

## **Environmental Indicator: Fish in British Columbia**

**Primary Indicator:**      *Conservation status of Steelhead Trout stocks rated as healthy, of conservation concern, and of extreme conservation concern.*

**Selection of the Indicator:** The conservation status of Steelhead Trout stocks is a *state* or *condition* indicator. It provides a direct measure of the condition of British Columbia's Steelhead stocks. Steelhead Trout (*Oncorhynchus mykiss*) are highly valued by recreational anglers and play a locally important role in First Nations ceremonial, social and food fisheries. Because Steelhead Trout use both freshwater and marine ecosystems at different periods in their life cycle, it is difficult to separate effects of freshwater and marine habitat quality and freshwater and marine harvest mortality. Recent declines, however, in southern stocks have been attributed to environmental change, rather than over-fishing because many of these stocks are not significantly harvested by sport or commercial fisheries.

With respect to conservation risk, if a stock is over fished, it is designated as being of 'conservation concern'. The term 'extreme conservation concern' is applied to stock if there is a probability that the stock could be extirpated.

**Data and Sources:**

**Table 1. Conservation Ratings of Steelhead Stock in British Columbia, 2000**

Steelhead Stock (Conservation Unit Name)	Extreme Conservation Concern	Conservation Concern	Healthy	Total
Bella Coola-Rivers Inlet		1	32	33
Boundary Bay	4			4
Burrard Inlet	4			4
Central Coast			137	137
Dean			1	1
East Coast Vancouver Is.	44			44
East Coast Vancouver Is. Summer run	6			6
Fraser Canyon	4			4
Lower Fraser Summer run	2			2
Lower Nass River			4	4
Lower Skeena River			11	11
Lower Stikine River			5	5
North Coast			30	30
North Fraser	15			15
Queen Charlotte Islands			28	28
South Coast	56			56
South Coast Summer run	6			6
South Fraser	3	1		4
Stamp		1		1
Taku			8	8
Tsitika	1			1

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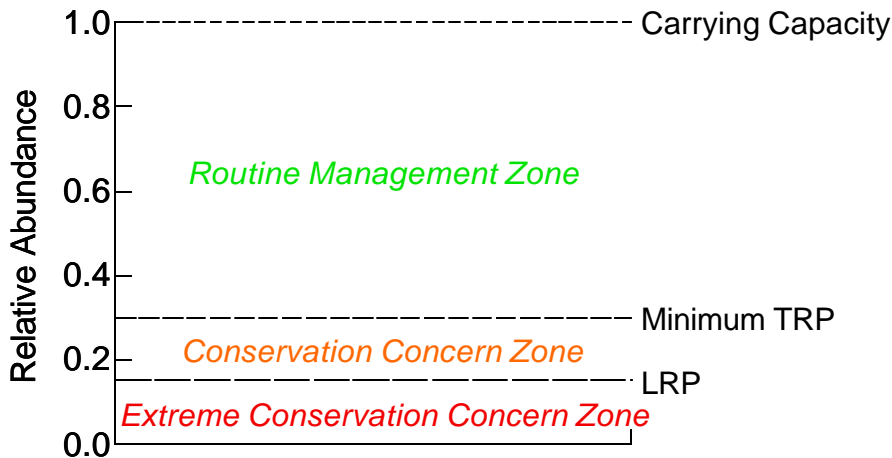
<b>Steelhead Stock (Conservation Unit Name)</b>	<b>Extreme Conservation Concern</b>	<b>Conservation Concern</b>	<b>Healthy</b>	<b>Total</b>
Upper Fraser Summer run	1	6		7
Upper Nass			13	13
Upper Skeena			33	33
Upper Stikine			9	9
West Vancouver Island		95		95
West Vancouver Island Summer run	19			19
<b>Total</b>	<b>170</b>	<b>131</b>	<b>279</b>	<b>580</b>

Source: Ministry of Water, Land and Air Protection, BC Fisheries, 2001.

**Methodology and Reliability:** There are about 600 Steelhead stocks (which are discrete, reproductively isolated populations) in British Columbia. Steelhead stocks are generally managed at the watershed scale, with a few stocks divided into summer-run and winter-run ecotypes on the basis of migration timing and other life history attributes. Some groups of related stocks living in close geographical proximity are managed as stock aggregates. This is done partly because their component stocks have similar productivity and dynamics, and partly because it is difficult to manage these stocks separately in a mixed-stock fisheries.

The status of stocks is determined using data from several well-studied populations in BC and from analytical models used to estimate stock-specific spawner abundance levels, which are required to calculate maximum long-term yields.

There are three status categories: Healthy; Conservation Concern; and Extreme Conservation Concern. These are defined by three population conditions: the carrying capacity (or the asymptotic maximum recruitment); the minimum target reference point (TRP); and the limit reference point (LRP). See Figure 1.



**Fig. 1. A management framework that uses reference points defined in terms of Steelhead abundance results.**

Note: The carrying capacity is the asymptotic maximum recruitment. TRP and LRP are target and limit reference points.

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The minimum target reference point (TRP) refers to the minimum healthy population size for a particular stock, below which there is a conservation concern. The TRP is defined as 25% of the maximum recruitment (carrying capacity) determined from the long-term average smolt-to-adult survival rate (smolts are young fish at the stage when they first migrate from fresh water to the ocean). Populations with abundance above the TRP are considered healthy.

The limit reference point (LRP) refers to the population size at which, should a population drop below this point, there is the risk of extinction. The LRP is defined as 15% of the maximum recruitment determined from the long-term average smolt-to-adult survival rate. It can also be defined as the number of spawners (adults who return and spawn) in a modelled population that are needed to enable recovery to the minimum TRP within one generation in the absence of any harvest. Populations with abundance below TRP, but above LRP, are considered to be of 'conservation concern'. Populations below LRP are of 'extreme conservation concern'.

Smolt-to-adult survival refers to the number of smolts that return to spawn as adults, expressed as a rate. For example, 1,000 spawners returning from a total of 4,000 smolts would equal a rate of 0.25, indicating that 25% of the smolts in that year returned to spawn.

A mathematical model is used because in most cases there are little, if any, field data and those data that are available can be very imprecise. The model used to determine stock-specific TRPs and LRPs is derived from the Beverton-Holt stock recruitment model. The method assumes that there is an upper limit to smolt production that is determined by the amount and quality of freshwater spawning and rearing habitat, and that the maximum smolt recruitment (number of smolts added to the population annually) is, in principle, predictable from habitat characteristics.

**References:**

Ministry of Water, Land and Air Protection. 2000. Discussion Paper: A Draft Policy Framework for the Management of Steelhead [draft].

**Secondary Measure:**    *Age distribution of White Sturgeon.*

**Selection of the Indicator:** The White Sturgeon (*Acipenser transmontanus*) is a very long-lived species, with individuals known to have lived more than 100 years. White Sturgeon are also slow to reach sexual maturity. In the lower Fraser River, males first spawn at 11–24 years of age, and females at 26–34 years (Cannings and Ptolemy 1998). The proportion of juveniles to sub-adults and adults in a population is thus considered a good indicator of that population's long-term viability. A population dominated by juveniles, such as the one found in the mid-Fraser, indicates success in spawning and early rearing. A population dominated by older fish, as is found in the Nechako River, indicates reduced spawning and rearing success.

White Sturgeon can be found scattered along much of the west coast of North America, but are only known to spawn in 3 rivers: the Columbia, the Fraser and the Sacramento. In British Columbia, sturgeon populations occur throughout most of the length of the Fraser River and its major tributary, the Nechako. They are also found in the Kootenay Lake/River system and in the Arrow Lakes/Columbia River. The White Sturgeon is on the provincial Red List of threatened or

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endangered species, and three populations (Nechako, Kootenay, and Columbia) are listed as ‘critically imperilled’ by the BC Conservation Data Centre.

Although overfishing was a major factor in sturgeon declines in the past, commercial and sport harvest of White Sturgeon has been illegal in British Columbia since 1994. Current threats to sturgeon include pollutants (which tend to concentrate in long-lived fish) and habitat degradation by activities such as dredging or gravel mining. The most significant habitat impacts may occur when river flows are regulated by major dams. Sturgeon spawn during the freshet flows of late spring or early summer, and young sturgeon emerge into relatively low and stable summer flows. Dams built for hydroelectric generation, such as on the Nechako, usually cause significant changes to the annual flow pattern. A common outcome for White Sturgeon is recruitment failure (lack of successful spawning or early rearing).

**Data and Sources:**

**Table 2. Age Distribution of White Sturgeon in British Columbia**

Sample Location	Number (%) by Age Class			
	Juveniles	Sub-adults	Adults	Total Number
Lower Fraser River	244 (25)	333 (34)	398 (41)	975
Middle Fraser River	222 (29)	400 (51)	158 (20)	780
Nechako River	7 (4)	32 (16)	158 (80)	197

Source: British Columbia Ministry of Fisheries, 2002.

Notes: Fraser River data were collected between Mission and Hell’s Gate, mid-Fraser Data between Boston Bar and Red Rock Creek, from May 1995 to October 1999. Nechako data were collected between its mouth and the Nautley River from June 1995 to September 1999.

Juveniles are fish <1.0 m in length; subadults are 1.0–1.5 m; adults are >1.5 m.

**Methodology and Reliability:** The data came from several major projects being coordinated by provincial Ministry of Water, Land and Air Protection staff. Most of the data collection was done by two consultants, RL&L and Limnotek.

The methodology included physical habitat assessments, fish collection, radiotracking and lab work. Fish were primarily collected through angling and set-lining, but tangle-netting and electrofishing were also used. Physical measurements were recorded and tissue samples were collected from live fish, which were then released. All fish were tagged by one or more methods, including radio-tags, which allowed their movements to be tracked. Selected fish were operated on to determine sex and maturity status. Standardized labs were used for determining age. The genetic work required development of new tools, but used standard techniques for mDNA and micro-satellite nuclear DNA.

The data are subject to several biases, which were minimized wherever possible.

- Collection methods can be biased towards certain categories of fish. This was minimized by using a variety of collection methods.
- The area covered is so immense that population clusters could have been missed.
- Tag loss can affect population estimates. This was minimized by double-tagging most fish and using internal PIT tags, which have a low loss rate.
- Genetic analyses can be biased by low sample numbers in some areas. This was minimized by intensive effort.

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- There was no sampling effort below Mission Bridge on the lower Fraser River, which means that one component of the metapopulation was not assessed.

**References:**

Cannings, S.G., and J. Ptolemy. 1998. *Rare Freshwater Fish of British Columbia*. Ministry of Environment, Lands and Parks, Victoria, BC.

**Secondary Measure:    *Status of Bull Trout in British Columbia.***

**Selection of Indicator:** The Bull Trout (*Salvelinus confluentus*) is a member of the char family rather than a true trout. In British Columbia, the Bull Trout has been identified listed on the provincial Blue list (indicating a “vulnerable” status). In Alberta it has been designated as a species of special concern. In the United States, where many populations have been extirpated, the Klamath River and Columbia River population segments are listed as “threatened” under the *Endangered Species Act*, June 1998.

The status of the Bull Trout has been selected as a *state* or *condition* indicator because British Columbia is the last remaining jurisdiction with a large presence and wide distribution of the species. Due to this species’ sensitivity to habitat changes, its status may be taken as an indicator of the health of the surrounding habitat. The species is threatened by habitat alteration from logging, grazing, mining and road building (which can lead to increased access and threats from poaching and over-fishing), and from dam construction (which can block migration routes).

**Data and Source:**

**Table 3. Conservation Status of Bull Trout in Watersheds in British Columbia (percentage of total watersheds that had a historical presence of Bull Trout shown in parenthesis)**

Number of Watershed Groups				
Presumed Healthy	Conservation Risk	Presumed Conservation Risk	Conservation Risk Unknown	No Historical Presence
79 (40%)	9 (5%)	60 (30%)	50 (25%)	48

Source: Ministry of Water, Air and Land Protection, 2002.

Notes: The total number of watershed groupings that have historically had Bull Trout populations is 198. The total number of watershed groups in BC is 246. For complete data set see Appendix A.

**Methodology and Reliability:** Little quantitative data on the Bull Trout’s status and trends exist in British Columbia. Therefore, the State of Environment Reporting Office used a qualitative research approach. A geographic survey of BC Bull Trout populations based on major watersheds (three digit codes) was undertaken in December 2001. The survey responses are based on the professional opinions and best expert guesses of regional fisheries staff and includes information provided by the Char Working Group. Those involved were asked to indicate on a table the conservation risks of Bull Trout populations in each watershed.

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The definitions and criteria used to define which populations were included in each conservation risk category are given below:

**1. Presumed Healthy**

- Viable for at least twenty years if no new threats are added to watershed
- AND Data are available for populations in the watershed
- OR there was an absence of significant threats and there was a known occurrence of Bull Trout in watershed.

**Conservation Risk**

- Population is known to be in decline (data are available) and threats are identified.

**Presumed Conservation Risk**

- Current threats are believed to be significantly affecting the population or the population is considered to be at risk.

**2. Risk Unknown**

- Bull Trout known to be present, but no information is available on population status or threats.

**3. No Historical Presence**

- Bull Trout have not historically been present in the watershed group.

**References:**

British Columbia. n.d. *Bull Trout in British Columbia: A Species of Special Concern*. Queen's Printer, Victoria, BC.

BC Environment Fisheries Program. 1994. *A Strategic Plan for the Conservation and Management of Char in British Columbia*. British Columbia Ministry of Environment, Lands and Parks, Victoria, BC.

Baxter, J.S., and J.D. McPhail. 1996. *A Review of Bull Trout (Salvelinus confluentus) Life-history and Habitat Use in Relation to Compensation and Improvement Opportunities*. Fisheries Management Report No. 104, Department of Zoology, University of British Columbia, Vancouver, BC.

Haas, G.R., and J.D. McPhail, 1991. Systematics and Distributions of Dolly Varden (*Salvelinus malma*) and Bull Trout (*Salvelinus confluentus*) in North America. *Canadian Journal of Fisheries and Aquatic Science*. 48: 2191-2211.

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**Appendix A: Status of Bull Trout in Each Watershed group in British Columbia.**

Source: Ministry of Environment, Lands and Parks, 2002.

Watershed Group Name	Watershed Abbreviation	Presumed Healthy	Conservation Risk	Presumed Conservation Risk	Conservation Risk Unknown	No Historical Presence
Adams River	ADMS		*			
Alberni Inlet	ALBN					*
Atlin Lake	ATLL	*				
Atnarko River	ATNA				*	
Babine Lake	BABL	*				
Babine River	BABR			*		
Barrington River	BARR	*				
Beaver River	BEAV	*				
Bella Coola River	BELA				*	
Big Bar Creek	BBAR				*	
Big Creek	BIGC				*	
Blackwater River	BLAR				*	
Blue River	BLUR	*				
Bonaparte River	BONP				*	
Bowron River	BOWR			*		
Bridge Creek	BRID					*
Brooks Peninsula	BRKS					*
Bulkley River	BULK		*			
Bull River	BULL	*				
Campbell River	CAMB					*
Canoe Reach	CANO			*		
Cariboo River	CARR			*		
Carp Lake	CARP			*		
Cheslatta River	CHES				*	
Chilako River	CHIL			*		
Chilko River	CHIR	*				
Chilliwack River	CHWK			*		
Chukachida River	CHUK				*	
Clayoquot	CLAY					*
Clearwater River	CLWR		*			
Coal River	COAL	*				
Columbia Reach	CLRH				*	
Columbia River	COLR				*	

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<b>Watershed Group Name</b>	<b>Watershed Abbreviation</b>	<b>Presumed Healthy</b>	<b>Conservation Risk</b>	<b>Presumed Conservation Risk</b>	<b>Conservation Risk Unknown</b>	<b>No Historical Presence</b>
Comox	COMX					*
Cottonwood River	COTR			*		
Cowichan	COWN					*
Crooked River	CRKD			*		
Cry Lake	CRYL	*				
Deadman River	DEAD					*
Dease Lake	DEAL	*				
Dease River	DEAR				*	
Dog Creek	DOGC				*	
Driftwood River	DRIR			*		
Duncan Lake	DUNC	*				
Dunedin River	DUNE	*				
Elk River	ELKR	*				
Euchiniko Lake	EUCL				*	
Euchiniko River	EUCH				*	
Finlay Arm	FINA		*			
Finlay River	FINL			*		
Firesteel River	FIRE			*		
Fontas River	FONT	*				
Fox River	FOXR				*	
Francois Lake	FRAN				*	
Fraser Canyon	FRCN			*		
Frog River	FROG	*				
Gataga River	GATA	*				
Gladys River	GLAR	*				
Gold River	GOLD					*
Graham Island	GRAI					*
Green Lake	GRNL					*
Guichon Creek	GUIC					*
Harrison River	HARR			*		
Hay River	HAYR					*
Herrick River	HERR			*		
Holberg	HOLB					*
Homathko River	HOMA				*	
Horsefly River	HORS					*
Ingenika River	INGR			*		

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<b>Watershed Group Name</b>	<b>Watershed Abbreviation</b>	<b>Presumed Healthy</b>	<b>Conservation Risk</b>	<b>Presumed Conservation Risk</b>	<b>Conservation Risk Unknown</b>	<b>No Historical Presence</b>
Inklin River	INKR	*				
Iskut River	ISKR	*				
Jennings River	JENR	*				
Jervis Inlet	JERV					*
Kahntah River	KAHN	*				
Kakiddi Creek	KAKC				*	
Kalum River	KLUM			*		
Keecha Creek	KEEC					*
Kettle River	KETL					*
Khutze River	KHTZ					*
Kicking Horse River	KHOR				*	
Kinskuch River	KINR	*				
Kiskatinaw River	KISK		*			
Kispiox River	KISP			*		
Kitasu River	KTSU					*
Kitimat River	KITR					*
Kitlope River	KITL					*
Klappan River	KLAR	*				
Klinaklini River	KLIN				*	
Knight Inlet	KNIG				*	
Kootenay Lake	KOTL	*				
Kootenay River	KOTR	*				
Kotcho Lake	KCHL					*
Kshwan River	KSHR					*
Kumowdah River	KUMR					*
Kusawa River	KUSR				*	
Lakelse River	LKEL			*		
Laredo River	LRDO					*
Liard River	LIAR	*				
Lillooet	LILL		*			
Little Rancheria River	LRAN	*				
Lower Arrow Lake	LARL	*				
Lower Beatton River	LBTN			*		
Lower Bell-Irving River	LBIR	*				
Lower Chilako River	LCHL			*		
Lower Chilcotin River	LCHR				*	

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<b>Watershed Group Name</b>	<b>Watershed Abbreviation</b>	<b>Presumed Healthy</b>	<b>Conservation Risk</b>	<b>Presumed Conservation Risk</b>	<b>Conservation Risk Unknown</b>	<b>No Historical Presence</b>
Lower Dean River	LDEN				*	
Lower Eutsuk Lake	LEUT				*	
Lower Fort Nelson River	LFRT	*				
Lower Fraser River	LFRA			*		
Lower Halfway River	LHAF			*		
Lower Iskut River	LISR	*				
Lower Ketchika River	LKEC	*				
Lower Muskwa River	LMUS	*				
Lower Nass River	LNAR	*				
Lower Nechako Reservoir	LNRS				*	
Lower Nicola River	LNIC			*		
Lower North Thompson	LNTH			*		
Lower Omineca River	LOMI	*				
Lower Peace River	LPCE	*				
Lower Petitot	LPET	*				
Lower Prophet River	LPRO	*				
Lower Salmon River	LSAL			*		
Lower Sikanni Chief River	LSIK	*				
Lower Skeena River	LSKE			*		
Lower Stikine River	LSTR	*				
Lower Trembleur Lake	LTRE			*		
Mahood Lake	MAHD					*
McGregor River	MCGR			*		
Mesilinka River	MESI			*		
Mess Creek	MESC	*				
Middle Banks Island	MBNK					*
Middle Dease River	MDEA	*				
Middle Fort Nelson River	MFRT	*				
Middle Fraser	MFRA				*	
Middle Muskwa River	MMUS	*				
Middle Prophet River	MPRO	*				
Middle River	MIDR			*		
Middle Skeena River	MSKE	*				
Middle Stikine River	MSTR	*				
Milligan Lake	MILL				*	
Morice River	MORR			*		

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Morkill River	MORK			*		
Morsby Island	MORI					*
Murray River	MURR		*			
Murtle Lake	MURT					*
Muskeg River	MUSK			*		
Nahlin River	NAHR	*				
Nakina River	NAKR	*				
Narcosli River	NARC				*	
Nascall River	NASC				*	
Nass River	NASR	*				
Nation River	NATR			*		
Nazko River	NAZR					*
Necako River	NECR			*		
Necleetsconnay River	NECL				*	
Nicola River	NICL					*
Niel Creek	NIEL				*	
Nimkish River	NIMP					*
North Banks Island	NBNK					*
Northeast Vancouver Island	NEVI					*
Okanagan River	OKAN					*
Ospika River	OSPK			*		
Owikeno River	OWIK				*	
Parksville	PARK					*
Parsnip Arm	PARA			*		
Parsnip River	PARS			*		
Peace Arm	PCEA		*			
Pine River	PINE		*			
Pitman River	PITR				*	
Porcher Island	PORI					*
Quesnel River	QUES			*		
Revelstoke Lake	REVL	*				
Sahdoanah Creek	SAHD				*	
Sahtaneh River	SAHT				*	
Salmon River	SALR			*		
Salmon River	SALM					*
San Jose River	SAJR					*

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San Juan River	SANJ					*
Seton Lake	SETN			*		
Seymour Inlet	SEYM				*	
Shekillie River	SHEK					*
Sheslay River	SHER	*				
Shuswap Lake	SHUL				*	
Simikameen River	SIML					*
Skagit River	SKGT	*				
Slocan River	SLOC	*				
Smoky River	SMOK			*		
South Thompson	STHM			*		
Spatsizi River	SPAT	*				
Squamish	SQAM			*		
St. Mary River	SMAR	*				
Stikine River	STIR	*				
Stuart Lake	STUL			*		
Stuart River	STUR			*		
Sustut River	SUST			*		
Swift River	SWIR	*				
Tabor River	TABR			*		
Tahltan River	TAHR	*				
Tahsis	TAHS					*
Takla Lake	TAKL			*		
Taseko River	TASR				*	
Tatshenshini River	TATR	*				
Taylor River	TAYR	*				
Teslin River	TESR	*				
Thompson River	THOM				*	
Toad River	TOAD			*		
Toba Inlet	TOBA				*	
Toodoggone River	TOOD				*	
Tsaytis River	TSAY				*	
Tsea River	TSEA				*	
Tsitka River	TSIT					*
Turnagain River	TURN	*				
Tutshi River	TUTR	*				

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Tuya River	TUYR	*				
Twan Creek	TWAC				*	
Unuk River	UNUR					*
Upper Arrow Lake	UARL	*				
Upper Beaton River	UBTN			*		
Upper Bell-Irving River	UBIR	*				
Upper Chilcotin River	UCHR				*	
Upper Dean River	UDEN				*	
Upper Eutsuk Lake	UEUT				*	
Upper Fort Nelson River	UFRT	*				
Upper Fraser River	UFRA			*		
Upper Halfway River	UHAF			*		
Upper Iskut River	UISR	*				
Upper Jennings River	UJER	*				
Upper Ketchika River	UKEC	*				
Upper Liard River	ULRD	*				
Upper Muskwa River	UMUS	*				
Upper Nass River	UNAR	*				
Upper Nechako Reservoir	UNRS				*	
Upper North Thompson	UNTH			*		
Upper Omineca River	UOMI			*		
Upper Peace River	UPCE	*				
Upper Petitot	UPET				*	
Upper Prophet River	UPRO	*				
Upper Shuswap	USHU			*		
Upper Sikanni Chief River	USIK	*				
Upper Skeena River	USKE	*				
Upper Stikine River	USTK	*				
Upper Trembleur Lake	UTRE			*		
Victoria	VICT					*
Willow River	WILL			*		
Work Channel	WORC					*
Zymoetz River	ZYMO			*		