Notes on Skeena Water Quality and Quantity

Jan 2009, Suskwa Research

The intent of this memo is to present some basic ideas on recent past and current water quality and quantity management in the Skeena watershed. Skeena watershed's climate and physiography are extraordinarily variable and produce a hydrologically complex drainage system. Precipitation varies from 3,000 mm in some coastal basins to less than 500 mm on the Nechako Plateau. Hydrology is complicated, with large amounts of water stored for varying lengths of time in snowpacks, subsurface aquifers, wetlands, and lakes.

Introduction

The purpose of monitoring surface water quality and quantity is to establish and maintain a freshwater water monitoring system that will effectively address all concerns relating to baseline status and potential impacts. This is accomplished through the development of a structured approach to program design that can be widely applied. Given the high degree of variability of the impact sources and the environment, national and provincial water quality monitoring protocols are utilized so that datasets and interpretation are relative.

Monitoring programs often involve a series of repetitive measurements for the purpose of detecting immediate or long term change. Monitoring programs are arbitrarily classified into one of the following monitoring categories: compliance, trend, impact assessment, and survey.

It should be noted that the information obtained from each of these categories is for specific needs. However, data from some categories is frequently useful for other monitoring. In the case of the Skeena Watershed, the emphasis is on trend monitoring; however, compliance monitoring is constant with permitted waste discharges and water withdrawals.

Trend monitoring is used to detect changes over time that may result from a potential short to long-term problem(s). Measurements are made at regular time intervals to determine if long-term trends are occurring for a particular variable. For example, pH or ions would be measured to determine the severity of impacts that acidic precipitation might be having on several water bodies over a defined geographic region, or the effects of climate change on water chemistry, water temperature, water level, time of snowmelt, etc. Long term datasets are critical to understanding past and present conditions, as well as, reliably projecting the scope and details of future conditions.

Trend monitoring is a commitment that extends over a long period (usually 10 years or more), and it is essential that the program minimizes variability through time. Therefore, as much as possible the program should remain consistent in terms of frequency, location, sampling time, and the analytical techniques used.

Lakes are less likely to exhibit the same degree of short term temporal variation as rivers. Consequently, lakes are in some ways more suited for long-term trend assessments. Lakes act as natural collectors of atmospheric deposition and are also integrators of upstream inputs within the watershed. Lakes also act as settling basins for suspended materials and analyses of sediments can be ideal for determining both historical (core samples) and ongoing (repeated grab samples over the duration of a monitoring program) long-term trends. Typically, spring and fall overturn periods produce relatively homogeneous conditions throughout the water column, and these are suitable periods to sample for long-term trends.

Water Survey of Canada Hydrometric Stations
Currently in the Skeena Basin, there are 25 active water level (m) and streamflow (m3/s) stations operated by the Water Survey of Canada (WSC) under the Canada—BC cost-sharing agreement. The stations measure a mix of mainstem, major tributary, and small stream flows. Two WSC stations collect sediment data; these are Usk located on the Skeena River 15 km upstream from Terrace, and Quick located on the Bulkley River approximately 25 km upstream from Smithers.

Long-term hydrometric data are necessary for assessing climate and hydrological variability. Climate change is one of today's most pressing issues and requires knowledge of long-term hydrological trends gained through the analysis of long-term data sets. Nanika River Station located at the outlet of Kidprice Lake, just upstream of the falls, is the representative stream included in the Reference Hydrometric Basin Network (RHBN). RHBN is a sub-set of the national network used in the monitoring and assessment of climate change, and as such, is part of Canada's contribution to the Global Climate Observing System (GCOS).

Currently active WSC Skeena stations with online real time data are numbered as shown in Figure 1 and relate to the table below.

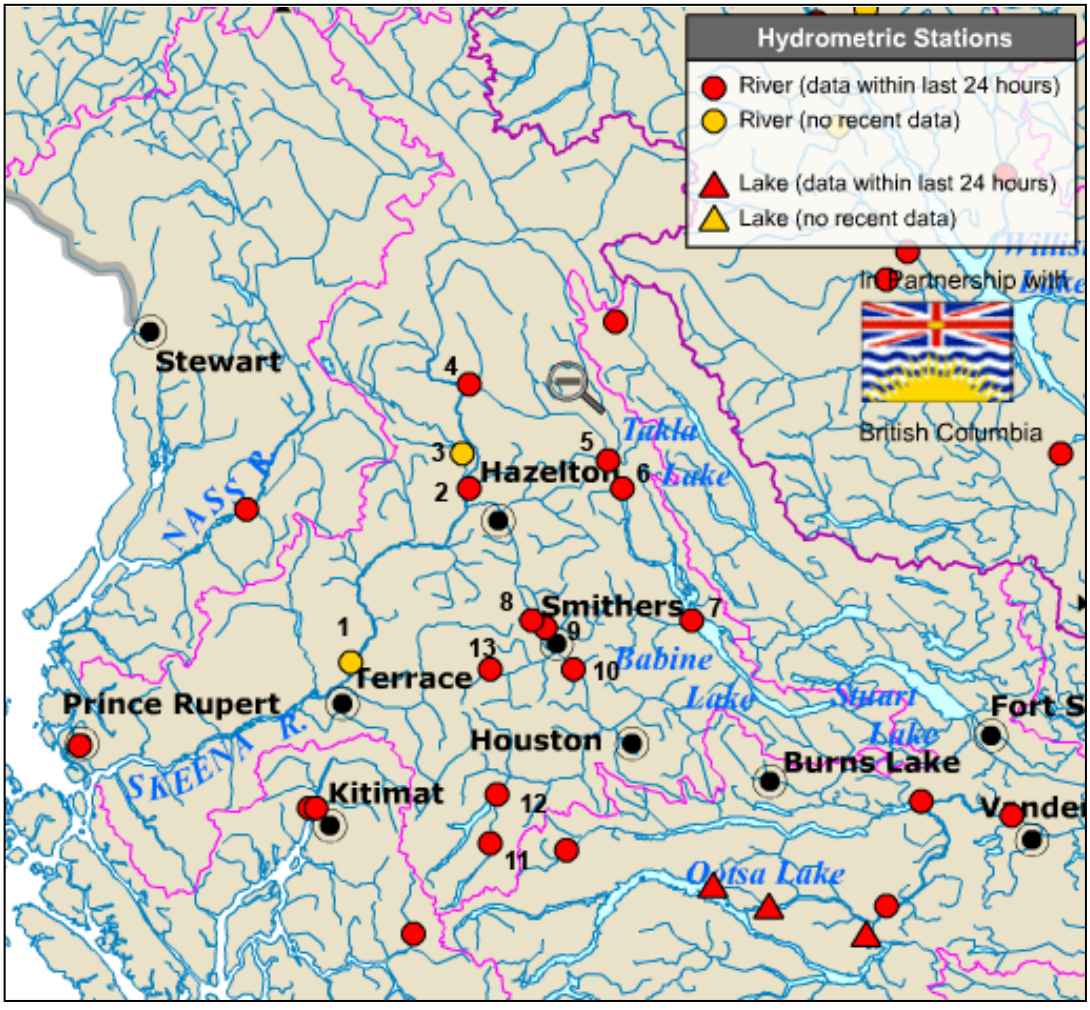

Figure 1. Skeena WSC hydrometric stations; numbered stations have online real time data.

Skeena Hydrometric Stations Active December 2008							
Map No.	**Station No.**	**Location**	**Year From**	**Year To**	**Sed Data**	**RHBN[1]**	**Real Time[2]**
2	08EB003	Skeena River at Glen Vowell, BC,	1960	2009	N	N	Y
3	08EB004	Kispiox river near Hazelton, BC	1963	2009	N	N	Y
4	08EB005	Skeena River above Babine River, BC	1970	2009	N	N	Y
	08EB006	Compass Creek near Kispiox, BC	1997	2009	N	N	N
6	08EC001	Babine River at Babine, BC	1929	2009	N	N	Y
7	08EC003	Babine Lake at Topley Landing, BC	1955	2009	N	N	Y
	08EC004	Pinkut Creek near Tintagel, BC	1929	2009	N	N	N
5	08EC013	Babine River at Outlet of Nilkitkwa Lake, BC	1972	2009	N	N	Y
	08EC014	Twain Creek tributary near Babine Lake, BC	1997	2009	N	N	N
11	08ED001	Nanika River at outlet of Kidprice Lake, BC	1950	2009	N	Y	Y
12	08ED002	Morice River near Houston, BC	1929	2009	N	N	Y
	08ED004	Thautil Corner Creek near Morice Lake, BC	1997	2009	N	N	N
	08EE003	Bulkley River near Houston, BC	1930	2009	N	N	N
10	08EE004	Bulkley River at Quick, BC	1930	2009	Y	N	Y
	08EE008	Goathorn Creek near Telkwa, BC	1960	2009	N	N	N
	08EE012	Simpson Creek at the mouth, BC	1969	2009	N	N	Y
	08EE013	Buck Creek at the mouth, BC	1973	2009	N	N	N
13	08EE020	Telkwa River below Tsai Creek, BC	1975	2009	N	N	Y
	08EE025	Two Mile Creek in District Lot 4834, BC	1982	2009	N	N	N
1	08EF001	Skeena River at Usk, BC	1928	2009	Y	N	Y
	08EF005	Zymoetz River above O.K. Creek, BC	1963	2009	N	N	N
	08EF006	M3 Creek near Smithers, BC	1997	2009	N	N	N
	08EG012	Exchamsiks River near Terrace, BC	1962	2009	N	N	N
	08EG017	Deep Creek above reservoir, BC	1992	2009	N	N	N
	08EG018	Egan Creek near Rosswood, BC	1997	2009	N	N	N
1. Reference Hydrometric Basin Network (RHBN)							
2. Real time data is available on the Internet at: http://scitech.pyr.ec.gc.ca/waterweb/formNav.asp							

Table 1. Active hydrometric stations in the Skeena Basin.

Canada and BC meet annually to review and adjust the hydrometric program according to need. The program's flexibility has permitted it to adapt to the changing needs of water management, and can potentially help to address emerging conservation and protection needs. While the existing network provides the minimum essential inputs to sustainable water management, it requires continuous adjustment to provide the information needed to meet current needs. Provision for such adjustment is provided for in the agreements.

The cost-sharing partners identify the adjustments through a process of network planning that considers client needs, resource restrictions, and the federal-provincial agreement. In terms of fish production and conservation, current WSC water quality and quantity data are frequently not adequate. Present-day and near-future water quality and quantity data are critically needed for a unified WSP monitoring program.

Under the agreement, the federal government publishes the collected data according to national standards. This is important in the case of discontinued Skeena hydrometric stations with 30 or more years of data. In the mid-1990s, WSC conducted a rationalization and reduction program with the hydrometric network. Discontinued stations within the Skeena are shown below.

Discontinued Skeena Basin Hydrometric Stations			
Station No.	**Location**	**Year From**	**Year To**
08EC002	FULTON RIVER AT THE MOUTH, BC	1963	1970
08EC005	FULTON RIVER AT FULTON LAKE NARROWS, BC	1960	1963
08EC006	CHAPMAN LAKE NEAR SMITHERS, BC	1967	1970
08EC007	FULTON LAKE NEAR SMITHERS, BC	1964	1973
08EC008	MORRISON RIVER AT OUTLET OF MORRISON LAKE, BC	1965	1970
08EC009	FULTON RIVER AT OUTLET OF CHAPMAN LAKE, BC	1967	1970
08EC011	BABINE LAKE AT SMITHERS LANDING, BC	1972	1977
08EC012	BABINE LAKE AT PENDLETON BAY, BC	1972	1976
08ED003	MORICE RIVER AT THE MOUTH, BC	1971	1971
08EE001	BULKLEY RIVER NEAR HAZELTON, BC	1915	1952
08EE005	BULKLEY RIVER NEAR SMITHERS, BC	1915	1971
08EE009	RICHFIELD CREEK NEAR TOPLEY, BC	1964	1974
08EE010	KATHLYN CREEK ABOVE SIMPSON CREEK, BC	1967	1979
08EE011	KATHLYN LAKE NEAR SMITHERS, BC	1968	1980
08EE014	CANYON CREEK NEAR SMITHERS, BC	1973	1998
08EE015	FOXY CREEK ABOVE LU CREEK, BC	1974	1975
08EE016	LU CREEK NEAR THE MOUTH, BC	1974	1975
08EE018	MAXAN CREEK ABOVE BULKLEY LAKE, BC	1974	1979
08EE019	MAXAN CREEK AT OUTLET OF MAXAN LAKE, BC	1974	1976
08EE028	STATION CREEK ABOVE DIVERSIONS, BC	1985	1998
08EF003	ZYMOETZ RIVER NEAR TERRACE, BC	1951	1964
08EF004	KITSEGUECLA RIVER NEAR SKEENA CROSSING, BC	1960	1971
08EG006	KITSUMKALUM RIVER NEAR TERRACE, BC	1928	1952
08EG007	LAKELSE RIVER NEAR TERRACE, BC	1948	1955
08EG008	WILLIAMS CREEK NEAR TERRACE, BC	1948	1954
08EG010	SCHULBUCKHAND CREEK NEAR TERRACE, BC	1953	1955
08EG011	ZYMAGOTITZ RIVER NEAR TERRACE, BC	1960	1995

Table 2. Discontinued hydrometric stations in the Skeena Basin.

Most of the 27 discontinued stations listed above show a short term of record. However, the Bulkley River at Hazelton, Canyon Creek near Smithers, and Zymagotitz (Zymacord) River have records ranging from 25 to 37 years in length. These data are archived in the national HYDAT database and can be accessed at: http://www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm. These data are useful in complimenting the other 18 active long-term station records when comparing trends, building hydrological models, and projecting streamflow.

Skeena Basin Programs

1. Skeena River at Usk

Water levels and discharge have been measured at Usk since 1928. This WSC station monitors trends and is the primary water quality monitoring site in the Skeena Basin. Water sampling is conducted on a bi-weekly basis and variables analyzed include: acid/base chemistry, carbon, carbon-nitrogen compounds, major ions, metals, dissolved metals, non-metals, nutrients, organic contaminants, oxygen, pathogens, and physical parameters.

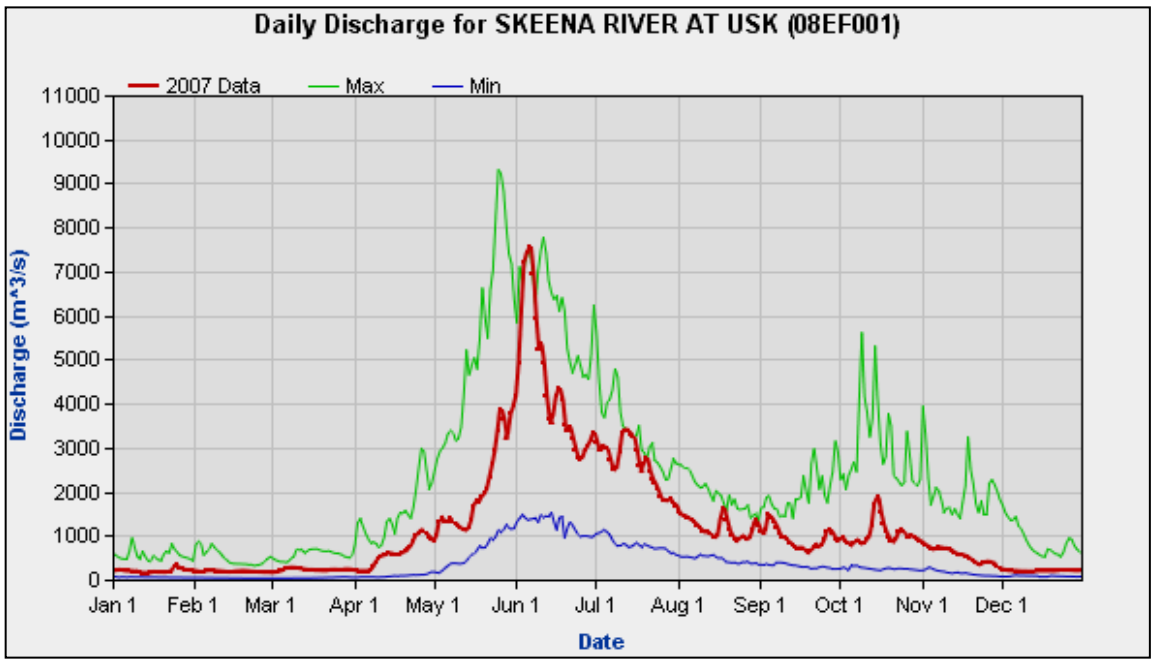

Figure 2. 2007 daily discharge at Usk.

2. Kispiox River

Water temperature and water level measurements have been recorded for approximately 10 years at Clifford and Skunsnat Creeks, which are located in the mid-Kispiox drainage. This data is held by the GWA.

3. Zymoetz River

On Zymoetz River, just downstream of the McDonell Lake outlet, water temperature and water level are recorded. This data is held by the GWA.

4. Suskwa River

A level and temperature logger is located on Natlan Creek, a tributary to Suskwa River. This is downloaded on an annual basis with the data held by the GWA.

5. Slamgeesh Drainage

Water temperature and water level measurements have been recorded at the Slamgeesh counting fence location for nine years. For the Slamgeesh Basin, these measurements are valuable in respect of the sockeye and coho populations. Data are held by the GWA.

6. Upper Skeena Headwaters
Water quality studies have been conducted since 2007 (one year of data) at 7 sites. The data consist of physical attributes (dissolved oxygen, temp, conductivity, total dissolved solids, total suspended solids, anions and nutrients, organic carbon, and total metals. The water quality program is important due to proposed development as well as addressing changing climate concerns in the high elevation headwaters area.

7. Kitwanga River
Water temperature and water level measurements have been recorded for approximately 8 years. The data loggers are located at Gitanyow (Kitwanga) Lake and downstream at the counting fence. This water quality initiative is associated with the Kitwanga Sockeye Recovery Plan. Gitanyow Fisheries Authorities hold the data.

8. Lakelse River
Water temperature, water levels, and an analysis regime of acid/base chemistry, carbon, carbon-nitrogen compounds, major ions, metals, dissolved metals, non-metals, nutrients, organic contaminants, oxygen, pathogens, and physical parameters have been undertaken since 2002. This program is a follow-up on water quality studies implemented in the 1980s. Water quality has been/is being threatened by an Elodia outbreak, elevated levels of iron and phosphorus, low oxygen levels, and frequent high temperatures. Currently, the B.C. Ministry of Environment is conducting a multi-year sediment program on the Lakelse mainstem, Williams Creek, Scully Creek, and other small tributaries to the lake.

9. Exchamsiks River
The WSC Exchamsiks Station (08EG012) measures water levels on Exchamsiks River, which is a tributary into the lower Skeena. This is the only water quality station recording coastal hydrological characteristics.

10. DFO — Skeena Watershed Data
Between 1994 and 2005, DFO has monitored water temperature and has collected a significant amount of data from 37 sites located across the watershed from the coast to the high interior plateau. Some sites have only 8 years of records, while most sites have at least 10 years. The sites are shown on Figure 3 below.

Babine Basin Programs

11. Babine Lake
Water quality has been intensively investigated and studied in the Babine Watershed, particularly in regards to Babine Lake, with limnological and fisheries studies dating back to the 1940s. Babine Lake is the largest sockeye nursery lake in BC and currently produces about 90% of the sockeye returns to the Skeena River. As well, two open pit copper mines operated in the early and mid-1990s and to date, have contributed low levels of copper, which is likely due to the lake water having a high affinity for adsorbing copper ions. Ongoing toxicology testing related to the decommissioned mine sites is conducted by Ned'u'ten Fisheries. Babine Lake levels are measured at Topley Landing (WSC Station 08EC003).

Babine River water levels are measured at Fort Babine (WSC Station 08EC001) and at the fisheries counting fence (WSC Station 08EC013) just downstream of Nilkitkwa Lake. Streamflow levels are measured by WSC at Twain Creek and Pinkut Creek.

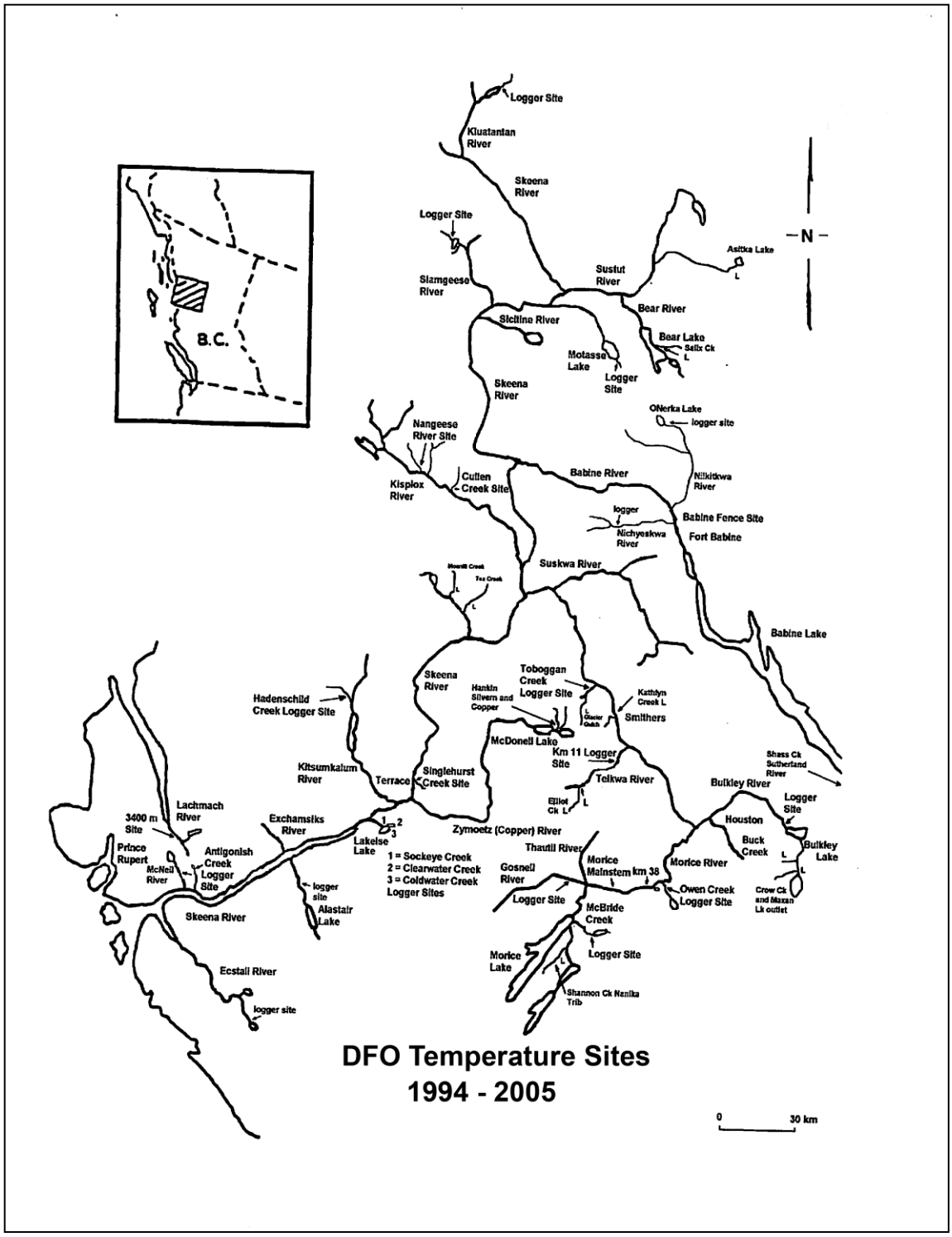

Figure 3. DFO water temperature sites, 1994 — 2005.

Bulkley Basin Programs

12. Upper Bulkley River

The upper Bulkley River (upstream of Morice confluence) has the most impacts due to human activity in the Skeena watershed. Linear development consists of CN Rail, Highway 16, and the PNG pipeline. Forestry, agricultural land clearing, and aspects of livestock operations, in conjunction with the easily erodible and phosphorous-rich soils, have affected water quality. Licensed water withdrawals are approximately 2.4 times the average 7-day, 10-year low flow. Treated ARD discharges into Foxy and Buck creeks from the closed Equity Silver Mine are based on available dilution; these discharges will continue for centuries.

Overall, upper Bulkley is characterized as a "high risk" drainage with the top water quality concerns being high temperatures, high suspended sediment loads, elevated nutrient loads, an increase in periphyton, and pathogens. Due to these concerns, water quality has been extensively studied; however, basic water temperature and flow levels are currently not measured. The Bulkley River at Houston (WSC Station 08EE003) station measures water levels and is located downstream of Houston. WSC Station 08EE013 is located at the mouth of Buck Creek. Several researchers have suggested that climate change could potentially reduce summer and fall low flows. This will increase current cumulative impacts.

13. Morice to Skeena River

Currently, WSC operates six water level stations downstream of Morice River that range from Quick downstream to Two Mile Creek , which discharges into Hagwilget Canyon. In the Skeena, Quick Station (08EE004) has one of the longest-running water records and is one of two stations measuring sediment. Water temperature, water levels, and physical parameter data have been collected at Toboggan Creek in the recent past. How water quality is affected in relation to the complex and extensive land use in this section of the drainage is not well understood.

14. Morice River

Morice River water quality is generally excellent. Three WSC stations are located in the drainage and include Nanika River at Kidprice Lake outlet, Morice River at the outlet of Morice Lake, and Thautil Creek. Water quality issues are focused on logging and mining land use, as well as the low intrinsic productivity of Morice Lake. The low productivity is compounded by the diminished abundance of sockeye returning to spawn and depositing marine nutrients.

As part of the Morice Lands and Resource Management Plan, and in partnership with the Wet'suwet'en, a large portion of Morice watershed was designated the Morice Water Management Area. The intent is to maintain the hydrological integrity, including water quality and quantity within the area. The outcome is to ensure that the habitat and water quality supporting salmon and other fish are not negatively impacted. The Wet'suwet'en have developed a water monitoring program and an area based water management plan and continue to collect data that will be applied to inform standards. This program is especially important due to proposed energy transmission (natural gas, condensate, and bitumen) developments in the Morice and Gosnell areas.

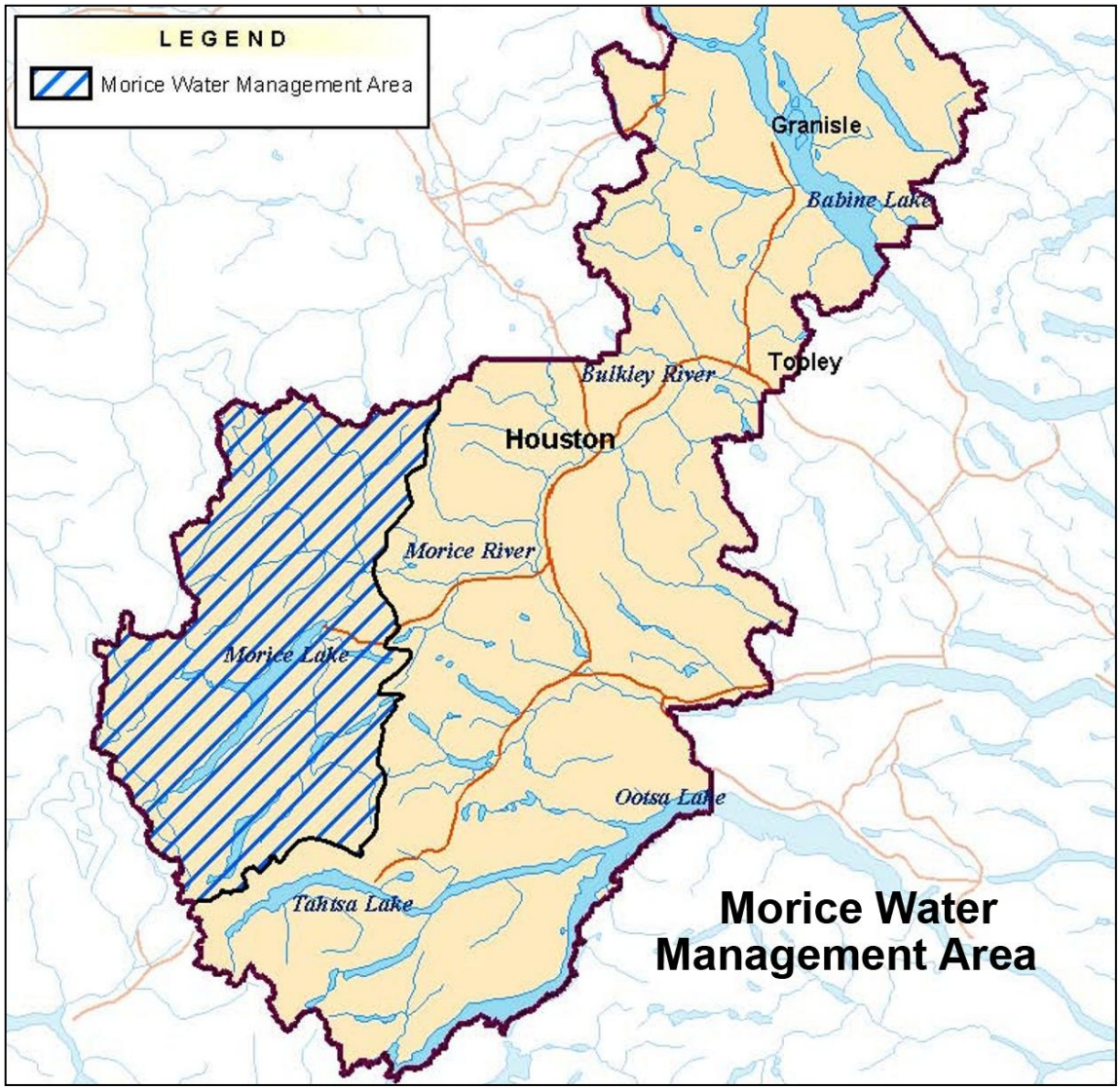

Figure 3. Morice Water Management Area

Discussion

There is a moderate amount of water quantity data for most parts of the Skeena watershed. The majority of the data is from relatively low-elevation stations. Data is lacking in the upper Skeena above Babine River, in the lower Skeena downstream of Terrace, and in some sub-basins. These sub-basins include the Zymoetz (Copper), the upper Bulkley, the Morrison (Babine), and the Suskwa.

Water quality information is scarce and scattered spatially; this is mostly due to short-term water quality compliance or impact monitoring programs. The only long-term water quality dataset is from the Skeena River at Usk.

There is an emerging need to increase monitoring of Skeena Basin water quality and quantity in order to:

1. provide and strengthen our understanding of potential effects from climate change;
2. develop a better understanding of the physical, chemical, and biological components of Skeena aquatic systems;

3. select indicators and develop benchmarks for WSP habitat assessment;
4. maintain and conserve terrestrial and freshwater salmon habitat and ecosystem integrity; no habitat = no salmon.
5. establish and enforce water quality guidelines that protect aquatic life.

The challenge for water monitoring programs will be to ensure that the data, analysis, and interpretation contribute as fully as possible to the achievement of the above objectives. The establishment and maintenance of high quality hydrometric data in the Skeena Basin will have substantial environmental, social, and economic benefits.

A unified water monitoring program needs to be implemented in the Skeena Basin. An inventory needs to compile water monitoring data, verify quality assurance, and rollup the data into a database. It would be helpful to map the existing water monitoring data in order to graphically display what, where, and how much is available. It will be important to note the data gaps and make decisions on the scope and details of what is needed to build a functional Skeena water quality monitoring network.

Accurate, reliable data are essential for determining trends in water quality, evaluating whether designated water uses are being impaired, and assessing whether applicable water quality objectives are being met. An effective monitoring program should be designed to accomplish combinations of or, in some circumstances, all of the following:

1. delineate and identify sources of natural variability and define the limits of this variability;
2. provide data leading to an accurate assessment of the state of aquatic ecosystem health, such as WSP monitoring indicators;
3. portray trends in water quality and provide warning of abnormal changes or conditions that might be damaging to the aquatic environment and associated species;
4. identify the potential agent(s) of any abnormal change that is detected;
5. identify the locations within the watershed that are most sensitive to abnormal changes or conditions.