PST as a process to cooperate on research, improve joint management systems and share salmon resources. The Transboundary annex in the PST was renewed in 1988 for the period 1988-1993. In 1988, the Transboundary agreement was also linked to the development of a sockeye enhancement program in the Taku and Stikine river systems (PSC 1988). A renewed Transboundary agreement was not reached for the period 1994-1997, although both Canada and US generally managed fisheries in a manner consistent with previous Treaty agreements. In 1999, PST Transboundary agreements for salmon harvest sharing were negotiated for the period 1999-2008.

The US and Canada Yukon Joint Technical Committee (JTC) was created in 1985 to provide science advice to the Yukon River Panel as part of the Pacific Salmon Treaty. As part of this process, Fisheries and Oceans Canada has responsibility for management and conservation of Canada's salmon resources in the Upper Yukon and Porcupine rivers of the Yukon watershed. DFO. In consultation and agreement with Yukon First Nations they manage Chinook and fall chum salmon fisheries in the Canadian portion of the Yukon River through a working relationship with ADF&G and the JTC. Fall chum salmon are defined as Canadian-origin Yukon fall chum salmon based on their run timing and genetic stock identification (Beacham et al. 1988, Crane et al. 2001) and are distinct from US origin summer chum salmon stocks.

In 1999, Canada and the US agreed to continue to develop salmon management programs based on forecasts to determine a surplus of returning salmon (abundance based management). Committee structures were developed each fall to: (a) generate post-season estimates of harvest and salmon escapement, (b) evaluate management decisions and harvest share, (c) review escapement goals, and (d) determine ongoing assessment and enhancement programs. Harvest and escapement estimates and management decisions are documented annually in PSC committee publications (www.psc.org), ADF&G, and DFO technical reports and summarized in this report for individual species and stocks for the Stikine, Taku, Aslek and Yukon rivers.

Map 1: Northwestern transboundary region and major salmon river systems of BC and Yukon including the Stikine, Taku, Alsek / Tatshenshini and Yukon (Upper Yukon and Porcupine) rivers.

Pacific Salmon of Northern BC and Yukon Transboundary Rivers

Seven salmon producing river systems are found in the Canadian transboundary area of northern BC and the Yukon including four major watersheds (Map 1), from south to north: (a) Stikine, (b) Taku, (c) Alsek and (d) Yukon, and three minor watersheds (Map 2), from south to north: (i) Unuk, (ii) Whiting, and (iii) Chilkat. Detailed salmon status is presented for the major watersheds and a brief watershed and salmon summary is presented below for minor salmon producing watersheds.

Minor Canadian Salmon Producing Transboundary Watersheds

Unuk River

The Unuk River is the most southerly transboundary river and lies next to the Stikine River (Map 2). The river is approximately 87 km long, has a watershed area of 4,400 km^2, and flows from glaciated BC headwaters to enter the Pacific Ocean at Burroughs Bay at the southerly extent of the Alaskan panhandle, north of the Portland Channel. The lower river valley is in Alaska and is broad, flat and characterized by large areas of flood plain (Smikrud and Prakash 2006). In contrast, the river's BC headwaters comprise steep canyons and highly turbid glacial waters. The river is restricted to salmon passage through a constricted canyon (Second Canyon) located 3km upstream of the Alaska / BC border. An impassible barrier is found further upstream of the Second Canyon.

The lower Alaskan and Canadian portion of Unuk River supports runs of all five species of anadromous Pacific salmon, including the largest US run of Chinook salmon in southeast Alaska (ADF&G 2007c, Weller and Evans 2009). Salmon access and production is restricted in BC due to the upstream canyon and high levels of glacial turbidity (Jang and Webber 1996) which act as barriers to salmon migration and spawning (Weller et al. 2006, Weller and Evans 2009). The primary salmon spawning tributary in BC is Border Creek and Lake located 2km upstream of the U.S. / Canada border in BC. Small numbers of sockeye (<200), Chinook and pink salmon have been observed in Border Creek and Lake (Department of Fisheries of Canada 1965). The upper Unuk River and Unuk Lake have observations of sockeye, Chinook and coho salmon. No salmon stock and assessment information is available for the salmon stocks of Canadian origin. The observation of salmon distribution and presence is identified in the Fisheries Information Summary System (FISS) maintained by the BC Ministry of Environment and DFO (www.env.gov.bc.ca/fish/fiss/index.html).

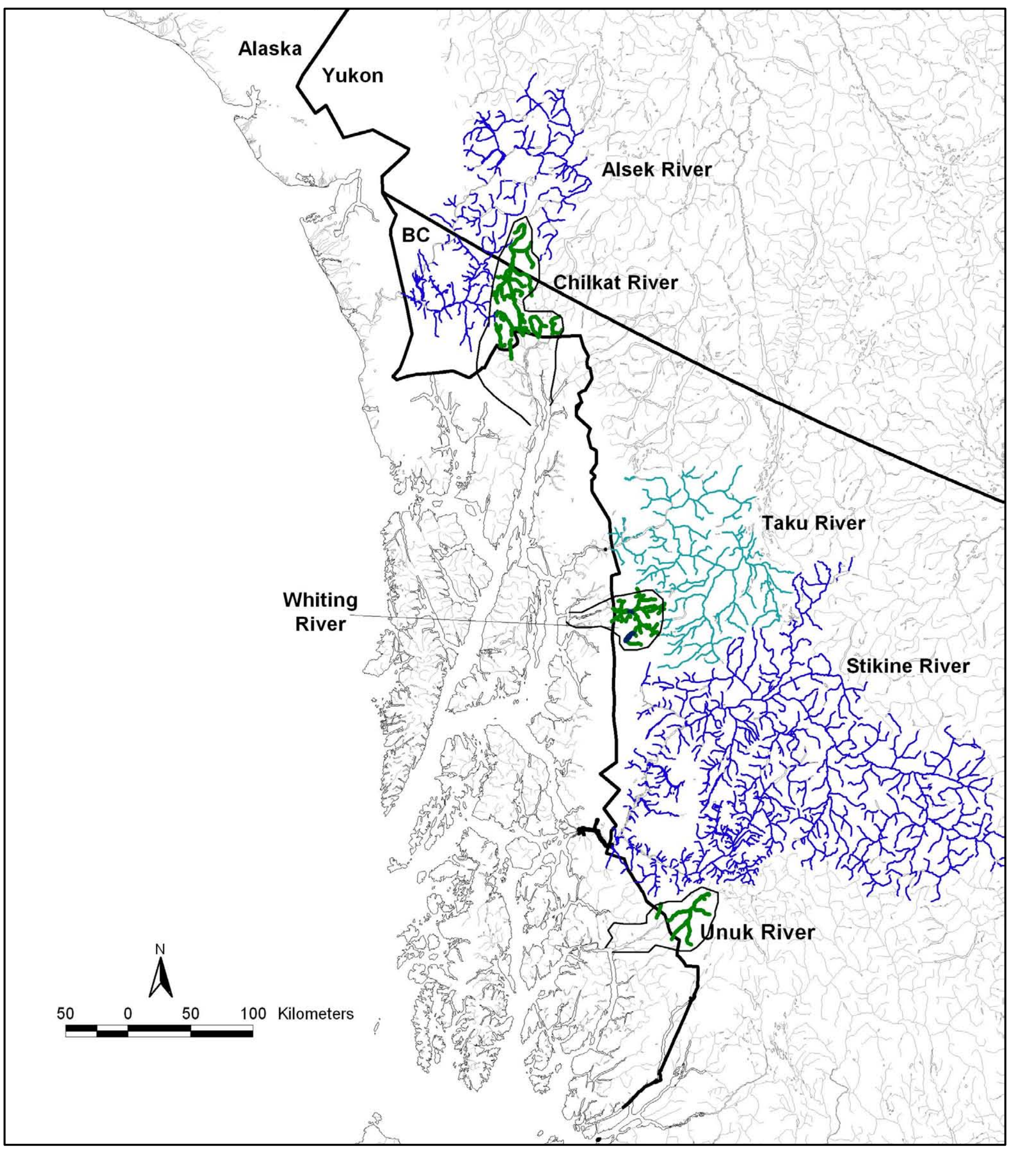
Whiting River

Whiting River is approximately 42 km in length and its headwaters are at Whiting Lake in northwestern BC (Map 2). The river flows into Stephens Passage in Alaska immediately south of the Taku watershed. The river is characterized by steep slopes, high flows and glacially turbid waters. There are limited observations of salmon in the Canadian portions of Whiting River, although surveys suggest salmon habitat does exist around extensive networks of beaver dams in the lower river (Department of Fisheries of Canada 1965). Survey information from the BC and First Nation fisheries surveys suggests the presence of all five species of salmon in the Canadian portion of the Whiting River. Smaller continuous runs of chum, coho and pink salmon have been observed based on surveys from the Taku River Tlingit First Nation (Atlin, BC).

Chilkat River

Chilkat River is a large glacial river system approximately 80 km in length. Its headwaters are in the coast range of northwestern BC, east of the Alsek watershed and north of the Taku River (Map 2). The salmon producing portion of the watershed is primarily in Alaska and terminates in Chilkat Inlet near Haines, Alaska, close to the junction of the Alaskan panhandle and the Yukon / BC borders. Three small headwater tributaries are found in BC and are considered salmon producing including the Klehini, Kelsall and Tahini Rivers (ADF&G 2007a). The Chilkat River supports all five species of anadromous Pacific salmon in the lower Alaskan portions of the watershed. Chum, coho and Chinook salmon are the most abundant species (Department of Fisheries of Canada 1965, Johnson et al. 1993, ADF&G 2007a, Elliot 2010). Small populations of chum salmon have been observed in BC in the Klehini, Kelsall and Tahini Rivers, populations of coho have been observed in the Tahini and sockeye in the Kelsall (Department of Fisheries of Canada 1965, ADF&G 2007a).

Map 2: Northwestern transboundary region and minor salmon river systems of BC and Yukon including the Unuk, Whiting and Chilkat rivers.



Major Canadian Salmon Producing Transboundary Watersheds

Stikine River

The Stikine River is approximately 539 km long and covers an area of 52,000 km^2. The headwaters are in the semi-arid Stikine Plateau in northwestern British Columbia and the river flows south-west through volcanic coastal mountains and glaciers to the ocean near Wrangell, Alaska. About 95% of the Stikine River watershed is in Canada (Map 3). Headwater portions of the Upper Stikine River are clear, while glacially turbid portions (Christina, Chutine, upper Iskut) of the river are mixed with clear groundwater fed sloughs found downstream. The Upper Stikine River is inaccessible to salmon beyond the Stikine Grand Canyon above Telegraph Creek.

The Canadian portion of the Stikine River supports all five species of anadromous Pacific salmon (TCTR 2006). Sockeye, followed by coho and Chinook salmon are the most abundant. Pink and chum numbers are limited in the watershed. The primary salmon tributaries in BC include the Tahltan, mainstem Stikine, Chutine, Iskut Rivers and through salmon enhancement activities the Tuya River (Table 1). Small runs of sockeye, Chinook and coho salmon occur downstream of the US / Canada border in Andrew Creek, Alaska (ADF&G 2007b). Salmon migration and access is restricted in BC in the upper Stikine and the Iskut Rivers due to a series of natural barriers.

Table 1: Reported presence and distribution of anadromous Pacific salmon in the Stikine River.

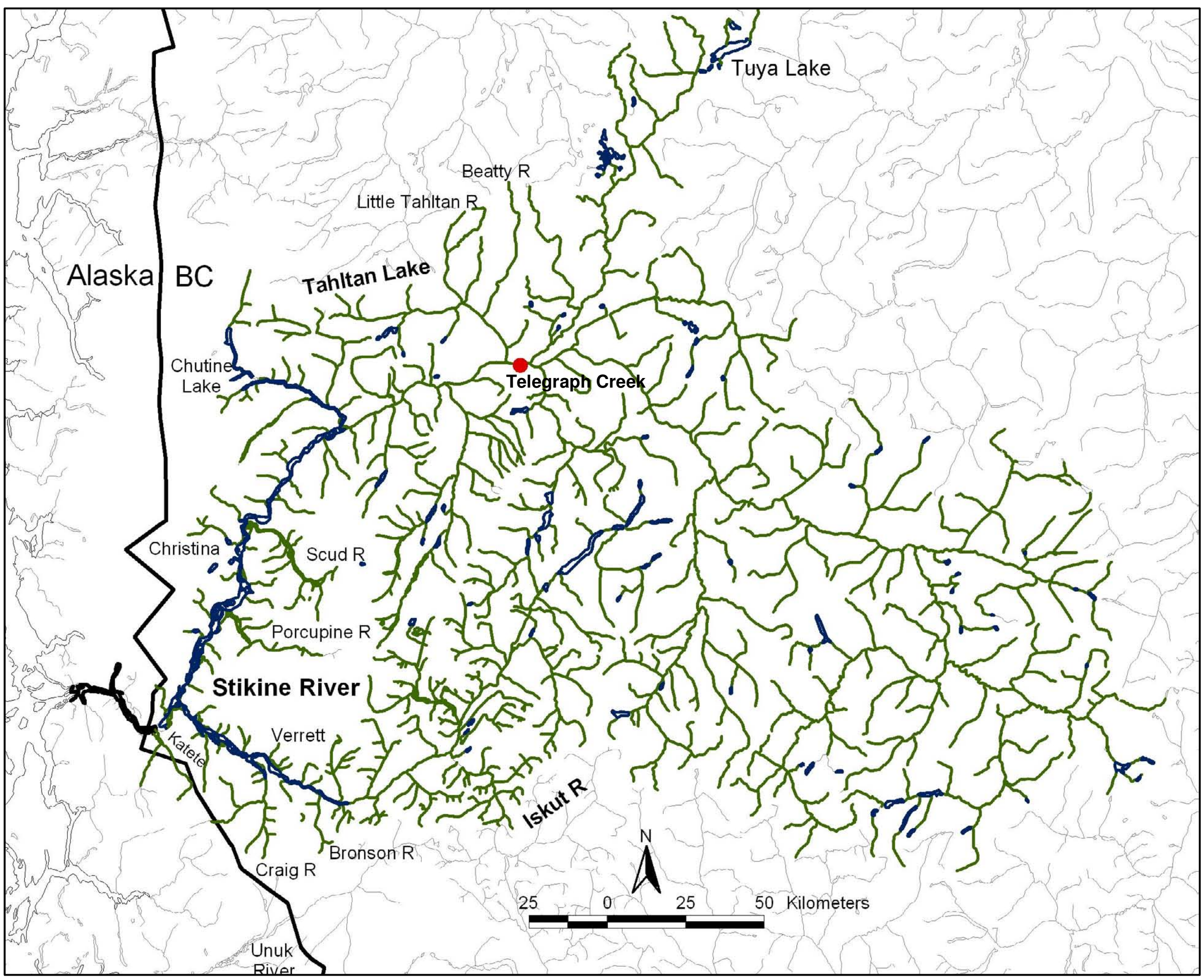
		Salmon Species in Canada				
	Major Tributaries	**Sockeye**	**Chinook**	**Coho**	**Chum**	**Pink**
Stikine	Stikine Mainstem	X	X	X	X	X
	Tahltan	X	X	X		
	Little Tahltan	X	X			
	Tuya	X	X	X		
	Beatty		X			X
	Katete	X	X	X	X	X
	Christina	X	X			
	Chutine	X	X	X		
	Iskut (Verrett, Bronson)	X	X	X	X	X
	Craig	X	X	X		
	Scud	X		X		
	Porcupine	X		X		

Stikine sockeye, Chinook, coho, pink and chum salmon are harvested by US commercial gillnet fisheries in Alaska, by Canadian commercial gillnet fisheries in the lower and upper river, and by aboriginal fisheries in the upper river. A sport fishery and in-river fisheries for coho and Chinook salmon in the lower river and in the Tahltan and Tuya Rivers are managed as an excess salmon-to-spawning requirement (ESSR) fishery (TCTR 2005a, b, DFO 2008a, TCTR 2009, 2010). Sockeye, Chinook and coho salmon stocks are considered the most economically and socially important species in the watershed.

Salmon populations of the Stikine River are assessed under a program jointly developed by Fisheries and Oceans Canada, the Alaskan Department of Fish and Game under the Pacific Salmon Treaty and through the Joint Transboundary Techncial Committee (TCTR) of the Pacific Salmon Commission. Stikine River sockeye, coho and Chinook salmon are monitored through series of annual programs to identify total salmon run size, differentiate important salmon stocks and wild and enhanced contributions to the salmon run. These programs generally involve: (a) estimating Canadian in river total run size through a cross border mark-recapture program where salmon are marked in set gillnets and recovered from counting weirs and spawning ground surveys throughout the watershed, and supplemented with commercial and test fishery catches, (b) marine and in-river catch recording, (c) biological sampling in catch and escapement to identify stocks of origin and wild and enhanced stock contributions (proportions) through use of scale pattern, egg size, thermal mark (enhanced salmon) analyses, and (d) weir / fence counts, annual aerial surveys and recent radio tagging studies to determine stock specific escapement and distribution. Catch per unit effort based abundance methods are verified through annual run reconstructions.

Salmon management in the Stikine has involved an eigteen-year history of enhancement. In 1987-1988, a feasibility study was undertaken to collect baseline data and examine sockeye fry outplanting options (PSC 1988). In 1989, sockeye brood stock was collected from Tahltan lake and fry were outplanted into Tahltan and Tuya lakes in 1990. Brood stock collection and fry outplanting has continued in Tahltan and Tuya from 1990 to present.

Map 3: Stikine River system and its major salmon spawning tributaries. A salmon passage barrier exists on the upper Stikine in the Grand Canyon upstream of Telegraph Creek ● and the confluence of the Stikine and Tuya rivers.



Stikine Sockeye

Stock Status at a Glance:

The status of Stikine sockeye salmon is expected to be near or above average levels of present abundance for wild and enhanced Tahltan, enhanced Tuya and slightly below average for wild mainstem populations. Increased average abundance in Stikine sockeye is based on recent trends in increased returns to Tahltan Lake and high numbers of out migrating smolts.

Sockeye salmon are monitored in three main populations of the Stikine including: Tahltan lake, eight aggregate mainstem stocks, and enhanced Tuya Lake. Tahltan Lake sockeye escapement (Figure 1) has been counted at a weir near the lake outlet from 1959 to present. Stikine sockeye runs are reconstructed annually based on the following:

i. Tahltan Lake weir counts,

ii. Estimated catches of Tahltan Lake wild and enhanced sockeye identified in commercial, aboriginal and test fishery catches (Wood and Johnston 1990, Wood et al. 1993, TCTR 2005a) based on scale pattern, thermal mark and egg size analyses (Craig 1985, Eggers et al. 2008) in test catch samples,

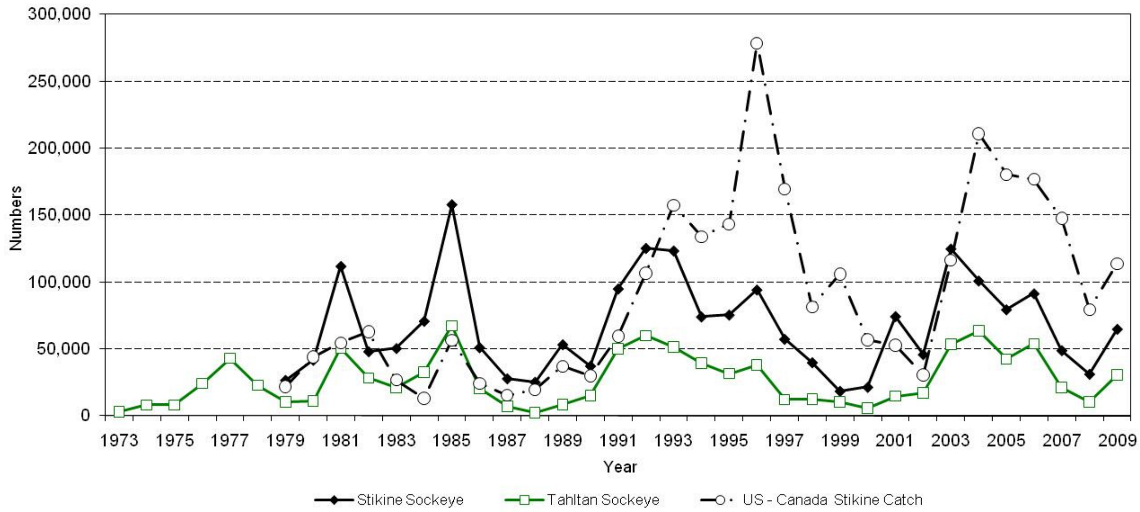
iii. Estimated catches of non-Tahltan wild and Tuya enhanced sockeye based on egg diameter and thermal marks, and

iv. Run timing of sockeye in different stock / run components (catch per unit effort in commercial and lower test fisheries).

Tahltan sockeye catch and escapement estimates, are combined and used as ratios to reconstruct numeric estimates relative to Tuya (thermal marked) and the remainder assumed to comprise mainstem sockeye stocks (Figure 2). Total cross border sockeye abundance has been estimated since 1999 using a mark-recapture program. These estimates are used to verify abundance estimates of total sockeye numbers derived from Tahltan based run reconstruction analyses. Starting in 1984 to present, a single annual aerial survey was conducted to estimate escapement in the eight sockeye stocks considered part of the mainstem stock aggregate (Figure 3 and 5) including: Scud River, Verrett Creek, Verrett Slough, Chutine River, Porcupine Slough / River, Bronson Slough / River, and Craig Creek.

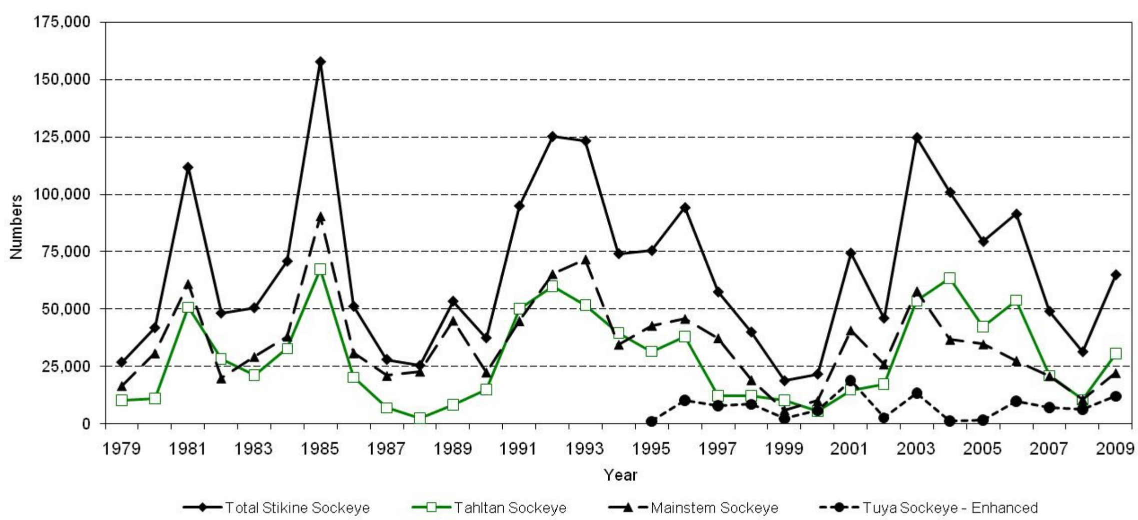
Stikine sockeye are harvested in directed commercial gill net and personal use subsistence fisheries in the U.S. and in Canada in First Nation, lower and upper river commercial fisheries.

Figure 1: Tahltan Lake sockeye escapement from 1973 to 2009 based on weir counts, US – Canada total sockeye catch from 1979 to 2009, and run reconstructed total in-river return estimates of Stikine sockeye stock aggregate from 1979 to 2009.



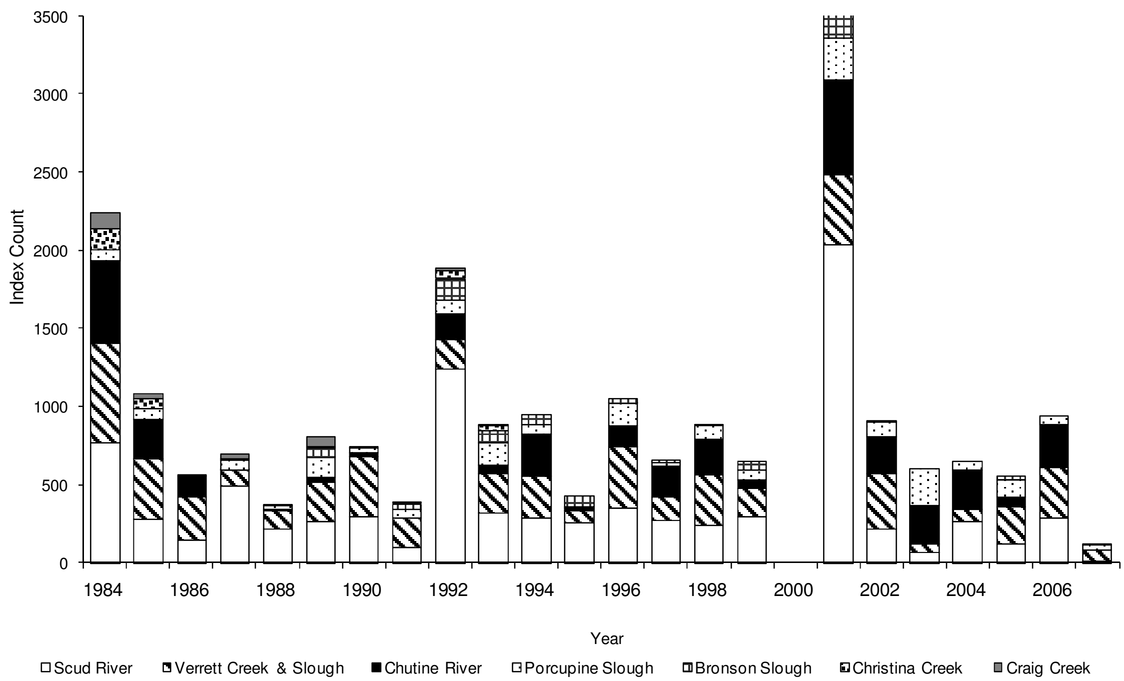
Stikine sockeye populations have demonstrated cycles in abundance with higher levels of escapement during the past decade (Figure 1). Total Stikine sockeye numbers parallel both the abundance of Tahltan and mainstem sockeye stocks and are reflected in the levels of US / Canada sockeye catch. Sockeye returns have shown a general increase over time since monitoring was established in 1959. During this period, Tahltan sockeye escapement has shown a cyclic like pattern of low, followed by a high abundance every three to five years. This pattern is also found in mainstem sockeye stocks (Figure 2) and in particular Scud River sockeye, but not readily noted in other mainstem stocks (Figure 3).

Figure 2: Escapement estimates for the total Stikine sockeye aggregate and the three main stock groupings for Tahltan, Tuya and mainstem sockeye from 1979 to 2006.



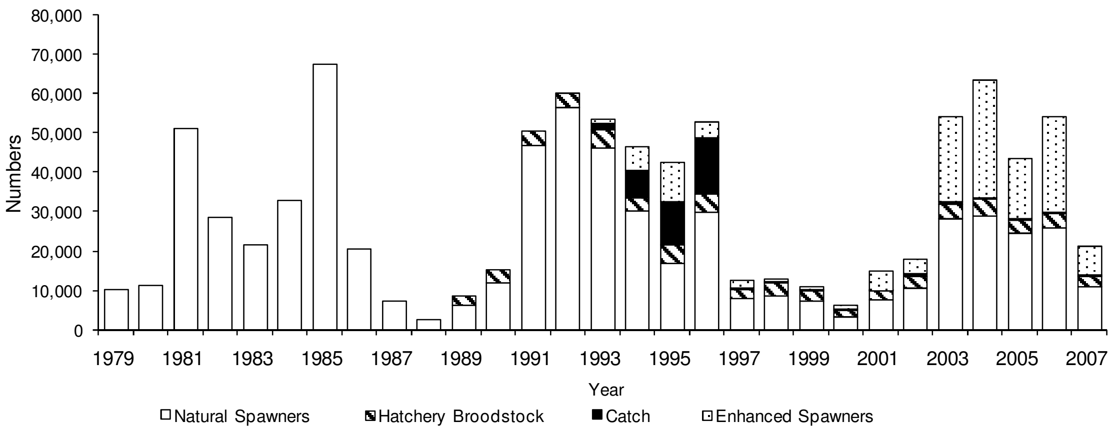
The Transboundary Rivers Salmon Enhancement Program (PSC 1988) was initiated in 1987 following a period of low returns to the Stikine and Taku River systems in the mid to late 80's. Past assessment work in the Stikine had concluded that sockeye spawning habitat was limited in Tahltan Lake (Wood et al. 1993), but sockeye juvenile nursery habitat and capacity was available in both Tahltan and upstream Tuya lakes. In 1989, Tahltan sockeye were collected as hatchery broodstock (Figure 5) and incubated to enhance survival and reared as fry to outplant to Tahltan and Tuya lakes. Wild sockeye salmon are not present Tuya Lake due to an existing migration passage barrier. Enhanced salmon now return to Tahltan Lake (Figure 4), in additional to lower Tuya River (Figure 2) and are captured in ocean and in-river fisheries (Eggers et al. 2008, TCTR 2006, 2009, 2010).

Figure 3: Annual aerial survey counts of mainstem spawning sockeye stocks in the Stikine River from 1984 to 2007.



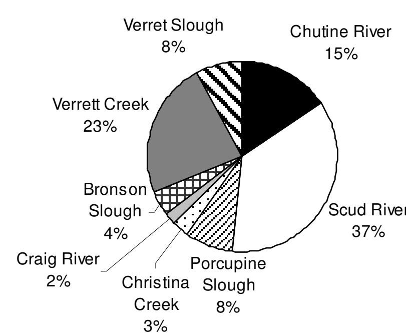
Stikine sockeye are composed of the following stock contributions in order of relative abundance including: Tahltan, Tuya, Scud, Verrett (Creek and Slough), Chutine followed by other lower Iskut River sockeye in Craig and Bronson and lower Stikine mainstem sockeye in Porcupine Slough and Christina River (Figure 2, 3, 5). Mainstem sockeye abundance has varied little over time. This observation may be a consequence of survey frequency or counting conditions but remains uncertain at this time due to limited sample frequency and variable survey and site conditions.

Figure 4: Numbers of natural spawners, hatchery broodstock, ESSR catch and enhanced spawners in the Tahltan Lake sockeye weir counts.



Stikine sockeye returns during the 1979 – 1993 pre-enhancement period averaged 42% Tahltan and 58% mainstem sockeye stock contributions. Returns during the 1994 to 2007 post enhancement period now average 46% Tahltan, 17% Tuya and 37% mainstem sockeye. Overall abundance of sockeye in the Stikine has increased since 2001 parallel with increased levels of enhanced spawners in Tahltan and Tuya (Figure 2, 4). Changes in average contribution between Tahltan, mainstem and enhanced Tuya and Tahltan are a result of increased abundance in Tahltan sockeye (wild and enhanced) and average levels of abundance in mainstem sockeye (Figure 2). Wood et al. (1993), supported by Hyatt et al. (2005), have shown that Tahltan Lake sockeye spawning habitat is limited to 20,000 total spawners, and that decreased incubation success is directly related to escapement beyond this limit. Escapement limits to Tahltan Lake, ESSR harvest and excess stock management, plus the success of fry enhancement programs to Tahltan and Tuya Lakes, has potentially helped support higher more stable levels of sockeye abundance in Tahltan Lake.

Figure 5: Averaged escapement counts for 8 surveyed tributaries for mainstem sockeye stocks from aerial surveys from 1984 to 2007.



Stikine Chinook

Stock Status at a Glance:

The status of Stikine Chinook salmon is expected to be near or slightly above average levels of present abundance. Increased abundance in Stikine Chinook is based on trends in stable and recent increased spawner numbers as represented in returns to Little Tahltan River.

Chinook salmon are monitored in Little Tahltan River and as a total Stikine Chinook escapement. Little Tahltan Chinook escapement has been counted at a weir from 1985 to present (Figure 6). This is the primary long term index site for Chinook escapement estimates in the Stikine River. Since 1996, a lower Stikine mark-recapture program has provided an annual estimate of total Chinook escapement and an estimate of the proportion of Little Tahltan Chinook to the total stock (Pahlke and Etherton 1998, 1999, 2000a, Pahlke et al. 2000, Der Hovanisian et al. 2001, 2003, 2004, 2005, Der Hovanisian and Etherton 2006, Richards et al. 2008, Pahlke et al. 2010). During 1979 to 2002, a single annual aerial survey was conducted to estimate escapement in Little Tahltan, Tahltan and Beatty Rivers (Figure 7). Aerial surveys were discontinued in 2002 following a review which indicated these data provided little additional information and were inconsistent with estimates of escapement for Little Tahltan and the total Stikine Chinook population (Bernard et al. 1999). A coded-wire tagging program has also been conducted since 2000 to collect information on Chinook marine survival, distribution and production (ADF&G 2007b).

Stikine Chinook are harvested in a directed commercial gillnet fishery started in 2005, U.S. troll, subsistence and recreational fisheries, as incidental catch in a lower river test fishery, and in an aboriginal and recreational fishery in the upper river near Telegraph Creek. Prior to 2005, Chinook were only commercially harvested as incidental catch in a directed Stikine sockeye fishery.

Figure 6: Little Tahltan Chinook escapement from 1985 to 2009 based on weir counts, Canadian lower and upper Stikine in-river catch (commercial, ESSR, aboriginal, sport fisheries) from 1973 to 2008, US – Canada total Chinook catch (marine and freshwater) from 2002-2008, and mark-recapture estimate of total Stikine Chinook escapement from 1996 to 2009.

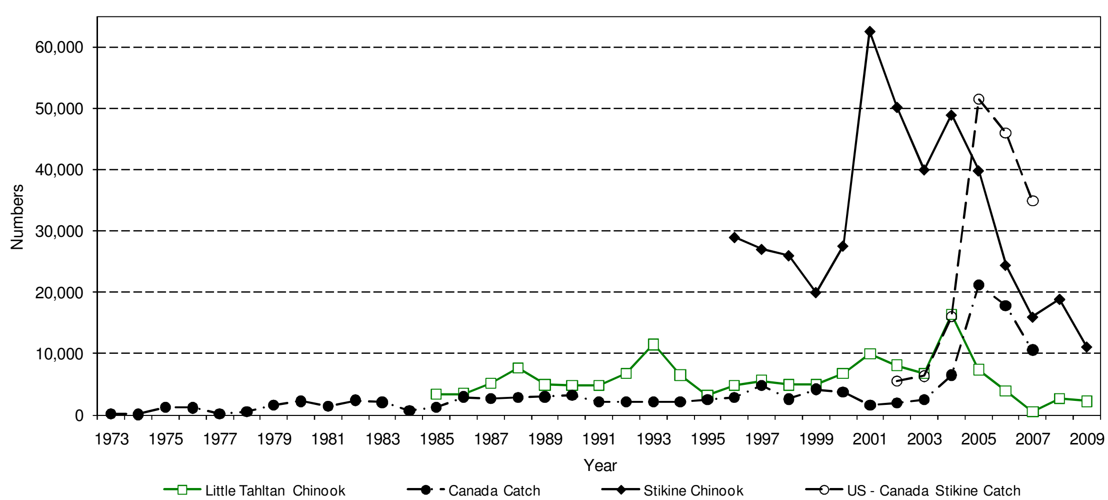
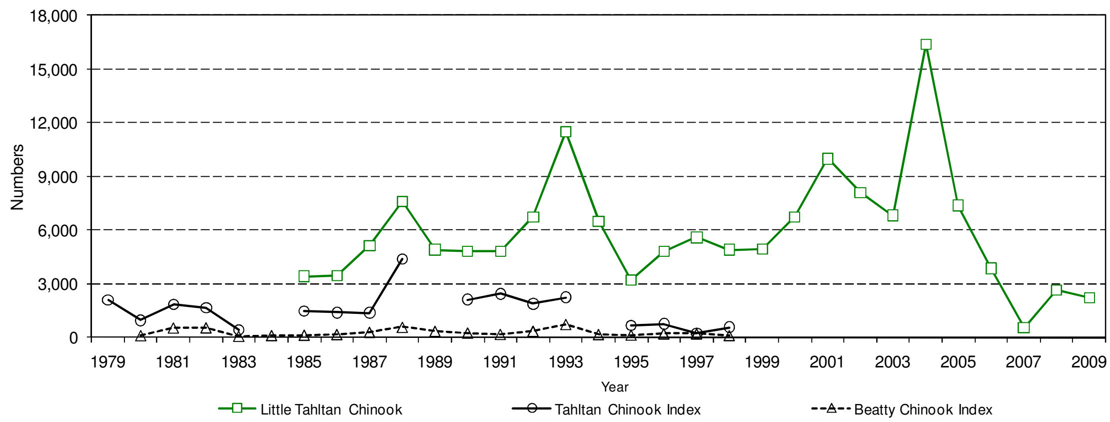


Figure 7: Little Tahltan Chinook escapement from 1985 to 2009 based on weir counts and Tahltan and Beatty River Chinook aerial survey counts of escapement from 1979 to 1998.



Chinook distribution is limited to the lower Stikine mainstem and includes spawning tributaries such as Little Tahltan, Tahltan, Chutine, Katete, Craig and Tuya rivers, and Beatty, Christina and Verrett creeks (Pahlke and Etherton 1999). Little Tahltan Chinook represent an average of 21%, and range from 16% to 34% (1996 to 2006) of the total Chinook escapement in the Stikine. Little Tahltan Chinook are comprised of at least 96% (range 83% to 99%) large Chinook typically 3-ocean age (age 1.3) and larger than 660mm (mid-eye to fork length) (TCTR 2005a, b, 2009, 2010).

Stikine River has one of the largest runs of spring Chinook salmon in northern BC and southern Alaska. During the mid to late 1970's, Stikine Chinook were considered depressed relative to historic levels, and a stock rebuilding program was started to limit commercial and recreational harvest rates (Kissner 1974, Pahlke 1999). Chinook stocks are now considered at slightly below average levels of return related to lower marine survival and warmer ocean conditions (TCTR 2005a, b; Davidson et al. 2007, 2009a,b, 2010a, b, TCTR 2009, 2010) with potential implications for lower recruit returns in future years.

Stikine Coho

Stock Status at a Glance:

The status of wild Stikine coho salmon is expected to be below the long-term average abundance. This is related to below-average recruitment and marine survival. Coho stock status data are limited and constrain development of reliable estimates of abundance.

Coho salmon stock status and escapement are not reliably monitored in the Stikine due to their extended run timing relative to Stikine sockeye and Chinook populations. Estimates of Stikine-wide coho escapement is derived from the ratio of coho and sockeye catch per unit effort in the lower test fishery and expanded by sockeye escapement (Figure 8). This estimate is based on an unconfirmed assumption that catch rates between coho and sockeye are comparable (TCTR 2005a, DFO 2004a, Shaul et al. 2008, TCTR 2009, 2010). Coho escapement is also monitored through a single annual aerial survey of eight index rivers since 1984 to 2006 (Figure 9, 10). Surveys are scheduled to coincide with favourable viewing conditions and spawning times, usually in late October or early November (TCTR 2005a, 2009). Stikine coho salmon are captured in directed US troll, gillnet and recreational fisheries.

Figure 8: Lower Stikine coho, pink, chum, sockeye and steelhead salmon test fishery catch per unit effort (CPUE) from 1986 to 2006.

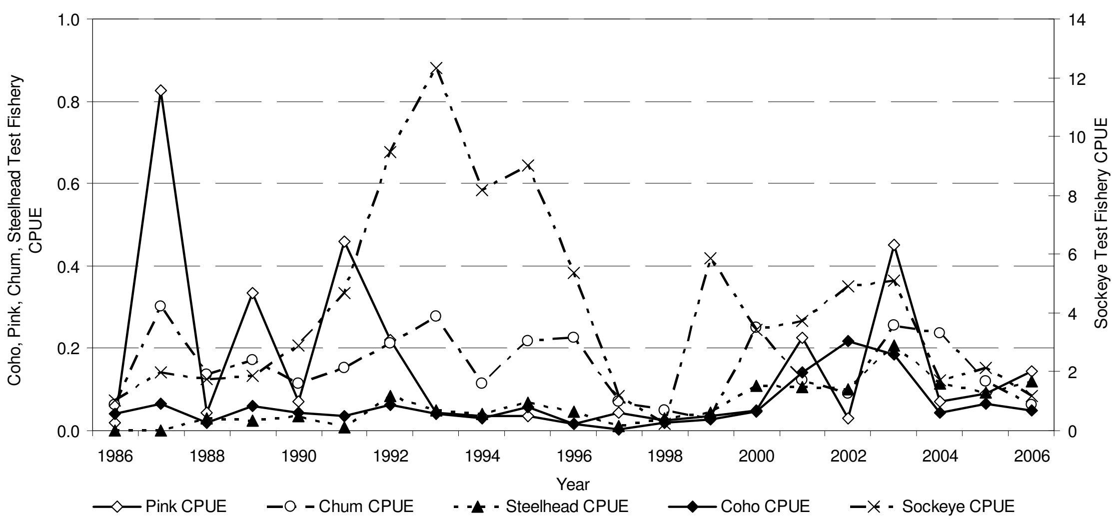
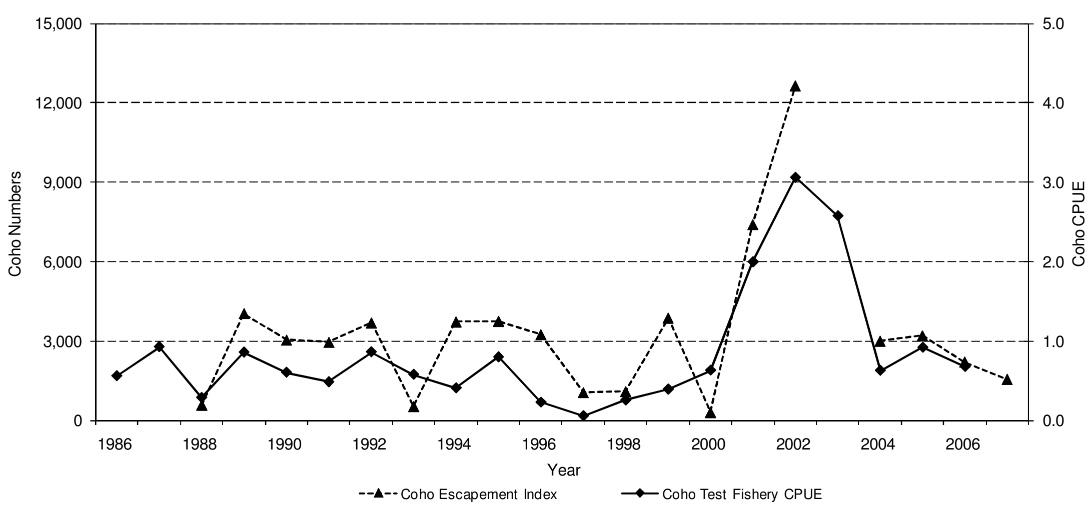


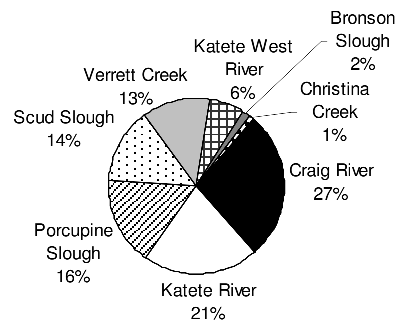
Figure 9: Total aerial index escapement counts for Stikine coho from 8 index stocks including: Craig, Katete, Katete West rivers, Christina and Verrett creeks, and Bronson, Scud and Porcupine sloughs from single surveys conducted annually from 1984 to 2007. Lower Stikine coho test fishery catch per unit effort (CPUE) from 1986 to 2006.



Reconstructed estimates suggest that approximately 30,000 coho escape on average to spawning tributaries in the Stikine. These estimates range from 6,000 (1988) to well over 100,000 coho spawners (2002) (DFO 2004a, Davidson et al. 2007). Stikine coho are composed of the following spawning populations in order of relative abundance including: Craig River, Porcupine Slough, Scud Slough and River, Verrett Creek, Katete West, Bronson Slough and Christine Creek (Figure 10). These estimates are based on average spawner counts from aerial surveys between 1984 and 2006. Stikine coho abundance is difficult to monitor due to extended run timing, poor water conditions, difficult logistics, and an unknown extent of coho spawner distribution in clear and glacial tributaries.

Stikine coho escapement is expected to be below the long-term average of approximately 30,000 spawners (Figure 9) (Shaul et al. 2005, 2008). A mark-recapture program was started in 2000 for Stikine coho to estimate escapement (ADF&D 2007b), but due to low tag recoveries did not provide reliable measures and was discontinued after 2005. Additional projects are underway to determine run timing and spawner distribution and identify key indicator coho stocks. It is unknown to what extent southeastern Alaskan coho hatchery and enhancement efforts influence wild Stikine coho populations.

Figure 10: Averaged escapement counts for 8 surveyed tributaries for Stikine coho stocks from annual aerial surveys from 1984 to 2006.



Stikine Pink and Chum

Stock Status at a Glance:

The status of wild Stikine pink salmon is expected to be above the long-term average abundance. The status of wild Stikine chum is unknown.

Pink salmon in northern BC and southeastern Alaska are the most abundant and valuable species in the commercial fisheries, particularly as part of directed fisheries in US waters (Heinl et al. 2008). Chum salmon are incidentally caught as part of directed sockeye, pink and coho fisheries (Eggers and Heinl 2008). Wild pink and chum salmon escapement is not monitored in the Stikine, with the exception of incidental catch of both species in the lower Stikine sockeye and Chinook fisheries. Trends in Stikine pink and chum catch per unit effort in test fisheries indicate levels of abundance that are at least as high as sockeye and coho populations in the watershed (Figure 9). Recent CPUE also indicates escapements are similar to long-term averages. Stikine pink salmon do not show persistent trends of odd or even year strength or dominance, although odd year populations have been more frequently observed in the past decade (Heinl and Geiger 2005). Pink and chum salmon are not routinely observed in First Nation river fisheries.

Taku River

The Taku River drainage is 18,800 km^2 with approximately 80% within Canada. The River is formed by the confluence of two large upstream rivers, the southern Inklin and northern Nakina Rivers, and flows southwest entering the ocean at Taku Inlet, 20km east of Juneau, Alaska. The river originates in the coast range and Stikine plateau and is largely fed by glaciers from the Inklin River, resulting in highly turbid waters and high midsummer flows. Clear water tributaries include the northern portions of the Taku from Nakina and Nahlin Rivers.

The Canadian portion of the Taku River supports all five species of anadromous Pacific salmon (Table 2). Pink, followed by sockeye are the most abundant species in the watershed, although coho and Chinook populations are considered the largest for these species in northern BC and southeastern Alaska (Davidson et al. 2007, 2009 a, b, 2010a, b). Much of the watershed is accessible to salmon with the following key spawning tributaries in BC including: Little Trapper, Kuthai, Nakina and Tatsamenie Lakes and Nahlin and Tatsatua Rivers (Map 4). Salmon spawning and nursery habitats are limited in the watershed due to high levels of glacial inputs. Small stocks of Chinook, coho and chum salmon occur in Alaska, US in Yehring and Johnson Creeks.

Table 2: Reported presence and distribution of anadromous Pacific salmon in the Taku River.

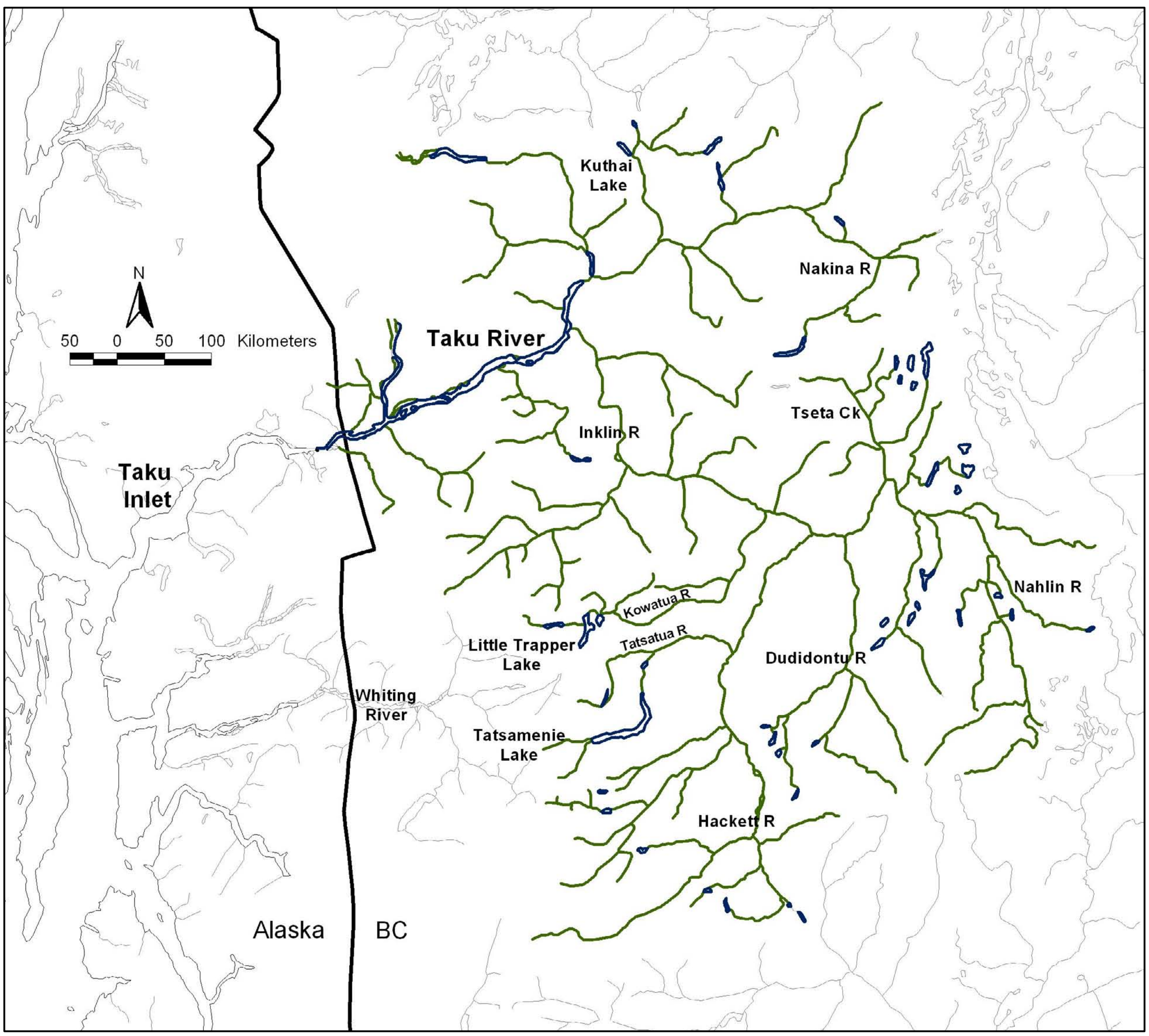
		Salmon Species in Canada				
	Major Tributaries	**Sockeye**	**Chinook**	**Coho**	**Chum**	**Pink**
Taku	Taku Mainstem	X	X	X	X	X
	Nakina	X	X		X	X
	Kuthai	X				
	King Salmon	X	X			
	Inklin		X	X	X	
	Little Trapper	X	X	X		
	Tseta		X			
	Tatsatua	X	X	X		
	Kowatua	X	X	X		
	Tatsamenie	X		X		
	Hackett	X	X	X		
	Dudidontu		X	X		
	Nahlin	X	X	X	X	

Taku sockeye, Chinook, coho, pink and chum salmon are harvested in Alaska by US commercial gillnet, seine and troll fisheries and near Juneau in a sport fishery and in-river personal use fishery. Taku salmon are harvested in Canada by commercial gillnet, aboriginal and sport fisheries (TCTR 2005b, 2009, 2010, DFO 2008b). Sockeye, Chinook and coho salmon stocks are considered the most economically and socially important species in the watershed.

Salmon populations of the Taku River are assessed under a program jointly run by Fisheries and Oceans Canada, the Alaskan Department of Fish and Game, and the Taku River Tlinglit First Nation under the Pacific Salmon Treaty and through the Transboundary Techncial Committee of the Pacific Salmon Commission (DFO 2004b, 2008b). Taku River sockeye, coho and Chinook salmon are monitored through a program and series of studies to identify total salmon run size, differentiate important salmon stocks and wild and enhanced contributions to the salmon run. These programs involve: (a) estimating Canadian in river total run size through a cross border mark-recapture program where salmon are marked in the Canyon Island fishwheels and recovered from Canadian commercial and test fisheries and supplemented with salmon caught at counting weirs and during spawning ground surveys throughout the watershed (TCTR 2005a, b, 2009, 2010; Andel and Boyce 2007), (b) marine and in-river catch recording, (c) biological sampling in catch and escapement to identify stocks of origin and wild and enhanced stock contributions (proportions) through use of scale pattern, parasite or genetic analyses, and (d) weir or fence counts or aerial surveys to determine stock specific escapements.

Taku River salmon management has also involved some small-scale enhancement. In 1987-88 a feasibility study was undertaken to collect baseline data and examine sockeye fry outplanting options (PSC 1988). In 1990, sockeye brood stock was collected from Tatsamenie and Trapper lakes and fry outplanted into both lakes in 1991. Fry outplanting was discontinued in Trapper lake in 1995 (brood year) but has continued in Tatsamenie lake.

Map 4: Taku River system and its major salmon spawning tributaries.



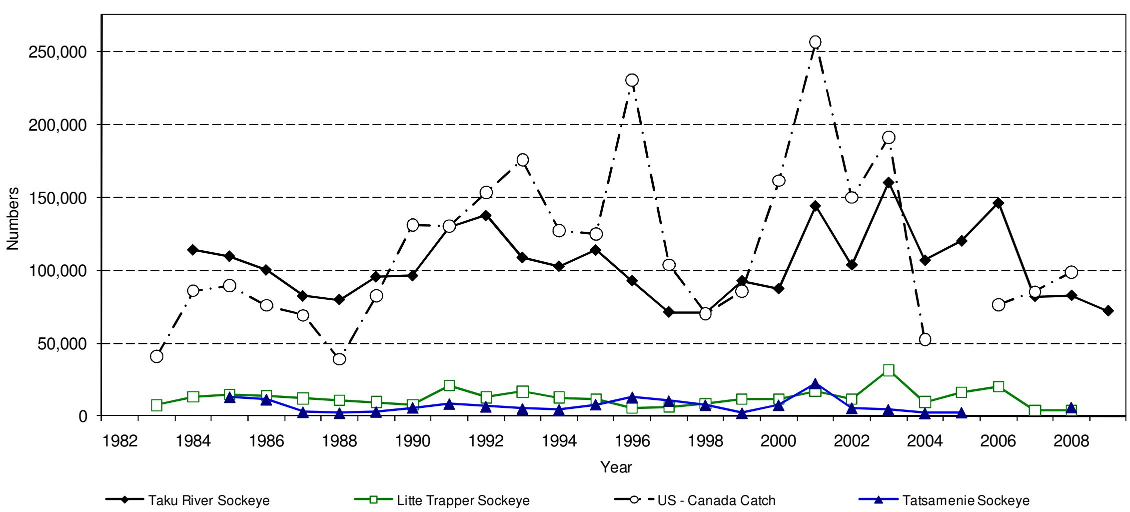
Taku Sockeye

Stock Status at a Glance:

The status of Taku sockeye salmon is expected to be near or slightly below average levels of present abundance for wild and enhanced Tatsamenie, Trapper, Kuthai and mainstem populations. Average or slightly lower levels of abundance in Taku sockeye are linked to trends in reduced returns to Kuthai, and very low returns of enhanced sockeye to Little Trapper and Tatsamenie.

Taku sockeye salmon are monitored in seven main populations including Little Trapper, Tatsamenie, Kuthai and King Salmon lakes, Hackett and Nahlin rivers and mainstem stocks (TCTR 2005a,b; Eiler et al. 1992). Weirs are operated on key systems within the Taku including Kuthai (1992 to present), Little Trapper (1983 to present), and Tatsamenie (from 1985 to present) (TCTR 2005a, b; 2009, 2010, Geiger et al. 2005, Eggers et al. 2008). A joint US / Canada mark-recapture program was started in 1984 to estimate Canadian spawning escapement (Clark et al. 1986, Boyce and Andel 2005, i.e. Kelly and Milligan 1997). Tags are applied to sockeye at the Canyon Island fishwheel just below the border, and recovered in the Canadian lower river commercial fishery and weirs at Trapper, Tatsamenie and Kuthai (Clark et al. 1986, Andel and Boyce 2007). Taku sockeye runs are reconstructed annually based on tag recovery at weir sites, and scale pattern and otolith (thermal marks) analyses used to assign contributions of wild and enhanced sockeye in Trapper and Tatsamenie lakes and all other mainstem sockeye populations (TCTR 2005b, 2009, 2010) (Figure 11). Radio telemetry studies in the 1980's provided key information on the distribution of sockeye spawning stocks (Eiler et al. 1992). Taku sockeye are harvested in directed commercial gill net and personal use fisheries in the US, and in Canada, commercial and First Nation fisheries upstream of the border (Geiger et al. 2004, 2005).

Figure 11: Little Trapper and Tatsamenie sockeye escapement from 1983 to 2008, and 1985 to 2008 respectively based on weir counts, US – Canada total sockeye catch from 1983 to 2008, and mark-recapture estimate of total Canadian Taku River sockeye stock escapement from 1984 to 2009.

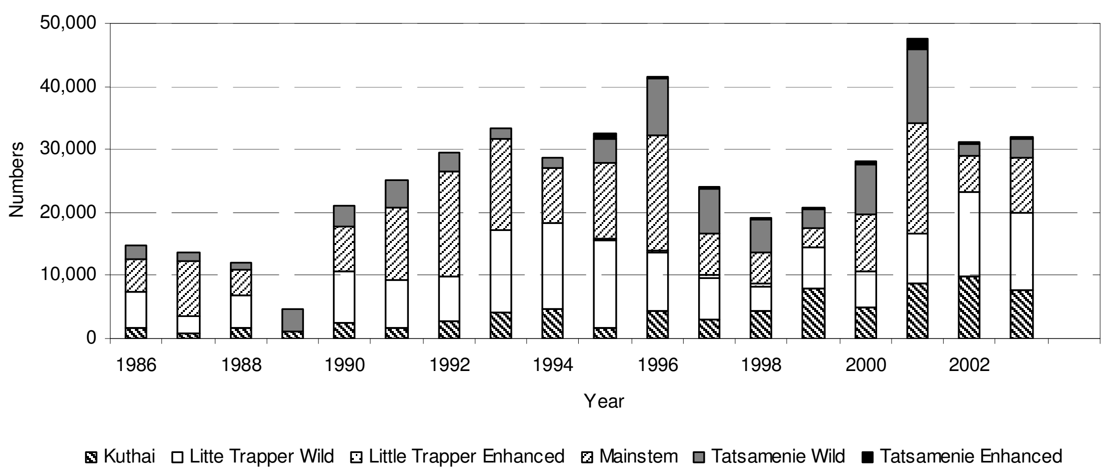


Taku sockeye are composed of the following stock contribution in order of relative abundance including: mainstem stocks, Little Trapper, Kuthai and Tatsamenie (Figure 12). In-river returns during the 1986-1994 pre-enhancement period averaged: 43% mainstem stocks, 35% Little Trapper, 12% Tatsamenie, and 10% Kuthai sockeye stock contributions. Returns during the 1995-2003 post-enhancement period now average: 29% mainstem stocks, 29% Little Trapper, 20% Kuthai, 19% Tatsamenie, and 2% enhanced from Tatsamenie and Little Trapper.

Taku sockeye populations are expected to be below average levels of escapement. Present levels of sockeye escapement and returns are supported by strong returns to Kuthai Lake. Below average returns are observed in Little Trapper and mainstem wild sockeye stocks; and in wild Tatsamenie and enhanced Little Trapper and Tatsamenie sockeye stocks (Figure 12). Sockeye returns have shown an increase over the period of monitoring from 1983 to present. During this period, Little Trapper and Tatsamenie sockeye escapement has shown a cyclic pattern of low followed by high levels of abundance every eight to ten years. High levels of escapement in 1985, 1991, 2003 are similar to patterns observed in the Tahltan sockeye (Figure 2) in the Stikine River.

The Transboundary Rivers Salmon Enhancement Program (PSC 1988) was started in the Taku following low sockeye returns in the mid to late 1980's and an analysis which suggested that sockeye production could be increased by forty-fold in Tatsamenie lake. In 1990, Tatsamenie and Little Trapper sockeye were collected as hatchery broodstock to enhance incubation success and hatchery rear fry to outplant to both lakes. Enhanced sockeye began returning to Tatsamenie and Little Trapper lakes in 1995 (Figure 12). However, the survival of enhanced fry in both lakes is considered poor, relative to wild sockeye fry (Mathias 2000, Hyatt et al. 2005), and this has resulted in low abundance of enhanced salmon. Hyatt et al. (2005) found that Tatsamenie Lake enhanced sockeye fry suffer from size mediated predation, as well as overall poorer survival than wild fry.

Figure 12: Sockeye escapement reconstructed using scale pattern analyses from Canadian catch to differentiate stock origins and expanded based on Little Trapper, Tatsamenie and Kuthai weir counts of escapement.



Taku Chinook

Stock Status at a Glance:

The status of Taku Chinook salmon is expected better than previous years, at slightly below average levels of abundance. Lower abundance of Taku Chinook is based on trends of declining spawner numbers in Nakina and average spawner numbers in smaller Taku Chinook stocks.

Chinook salmon are monitored as a total Taku stock aggregate and as index counts in key indicator tributaries. A cross-border Taku mark-recapture program was started in 1988 to present, to estimate total Chinook escapement and total returns (McGregor and Clark 1989, Boyce et al. 2006, Jones III et al. 2010, McPherson et al. 2010) (Figure 13). An annual aerial survey (McPherson et al. 1997, Pahlke 1996, 1997, 1999, 2006) is conducted to estimate escapement in Nakina, Nahlin, Tatsatua, Kowtua, Dudidontu and Tseta rivers from 1975 to present (Figures 14, 15). Only “large” Chinook (>age 3, >660mm mid-eye to fork length) are counted because they can be easily distinguished from other species by their size from the aerial helicopter surveys (Pahlke 1996). These surveys have been the primary long-term index sites for Chinook escapement estimates in the Taku River. During 1975 to 1994, aerial survey results were expanded using professional judgment based on site conditions and distribution of Chinook, to produce annual total estimates of escapement (Mecum and Kissner 1989, PSC 1993). In 1989-90, a mark-recapture and radio telemetry program was used to estimate escapement of Taku Chinook (Pahlke and Bernard 1996). Chinook were tagged from Canyon Island fishwheel catch and tags recovered in upstream spawning tributaries.

Prior to 1975, Taku Chinook were harvested in directed commercial gillnet and recreational fisheries in the Taku Inlet. In the period 1976 to 2004, fisheries were limited to incidental catch of Taku Chinook as part of stock rebuilding program across southeast Alaska. In 2005, directed commercial Chinook fisheries were re-established, and have occurred in the Taku Inlet (Davidson et al. 2007, 2009a,b). Taku Chinook are harvested in a lower river Canadian commercial and test fishery, and an aboriginal and recreational fishery.

Figure 13: Taku Chinook escapement from 1988 to 2009 based on cross border mark-recapture estimates, prior to 1988 based on Chinook stock reconstruction, and US – Canada total Chinook catch from 1979 to 2007.

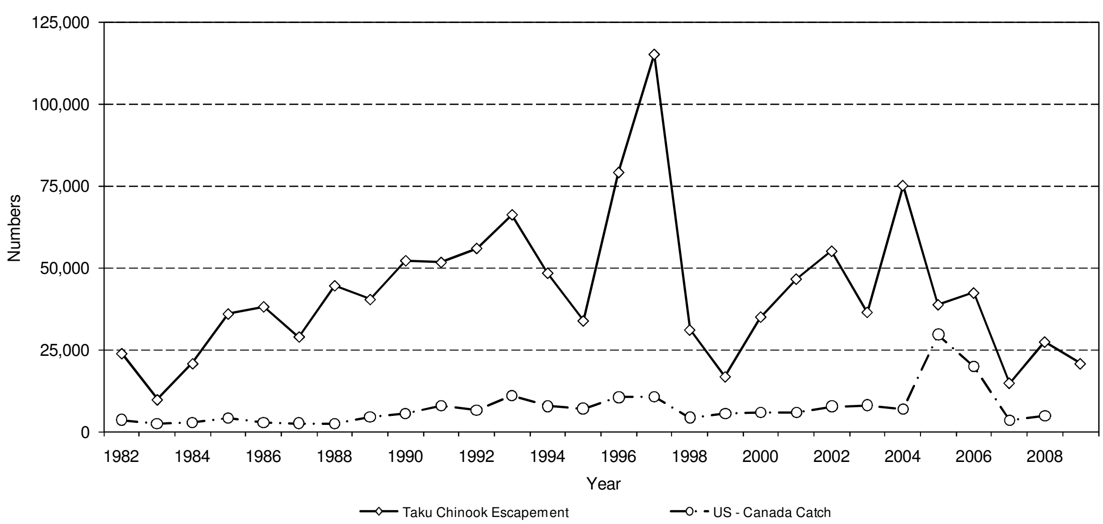
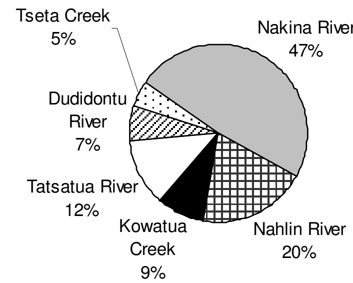


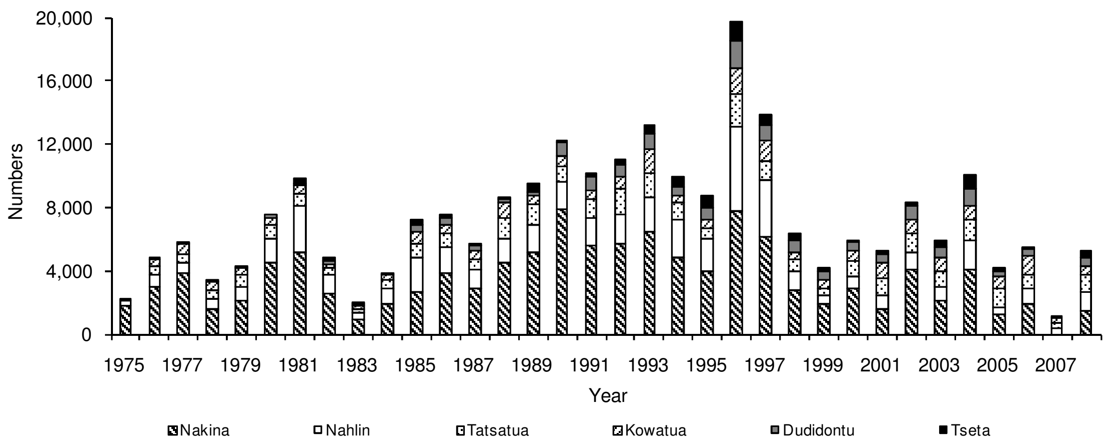
Figure 14: Averaged escapement counts for 6 major surveyed tributaries for Taku Chinook from aerial surveys from 1975 to 2004.



Taku Chinook are considered spring run with adult spawners returning from late April to early July, with spawning continuing until mid September. Chinook spawners are distributed throughout the major river systems in the Taku including: Nakina, Nahlin, Tatsatua (Tatsamenie), Kowatua (Little Trapper), Dudidontu, Tseta, King Salmon and mainstem Inklin River (McPherson et al. 1996, 1997a, 1998a, 1999, 2000, Boyce et al. 2006). Nakina Chinook represent an average of 47%, and range from 36% to 86% (1975 to 2004) of the total Chinook escapement in the Taku (Figure 15). Taku Chinook are composed of the following spawning populations in order of relative abundance including: Nakina, Nahlin, Tatsatua (Tatsamenie) rivers, Kowatua (Little Trapper) Creek, Dudidontu River and Tseta Creek (Figure 14).

Taku River has one of the largest runs of spring Chinook salmon in southeast Alaska and northern BC (Pahkle 1996, Pahlke and Bernard 1996, McPherson et al. 2003, 2004, 2005, 2010, Jones III et al. 2010). During the mid to late 1970's, Taku Chinook, like the Stikine Chinook, were considered depressed relative to historic levels and a stock rebuilding program was started to limit commercial and recreational harvest rates (Kissner 1974, Pahlke 1999, McPherson et al. 2000). Chinook stocks are now considered healthy and returns expected are slightly below average (Figure 13), but are not at levels sufficient to create an annual directed commercial fishery. Improved stock status over the past three decades has been related to harvest restrictions and favourable marine survival and ocean conditions (TCTR 2005a, b; 2009, 2010, Davidson et al. 2007, 2009a, b).

Figure 15: Aerial survey counts of large (> 3 ocean years) Taku Chinook salmon escapement from 1975 to 2008.



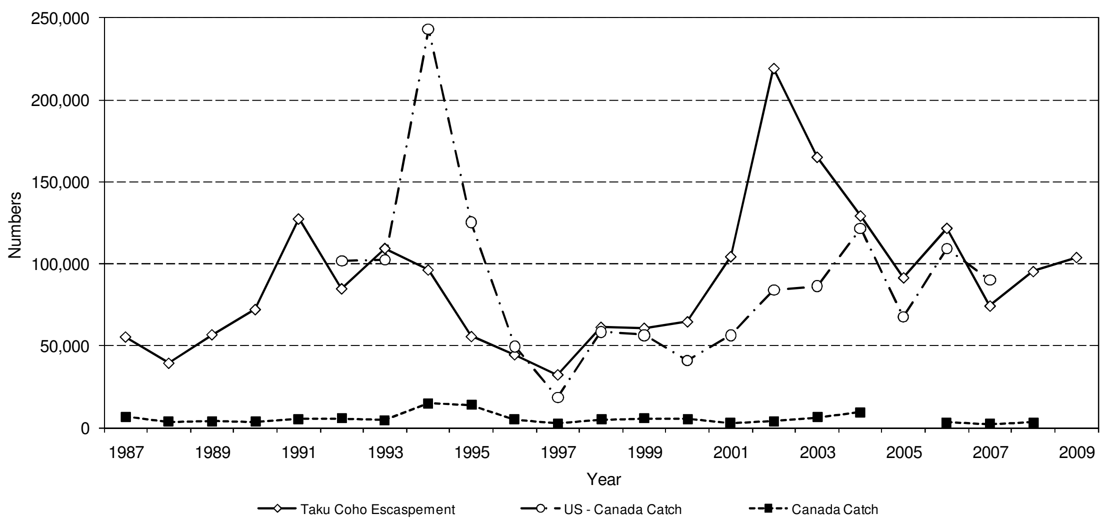
Taku Coho

Stock Status at a Glance:

The status of Taku coho salmon is expected to be near or slightly above average levels of present abundance. Average levels of abundance in Taku coho are linked to trends in improved smolt production, rather than increased marine survival.

Taku coho salmon are monitored as a single stock and produce annually an estimated 100,000 to 500,000 adult coho (Shaul et al. 2003, 2005, 2008, TCTR 2005b, 2009, 2010). Aerial surveys and weir counts have been used in the past to estimate distribution and abundance, but due to extended run timing and variable site conditions these surveys were discontinued in favour of a mark-recapture program and index catch in the Canyon Island fishwheel. A joint US / Canada index fisheries and mark-recapture program was started in 1987 to estimate in-river coho escapement (Clark et al. 1986, Elliott and Bernard 1994, McPherson et al. 1994, 1995, 1996, 1997b, Yanusz et al. 1999, 2000, Jones et al. 2006) (Figure 16). Tags are applied to coho at the Canyon Island fishwheel just below the border, and recovered in the lower river commercial and test fisheries in the lower Taku in Canada. Early weirs and aerial surveys were conducted in Tatsamenie, Hackett, Dudidontu and Upper Nahlin Rivers (Figure 17). Taku coho are harvested in directed commercial gill net and personal use and recreational fisheries in the US, and in Canada, commercial, test and aboriginal fisheries upstream of the border (Shaul et al. 2003, 2005, 2008, TCTR 2005b, DFO 2008b).

Figure 16: Taku coho in-river escapement from 1987 to 2009, combined US – Canada total coho catch from 1992 to 2007 and Canadian in-river catch from 1987 to 2008.



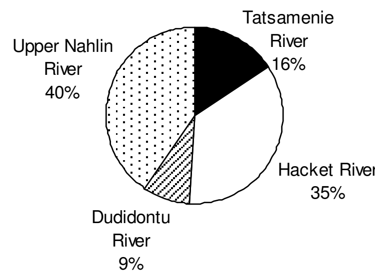
Taku coho spawning distribution is not well understood in the Taku River systems. Early monitoring programs demonstrated that coho spawners were abundant in Upper Nahlin, Hackett, Tatsamenie (Tatsatua) and Dudidontu rivers, although the extent of their distribution is unknown.

The Taku River is considered the largest coho salmon producing system in southeast Alaska and northern transboundary areas of BC (Shaul et al. 2005). From 1997, Taku coho numbers have continued to increase based on higher smolt numbers (Shaul et al. 2005). Marine survival rates for Taku coho increased in the early 1980's, and reached peaks in the mid 1990's (range - 7 to

23% marine survival) before declining to more moderate levels from 1995 to 2004 (range - 8 to 13% marine survival) (Shaul et al. 2005, 2008). Shaul et al. (2004) presented an inverse relationship between marine survival and coho abundance across stocks in the northern inside and southern boundary areas of southeast Alaska.

Estimated escapement of Taku coho in Canada increased substantially in 2002-04 to levels approximating the peaks returns observed in 1991 to 1994. Recent harvest rates of Taku coho have been lowered in order to protect declining Taku chum stocks. In 2002, escapement into the Taku reached peaks above 200,000 spawners. Recent increases in Taku coho returns appear to be related to good smolt production and reduced harvest rates, rather than improved marine survival conditions.

Figure 17: Averaged escapement counts for 4 major surveyed tributaries for Taku coho from aerial and weir counts from 1984 to 2000.



Taku Pink and Chum

Stock Status at a Glance:

The status of wild Taku pink salmon is expected to be at or near the long-term average abundance. Wild Taku chum stocks are depressed and remain stable of levels 10% of those in the 1970's and 80's.

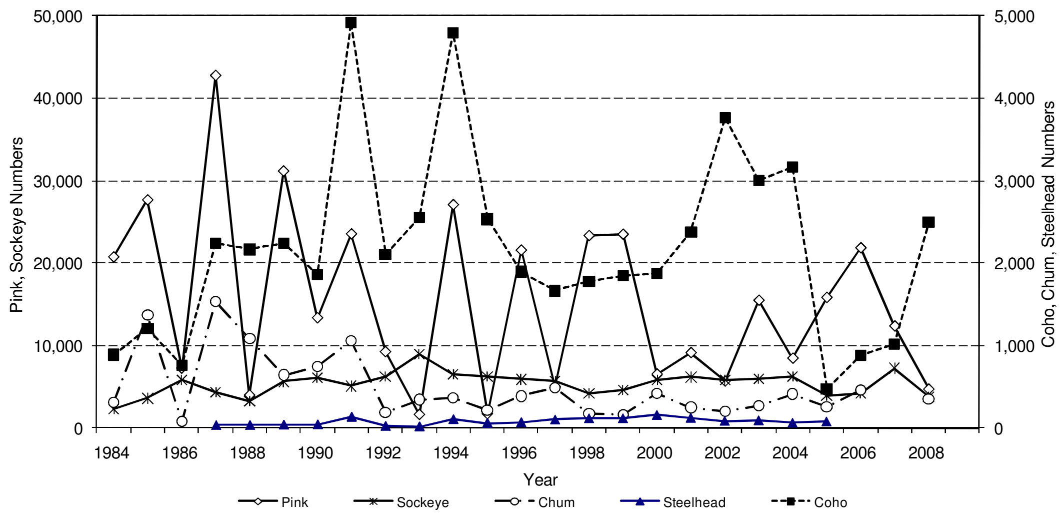
Pink salmon in northern BC and southeastern Alaska is the most abundant species, and it considered one of the most valuable in commercial fisheries, particularly as part of directed fisheries in US waters (Heinl et al. 2008). This level of abundance in total and relative to other salmon species is not observed in the Taku River.

Chum salmon are incidentally caught as part of directed sockeye and particularly coho fisheries. Wild pink and chum salmon escapement is monitored in the Taku through an index of annual variation in catch at the Canyon Island fishwheels, downstream of the US / Canada border. In Canada, both salmon are incidentally captured in commercial test fisheries (DFO 2008b). Pink and chum are harvested in the Taku Inlet commercial fisheries and not harvested in Canadian fisheries.

Comparison of Taku pink average catch and variation over time with other salmon, indicates that levels of abundance are at or potentially higher than sockeye and coho populations in the watershed (Figure 18). Recent catch indices also indicate that escapements are at levels near or similar to long-term averages. Taku pink salmon, like Stikine pink, do not show persistent trends of odd or even year strength or dominance, although odd year pink salmon have returned more frequently over the past decade (Heinl and Geiger 2005).

Taku River chum, along with the Chilkat River, have historically had some of the largest fall chum returns in the region (Heinl et al. 2004, Heinl 2005). Taku chum returns declined in the 1980's to lows in 1992. The reason for this decline is unknown, but is expected to be a combination of impacts in freshwater habitats, over harvestings, ocean production, and increased interactions with other species and particularly enhanced chum salmon from southeast Alaskan hatcheries and sea ranching initiatives. Taku chum numbers are now stable at lower abundance levels 10% of those observed in the 1970's and 80's (Heinl et al. 2004). Commercial fisheries catch has been reduced through fishing restrictions to help protect levels of escapement returning to the Taku. Radio telemetry projects were conducted in 2004 to examine the distribution and escapement of Taku chum stocks.

Figure 18: Taku Canyon Island fishwheel pink, chum, coho and steelhead salmon catch from 1984 to 2008.



Alsek / Tatshenshini Rivers

Alsek River is approximately 200 km long with a drainage area of 28,000 km^2, of which 95% of the watershed is located in northern BC and Yukon. The headwaters are in Yukon's St. Elias Mountains and the river flows southwest from BC to terminate in Dry Bay, 80km south of Yakutat, Alaska (Map 5). The watershed is glacial in origin from two large tributaries, the Alsek and the Tatshenshini rivers. The Tatshenshini joins the Alsek River 15km upstream of the BC / Alaska border.

The Canadian portion of Alsek / Tatshenshini River primarily supports sockeye, Chinook and coho salmon and lower numbers of pink and chum salmon. Salmon migration on the Alsek River portion is impassible beyond a barrier 20km upstream of the Alsek and Tatshenshini confluence. The highest salmon population abundance originates from the Tatshenshini portion of the watershed with major spawning habitats located in the Klukshu, Blanchard and Takhanne rivers and Village Creek.

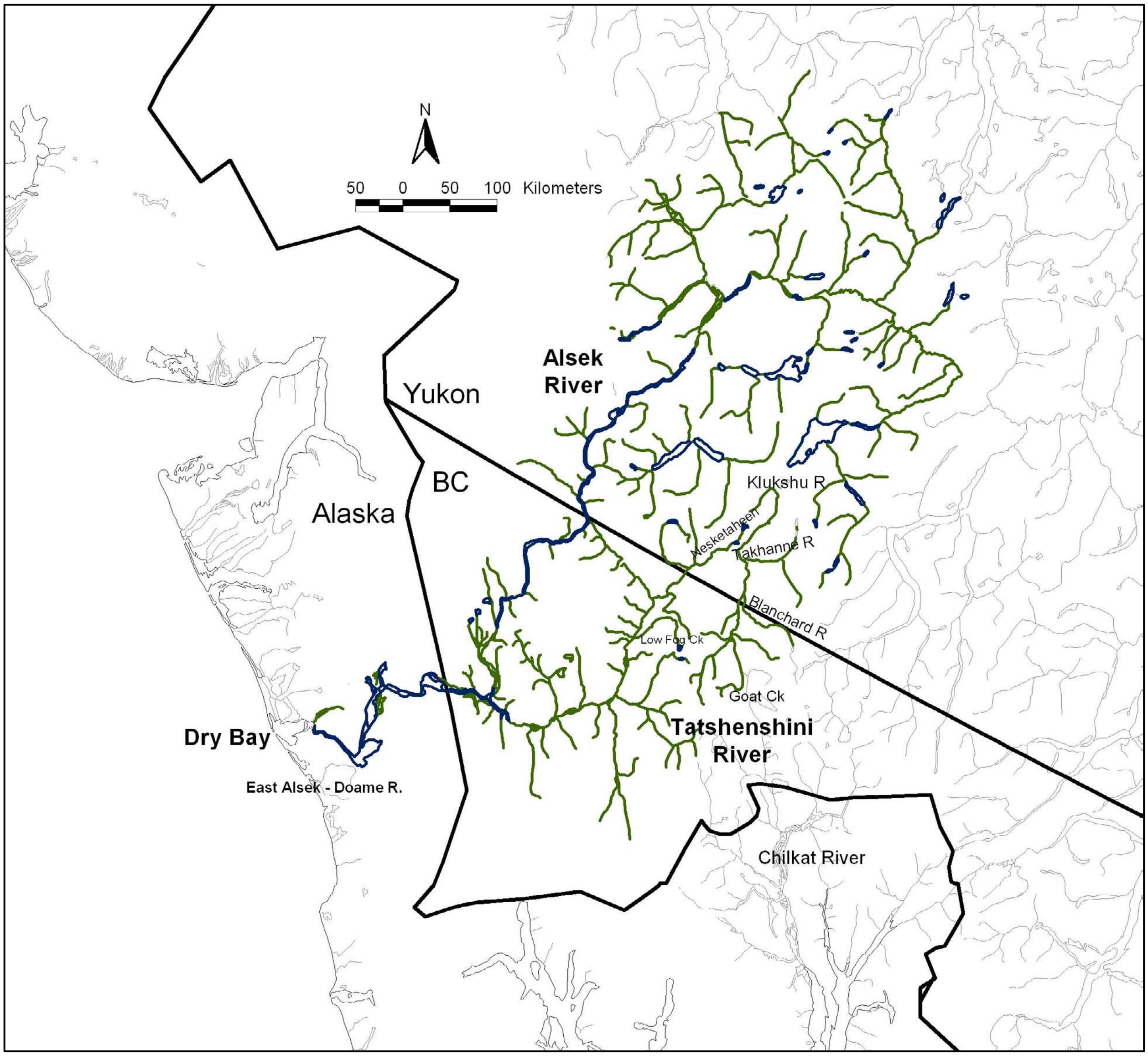
Table 3: Reported presence and distribution of anadromous Pacific salmon in the Alsek / Tatshenshini River.

		Salmon Species in Canada				
	Major Tributaries	**Sockeye**	**Chinook**	**Coho**	**Chum**	**Pink**
Alsek / Tatshenshini	Alsek Mainstem	X	X	X	X	X
	Tatshenshini Mainstem	X		X	X	X
	Blanchard	X	X			
	Takanni		X			
	Klukshu	X	X	X		
	Silver		X			
	Goat		X			
	Takhanne		X	X		
	Village / Nesketaheen	X	X	X		

Alsek sockeye, Chinook, coho and occasionally pink and chum salmon, are harvested by US commercial gillnet and troll fisheries in Dry Bay and Yakutat areas of Alaska. No Canadian commercial fisheries exist in the Alsek / Tatshenshini, although an aboriginal food, social and ceremonial fishery and a recreational sport fishery are found in the Tatshenshini River, upper Klukshu River and headwater tributaries (DFO 2004c, 2008c, TCTR 2005b, 2009, 2010, Woods 2006, 2007). Harvest sharing agreements do not exist in the PST for the Alsek River, although sockeye and Chinook salmon are managed under guidelines of the PST. Sockeye, Chinook and coho salmon stocks are considered the most economically and socially important species in the watershed. Information for pink and chum salmon stocks is not collected.

Sockeye, Chinook and coho salmon populations of the Alsek River are assessed under a program directed by Fisheries and Oceans Canada, which involves joint activities with the Champagne-Aishihik First Nation at the Klukshu River weir, and now involves joint programs with Alaska Department of Fish and Game. Alsek River sockeye and Chinook salmon are monitored through series of annual programs developed to identify total salmon run size and monitor important salmon stocks. These programs involve: (a) estimating Canadian in river total run size through a cross border mark-recapture program where sockeye and Chinook salmon are marked in set gillnets and recovered from counting weirs and spawning ground surveys in index sites in the watershed, (b) marine and in-river catch recording, (c) biological sampling in catch and escapement to identify stocks of origin and wild and enhanced stock contributions (proportions) through use of scale pattern, egg size analyses, and (d) weir counts, electronic counters or aerial surveys to determine stock specific escapements.

Map 5: Alsek / Tatshenshini River system and its major salmon spawning tributaries.



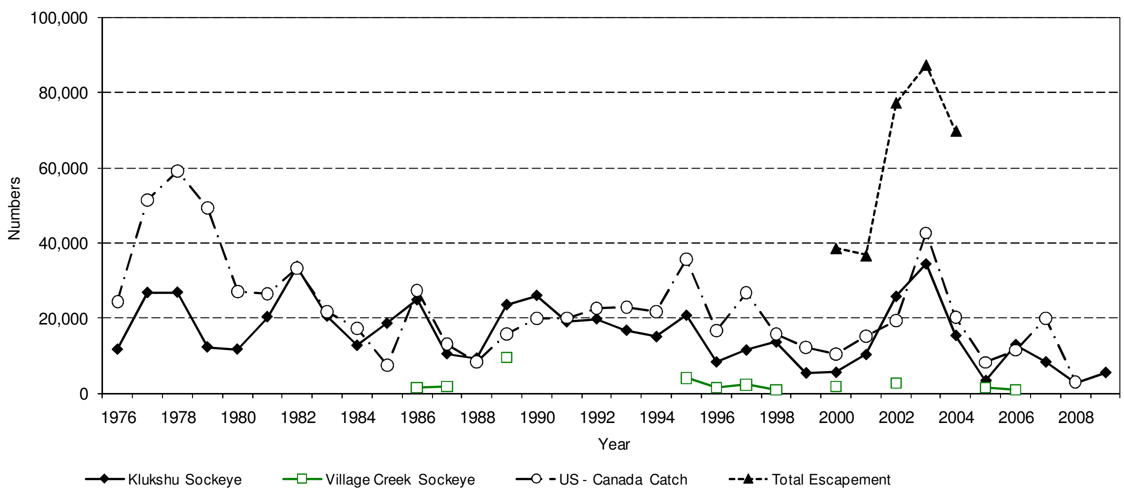
Alsek Sockeye

Stock Status at a Glance:

The status of Alsek sockeye salmon is expected to be below recent levels of abundance. Lower returns of Alsek sockeye are linked to later run timing, lower than average returns of Klukshu sockeye and poor returns in Nesketaheen and mainstem sockeye stocks.

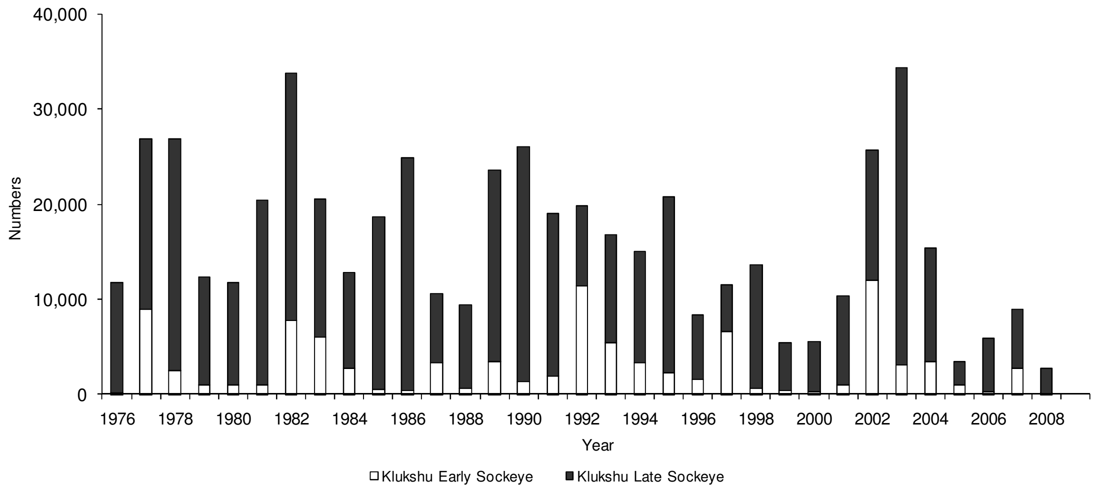
Alsek sockeye are monitored in two main populations: Klukshu and Nesketaheen (Village Creek). Other known populations of sockeye in the Alsek include: Nesketaheen Lake, Blanchard Lake and River, Takhanne River, Goat Creek, Low Fog Creek, and mainstem Tatshenshini and Alsek rivers stocks (Jensen et al. 2005, TCTR 2009). Attempts have been made to develop system wide abundance estimates. Since 1976, a weir has been operated on the Klukshu River to count sockeye escapement. Sockeye identified as early or late portions of the population are based on run timing before (early) or after (late) August 15th (Figure 19, 20) (Waugh et al. 2005, TCTR 2005a, b). Preliminary assessment of sockeye genetics suggests that early and late run sockeye are genetically distinct. Nesketaheen sockeye escapement has been monitored through an electronic counter in Village Creek from 1986 to present.

Figure 19: Klukshu Lake sockeye escapement from 1976 to 2009 based on weir counts, US – Canada total sockeye catch from1976 to 2008, and Nesketaheen Lake sockeye escapement into Village Creek from 1986 to 2006 based on electronic counter estimates of sockeye passage.



Since 2000, sockeye stocks are managed based on total abundance determined by mark-recapture program estimates of in-river run size (Figure 22), catch monitoring and ongoing escapement enumerations at Klukshu and Village sites (Clark and Etherton 2000, Waugh et al. 2005). A joint US / Canada mark-recapture program was run from 2000 to 2004 to estimate total upstream escapement (Figure 19) and estimate the contribution of Klukshu salmon (TCTR 2005b, Jensen et al. 2005, Waugh et al. 2005). Tags were applied to sockeye using gill net sets to capture fish below the border, and tags recovered and counted in upstream fisheries, spawning sites and the Klukshu weir. Intermittent sockeye aerial surveys have been conducted across the watershed since 1986. The relative contribution of Klukshu sockeye to the total Alsek sockeye population was not clearly known (Jensen et al. 2005) throughout the early assessment program, although represented by various studies with estimates ranging from 25 to 60% of the entire stock (McBride and Bernard 1984, Waugh et al. 2005) (Figure 22). A radio tagging study (Jensen et al. 2005) in 2001 to 2003 recently examined stock distribution and proportions of sockeye across the watershed (Figure 21) and suggests that Klukshu sockeye represent about 25% of the population.

Figure 20: Klukshu Lake early (including August 15) and late (following August 15) run sockeye escapement based on weir counts.



Alsek sockeye have shown the lowest and highest escapement over the past decade (Figure 19, 20). Recent escapement is predicted at levels lower than historic levels (30,000 to 90,000) (Woods 2007, DFO 2008c, TCTR 2010). The pattern of low and high abundance for Alsek sockeye follow a pattern consistent with Klukshu escapement (Figure 19) and the proportions of early and late run sockeye (Figure 20). Catch and run-size of the total Alsek sockeye stock appears related to the run strength and proportion of early and later run Klukshu sockeye in a particular year (Figure 22). It is unclear from the existing studies whether marine survival is lower during years with large proportions of later run Klukshu sockeye, although few sockeye return in years with high proportions of late run Klukshu sockeye. This association is consistent with the suggestion that warming trends in ocean and freshwater habitats are believed to negatively influence marine survival and delay run migration of Alsek sockeye.

Figure 21: Percent radio tags recovered from major Alsek sockeye spawning areas from 2001 to 2003 survey years (adapted from Jensen et al. 2005).

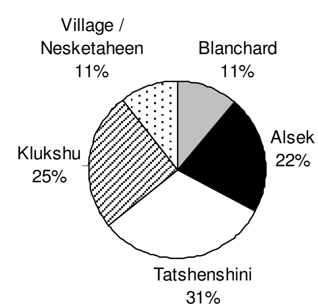
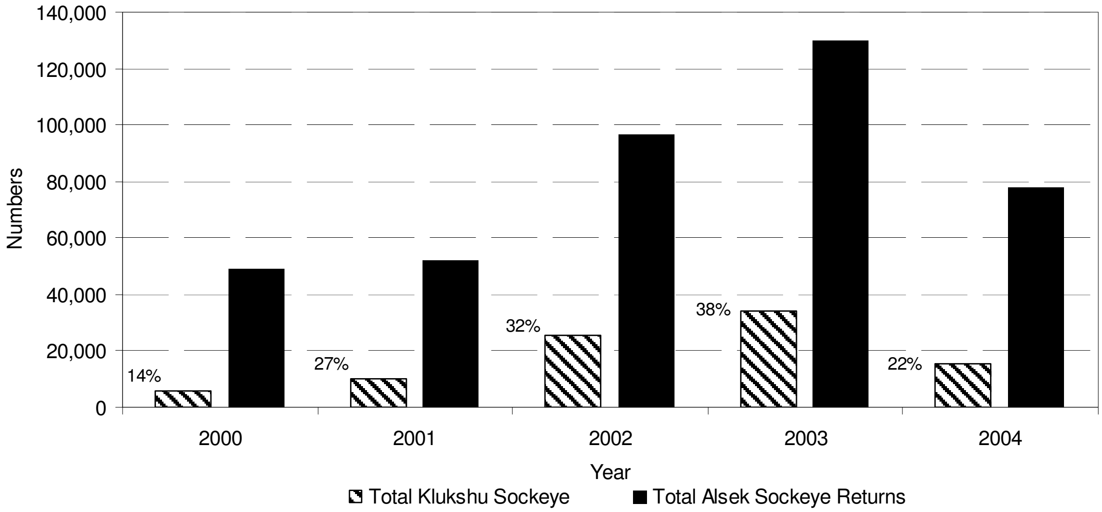


Figure 22: Klukshu sockeye escapement based on weir count during 2000 to 2004, percent Klukshu sockeye escapement relative to total Alsek sockeye escapement (Figure 19), and Alsek sockeye total returns (catch plus escapement - above Dry Bay) based on mark-recapture program estimates from 2000 to 2004. The mark-recapture program was discontinued in 2005.



Alsek Chinook

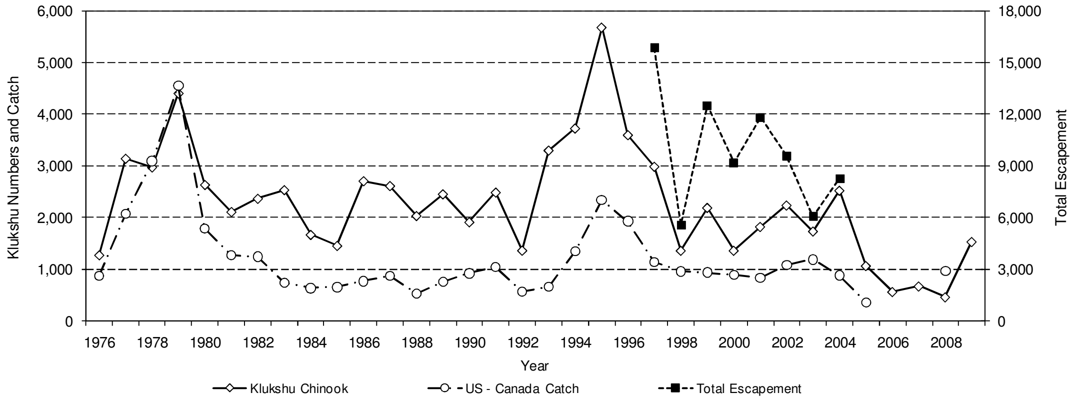
Stock Status at a Glance:

The status of Alsek Chinook salmon is expected to be below recent and historic levels of abundance. Decreased Alsek Chinook abundance is linked to declines in Klukshu Chinook spawners.

Alsek Chinook are monitored in five main populations: Klukshu, total Alsek Chinook, Blanchard, Takhanne, and Goat Creek, and comprise eight known populations including: Klukshu, Blanchard, Takhanne, Goat, mainstem Alsek, Takanni, Silver, and Neshetaheen stocks (McPherson et al. 1998c). Since 1976, a weir has been operated on the Klukshu River to count Chinook escapement.

Since 1997, Alsek Chinook stocks have been managed based on total abundance determined by mark-recapture program estimates of in-river run size (Figure 23), catch monitoring and ongoing escapement enumerations at Klukshu, Blanchard, Takhanne, and Goat Creek (Pahlke and Waugh 2006). A joint US / Canada mark-recapture program was run from 1997 to 2004 to estimate total upstream escapement (Figure 23, 24) and estimate the contribution of Klukshu Chinook salmon to total stock size (Pahlke et al. 1999, Pahkle and Etherton 1999, 2000b, 2001, 2002. Pahlke and Waugh 2003, 2004, 2006, TCTR 2005b). Tags were applied to Chinook using gill net sets to capture fish below the border, and were recovered in upstream fisheries, spawning sites including Klukshu (weir), Blanchard and Takhanne rivers, and Goat Creek. Chinook aerial surveys have been conducted across the watershed since 1984. The relative contribution of Klukshu Chinook to the total Alsek population was not known until the mark-recapture program was started in 1997 and is now estimated from 14% to 32% of the population (Figure 24).

Figure 23: Klukshu River Chinook escapement from 1976 to 2009 based on weir counts and US – Canada total Chinook catch from1976 to 2008.



Prior to 1962, Alsek Chinook were harvested in a directed US commercial gillnet fishery near Dry Bay at the mouth of the Alsek. The fishery was closed due to depressed Chinook stocks and now Chinook are only harvested incidentally during a directed sockeye fishery in the Alsek. Due to poor predicted run sizes, a directed Chinook fishery was not opened in Alsek, as in the Taku and Stikine rivers. Alsek Chinook are also caught in other Alaskan fisheries. A test fishery has been developed to: (i) examine it's potential use as an index of relative abundance, and (ii) to collect DNA samples throughout the run for use in estimating total in-river run size

Figure 24: Klukshu Chinook escapement based on weir counts during 1997 to 2004, percent Klukshu Chinook escapement relative to total Alsek sockeye escapement, and Alsek Chinook total returns (catch plus escapement - above Dry Bay) based on mark-recapture program estimates.

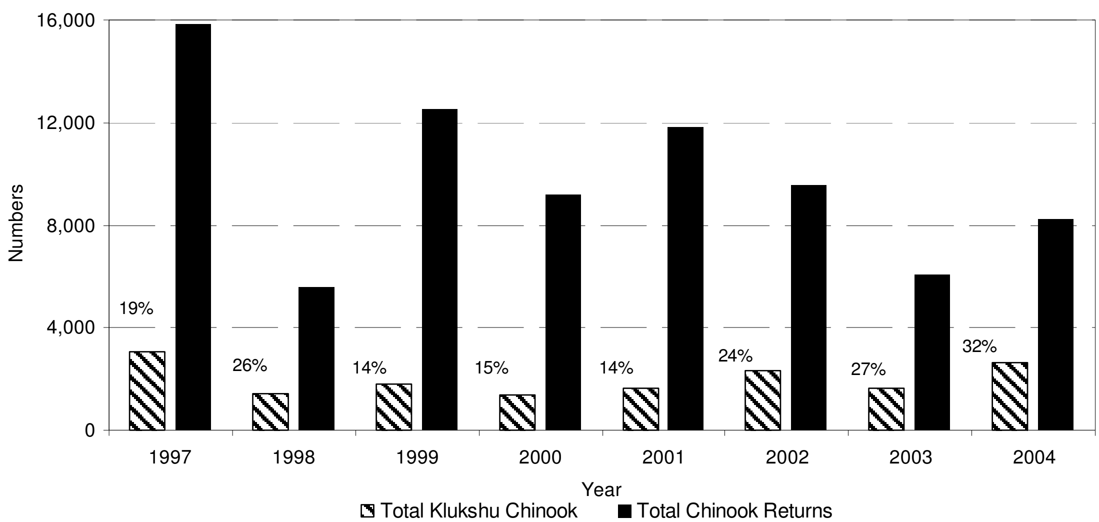
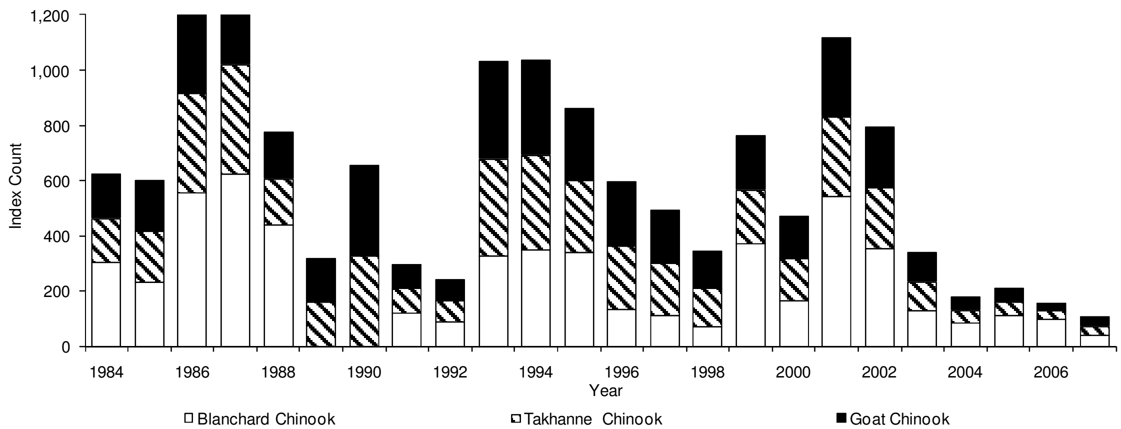


Figure 25: Aerial survey counts of Alsek Chinook escapement in Blanchard, Takhanne Rivers and Goat Creek from 1984 to 2007.



Alsek Chinook have returned at levels similar to historic averages over the past decade. However in the past four years, the stock has declined and shown some of the lowest returns on record (Figure 23). Recent Klukshu escapement is predicted to be lower than historic levels (1,100 to 2,300) and well below escapement targets in the Klukshu (Woods 2007). The patterns of low and high abundance for Alsek Chinook are not consistent with patterns of escapement in Klukshu (Figure 24) and indices of escapement in Blanchard, Takhanne and Goat (Figure 25). Alsek total Chinook escapement generally follows the patterns of low and high shown in the Taku and Stikine. Chinook stocks are still considered below acceptable levels of returns potentially related to warming conditions in marine and freshwater.

Alsek Coho

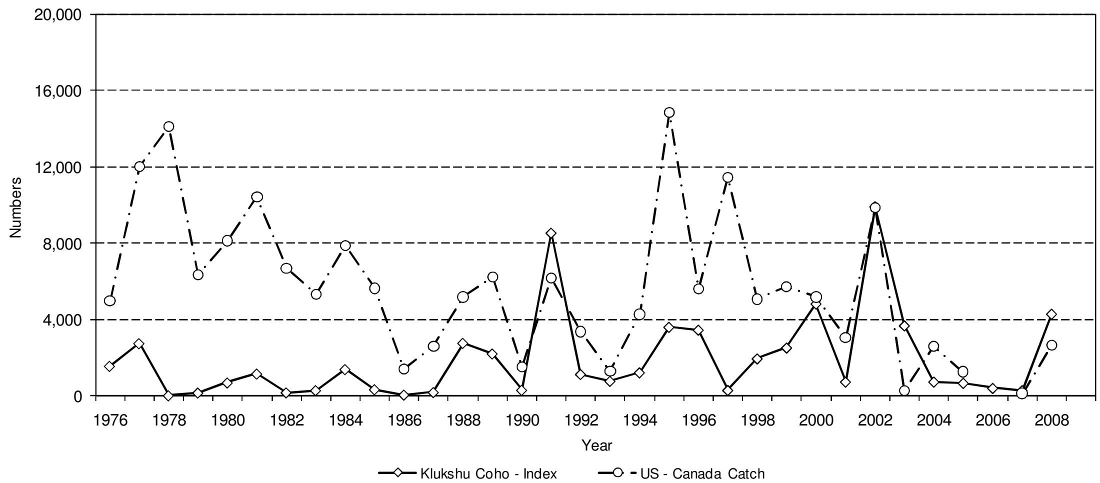
Stock Status at a Glance:

The status of Alsek coho salmon is expected to be below recent and historic levels of abundance with some recent improvement in returning salmon. Decreased Alsek coho abundance is linked to declines in Klukshu coho spawners and recent poor marine survivals.

Alsek coho are monitored in two main populations: Klukshu and total Alsek coho. Coho originate from five known populations including: Klukshu, Takhanne, mainstem Alsek, Village / Neshetaheen and mainstem Tatshenshini stocks. Since 1976, a weir has been operated on the Klukshu River to count coho escapement. Unlike sockeye and Chinook, coho counts only represent an index due to partial overlap between the period operation for the Klukshu weir and the extended run timing of coho beyond the operation of the weir. No other monitoring or stock assessment programs are undertaken in the Alsek for coho salmon due to fall related poor weather conditions in local tributaries. Alsek coho are harvested in a directed U.S. gillnet fishery and in Canadian recreational and First Nation fisheries.

Alsek coho returns are expected to be well below the long-term average as demonstrated in recent harvests and index counts to Klukshu (Woods 2007). Patterns of abundance and recent declines are consistent with those demonstrated in the Stikine and Taku systems. It is unclear to what extent levels of harvest and freshwater and marine conditions influence stock success and production.

Figure 26: Klukshu River coho escapement from 1976 to 2008 based on incomplete weir counts to mid-October, and US – Canada total coho catch from1976 to 2008.



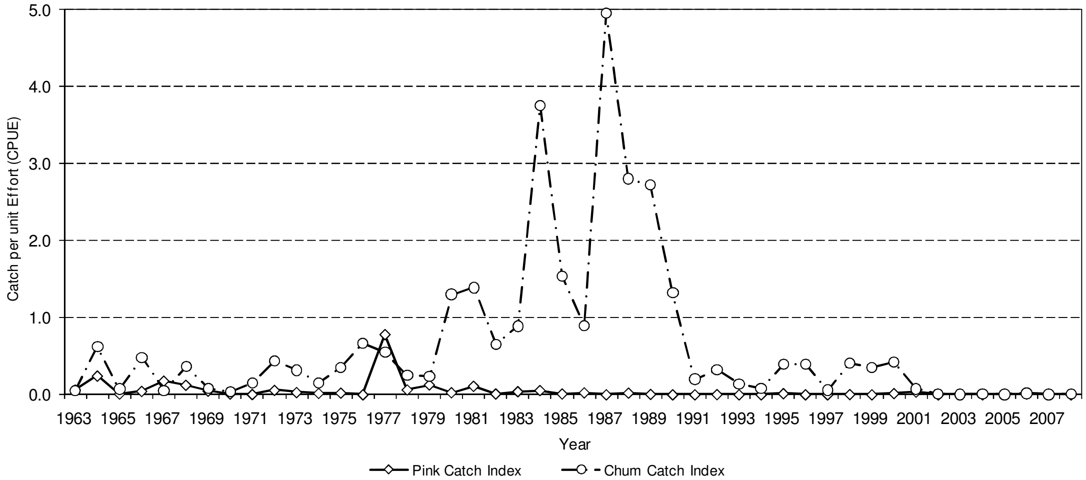
Alsek Pink and Chum

Stock Status at a Glance:

The status of wild Alsek pink and chum is unknown.

Small numbers of pink and chum salmon return to the Alsek relative to sockeye, coho and Chinook stocks. Alsek pink and chum salmon are incidentally caught in low numbers in U.S. commercial gillnet catches and sockeye, Chinook and coho test fisheries in the lower river. No escapement, abundance trend, or stock status information is available for both these species. Catch per unit effort (Figure 27) indicate the presence of primarily chum followed by pink salmon in the US fisheries, but demonstrate no consistent pattern or trend in abundance. The lower river commercial fisheries are selective for sockeye, Chinook and coho and therefore only represent presence / absence for these species. Chum and pink salmon are not caught upstream in Canadian First Nation and recreational fisheries.

Figure 27: Lower Aslek pink and chum salmon catch per unit effort (CPUE) in Dry Bay, Alaska from 1963 to 2008.

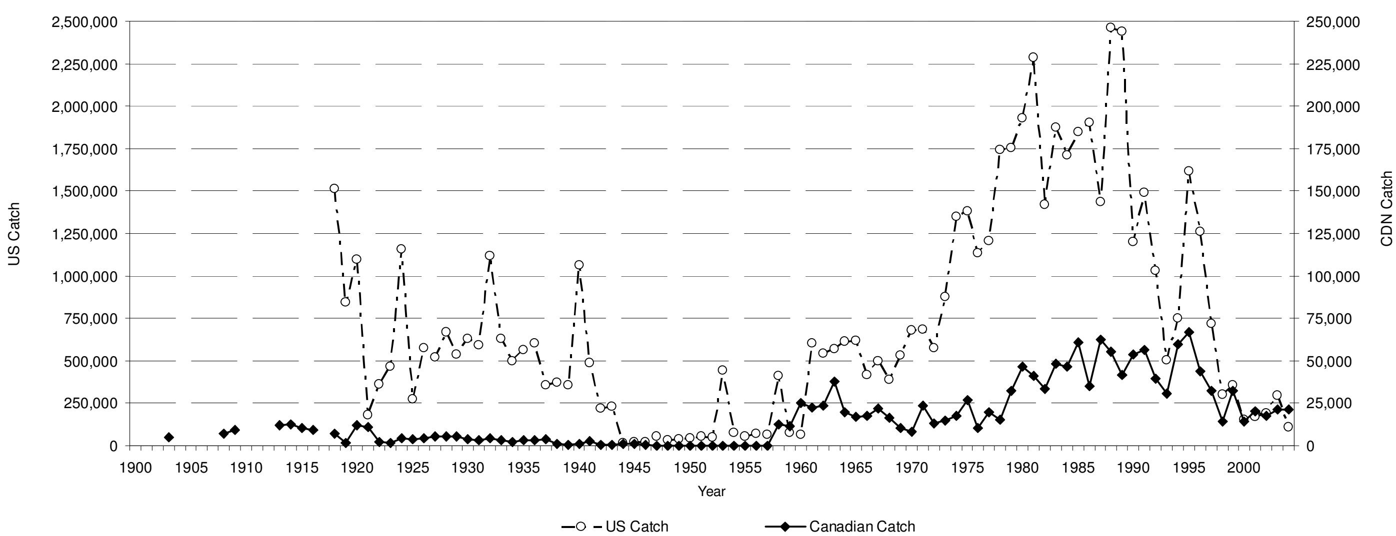


Upper Yukon and Porcupine River

The Yukon River is one of the largest salmon river systems in North America with a drainage area of 854,700 km^2. It originates at the Llewellyn Glacier at the south end of Atlin Lake, BC, and flows 3,700 km through the Yukon and Alaska before entering the Bering Sea. Forty-one percent of the Yukon River is within Canada and this portion of the watershed is divided into nine major sub-basins (Map 6) including: (i) North Yukon mainstem and tributaries (Klondike, Chandindu, Sixty-mile), (ii) Stewart (McQuesten, Janet, Mayo, Crooked, Beaver, Hess), (iii) White (Kluane, Tincup, Nisling), (iv) Pelly (MacMillan, Blind, Ross), (v) mid Yukon mainstem and tributaries (Tatchun, Big Salmon, Little Salmon, Nordenskiald), (vi) Teslin (Nisutlin, Wolf, Morky, Gladys), (vii) south Yukon mainstem and tributaries (Takhini, Michie), (viii) Porcupine (Fishing Branch, Miner, Whitestone) and (ix) Old Crow (DFO 2004d, 2008d, von Finster 2003, 2006). The Upper Yukon and Porcupine rivers comprise a variety of watercourse characteristics and salmon habitats including clear, gravel – rock, fast moving tributaries from mountain headwaters and glaciers, and slow, tannin stained, meandering tributaries that drain sub Arctic tundra (Brabets et al. 1999).

All anadromous salmon species are found in the Yukon River system, but only Chinook, fall chum and coho salmon are present in the Canadian portion of the watershed. Major Chinook spawning areas include the Yukon mainstem, Big Salmon, Little Salmon, Teslin, Pelly and Nisutlin rivers, and spawning has been documented in approximately 112 other spawning streams across the watershed (Table B, Table 4) (von Finster 2003, 2006). Fall chum salmon are abundant in the Yukon mainstem, Kluane, Teslin and Porcupine rivers and also spawn in other systems in the watershed (Table D, Table 4), although more restricted than Chinook in their spawning distribution. Coho salmon appear to be restricted to the Porcupine River, although small numbers of adult salmon are observed and caught regularly in the upper Yukon mainstem late in the fall (JTC 2001, 2006, 2010). The knowledge of Chinook, fall chum and coho spawning distribution and habitats in the upper Yukon and Porcupine rivers in Canada is largely derived from stream inventories and a number of radio telemetry studies.

Figure 28: Summary of Chinook, fall chum and coho salmon catch in the US and Canadian portions of the Yukon River from 1900 to 2007.



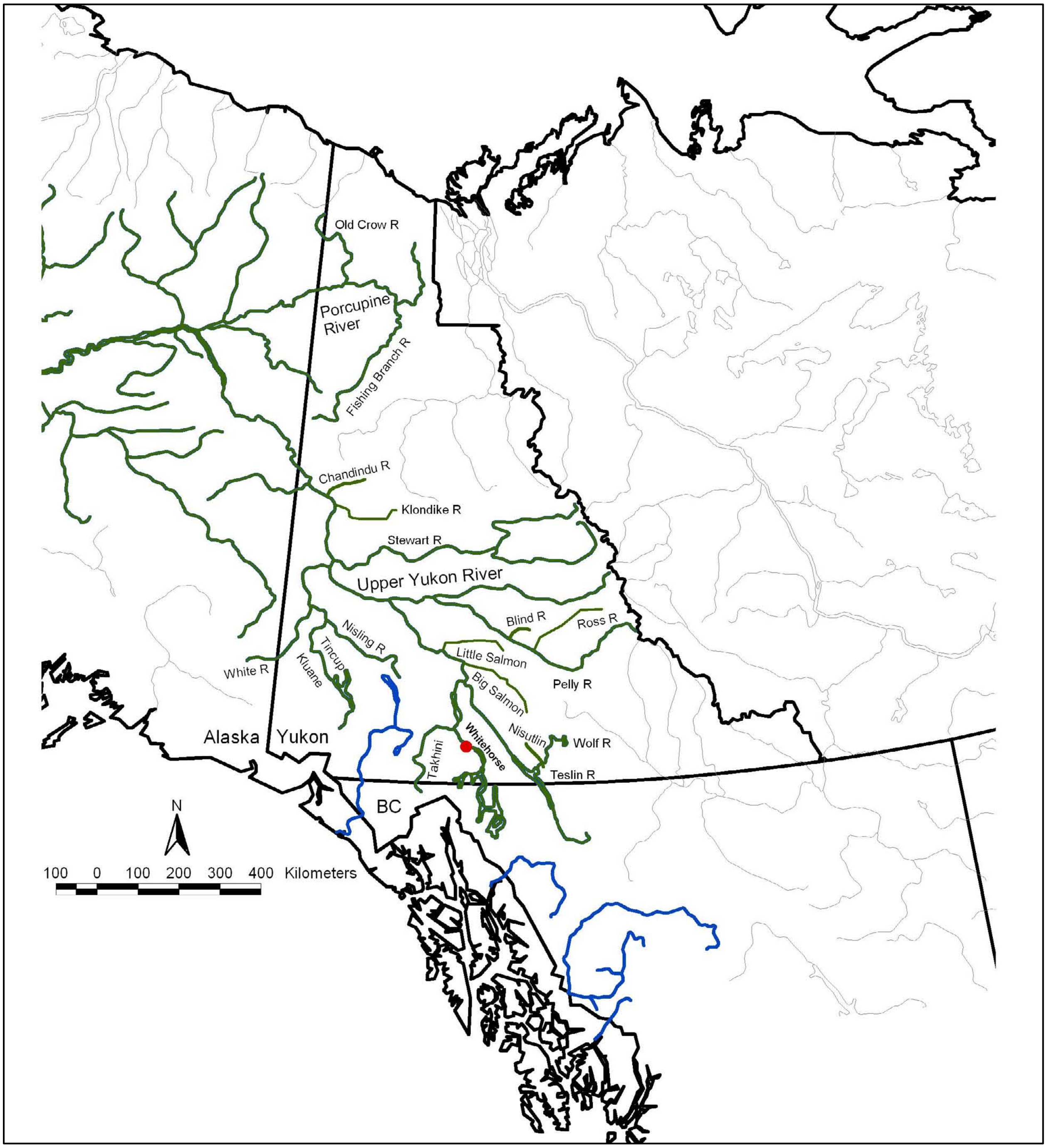
Aboriginal, commercial and sports fisheries have a long history in the Yukon watershed (Brabets et al. 1999) and have supported annual catches of thousands to millions (Figure 28). Yukon Chinook, summer and fall chum and coho salmon and smaller numbers of sockeye and pink salmon, are harvested by U.S. commercial, subsistence, personal use and sports fisheries in Alaska. In Canada, Chinook and fall chum salmon and small numbers of coho are caught in commercial gillnet, fishwheel and test fisheries in the upper Yukon River, by aboriginal fisheries in the upper Yukon and Porcupine rivers, small domestic use and sport fisheries in the upper Yukon (DFO 2004d, 2006b, JTC 2001, 2006, 2008, 2009, 2010). Chinook and fall chum salmon stocks are considered the most economically and socially important species in the Canadian portion of the watershed. Assessment and monitoring programs are lacking for coho salmon in the watershed due to their extended run timing in relation to the onset of difficult winter conditions and high logistical costs for surveys.

Salmon populations of the upper Yukon and Porcupine rivers are assessed under a program developed by DFO. Many of the projects are focused on implementing the 2002 Yukon River Salmon Agreement that is an annex to the Pacific Salmon Treaty. They are reviewed by the Yukon Salmon Sub-Committee and Yukon River Joint Technical Committee (JTC). Some projects, such as the Eagle sonar project and genetic stock identification are undertaken cooperatively with ADF&G. Upper Yukon and Porcupine River Chinook and fall chum salmon are monitored through series of annual programs to identify total salmon run size, differentiate important salmon stocks and wild and enhanced contributions to the salmon run. These programs generally involve: (a) run strength estimates from US based monitoring programs (sonar estimates, early escapement counts) and test and commercial fisheries; (b) estimating Canadian in river total run size through a cross border mark-recapture program where salmon are marked in fishwheels and recovered in commercial fisheries and supplemented with test fisheries downstream of Dawson City on the north sub-basin of the Yukon; (c) in-river US and Canadian catch recording, (d) biological sampling in catch and escapement to identify stocks of origin and wild and enhanced stock contributions (proportions) through use of scale pattern analyses, genetic stock identification, coded-wire tag recovery and radio tagging and recovery programs, and (e) weir (Blind, Fishing Branch) and fishway (Whitehorse Rapids) counts, aerial or foot surveys to determine stock specific escapements. Commencing in 2005, a joint sonar enumeration programs was established and used to estimate salmon border passage. It is expected that the mark-recapture program will be terminated in 2009-2010 with transition and use of the sonar.

Table 4: Reported presence and distribution of anadromous Pacific salmon in the Upper Yukon and Porcupine Rivers (DFO 2004d, 2008d, Holtby and Ciruna 2007, Howard et al. 2009, JTC 2006, 2009, 2010, von Finster 2006).

		Salmon Species in Canada				
	Major Tributaries	**Sockeye**	**Chinook**	**Coho**	**Fall Chum**	**Pink**
Upper Yukon	Upper Yukon Mainstem		X	X	X	
	Klondike		X			
	Stewart		X		X	
	Tatchun		X			
	Teslin		X		X	
	Takhanni		X			
	Big Salmon		X			
	Little Salmon		X			
	Wolf		X			
	Nisutlin		X			
	Koidern				X	
	White		X		X	
	Kluane				X	
	Tincup		X			
	Pelly		X		X	
	Ross		X			
	Blind		X			
	Chandindu		X		X	
Porucpine	Porcupine Mainstem		X	X	X	
	Fishing Branch		X	X	X	

Map 6: Upper Yukon and Porcupine River systems and major salmon spawning tributaries in the Yukon River - Canada.



Upper Yukon Chinook

Stock Status at a Glance:

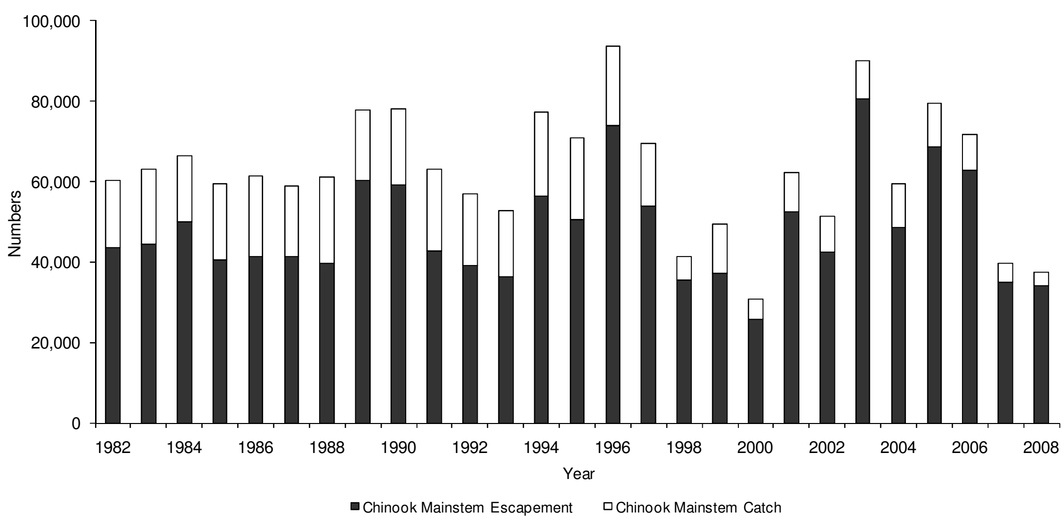
The status of upper Yukon Chinook salmon of Canadian origin is expected to be below average levels of long-term abundance. Chinook salmon runs are expected to increase in upcoming years to reflect to some of the highest returns (1999-2004) observed in Canadian stocks during the period of record reflect stock rebuilding strategies and improved marine conditions and survival.

Upper Yukon Chinook are monitored in 11 main populations in Canada including: total upper Yukon mainstem, Chandindu, Tincup, Blind, Ross, Tatchun, Big and Little Salmon, Nisutlin, Wolf, Whitehorse Rapids and Porcupine (JTC 2006, 2009, 2010) and comprise more than 112 known spawning populations as defined by radio telemetry studies, stream inventories and anecdotal records from salmon habitat surveys (von Finster 2003, 2006).

Since 1982, DFO mark-recapture program has been used to estimate total cross border run size and escapement (Figure 29) (JTC 2006, 2009, 2010, Spencer et al. 2005, 2006, 2007). Tags are applied to Chinook caught in fish wheels, and recovered upstream in test and commercial fisheries and at various spawning sites. Commencing in 2005, a joint program between DFO and ADF&G used Didson and side scanning sonar to determine border passage of Chinook and fall chum salmon. This program replaced the mark-recapture program in 2010. Preliminary results suggest that the mark-recapture estimates are biased 40 to 50% lower for numbers of Chinook salmon passing across the border, than estimates produced by sonar during the 2005 to 2007 period (S. Johnson pers. comm.).

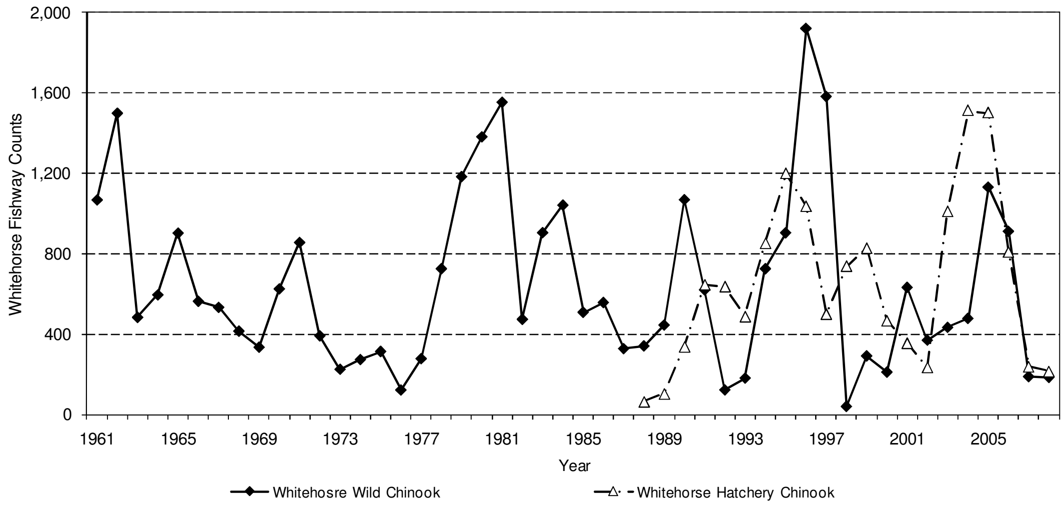
In addition, a number of Chinook monitoring programs have been conducted since 1961 including: counting weirs in Chandindu River and Blind Creek; fishway counts at the Whitehorse Rapids fish ladder and hatchery (Figure 30); test fishery near Dawson City, fish wheels above the U.S. / Canada border, and since 1968, annual aerial surveys across a series of up to seven important spawning systems (Figure 31).

Figure 29: Total Chinook escapement estimates and catch for the Canadian portion of the upper Yukon River, excluding Porcupine River (based on map 6).



Recent tagging radio telemetry work and genetic stock identification has shown that Canadian origin Chinook comprise at least 50% (47- 52%), while Porcupine Chinook comprise less than 3% of entire Yukon Chinook stock (Beacham et al. 1989, Eiler et al. 2004, 2006, Spencer 2006). Spencer (2006) has shown that Canadian origin Chinook are abundant in the lower Yukon River throughout the period of run timing from June 1 to mid July, but peak around mid June. Eiler et al. (2004, 2006) has similarly observed that North Yukon spawning Chinook in the Klondike, Stewart and White river are early run, while headwater and southern Yukon spawning Chinook including Teslin, Whitehorse, Pelly among others, show a later extended run timing. Upper Yukon Chinook spawning populations include: Big Salmon, Blind, Little Salmon, Nisutlin, Ross, Tatchun, Wolf, Chandindu and Tincup rivers (Figure 31, 32) based on average spawner counts from annual aerial surveys between 1968 to 2006.

Figure 30: Escapement estimates for wild and hatchery enhanced Chinook salmon returning to the Whitehorse Rapids fish ladder and hacthery.



Through the mid 2000's, Canadian origin Chinook were differentiated from U.S. stocks in lower Yukon River fisheries using scale patterns analysis to determine age and stock composition (Templin et al. 2005, JTC 2006). Flannery et al. (2006a), Templin et al. (2005) and Beacham et al. (1989) suggest at least six to eight Canadian Chinook stocks can be phenotypically and genetically differentiated (i.e. Table B) including: Canadian border (Klondike, Chandindu), Pelly, (Ross, Blind), Upper Yukon (Tatchun, Big and Little Salmon; Tatchun, Nisutlin), Takhini (Whitehorse), Teslin, White, and Porcupine (Miner, Fishing Branch) river stocks.

Upper Yukon Chinook are harvested in directed Canadian commercial, aboriginal, domestic and sport fisheries and in U.S. commercial, subsistence, personal use and recreational fisheries throughout the watershed. Yukon First Nation fisheries have a long history in the Upper Yukon and include use of gillnets and fish wheels in larger rivers, drift gillnets (Teslin River) and gaffs in smaller tributaries. A directed commercial Chinook fishery was begun in 1898 (Figure 28) and is presently restricted by the number of licences, areas of fishing, timing of openings and types of gear (Brabets et al. 1999).

The Whitehorse Rapids Fishway provides counts on the escapement of wild and enhanced Chinook salmon into the upper Yukon River above Whitehorse (Figure 30). Upper Yukon River Chinook enhancement was initiated in 1984 at the Whitehorse Rapids Fish Hatchery to compensate for loss of downstream migrating Chinook fry at the Whitehorse Rapid hydroelectric facility. Chinook hatchery fish were first observed returning to this fishway in 1988 and have shown increasing levels of enhanced Chinook returns to date.

In the early 1980's and again in the late 1990's, Chinook escapement reached the lowest levels on record (Figure 29, 30, 31). During these periods, rebuilding strategies were used to reduce commercial harvests and stabilize escapement for Canadian origin Chinook (Hayes et al. 2006). Since 2001, upper Yukon Chinook have returned at levels similar to or greater than historic averages (ADF&G 2007d).

Canadian-origin Chinook are believed to have below average levels of escapement in 2008-2010. The patterns of low and high run size for upper Yukon Chinook are consistent with patterns of recent escapement in Whitehorse (Figure 30) and indices of escapement in Big Salmon, Blind, Little Salmon and Tincup rivers (Figure 31). Upper Yukon Chinook escapement generally follows the patterns of low and high abundance observed in the Alsek, Taku and Stikine. Chinook stocks are still considered below acceptable levels of returns, potentially related to fishing pressure within the Yukon River and in marine fisheries (bycatch) and impacts including warming conditions in marine and freshwater habitats.

Figure 31: Aerial survey counts of Upper Yukon Chinook salmon escapement in 9 index systems from 1966 to 2008.

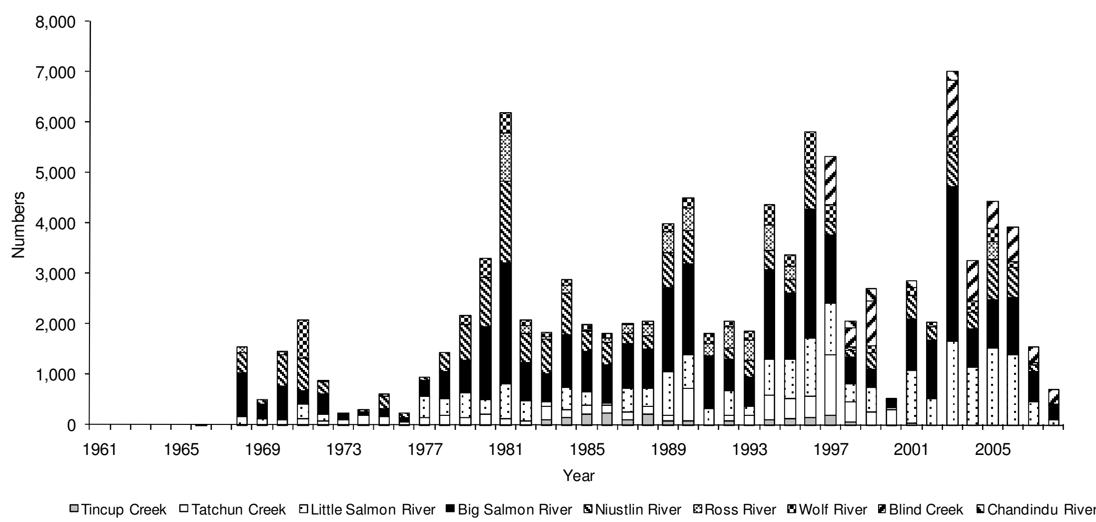
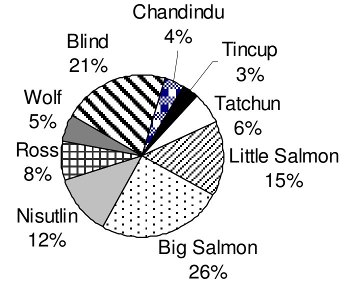


Figure 32: Averaged Chinook escapement counts for 9 major spawning tributaries in the Upper Yukon from annual aerial surveys from 1961-2006.



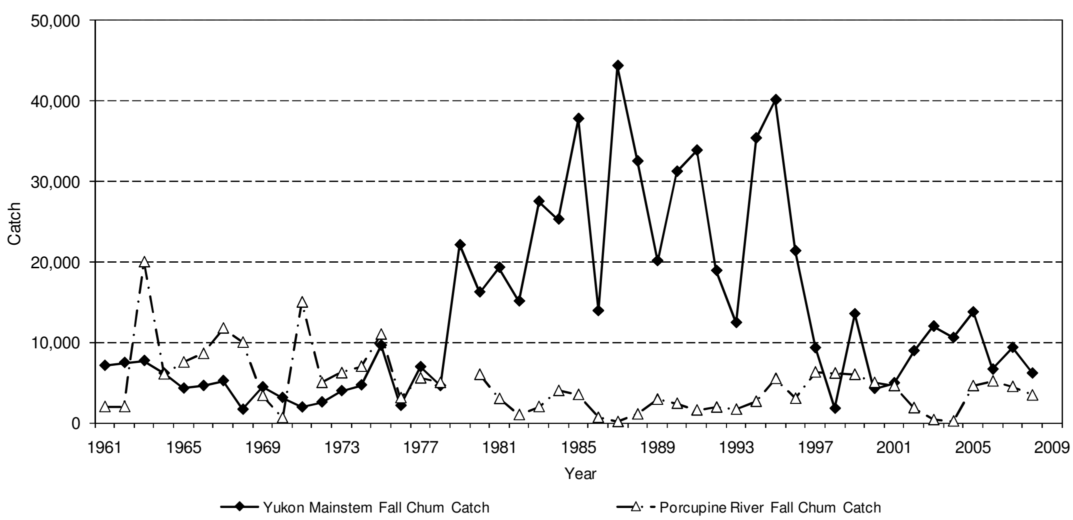
Upper Yukon Fall Chum

Stock Status at a Glance:

> *The status of upper Yukon fall chum salmon of Canadian origin is expected to be at average levels of recent abundance, with expectation of increased level of abundance based on recent higher escapements. Fall chum salmon runs are expected to increase in upcoming years to reflect increased returns based on stock rebuilding strategies and improved marine conditions and survival. The status of Porcupine chum salmon is expected to be average.*

Upper Yukon chum salmon are monitored in four main populations in Canada including: total upper Yukon mainstem, Kluane, Teslin and Porcupine rivers (JTC 2006, 2008, 2009, 2010). The extent of chum spawning distribution has been documented using stream inventories and radio telemetry (Milligan et al. 1986). Fall chum salmon enter the Yukon River usually early to mid July and comprise the main portion of the chum salmon returning to Canadian rivers (ADF&G 2003). Limited numbers of summer run chum that enter the river have also been recently observed in the Fortymile and Klondike rivers of the Upper Yukon (Yukon River Panel 2007). Upper Yukon chum salmon are considered more abundant than Porcupine River stocks (Figure 33), although both sets of chum stocks were considered depressed in run size during the 1998 to 2003 period (Bue et al. 2006).

Figure 33: Fall chum salmon total catch from commercial, First Nation, domestic and recreational fisheries in the upper Yukon mainstem and Porcupine rivers in Canada.



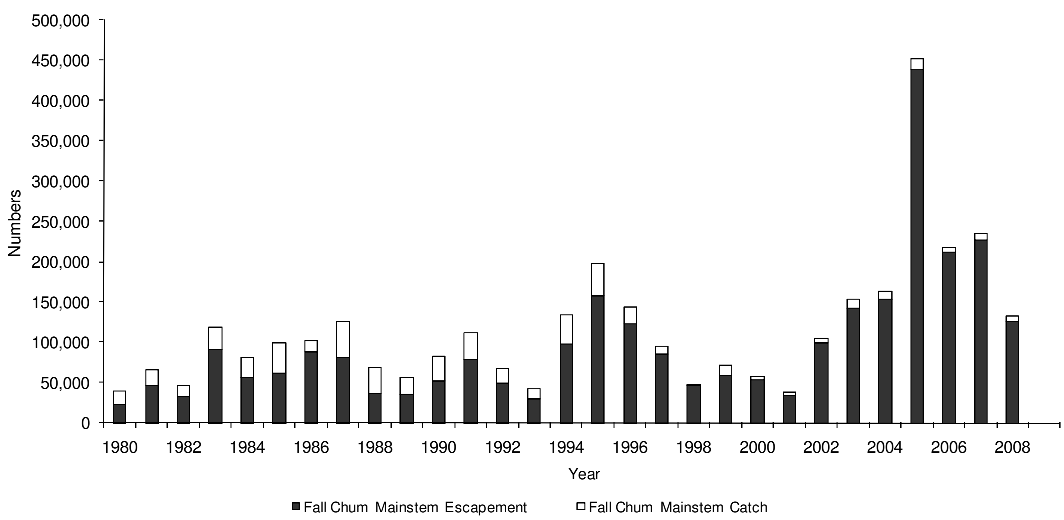
Since 1982, a joint U.S. / Canada mark-recapture program has been used to estimate total cross border fall chum run size and escapement (Figure 34) (Gordon et al. 1998, JTC 2006, 2008, 2009, 2010). Tags are applied to fall chum caught in fish wheels, and recovered in upstream test and commercial fisheries and various spawning sites. As with Chinook, the Eagle sonar program replaced the mark-recapture program in 2010. In addition, a number of fall chum monitoring programs have been conducted since 1972 including: counting weirs in Fishing Branch River

(Porcupine River) (Figure 35); test fishery near Dawson City, fish wheels upstream of the U.S. / Canada border, and since 1972 annual aerial surveys across a series of spawning systems including Yukon mainstem, Koidern, Kluane and Teslin rivers (Figure 36).

Canadian origin fall chum are currently differentiated from US stocks in lower Yukon River fisheries using run timing and biological sampling (larger sized salmon) to determine age and stock composition (JTC 2006). Candy et al. (2005) and Beacham et al. (1998) suggest at least three to four Canadian chum stocks can be phenotypically and genetically differentiated including: Porcupine – Fishing Branch River, mainstem Yukon, White – Kluane, and southern Teslin stocks. More recently genetic techniques have been used to differentiate stock composition in lower Yukon River fisheries.

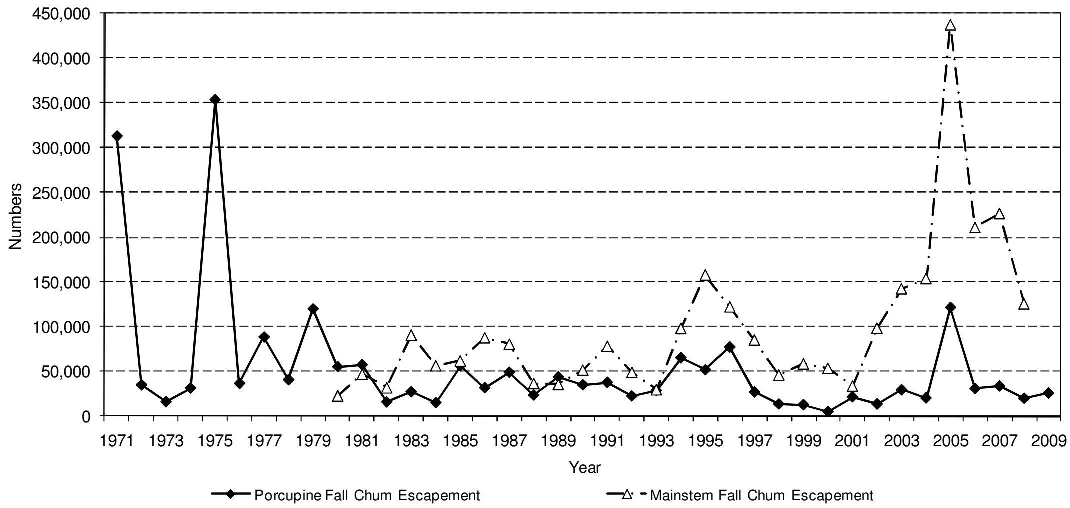
Porcupine River fall chum escapement is monitored at the Fishing Branch weir and is operated by the Vuntut Gwitchin First Nation and Fisheries and Oceans Canada. A single annual aerial survey is usually conducted to estimate escapement in the Yukon mainstem, and Kluane rivers in the White River system, and in the Teslin River (Figure 36). These surveys have been used as a long term index of fall chum escapement.

Figure 34: Total fall chum escapement estimates and catch for the Canadian portion of the upper Yukon River, excluding Porcupine River.



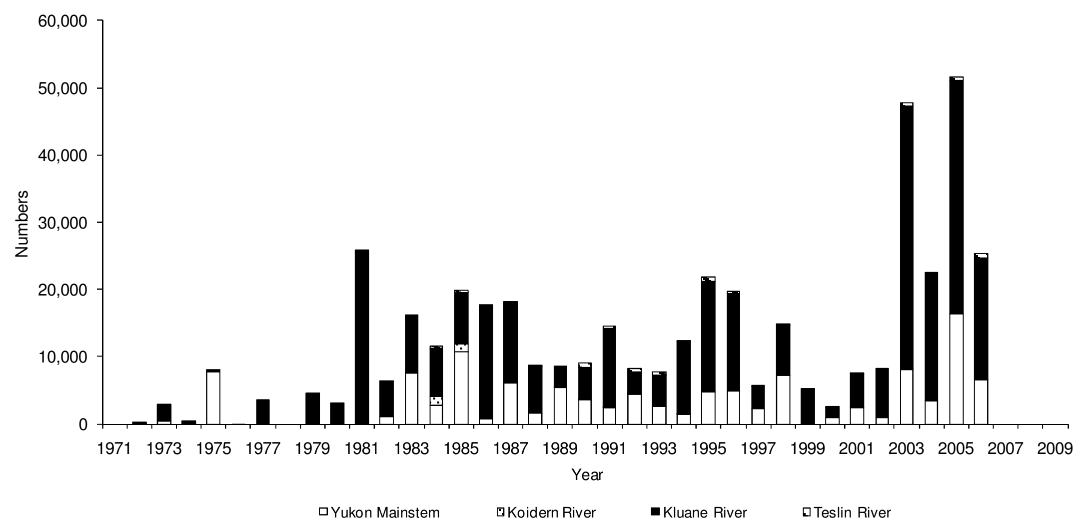
As for Chinook, upper Yukon chum are harvested in directed U.S. commercial, subsistence and personal use and Canadian commercial and aboriginal fisheries, although some interception occurs in U.S. marine waters (Figure 33). Commercial and First Nation fisheries have a long history in the Upper Yukon and include use of gillnets and fish wheels in larger rivers and drift gillnets in smaller tributaries (Figure 28). Fall chum salmon are an important subsistence fishery with greater than 30% of the total salmon aboriginal harvest in the upper Yukon (Bue and Hayes 2007).

Figure 35: Porcupine River (Fishing Branch River) and Upper Yukon mainstem fall chum salmon escapement from 1971 to 2005.



Throughout the 1980's, cycling into the late 1980's – early 1990's, and again in the late 1990's, fall chum escapement and total returns were consider depressed (Figure 33, 34, 35). During these periods stock rebuilding strategies were used to reduce commercial harvests and stabilize escapement for Canadian origin fall chum. Mixed stock analyses have begun using non-invasive DNA samples and techniques to estimate stock contribution and allocate harvest share. Since 2001, upper Yukon fall chum and since 2004, Porcupine chum have returned at levels greater than historic averages (Bue et al. 2004, 2006, ADF&G 2007d). During the past decade stock rebuilding initiatives have reduced exploitation rates on fall chum from greater than 40% before the 1990's to levels less than 20% during the last decade (Bue et al. 2006).

Figure 36: Aerial survey counts of Upper Yukon fall chum salmon in Yukon mainstem, Koidern, Kluane and Tesline rivers from 1972 to 2007.



Canadian origin upper Yukon fall chum were predicted to have above average levels of escapement in 2007. Porcupine River fall chum were predicted to have average levels of escapement in 2007. The patterns of low and high run size for upper Yukon fall chum are consistent with recent patterns of escapement in the Yukon mainstem, Koidern, Kluane and Teslin rivers(Figure 36). Upper Yukon chum escapement generally follows the patterns of low and high abundance observed in the Alsek, Taku and Stikine and is consistent with coast wide patterns of exploitation rates and suggested patterns of marine conditions and survival.

Upper Yukon Coho

Stock Status at a Glance:

The status of upper Yukon coho salmon of Canadian origin is expected to be consistent with increasing levels of abundance observed in lower Yukon Alaskan stocks. Coho salmon runs are expected to remain stable or increase in abundance in upcoming years to reflect reduced fisheries impacts through stock rebuilding strategies and improved production.

Coho salmon are not monitored in the Porcupine and upper Yukon rivers of Canada. Coho salmon are more abundant in the Porcupine River and have been observed returning to spawning sites at the latter half of chum salmon spawning. It is suspected that the majority of the coho run arrives after winter and ice conditions in late October. Yukon River coho salmon have been genetically differentiated as two stocks, lower and upper Yukon in both US and Canada (Flannery et al. 2006b). Porcupine and Fishing Branch River coho form a portion of the larger upper Yukon stock aggregate.

Coho salmon form part of the directed fall chum fisheries in the lower Yukon, and an aboriginal fishery from Old Crow in the Porcupine River (Bue et al. 2006). The aboriginal coho fishery occurs late in the season and harvests on average 340 coho annually and ranging from 11 to 1500 fish (JTC 2006). Alaskan based lower and upper Yukon domestic and subsistence fisheries annually harvest approximately 21,000 coho salmon (Bue et al. 2006).

Recent radio telemetry and under ice gillnetting programs have monitored distribution of coho in the Porcupine and Fishing Branch rivers. Little information is available for upper Yukon and Porcupine river coho salmon in Canada.

Upper Yukon and Porcupine river coho are expected to follow patterns of abundance predicted for upper Alaskan Yukon coho. Upper Yukon coho are predicted to have average to above average returns in the near future related to reduced exploitation rates and enhanced survival and production potentially related to marine conditions and survival.

Glossary

Assessment—an evaluation of the productivity of a fish population conducted to determine the minimum an optimal number of spawners required, and determine the maximum allowable harvest rates on the population.

CU—a Conservation Unit, defined under the Wild Salmon Policy of Fisheries & Oceans Canada, as a group of wild salmon sufficiently isolated from other groups that, if extirpated, is very unlikely to re-colonize naturally within an acceptable time frame, such as a human lifetime or a specified number of salmon generations.

DFO—the Canadian Department of Fisheries and Oceans, also referred to as Fisheries & Oceans Canada. It is the federal agency responsible for managing Pacific salmon and their habitats.

Escapement—the number of fish escaping from a fishery. The escapement from all fisheries is the spawning escapement (i.e., the fish reaching their natal spawning stream).

ESSR—Excess Salmon to Spawning Requirements, a management target, the number of fish desired on the spawning ground. The goal maybe established based on maximizing yield, habitat capacity, or historical precedent.

Habitat—area in which an organism would naturally be found; the place that is natural for life and growth of the organism.

Harvest rate—the percent of the abundance of fish in a fishing area (defined by gear, location, and timing) that are killed in that fishery. Also used to describe the percent of a single age class harvested by all fisheries, e.g., catch of Age-3 Coho salmon.

Index stream—a stream selected as being representative of other streams in an area.

Index stock—a spawning population of fish that is monitored as representative of other populations of the same species in a proximal geographic area or habitat.

Monitoring—sampling of a stream or salmon population on a continuing basis; tracking and reporting on conditions of the environment and salmon.

Pacific Scientific Advice Review Committee (PSARC)—scientific peer review process for stock assessment and scientific information to be used by Fisheries and Oceans Canada.

Population—a localized spawning group of fish that is largely isolated from other such groups. In Pacific salmon, these groups maybe adapted to their local environment due to the high fidelity of homing to their natal streams. The term often refers to salmon of one species that occupies a watershed.

Production—the total number of fish produced from one or several populations.

Productivity—the rate of production per parent in a population. Frequently expressed as a ratio between the parent and the number of adult progeny they produce.

Rate of adult return—is used as a measure of productivity, and determined by the number of mature progeny produced from the number of spawning salmon in the parent generation. Mature progeny are fish returning to their natal streams, i.e., next generation of adults.

Return year—the year that salmon return to fresh water for spawning.

Salmon life stages—*alevins* emerge from eggs and reside in the gravel; *fry* emerge from the gravel and maybe reside in freshwater or migrate to the sea; *parr* are juveniles that reside and grow in freshwater; *smolts* are a transition phase from freshwater parr to seaward migrants and early The period of these stages differs between salmon species.

Spawning year—the year in which eggs were fertilized, may also be referred to as the brood year.

Stock—a genetically similar group of fish, usually returning to a specific geographic area and/or time period.

Stock assessment—evaluation of the productivity of a stock as a basis for deciding escapement goals and sustainable exploitation rates. These analyses provide the basis for conservation, management, and restoration strategies.

Survival rate—portion of the juveniles migrating to sea that survives to adult stages (usually determined by the sum of catches and escapements from a spawning year). Marine survival rate refers to survival of salmon entering the sea to adult stages but frequently also includes a period of freshwater downstream migration before sea entry.

Terminal harvest rate—the portion of a population's returning adults that are killed in fisheries that largely affect just on that population.

Total run—the sum of catches and spawners (all mature fish returning) for a population and spawning year.

Wild—as defined under the Wild Salmon Policy of Fisheries & Oceans Canada, this includes salmon that completed their entire life cycle in the wild, and are the offsprings of naturally spawning salmon that have also continuously lived in the wild.

WSP—the Canadian Policy for the Conservation of Wild Pacific Salmon, commonly referred to as the Wild Salmon Policy of Fisheries & Oceans Canada.

Acknowledgements

The report was prepared with the input and subsequently reviewed by Sandy Johnston, Fisheries and Oceans Canada, Whitehorse with input from Whitehorse Fisheries and Oceans Canada staff. The report benefited from the guidance and review of PFRCC council members, council chair Dr. Jeff Marliave and input from Gordon Ennis and Ken Beeson of the PFRCC.

References

Andel, J.E. and I.A. Boyce. 2007 Mark-Recapture Studies of Taku River Adult Sockeye Salmon Stocks in 2004. Pacific Salmon Commission Technical Report No. 20.

Alaska Department of Fish and Game. 2003. Run timing of summer vs. fall chum salmon on the Yukon River, Alaska. Accessed Jan. 14, 2007.
http://www.genetics.cf.adfg.state.ak.us/publish/handouts/chum03.pdf

Alaska Department of Fish and Game. 2007a. 2006 Chilkat River salmon studies. Accessed Jan. 14, 2007. www.sf.adfg.state.ak.us/region1/salmon/chilkat.cfm 8p.

Alaska Department of Fish and Game. 2007b. 2006 Stikine River salmon studies. Accessed Jan. 14, 2007. www.sf.adfg.state.ak.us/Region1/salmon/stikine.cfm 4p.

Alaska Department of Fish and Game. 2007c. 2006 Unuk River Chinook salmon studies. Accessed Jan. 14, 2007. www.sf.adfg.state.ak.us/Region1/salmon/unuk.cfm 8p.

Alaska Department of Fish and Game 2007d. 2007 Yukon River fisheries outlook. Accessed Mar. 12, 2007. www.cf.adfg.state.ak.us/region3/finfish/salmon/forecast/07yukstrat.pdf

Augerot, X. 2005. Atlas of Pacific salmon: The first map-based status assessment of salmon in the North Pacific. State of the Salmon, Wild Salmon Centre, Portland, OR 161p.

Beacham, T.D., C.B. Murray, and R.E. Withler. 1988. Age, morphology, developmental biology, and biochemical genetic variation of Yukon River fall chum salmon (*Oncorhynchus keta*) and comparisons with British Columbia populations. Fishery Bulletin 86:663-674

Beacham, T.D., C.B. Murray, and R.E. Withler. 1989. Age, morphology, and biochemical variation of Yukon River Chinook salmon. Transactions of the American Fisheries Society 118:46-63.

Beacham, T.D., B. Mcintosh, and C. Macconnachie. 2004. Population structure of lake-type and river-type sockeye salmon in transboundary rivers of northern British Columbia. J. of Fish Biology 65:389-402.

Beacham, T.D., B. McIntosh, C. Macconnachie, K.M. Miller, R.E. Withler. 2006. Pacific Rim population structure of sockeye salmon as determined from microsatellite analysis. Transactions of the American Fisheries Society 135:174-187

Bernard, D.R., S.A. McPherson, K.A. Pahlke, and P. Etherton. 1999. Optimal production of Chinook salmon from the Stikine River. Canadian Stock Assessment Secretariat Research Document – 99/208

Bernard, D.R., and E.L. Jones III. 2010. Optimum escapement goals for Chinook salmon in the transboundary Alsek River. Alaska Department of Fish and Game, Fishery Manuscript Series No. 10-02, Anchorage.

Borba, B.M,. D.J. Bergstrom, and F.J. Bue. 2009. Yukon River fall chum salmon stock status and fall season salmon fisheries, 2009; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 09-24, Anchorage.

Boyce, I.M. and J.E. Andel. 2007. Mark-Recapture Studies of Taku River Adult Sockeye Salmon Stocks in 2005. PSC Tech. Rep. No. 22, November 2007

Boyce, I.M. and J.E. Andel. 2005. Mark-Recapture Studies of Taku River Adult Sockeye Salmon Stocks in 2003. PSC Tech. Rep. No. 17, December 2005

Boyce, I. M., S. A. McPherson, D. R. Bernard, and E. L. Jones III. 2006. Spawning abundance of Chinook salmon in the Taku River in 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-16

Bue, F.J.,B.M. Borba, D.J. Bergstrom. 2004. Yukon River fall chum salmon stock status and action plan. Regional Information Report No. 3A04-05. Alaska Department of Fish and Game, Division of Commercial Fisheries, 333 Raspberry Road, Anchorage, AK 99518

Bue, F.J., B. M. Borba, and D. J. Bergstrom. 2006. Yukon River fall chum salmon stock status and fall season salmon fisheries; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 06-36, Anchorage.

Bue, F.J., and S. J. Hayes. 2007. 2007 Yukon Area subsistence, personal use, and commercial salmon fisheries outlook and management strategies. Alaska Department of Fish and Game, Regional Information Report No. 3A07-04, Anchorage.

Bue, F.J. and S.J. Hayes. 2009. 2009 Yukon Area subsistence, personal use, and commercial salmon fisheries outlook and management strategies. Alaska Department of Fish and Game, Regional Information Report No. 3A09-02, Anchorage.

Burr, J. 2009. Fishery Management Report for sport fisheries in the Yukon Management Area, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 09-51, Anchorage.

Candy J.R., Flannery BG, Beacham TD (2005) Building a collaborative chum salmon microsatellite baseline for Yukon River genetics stock identification. Proceedings of the 22d Pink and Chum Workshop 13 pp.

Clark, J.H. and P. Etherton. 2000. Biological escapement goal for Klukshu River system sockeye salmon. Alaska Department of Fish and Game. Division of Commercial Fisheries. Regional Information Report 1J00-24.

Clark, J. E., A. J. McGregor, and F. E. Bergander. 1986. Migratory timing and escapement of Taku River salmon stocks, 1984-1985. In ADF&G (Alaska Department of Fish and Game) Section Report in 1985 Salmon Research conducted in Southeast Alaska by the Alaska Department of Fish and Game in conjunction with the National Marine Fisheries Service Auke Bay Laboratory for Joint U.S.-Canada Interception Studies. Division of Commercial Fisheries, Final Report, Contract Report WASC-85-ABC-00142 Juneau, Alaska.

Craig, P.C. 1985. Identification of sockeye salmon (*Oncorynchus nerka*) stocks in the Stikine River based on egg size measurements. Can. J. Fish. Aquat. Sci. 42:1696-1701.

Crane, P.A., W.J. Spearman, and L.W. Seeb. 2001. Yukon River chum salmon: Report for genetic identification studies, 1992-1997. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 5J01-08, Anchorage.

Davidson, W, R. Bachman, W. Bergmann, J. Breese, E. Coonradt, S. Forbes, D. Gordon, D. Harris, B. Meredith, K. Monagle, T. Thynes, A. Tingley, and S. Walker. 2007. 2007 Southeast Alaska drift gillnet fishery management plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J07-05, Juneau.

Davidson, W., R. Bachman, W. Bergmann, J. Breese, E. Coonradt, S. Forbes, D. Harris, K. Monagle and S. Walker. 2009. 2009 Southeast Alaska drift gillnet Fishery Management Plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J09-08 Douglas.

Davidson, W., R. Bachman, K. Clark, B. Meredith, E. Coonradt, D. Harris, and T. Thynes. 2010. 2010 Southeast Alaska Drift Gillnet Fishery Management Plan. Alaska Department of Fish and Game, Regional Information Report Series No. 1J10-09 Douglas.

Davidson, W., T.Thynes, D. Gordon, S. Heinl, K. Monagle, and S. Walker. 2009. 2009 Southeast Alaska Purse Seine Fishery Management Plan. Alaska Department of Fish and Game, Regional Report Series No. 1J09-10, Douglas.

Davidson, W., T.Thynes, D. Gordon, S. Heinl, K. Monagle and S. Walker. 2010. 2010 Southeast Alaska Purse Seine Fishery Management Plan. Alaska Department of Fish and Game, Regional Information Report 1J10-11, Douglas.

Department of Fisheries of Canada. 1965. A summary on the status of salmon stocks indigenous to streams originating on the Canadian side of the international border between British Columbia and the Alaskan panhandle. Vancouver, B.C. 20p.

Der Hovanisian, J.A., K.A. Pahlke, P. Etherton. 2001. Abundance of the Chinook salmon escapement on the Stikine River, 2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-18, Anchorage.

Der Hovanisian, J.A., P. Etherton, and K.A.Pahlke. 2003. Abundance of the Chinook salmon escapement on the Stikine River, 2001. Alaska Department of Fish and Game, Fishery Data Series No. 03-09, Anchorage.

Der Hovanisian, J.A., P. Etherton, and K.A.Pahlke. 2004. Abundance of the Chinook salmon escapement on the Stikine River, 2002. Alaska Department of Fish and Game, Fishery Data Series No. 04-28, Anchorage.

Der Hovanisian, J.A., P. Etherton, and K.A.Pahlke. 2005. Abundance of the Chinook salmon escapement on the Stikine River, 2003. Alaska Department of Fish and Game, Fishery Data Series No. 05-25, Anchorage.

Der Hovanisian, J. A., and P. Etherton. 2006. Abundance of the Chinook salmon escapement on the Stikine River, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 06-01, Anchorage.

Eggers, D.M., J.H. Clark, R.L. Bachman, and S.C. Heinl. 2008. Sockeye salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 08-17, Anchorage.

Eggers, D.M., and S.C. Heinl. 2008. Chum salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 08-19, Anchorage.

Eiler, J.H., B.D. Nelson, and R.F. Bradshaw. 1992. Riverine spawning of sockeye salmon in the Taku River in Alaska and British Columbia. Transactions of the American Fisheries Society 121:701-708

Eiler, J.H., T.R. Spencer, J.J. Pella, M.M. Masuda, and R.R. Holder. 2004. Distribution and movement patterns of Chinook salmon returning to the Yukon River basin in 2000–2002. NOAA Technical Memorandum NMFS-AFSC-148, U.S. Department of Commerce. 99p.

Eiler, J.H., T.R. Spencer, J.J. Pella, and M.M. Masuda. 2006. Stock composition, run timing, and movement patterns of Chinook salmon returning to the Yukon River basin in 2004, 107 p. NTIS No. PB2007-102224

Elliott, S.T. and D. R. Bernard. 1994. Production of Taku River coho salmon, 1991-1992. Alaska Department of Fish and Game, Fishery Data Series No. 94-1, Anchorage, Alaska, USA.

Elliot, B.W. 2010. Production and escapement of coho salmon from the Chilkat River, 2006-2007. Alaska Department of Fish and Game, Fisheries Data Series No.10-60, Anchorage.

Fisheries and Oceans Canada (DFO). 2004a. Integrated fisheries management plan salmon Stikine River, BC. June 1, 2003 to May 31, 2004. Fisheries and Oceans Canada, Vancouver, BC. 45p.

Fisheries and Oceans Canada (DFO). 2004b. Integrated fisheries management plan salmon Taku River, BC. June 1, 2003 to May 31, 2004. Fisheries and Oceans Canada, Vancouver, BC. 43p.

Fisheries and Oceans Canada (DFO). 2004c. Integrated fisheries management plan salmon Alsek / Tatshenshini River, BC. June 1, 2003 to May 31, 2004. Fisheries and Oceans Canada, Vancouver, BC. 28p.

Fisheries and Oceans Canada (DFO). 2004d. Integrated fisheries management plan salmon Yukon River, YT. June 1, 2003 to May 31, 2004. Fisheries and Oceans Canada, Whitehorse, YT. 62p.

Fisheries and Oceans Canada (DFO). 2005. Canada's Policy for Conservation of Wild Pacific Salmon. DFO. 49p.

Fisheries and Oceans Canada (DFO). 2006a. Outline of proposed method identify salmon conservation units Canada's Policy for Conservation of Wild Pacific Salmon. September 26, 2006. Accessed April 10, 2007. http://www.pac.dfo-mpo.gc.ca/species/salmon/wsp/consultation/wspcumethod.pdf

Fisheries and Oceans Canada (DFO). 2006b. Yukon River salmon update. September 29, 2006. Whitehorse, Yukon. 3p. Accessed Jan. 14, 2007. http://www.yukonsalmoncommittee.ca/pubs/Yukon_River_Salmon/YSC_Update-29Sept2006.pdf

Fisheries and Oceans Canada (DFO). 2008a. Integrated fisheries management plan salmon Stikine River, BC. April 1, 2008 to March 31, 2009. Fisheries and Oceans Canada, Vancouver, BC. 49p.

Fisheries and Oceans Canada (DFO). 2008b. Integrated fisheries management plan salmon Taku River, BC. April 1, 2008 to March 31, 2009. Fisheries and Oceans Canada, Vancouver, BC. 52p

Fisheries and Oceans Canada (DFO). 2008c. Integrated fisheries management plan salmon Alsek / Tatshenshini River, BC. 2008-2009. Fisheries and Oceans Canada, Vancouver, BC. 40p

Fisheries and Oceans Canada (DFO). 2008d. Integrated fisheries management plan salmon Yukon Chinook and fall chum salmon. April 1, 2009 to March 31, 2010. Fisheries and Oceans Canada, Vancouver, BC. 68p

Flannery B, Beacham T, Wetklo M, Smith C, Templin B, Antonovich A, Seeb L, Miller S, Schlei O, Wenburg JK. 2006a. Run timing, migratory patterns, and harvest information of Chinook salmon stocks within the Yukon River. Alaska Fisheries Technical Report 92, U.S. Fish and Wildlife Service, Anchorage.

Flannery B, Luiten L, Wenburg JK. 2006b. Yukon River coho salmon genetics. Alaska Fisheries Technical Report 93, U.S. Fish and Wildlife Service, Anchorage.

Fleischman, S.J. and B.M. Borba. 2009. Escapement estimation, spawner-recruit analysis, and escapement goal recommendation for fall chum salmon in the Yukon River drainage. Alaska Department of Fish and Game, Fishery Manuscript Series No. 09-08, Anchorage.

Foerster, R.E. 1968. The sockeye salmon, *Oncorhynchus nerka*. Bull. Fish. Res. Bd. Can. 162, 422p.

Geiger, H.J., M.A. Cartwright, J.H. Clark, J. Conitz, S.C. Heinl, K. Jensen, B. Lewis, A.J. McGregor, R. Riffe, G. Woods, and T.P. Zadina. 2004. Chapter 2: Sockeye Salmon Stock Status and Escapement Goals in Southeast Alaska. Special Publication SP 04-02 Chapter 2.

Geiger, H. J., R. L. Bachman, S. C. Heinl, K. Jensen, T. A. Johnson, A. Piston, and R. Riffe. 2005. Sockeye salmon stock status and escapement goals in Southeast Alaska [in] Der Hovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22 Chapter 2, Anchorage.

Gordon, J. A., S. P. Klosiewski, T. J. Underwood, and R. J. Brown. 1998. Estimated abundance of adult fall chum salmon in the upper Yukon River, Alaska, 1996. U. S. Fish and Wildlife Service, Fairbanks Fishery Resource Office, Alaska Fisheries Technical Report Number 45, Fairbanks, Alaska.

Government of Canada, Government of the United States of America. 2006. Treaty between the Government of Canada and the Government of the United States of America concerning Pacific Salmon. November 15, 2006. Pacific Salmon Commission, Vancouver, BC, 137p. Accessed Jan. 14, 2007. http://www.psc.org/pubs/treaty.pdf

Groot, C. and Margolis, L. 1991. Pacific salmon life histories. UBC Press: Vancouver, Canada, 564 p.

Guthrie III, C.M., and R.L. Wilmot. 2004. Genetic structure of wild Chinook salmon populations of Southeast Alaska and northern British Columbia. Environmental Biology of Fishes 69:81-93

Hayes, S.D. J.F. Evenson, G.J.. Sandone. 2006. Yukon River Chinook salmon status and action plan: a report to Alaskan Board of Fisheries. Alaska Department of Fish and Game, Special Publication 06-38, Anchorage.

Heinl, S.C. 2005. Chum salmon stock status and escapement goals in Southeast Alaska [in] Der Hovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22 Chapter 5, Anchorage.

Heinl, S.C., D.M. Eggers, and A.W. Piston. 2008. Pink salmon stock status and escapement goals in Southeast Alaska and Yakutat. Alaska Department of Fish and Game, Special Publication No. 08-16, Anchorage.

Heinl, S. C., and H. J. Geiger . 2005. Pink salmon stock status and escapement goals in Southeast Alaska [in] Der Hovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22 Chapter 4, Anchorage.

Heinl, S.C., T.P. Zadina, A.J. McGregor, and H.J. Geiger. 2004. Chapter 5: Chum Salmon Stock Status and Escapement Goals in Southeast Alaska. Special Publication 04-02 Chapter 5.

Hendrich, C.F., J.L. Weller, S.A. McPherson, and D.R. Bernard. 2008. Optimal production of Chinook salmon from the Unuk River. Alaska Department of Fish and Game, Fishery Manuscript No. 08-03, Anchorage.

Holtby, L.B. and K.A. Ciruna. 2007. Conservation units for Pacific salmon under the Wild Salmon Policy. CSAS Res. Doc. 2007-070. 350pp.

Horne-Brine, M.H., and L. DuBois. 2010. Salmon age and sex composition and mean lengths for the Yukon River Area, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 10-43, Anchorage.

Howard, K.G., S.J. Hayes, and D.F. Evenson. 2009. Yukon River Chinook salmon stock status and action plan 2010; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 09-26, Anchorage.

Hyatt, K.D., K.L. Mathias, D.J. McQueen, B. Mercer, P. Milligan and D.P. Rankin. 2005. Evaluation of hatchery versus wild sockeye salmon fry growth and survival in two British Columbia lakes. North American Journal of Fisheries Management 25:745-762

Irvine, J.R., E. Linn, K. Gillespie, C. McLeod, and J.D. Reist. 2009. Pacific salmon in Canada's Arctic draining rivers, with emphasis on those in British Columbia and the Yukon. Pacific Fisheries Resource Conservation Council. Vancouver B.C.

Jang, L. and T. Webber. 1996. State of water quality of Unuk River near U.S. border, 1991-1993. Environment Canada and BC Ministry of Environment, Lands and Parks. British Columbia. Access Mar. 10, 2007. http://www.env.gov.bc.ca/wat/wq/quality/unuk/index.htm#TopOfPage

Jensen, K.A., B. Waugh and P. Etherton. 2005. Are 5 years of population estimation and 3 years of radio telemetry enough to manage Alsek River sockeye salmon? Commercial Fisheries Division, Alaskan Department of Fish and Game, 3p. Accessed Jan. 14, 2007. http://www.cf.adfg.state.ak.us/geninfo/research/projects/documents/afs05galley.pdf

Jensen, K.A. and S.R.A. Johnston. 2005. Three case studies of cooperative research and management of shared salmon resources in southeast Alaska and northern British Columbia. Commercial Fisheries Division, Alaskan Department of Fish and Game PP-240. 14p. Accessed Jan. 14, 2007. http://www.cf.adfg.state.ak.us/geninfo/research/projects/documents/pst_c.pdf

Joint Technical Committee of the Yukon River US/Canada Pane. 2010. Yukon River salmon 2009 season summary and 2010 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A10-01, Anchorage.

Joint Technical Committee of the Yukon River US/Canada Panel. 2009. Yukon River salmon 2008 season summary and 2009 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A09-01, Anchorage.

Joint Technical Committee of the Yukon River US/Canada Panel. 2008. Yukon River salmon 2007 season summary and 2008 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A08-01.

Joint Technical Committee of the Yukon River US/Canada Panel. 2007. Yukon River salmon 2006 season summary and 2007 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A07-01, Anchorage.

Joint Technical Committee of the Yukon River US/Canada Panel (JTC). 2006. Yukon River salmon 2005 season summary and 2006 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A06-03, Anchorage, AK. 189p.

Joint Technical Committee of the Yukon River US/Canada Panel (JTC). 2001. Yukon River salmon season review for 2001 and technical committee report. Anchorage.

Johnson, R.E., R.P. Marshall, and S.T. Elliot. 1993. Chilkat River Chinook salmon studies, 1992. Alaska Department of Fish and Game, Division of Sport Fish, Fisheries Data Series No. 93-50, 42p.

Jones III, E.L., S.A. McPherson, D.J. Reed, and I.M. Boyce. 2010. Spawning Abundance of Chinook salmon in the Taku River from 1999 to 2007. Alaska Department of Fish and Game, Fishery Data Series No. 10-70, Anchorage.

Jones III, E.L., S.A. McPherson, D.R. Bernard and I.M. Boyce. 2006. Production of coho salmon from the Taku River, 1999–2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-02, Anchorage.

Kelly, M.S., P.A. Milligan. 1997. Mark-recapture studies of Taku River adult salmon stocks in 1996. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J97-22, Anchorage.

Kissner, P.D. Jr. 1977. A study of Chinook salmon in Southeast Alaska. Alaska Department of Fish and Game. Annual report 1976-1977, Project F-9-8, (AFS-41), Anchorage.

Labelle, M. 2009. Status of Pacific salmon resources in southern British Columbia and the Fraser River Basin. Pacific Fisheries Resource Conservation Council, Vancouver, BC, 91p.

Lingnau, T. L. and D. J. Bergstrom. 2003. Yukon River Chinook salmon stock status and action plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A-03-34, Anchorage.

McBride, D.N. and D.R. Bernard. 1984. Estimation of the 1983 sockeye salmon (*Oncorhynchus nerka*) return to the Alsek River through analysis of tagging data. Alaska Department of Fish and Game Technical Report Number 115, Juneau.

McGregor, A.J. and J.E. Clark. 1989. Migratory timing and escapement of Taku River salmon stocks in 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J89-40, Juneau.

McPherson, S.A. and D.R. Bernard. 1995. Production of coho salmon from the Taku River, 1993-1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-29, Anchorage.

McPherson, S.A. and D.R. Bernard. 1996. Production of coho salmon from the Taku River, 1994–1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-25, Anchorage.

McPherson, S.A., D. R. Bernard and J.H. Clark. 2000. Optimal production of Chinook salmon from the Taku River. Alaska Department of Fish and Game, Fishery Manuscript 00-2, Anchorage. Pacific Salmon Commission Joint Chinook Technical Committee Report (99)-3. 1999.

McPherson, S.A., D.R. Bernard, and S.T. Elliott. 1994. Production of coho salmon from the Taku River, 1992-1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-38, Anchorage,

McPherson, S.A., D.R. Bernard, M.S. Kelley, P. A. Milligan, and P. Timpany. 1996. Spawning Abundance of Chinook salmon in the Taku River in 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-36, Anchorage.

McPherson, S.A., D.R. Bernard and M.S. Kelley. 1997b. Production of coho salmon from the Taku River, 1995-1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-24, Anchorage.

McPherson, S.A., D.R. Bernard, R.J. Yanusz, P.A. Milligan, and P. Timpany. 1999. Spawning Abundance of Chinook salmon in the Taku River in 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-26, Anchorage, AK.

McPherson, S., D. Bernard, J. H. Clark, K. Pahlke, E. Jones, J. Der Hovanisian, J. Weller, and R. Ericksen. 2003. Stock status and escapement goals for Chinook salmon stocks in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 03-01, Anchorage.

McPherson, S., D. Bernard, J.H. Clark, K. Pahlke, E. Jones, J. Der Hovanisian, J. Weller, C. Hendrich, and R. Ericksen. 2005. Chinook salmon stock status and escapement goals in Southeast Alaska [in] Der Hovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22 Chapter 1, Anchorage.

McPherson, S.A., D.R. Bernard, J. Clark, K. Pahlke, E. Jones, J. Der Hovanisian, J. Weller, and R. Ericksen. 2004. Chapter 1: Chinook salmon status and escapement goals for stocks in Southeast Alaska. Special Publication 04-02 Chapter 1.

McPherson, S.A., D.R. Bernard, M.S. Kelley, P. A. Milligan, and P. Timpany. 1998a. Spawning abundance of Chinook salmon in the Taku River in 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-41, Anchorage.

McPherson, S.A., D.R. Bernard, M.S. Kelley, P. A. Milligan, and P. Timpany. 1997a. Spawning Abundance of Chinook salmon in the Taku River in 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-14, Anchorage.

McPherson, S.A., P. Etherton, and J.H. Clark. 1998c. Biological escapement goal for Klukshu River Chinook salmon. Alaska Department of Fish and Game, Fishery Manuscript 98-02, Anchorage.

McPherson, S.A., E.L. Jones III, S.J. Fleischman and I.M. Boyce. 2010. Optimal Production of Chinook Salmon from the Taku River Through the 2001 Year Class. Alaska Department of Fish and Game, Fishery Manuscript Series No. 10-03, Anchorage.

McPherson, S.A., R.J. Yanusz, D.R. Bernard and M.S. Kelley. 1998b. Production of coho salmon from the Taku River, 1996-1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-18, Anchorage, AK

Mecum, R.D. and P.D. Kissner. 1989. A study of Chinook salmon in southeast Alaska. Alaksa Department of Fish and Game, Fishery Data Series No.117, Juneau.

Milligan, P. A., W. O. Rublee, D. D. Cornett, and R. A. C. Johnston. 1986. The distribution and abundance of chum salmon *Oncorhynchus keta* in the upper Yukon River basin as determined by a radio-tagging and spaghetti tagging program: 1982-1983. Canadian Technical Report of Fisheries and Aquatic Sciences 1351:141 p.

Murphy, M. and K. Koski and J. Lorenz and J. Thedinga. 1989. Habitat Utilization by Juvenile Pacific Salmon in the Glacial Taku River, Southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences. 46:1677-1685

Olsen J.B., Beacham T.D., Le K.D., Wetklo M., Luiten L.D., Kretschmer E.J., Wenburg J.K., Lean C.F., Dunmall K.M., and P.A. Crane. 2006. Genetic variation in Norton Sound chum salmon populations. Final report for study 45081, Arctic Yukon Kuskokwim Sustainable Salmon Initiative.

Olsen J.B., Spearman W.J., Sage G.K., Miller S.J., Flannery B., and J.K. Wenburg. 2004. Variation in the population structure of Yukon River chum and coho salmon: evaluating the potential impact of localized habitat degradation. Transactions of the American Fisheries Society 133, 476-483.

Pacific Fisheries Resource Conservation Council (PFRCC) 2002. 2001–2002 Annual Report. Vancouver, BC: Pacific Fisheries Resource Conservation Council. 112p.

Pacific Salmon Commission. 1988. Sockeye salmon enhancement feasibility studies in the transboundary rivers. Pacific Salmon Commission, Transboundary Technical Committee, Report TCTR 88-1, Vancouver.

Pacific Salmon Commission. 1993. Transboundary river salmon production, harvest, and escapement estimates, 1992. Transboundary Technical Committee, Report 93-3, Vancouver.

Pacific Salmon Commission, Joint Transboundary Technical Committee (TCTR). 2005a. Estimates of transboundary river salmon production, harvest and escapement and a review of joint enhancement activities in 2003. Report TCTR (05)-1, Vancouver, BC. 179p.

Pacific Salmon Commission, Joint Transboundary Technical Committee (TCTR). 2005b. Preliminary estimates of transboundary river salmon production, harvest and escapement and a review of joint enhancement activities in 2004. Vancouver, BC. 182p.

Pacific Salmon Commission, Joint Transboundary Technical Committee (TCTR). 2006. Preliminary estimates of transboundary river salmon production, harvest and escapement and a review of joint enhancement activities in 2005. Vancouver, BC. 107p.

Pacific Salmon Commission, Joint Transboundary Technical Committee (TCTR). 2009. Salmon management and enhancement plans for the Stikine, Taku and Alsek Rivers, 2009. Report TCTR (09)-02, Vancouver, BC. 76p.

Pacific Salmon Commission, Joint Transboundary Technical Committee (TCTR). 2010. Salmon management and enhancement plans for the Stikine, Taku and Alsek Rivers, 2010. Report TCTR (10)-01, Vancouver, BC. 100p.

Pahlke, K.A. 1999. Escapement of Chinook salmon in Southeast Alaska and Transboundary rivers in 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-17, Anchorage.

Pahlke, K.A. 2006. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2004. Alaska Department of Fish and Game, Fishery Data Series No. 06-04, Anchorage.

Pahlke, K.A. 2007. Escapements of Chinook salmon in Southeast Alaska and Transboundary Rivers in 2005. Alaska Department of Fish and Game, Fishery Data Series No. 07-62, Anchorage.

Pahlke, K.A. 2008. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2006. Alaska Department of Fish and Game, Fishery Data Series No. 08-20, Anchorage.

Pahlke, K.A. 2009. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2007. Alaska Department of Fish and Game, Fishery Data Series No. 09-08, Anchorage.

Pahlke, K.A. 2010. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2008. Alaska Department of Fish and Game, Fishery Data Series No. 10-71, Anchorage.

Pahlke, K.A., and P. Etherton. 1998. Abundance of the Chinook salmon escapement on the Stikine River, 1996. Alaska Department of Fish and Game, Fishery Data Series, No. 97-37, Anchorage.

Pahlke, K.A. and P. Etheton. 1999. Chinook salmon research on the Stikine River, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 99-6, Anchorage.

Pahlke, K.A., and P. Etherton. 2000a. Abundance of the Chinook salmon escapement on the Stikine River, 1998. Alaska Department of Fish and Game, Fishery Data Series No. 00-24. Anchorage.

Pahlke, K.A., and P. Etherton. 2000b. Abundance of the Chinook salmon escapement on the Alsek River, 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-11. Anchorage.

Pahlke, K.A. and P. Etherton. 2001. Abundance of the Chinook salmon escapement on the Alsek River, 1999. Alaska Department of Fish and Game, Fishery Data Series, No. 01-11, Anchorage.

Pahlke, K.A. and P. Etherton. 2002. Abundance of the Chinook salmon escapement on the Alsek River, 2000. Alaska Department of Fish and Game, Fishery Data Series, No. 01- 30, Anchorage.

Pahlke, K.A., P. Etherton, and J.A. Der Hovanisian. 2000. Abundance of the Chinook salmon escapement on the Stikine River, 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-25. Anchorage.

Pahlke, K.A., P. Etherton, R.E. Johnson, and J.E. Andel. 1999. Abundance and Distribution of the Chinook salmon escapement on the Alsek River, 1998. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 99-44, Anchorage.

Pahlke, K.A., P. Richards, and P. Etherton. 2010. Production of Chinook salmon from the Stikine River, 1999–2002. Alaska Department of Fish and Game, Fishery Data Series No. 10-03, Anchorage.

Pahlke, K.A., and B. Waugh. 2003. Abundance and distribution of the Chinook salmon escapement on the Alsek River, 2002. Alaska Department of Fish and Game, Fishery Data Series No. 03-20, Anchorage.

Pahlke, K. A. and B. Waugh. 2004. Abundance of the Chinook salmon escapement on the Alsek River, 2003. Alaska Department of Fish and Game, Fishery Data Series No. 04-27, Anchorage.

Pahlke, K. A., and B. Waugh. 2006. Abundance of the Chinook salmon escapement on the Alsek River in 2004. Alaska Department of Fish and Game, Fishery Data Series No. 06-12, Anchorage.

Richards, P.J., K.A. Pahlke, J.A. DerHovanisian, J.L. Weller and P. Etherton. 2008. Abundance and distribution of the Chinook salmon escapement on the Stikine River in 2005, and production of fish from brood year 1998. Alaska Department of Fish and Game, Fishery Data Series No. 08-33 Anchorage.

Riddell, B. 2004. Pacific salmon resources in central and north coast British Columbia. Vancouver, BC: Pacific Fisheries Resource Conservation Council. 157p.

Scribner, K.T., P.A. Crane, W.J. Spearman, and L.W. Seeb. 1998. DNA and allozyme markers provide concordant estimates of stock differentiation: analyses of U.S. and Canadian stocks of Yukon River fall-run chum salmon (*Oncorhynchus keta*). Canadian Journal of Fisheries and Aquatic Sciences 55:1748–1758.

Shaul, L., E. Jones, and K. Crabtree. 2005. Coho salmon stock status and escapement goals in Southeast Alaska [in] Der Hovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22 Chapter 3, Anchorage.

Shaul, L., S. McPherson, E. Jones and K. Crabtree. 2003. Stock status and escapement goals for coho salmon stocks in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 03-02, Anchorage.

Shaul, L., S. McPherson, E. Jones, and K. Crabtree. 2004. Chapter 3: Coho Salmon Stock Status and Escapement Goals in Southeast Alaska. Special Publication 04-02 Chapter 3.

Shaul, L., E. Jones, K. Crabtree, T. Tydingco, S. McCurdy, and B. Elliott. 2008. Coho Salmon Stock Status and Escapement Goals in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 08-20, Anchorage.

Smikrud, K.M. and A. Prakash, 2006. Monitoring large woody debris dynamics in the Unuk River, Alaska using digital aerial photography, GIScience & Remote Sensing, 43(2):142-154.

Spencer, T.R. 2006. Yukon River salmon agreement studies: Yukon River Chinook salmon radio telemetry. Alaska Department of Fish and Game, Anchorage. Accessed May 20, 2007. http://www.cf.adfg.state.ak.us/geninfo/research/projects/documents/yukonriver_radio.pdf

Spencer, T.R., J.H. Eiler, and T. Hamazaki. 2009. Mark–recapture abundance estimates for Yukon River Chinook salmon in 2000–2004. Alaska Department of Fish and Game, Fishery Data Series No. 09-32, Anchorage.

Spencer, T.R., T. Hamazaki, and J.H. Eiler. 2007. Mark-recapture abundance estimates for Yukon River Chinook salmon in 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-30, Anchorage.

Spencer, T.R., T. Hamazaki, and J.H. Eiler. 2006. Mark-recapture abundance estimates for Yukon River Chinook salmon in 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-31, Anchorage.

Spencer, T.R., T. Hamazaki, and J.H. Eiler. 2005. Mark–recapture abundance estimates for Yukon River Chinook salmon in 2002. Alaska Department of Fish and Game, Fishery Data Series No. 05-75, Anchorage.

Templin, W.D., R.L. Wilmot, C.M. Guthrie II, and L.W. Seeb. 2005. United States and Canadian Chinook salmon populations in the Yukon River can be segregated based on genetic characteristics. Alaska Fishery Research Bulletin 11(1): 44-60

Tingley, A., and W. Davidson. 2010. Overview of the 2009 Southeast Alaska and Yakutat commercial, personal use, and subsistence salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No.10-15, Anchorage.

Volk, E., M.J. Evenson, and R.H. Clark. 2009. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2010. Alaska Department of Fish and Game, Fishery Manuscript No. 09-07, Anchorage.

Von Finster, A. 2003. Notes of fish and fish habitat of the waters of the Yukon Territory. Evergreen Paper, Oct. 2003. Fisheries and Oceans Canada, Whitehorse, YK. Accessed April 10, 2007 http://www.pac.dfo-mpo.gc.ca/yukon/evergrnpaper.pdf

Von Finster, A. 2006. Utilization of habitats by Chinook, chum and coho salmon in the Yukon River basin in Canada. February 15, 2006. Fisheries and Oceans Canada, Whitehorse, YK. 5p.

Waugh, B., P. Etherton, S. Stark, and K. Jensen. 2005. Abundance of the Sockeye Salmon Escapement in the Alsek River Drainage, 2004. Pacific Salmon Commission Technical Report No. 15.

Weller, J.L., and D.G. Evans. 2009. Estimation of the Escapement of Chinook Salmon in the Unuk River in 2006. Alaska Department of Fish and Game, Fishery Data Series No. 09-02, Anchorage.

Weller, J.L., E.L. Jones III, and A.B. Holm. 2006. Production of coho salmon from the Unuk River, 2003–2004. Alaska Department of Fish and Game, Fishery Data Series No. 06-60, Anchorage.

Wood, C.C. and R.A.C. Johnston. 1990. Stock status of Stikine sockeye. Department of Fisheries and Oceans, Pacific Stock Assessment Review Committee S90-7.

Wood, C.C., R.B. Morley, M.R.S. Johannes, R.A.C. Johnston and P. Etherton. 1993. Review of the spawning escapement target for Tahltan lake sockeye salmon. Department of Fisheries and Oceans, Pacific Stock Assessment Review Committee, S93-01.

Woods, G.F. 2006. Yakutat set gillnet fishery 2006 management plan. Alaska Department of Fish and Game, Fishery Management Report No. 06-33, Anchorage.

Woods, G.F. 2007. Summary of the 2006 Yakutat Area commercial salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 07-11, Anchorage.

Yanusz, R.J., S.A. McPherson, and D.R. Bernard. 1999. Production of coho salmon from the Taku River, 1997-1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-34, Anchorage.

Yanusz, R.J., S.A. McPherson, D.R. Bernard, and I.M. Boyce. 2000. Production of coho salmon from the Taku River, 1998/1999. Alaska Department of Fish and Game, Fishery Data Series No.00-31, Anchorage.

Yukon River Panel. 2007. Yukon River chum salmon. Accessed April 10, 2007. http://www.yukonriverpanel.com/chum.htm

Yukon Salmon Committee (YSC). 2006a. Yukon Salmon Committee Minutes – April 4-6, 2006, Meeting #56. Dawson, YK, Accessed April 10, 2007 http://www.yukonsalmoncommittee.ca/pubs/minutes/YSC-Minutes-04Apr2006.pdf

Yukon Salmon Committee (YSC). 2006b. Alsek drainage salmon updates. July 19, 2002 to October 5, 2006. Accessed Jan. 14, 2007. http://www.yukonsalmoncommittee.ca/publications2.shtml#yukon