Low Flows in High Value Fish Streams – Thompson Basin, 2003

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Executive Summary

Drought condition in the British Columbia interior resulted in the need water conservation in sensitive streams and raised substantial concerns for maintaining aquatic habitat and fish life history needs. Fisheries and Oceans Canada and the Ministry of Water, Land and Air Protection developed a drought strategy program to address these concerns. Media, stewardship, monitoring and enforcement were incorporated into the strategy. Advertisements were placed in newspapers throughout the southern BC interior requesting water uses to practice effective water conservation practices. Flow monitoring was conducted in sensitive streams within the Thompson watershed. During flow monitoring staff were asked to take opportunities to speak with water user about conservative water use.

The project scope was divided into three study areas: the Nicola watershed, North Thompson and Shuswap. The Fraser Basin Council and the Salmon River Roundtable were involved with assisting in this program delivery in the Nicola and Shuswap areas.

The commitment to a flow monitoring program was not made until late July. At this time the project was challenged with resources, planning time and limited staff. Valuable information was collected but, as a result of the project constraints, many biophysical impacts went unnoticed or undocumented. The limited information collected regarding biophysical impacts has been obtained by interviewing staff involved with the project, and reviewing field notes and photographs taken during the field work.

Since the use of water with-in these systems continues to be an ongoing issue the report contains recommendations that, hopefully if implemented , will begin to lay the foundation to make decisions on water allocation based on sustainable use that respects the needs of all users.

1.0 Introduction

Severe drought conditions occurred in southern interior watersheds of British Columbia in 2003 as a result of, above average summer temperatures, limited precipitation in June through September, and low snow pack runoff from the previous winter. These conditions raised considerable concerns for conservation of the fisheries resources within the BC Southern Interior region.

Fisheries and Oceans Canada (DFO) and the BC Ministry of Water, Land and Air Protection (MWLAP) initiated a collaborative program to monitor flow conditions in sensitive streams of the Thompson watershed. Monitoring was divided into three geographic regions: the Nicola system, the North Thompson and the Shuswap. The Fraser Basin Council (FBC) and the Salmon River Watershed Roundtable (SRWR) assisted federal and provincial staff with the field monitoring in the Nicola and Shuswap areas respectively.

Between July and October flow monitoring was conducted by team members at irregular intervals with frequencies varying between 2 day and 3 week periods depending on the area. Monitoring consisted of gathering temperature data, stream flow data using various measuring devices and stream depth using standard measuring techniques.

Two continuous stream flow gauges were installed on the Nicola River to provide regular stream flow and temperature data. Doyle (2004) summarized flow data collected during field monitoring and used Water Survey Canada (WSC) gauging station data to calculate 7-day average low flows. Stations sampled exclusively by Doyle for MWLAP and Land and Water B.C (LWBC) indicated that the 2003 drought return period varied from one I 5 years to one in 100 years but overall was one of the most severe on record (Doyle, 2004).

The British Columbia Conservation Foundation (BCCF), under contract with MWLAP, was involved in monitoring temperatures in sensitive streams throughout the Thompson watershed. Coincidentally, some of the monitoring from their project overlapped with our area of interest and thus continuous temperature data was available and provided valuable information for gaps in the temperature data collected during flow monitoring. The Nicola Watershed Stewardship Fisheries Authority (NWSFA) was also able to provide comment to circumstances observed in the Nicola watershed by field staff during summer and fall enumeration counts.

In addition to the flow and temperature data collected, and, as an attempt to summarize all relevant biological impacts observed during field operation, field notes and photos from the project were gathered and reviewed, and interviews were conducted with lead individuals from DFO, MWLAP and SRWR. Other organizations involved with various fisheries projects were also interviewed and were able to provide information.

Preliminary analysis from the 2003 flow monitoring data suggests that frequency of drought flows in the Nicola area exceeded a 10 yr recurrence interval and the Shuswap and North Thompson areas experienced drought flows exceeding a 20-yr recurrence (Doyle, 2004). Within each area significant variations of drought frequencies occurred between watersheds.

2.0 Methodology

Recorded impacts to fish and fish habitat were limited by the methodology developed for the project. Transect sites were chosen on sensitive streams within the Thompson Region to obtain flow discharge measurement. Site selection varied among areas but, in general, sites were chosen that were easily accessible and contained stream features that would assist in accurately obtaining flow data. These areas did not represent sections of the system that pertained to critical fish habitat values nor would they necessarily provide valuable habitat information. Selected sites also had a low probability of complete detwatering. This meant that sampling did not capture impacts to habitats more susceptible to detwatering such as food producing riffles

Data sheets were developed to record detailed flow information but provided no specific fields to address or record fish habitat features, such as substrates, pool depths or cover. A small comment section was available that could be used to record any observed biophysical impacts but limited use of this area was made. Flow gauging was measured using various techniques and equipment depending availability and flow conditions.

Photographs used to summarize low flow impacts were taken at all flow sites. However, as stated, transect sites did not necessarily represent critical habitat areas and few additional photographs specifically addressing fisheries concerns were taken. Due to the time constraints of the project no training was provided field staff to coordinate consistent methods to address biophysical impacts to fish and fish habitat.

3.0 Study Areas

The project scope was divided into three geographic study areas: the Nicola system, the North Thompson and Shuswap areas. Sensitive streams within each of the three areas were selected for monitoring. The sites focussed on systems that could be monitored under the logistical constraints of the project. The amount of monitoring in each area was representative of the staff and equipment resources that were available. The selected sites were not an exhaustive list of streams in which low flows concerns existed in the Thompson watershed.

3.1 Nicola Area

The Nicola watershed is an important contributor to salmon and resident fish stock in the Thompson basin. The Nicola system supports chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*) and steelhead trout (*O. mykiss*) and various resident species including rainbow trout (*Oncorhynchus mykiss*), bull trout (*Salvelinues confluentus*), kokanee (*O. nerka*), burbot (*Lota lota linnaeus*) and mountain whitefish (*Prosopium williamsoni*). The fish stocks of this system provide First Nation, commercial and recreational fishing opportunities.

In addition to the Nicola River, important tributaries include the Coldwater River, Spius Creek, Guichon Creek and Clapperton Creek. In 2000, portions of the Nicola system and its tributaries were designated as “known temperature sensitive streams” by the Forest Practices Code of British Columbia Act Operational and Planning Regulations. A storage dam at the outlet of Nicola Lake is the largest regulated storage on the system. Regulated storage is also present on Clapperton Creek, Upper Nicola River and Guichon Creek.

Forestry and agriculture are the two primary resource development activities within the area with linear development, urban development and mining as secondary activities (DFO, 1998).

Flow monitoring was conducted at ten sites on the Nicola system and sites were revisited between 1 and 13 times. Sites include the Upper Nicola, Nicola, Coldwater, Guichon, Spius and Clapperton systems.

The Deadman River is not part of the Nicola system but was monitored for high fish values and was included in the Nicola circuit for logistical reasons.

3.2 North Thompson Area

The North Thompson watershed supports chinook, coho, sockeye, and pink salmon stocks and several important resident species including rainbow and bull trout. Approximately one-third of the total Thompson watershed escapements of interior Fraser coho are from the North Thompson area (DFO, 1994). These species all contribute to important First Nations, recreational and commercial fisheries.

Agriculture and forestry have had substantial impacts on the flow regimes in this area. Increasing recreational development in some of the watersheds has also likely affected flows.

Flow gauging was conducted on Louis and Lemieux Creeks on the North Thompson and Sinmax Creek. Sinmax flows into Adams Lake of the South Thompson-Shuswap system but was included in the North Thompson area for logistical reasons.

Three sites on Louis Creek, two sites on Lemieux Creek and one location on Sinmax Creek were sampled. Louis and Lemieux Creeks have high irrigation demands in summer and fall which reduces flows to levels that may significantly limit rearing population and impede spawning migrations (DFO, 1994).

Forest fires that erupted in the North Thompson in August of 2003 resulted in travel bans and thus prevented staff from accessing gauging locations during critical low flow periods. Therefore, large gaps in data exist for this area during this time.

3.3 Shuswap Area

Monitoring of sensitive streams in the Shuswap area was conducted by DFO on tributaries of the Lower and Middle Shuswap River and direct tributaries to Shuswap Lake near Salmon Arm. The SRWR undertook extensive monitoring on the Salmon River in August and September. The area supports sockeye, chinook, coho and small populations of pink salmon (DFO, 1997). These species contribute to First Nations, recreational and commercial fisheries. Resident populations of rainbow and bull trout, kokanee and mountain whitefish are also valuable species to the area. Logging and agriculture are the primary resource activities affecting low flow levels. Logging occurs primarily in the headwater areas with the majority of watershed area logged between 20% and 40% (DFO, 1997). Agricultural activities general occur in valley bottoms along stream corridors.

DFO staff visited a total of 18 systems between the July 30th and the September 25th, 2003. Sites were visited between 1 and 7 times over this period. The number of gauging sites that were conducted daily varied depending on flow conditions and available staff time. In several systems, within the Shuswap area, irrigation pressures, or diversions for irrigation purposes were sufficient enough to dewater systems, or substantially increase or decrease flow regimes. In general, flows increased in the Shuswap area around the third week in September. These increases may have been a result of rainfall, cooler temperatures and/or decreased agricultural pressure as the irrigation season neared its end.

4.0 Discussion

Substantial effort has been focussed on addressing the impacts that low flow regimes have on fish and fish habitat. However, the ability to predict biotic responses to changes in flow regimes remains very limited (Hatfield et al, 2003). In-stream flows will have direct impacts on physical habitat and water quality within a system. In turn, habitat and water quality have direct relationship to fish productivity. Measuring and understanding the relationship between each of these factors is not easily determined.

The most common estimates of freshwater production in the Thompson watershed are adult salmon and steelhead enumerations. More adequate measures of the relationship between factors may come from work such as counts of smolts, resident salmonid growth and abundance (Hatfield et al, 2003).

The flow data collected in 2003 fulfilled the primary flow gauging objectives of the program. However, limited information that specifically addressed impacts to the fishery resource was collected. The objectives and methodology used for this project, limit the conclusions that can be drawn relating the flow conditions to impacts to the fisheries resource.

In many areas constraints of the project resources resulted in limited, or no monitoring of critical fish habitats beyond the flow transect locations.

Low flow, poor water quality and habitat loss as a result of drought conditions and water use likely lead to significant impacts to the fisheries resource in 2003. Effects such as spatial reductions in rearing habitat, decreased food production from riffles and density dependent effects on fish crowded into limited habitat are less visible. Further detailed monitoring to directly address these impacts needs to be conducted to measure the effects of the drought conditions.

4.1 Fish Habitat and In-stream Flow

Fish habitat is the physical space that fish rely on directly or indirectly to carry out life processes. Flow has obvious impacts to the availability of this physical space as low flows can limit the ability of fish to carry out essential life processes including spawning, migration, rearing and foraging. A positive association between fish habitat and flow has frequently been observed (Ptolemy and Lewis, 2002).

Methods that support fish flow as a percent of mean annual flow (MAF) have been used as a default for addressing minimum fish flow requirements. The Ptolemy and Tennant methods are commonly used as a guide for developing conservation fish flows. Ptolemy and Lewis (2003) have presented rationale for in-stream flow standards based on the premise that habitat use reflects fish preference and results in higher growth and survival. In-stream flow guidelines are currently being developed to address proposed water use applications and specific fish requirements.

Minimum fish flow requirements can vary among species and life stage. Addressing in-stream flow requirement by recommending the maximum habitat value for a single life stage of a single species can result in unrealistic values (Ptolemy and Lewis, 2003). Biologists working for the BC Fisheries Branch have modified the Tennant method to develop a “BC Modified-Tennant Method” that incorporates local biological and physical information to address local conditions (Hatfield et al, 2003). A summary of the BC modified-Tennant flow criteria is presented in Table 1.

Table 1. Summary of BC modified-Tennant recommended flows to satisfy biological and physical needs in British Columbia streams

Biological or Physical Requirement	Flow Recommendation (% MAD)	Duration
A. Rearing	20	Months
Juvenile	20	Months
Adult	>55	Months
B. Over-wintering	20	Months
C. Incubation	20	Months
D. Migration and Spawning	30-200	Days-Weeks
Summer Steelhead Passage	50-100	Days
Spawning	$1.56*MAD^{0.63}$	Days-Weeks
Smolt Migration	50	Weeks
E. Short-term maintenance	10	Days to a Week
F. Channel Maintenance	>400	Days
G. Wetland Linkage	100	Weeks

Flow monitoring data collected during the drought conditions in 2003 revealed that many streams in the Thompson region were significantly lower than the 20% MAF recommended for rearing, incubation and overwintering. The BC modified-Tennant method suggests that 10% MAF can provide adequate wetted width, depth and flow requirements for short-term maintenance, while migration in many streams at this flow are uncertain. Flows less than 5% MAF can result in detwatered riffle habitats and do not facilitate fish migrations, a problem for adult and juveniles trying to move away from localized high temperature areas (pers comm. Al Caverly). Streams flows less than 2% MAF were recorded during drought monitoring and < 10% MAF for low flow periods was common. MAF data was not available for all systems that were monitored although representative streams for which this data was obtained were located in each of the study areas.

Developing specific minimum fish flow requirements for a system will depend on factors such as species presence and periodicity. In most cases they may be slightly higher or lower than the 20% MAF coarse filter. **Of the stream that were monitored in 2003 that had specific existing minimum fish flow requirements, not one, met those flow requirements.**

4.2 Fish Periodicity

Defining accurate life history and timing of the species that depend on any particular system is essential to addressing low flow impacts. Flow requirements vary significantly with life stages and species. In general, minimum fish flow requirements for the selected streams covered during the monitoring period between late July and early October were based on chinook and coho.

The monitoring also covered migration and/or spawning periods for sockeye salmon, pink salmon, bull trout and whitefish. Considerable variation in timing of the same species can vary between watersheds. Juvenile salmonids that would also include rainbow and steelhead would have been present in parts of the study areas during the entire monitoring period.

The availability of complete fish periodicity tables was limited to only a few of the systems that were monitored. Staff from the MWLAP and DFO were able to provide additional life history timing information for systems in which periodicity tables were not available.

4.3 Water Quality

The collection of water quality data was limited to stream temperatures with exception of the Shuswap area where dissolved oxygen measurements were taken. Spot temperature data was collected during flow monitoring and in some systems continuous temperature logger stream data was available through BC Conservation Foundation's Temperature Sensitive Stream Monitoring Program.

General guidelines that identify critical temperature levels for various species and life stages of Pacific salmonids are used to relate temperature sensitive issues (Table 2). Lethal temperatures can depend upon acclimation, ambient temperatures and other additional stresses. Differences amongst individual runs have been identified, however, is it not feasible to assume that warmer climates, such as the Nicola basin, have significantly higher thresholds.

Table 2. Critical temperature levels for salmonids (Walthers and Nener, 1997)

>25 C	Upper Range of LT50 for salmon
>21 C	Lower Range of LT50 for salmon
>16 C	Cessation of Spawning Increase in Disease
8-15 C	Preference for Rearing
5-15 C	Preference for Spawning Migration
4-14 C	Preference for Spawning

LT50 – is the temperature which is tolerated by 50% of a test population for a sustained period of time

Pre-spawning temperature above acceptable levels can have critical influences on egg survival. The viability of eggs within a maturing female is often reduced if holding temperatures exceed tolerances of individual species prior to spawning (Oliver and Fidler 2001). These types of temperatures were consistently measured in parts of the study area during peak chinook migration and spawning period.

High temperatures could also result in decreased feeding and growth in prime growing seasons or increased susceptibility to disease for juveniles and adults.

Continuous temperature data provided by MWLAP and the BCCF was valuable in addressing potential impacts incurred by low flow drought conditions combined with above average temperatures in 2003. Critical temperatures often occur in late afternoon several hours after flow gauging was conducted by field staff. The logistics of the flow monitoring program resulted in temperatures being collected often at times when water temperatures were near the lowest daily values. Therefore, the continuous temperature data was often necessary to gain relevant stream temperature information.

4.5 Nicola Basin

Fish flow requirements in the Nicola Basin were developed from Kosakoski and Hamilton (1982) and the Tennant method. In 2003, the streams within the Nicola basin experienced drought frequencies that ranged from a 5-year recurrence interval to an estimated 40-year recurrence interval and, as a whole, was estimated to be a 10-15 year natural flow event (Doyle, 2004).

Flows throughout the summer in most areas of the watershed were well below the minimum fish flow requirements and often failed to meet critical threshold levels. In some cases flows below 2% MAF were recorded.

Flows experienced in 2003 likely resulted in several limiting factors to fish production. Impacts, such as migration barriers, stranding or fish mortalities, are obvious results of insufficient flows. Other, less visibly detectable, negative impacts were also likely to have occurred.

Chinook migration upstream into the Nicola River normally begins in August and peak spawning occurs in mid–September (Kosakoski and Hamilton. 1982). Peak chinook migration and spawning occurred during extreme low flow levels in the Nicola system and problems associated with insufficient flow were noted at several locations. A small early chinook run occurs in late May-June in Spius and Coldwater during this time chinook are able to ascend to the headwaters prior to low flow conditions (pers. comm. Al Caverly).

High water temperatures recorded throughout the Nicola watershed also posed potential negative impacts to fish and fish habitat in the Nicola basin. Daily maximums above 28 C recorded in some areas could result directly in fish mortalities while temperatures of 23C that were common from late July through August may have resulted in limitation to fish production.

4.5.1 Upper Nicola River

Fish Presence

Adult chinook were observed in the lower section of the Upper Nicola River. Adult chinook were not seen at the flow monitoring site at Beaks Bridge located approximately 7 km upstream of Nicola Lake.

Electrofishing conducted by BCCF and MWLAP staff near Beaks Bridge on September 2nd and 4th identified juvenile rainbow, chinook, mountain whitefish and various non-salmonid species.

Fish Habitat and In-stream Flows

Existing minimum fish flow requirements for the Upper Nicola River are set at approximately 20%. Data summarized by Doyle (2004) suggest that in 2003 7-day average low flow equated to only approximately 0.053 cms, which is less that 10% of the existing minimum fish flow. These flows are well below the threshold levels suggested by the BC modified-Tennant method (Table 1) needed to maintain adequate rearing and spawning migrations levels.

Flow monitoring conducted near the mouth of Upper Nicola River suggest that in late September flows in the lower section may have been considerably lower than the 0.053 cms 7-day average low flow.

Flow monitoring was conducted at two sites on the Upper Nicola River and substantial differences in flows were recorded between the sites. The lower site, located directly downstream of the Highway 5 bridge, was only measured once on Sept 29 due to back flooding from Nicola Lake. The discharge at this site (0.01 cms) represented less than 10% of the flow measured on the same day at the site upstream of Beaks Bridge (0.088 cms). A more suitable location for a second gauging site in the lower section of the Upper Nicola River would provide better information regarding flow regimes between July and late September.

Migration and Spawning

Adult chinook were present in the system between mid-August and mid-September. Historically, salmon distribution occurred above Douglas Lake. Flow monitoring throughout this period show that discharges were well below minimum fish flow requirements.

In August, the Nicola Watershed Stewardship Fisheries Authority (NWSFA) staff conducted two chinook salvages as low flows prevented adult migration beyond the lower few kilometres of the Upper Nicola River (pers. comm. Dave Coutlee). Chinook spawning activity was witnessed downstream of the Hwy 5 bridge near the mouth of the system.

Water Quality

Temperatures recorded in 2003 suggest that water temperatures in the Upper Nicola River system exceeded critical levels. Table 3 summarizes average and maximum temperatures in periods between July and September. These temperatures suggest that during peak migration and spawning critical temperatures were exceeded and in late July and early August temperatures were at the upper end of the lethal threshold for salmonids.

Table 3. Average and maximum temperatures in the Upper Nicola River in periods between late July 30th and September 30th from continuous temperature recordings taken at 1-hour intervals.

Period	Average Temp	Max. Temp.
July 30-31	21.8	26.1
August 1-15	19.5	24.7
August 16-31	17.5	23.5
Sept 1-15	15.2	20.5

4.5.2 Quilchena Creek

Monitoring was not conducted to measure flow levels in Quilchena Creek throughout the low flow period. The proximity of the creek to the highway did, however, allow some personal observation of conditions and these were noted by field staff.

Fish Presence

Juvenile salmonids were observed in downstream of the highway 5 bridge crossing in early August. No other instances of fish presence were recorded

Fish Habitat and In-stream Flows

Photographs taken at the highway 5 bridge show variability in juvenile rearing habitat availability throughout August (Figure 1). Changes to the channel were a result of beaver activity in the section of creek downstream of the highway bridge. Pools created by this activity may have provided habitat for juvenile salmonids.

Figure 1. Flow levels and changes to habitat as a result of beaver activity in August (left) and September (right) at Quilchena Creek.

Migration and Spawning

Due to low lake levels and flows in Quilchena Creek, kokanee were unable to migrate into the system to spawn (pers. comm. Dave Coutlee). Adult salmonids were not observed at any time during the monitoring period.

4.5.3 Nicola River (below Nicola Lake)

Fish Presence

Adult chinook and pink salmon were observed in the mainstem below Nicola Lake to the confluence at Spences Bridge. Chinook were observed throughout the system; however pink salmon were primarily seen below Spius Creek. Electrofishing conducted for the Sensitive Stream Monitoring Project and during the installation of the stilling wells upstream of the Coldwater and Spius confluences identified rainbow, chinook and various non-salmonid species.

Fish Habitat and In-stream Flows

The existing minimum fish flow requirements for both of these areas are set slightly above 20% MAF. WSC data at long-term gauging stations near Merritt and Spences Bridge were used to estimate 7-day average flows at approximately 15% and 10% of the MAF respectively (Doyle, 2004).

Flow data analysis from the two stilling well sites has shown that significant water extraction does occur between the two sites (pers. comm. Bruce McFarlane). However, habitat impacts as a result of extraction or water loss in this area were not directly observed or addressed. Using rationale outlined in Table 1, the 7-day average low flow suggest that threshold habitat features were not maintained to provide adequate conditions for the fisheries resource.

Water Quality

Temperature recordings from continuous loggers provided the most consisted measure of water quality condition during this period. Two continuous loggers were installed and were located near flow gauging stations in Merritt and near the confluence with the Thompson River. Maximum and average temperatures for periods between late July and mid September are summarized in Tables 4 and 5

Table 4. Average and maximum temperatures recorded in the Nicola River at Merritt in periods between July 24th and Sept 15th, 2003

Period	Average Temp.	Max. Temp
July 24-31	23.0	26.7
Aug. 1-15	21.1	25.3
Aug. 16-31	18.7	22.7
Sept. 1-15	16.7	21.5

Table 5. Average and maximum temperatures recorded in the lower Nicola River approximately 100m upstream of the confluence between July 15th and Sept 15th, 2003

Period	Average Temp.	Max. Temp.
July 15-31	22.7	27.1
Aug. 1-15	21.0	26.1
Aug. 16-31	19.2	25.2
Sept. 1-15	16.9	22.5

Both sites demonstrated similar trends in stream temperature regimes between July and mid-September with slightly higher maximum temperatures occurring in the lower site. Late July was when the maximum temperatures occurred, however, critical temperatures existed through mid-September. The extreme temperatures recorded in July and August would have likely affected rearing salmonid population.

During early chinook migration the average temperature exceeded preferred migration temperatures and could potentially have resulted in loss to egg viability. Favourable temperatures during migration for salmon are important for managing limited energy reserves in time allotted for spawning and migration.

In previous years unfavourable temperatures in the Nicola system have caused thermal blockages that encourage salmon to hold in the Thompson near the mouth of the Nicola River. In such situations increased flows are released at the outlet of Nicola Lake to create a pulse to encourage fish to move into the system. Limited available water in 2003 prevented release of a pulse sizable enough to result in increased migration (pers. comm., Dean Watts). Kosakoski and Hamilton (1982) suggested that additional releases from the Nicola Lake reservoir may not be beneficial because of high lake water temperatures, particularly during low flow periods in very hot weather.

Migration and Spawning

No migration barriers were reported on the Nicola River mainstem below Nicola Lake. Possible problems with decreased resting pools, increased energy use, difficulty in negotiating obstructions, and temperatures that were well above optimum migration levels may have occurred. Pulses released for Nicola dam have been used, in the past, to encourage migration of chinook at the confluence of Nicola and the Thompson.

Chinook and pink salmon spawning was observed at the monitoring sites near the mouth and upstream of Spius Creek. Several redds were located at both sites. Spawning was also observed while monitoring the reach upstream of the Coquilhalla Highway to the Nicola dam with spawning concentrated in specific areas (pers. comm. Bruce McFarlane)

4.5.4 Clapperton Creek

Monitoring was conducted at two sites located just upstream and approximately 70m downstream of the Highway 5 bridge. The downstream site was chosen as the most suitable location and was used exclusively in the later part of the project.

Fish Presence

Adult chinook and coho salmon were both observed during flow monitoring. Juvenile trapping conducted by DFO Resource Restoration Unit in 2001 suggests that Clapperton Creek provides valuable summer and early fall habitat for juvenile salmonids. During the late summer and fall they observed significantly greater catch per unit efforts were achieved in Clapperton Creek when compared to the mainstem Nicola River.

Fish Habitat and In-stream Flow

Current fish flow requirements for Clapperton Creek are 0.14 cms. Seven day average low flow estimates reported by Doyle (2004) from Clapperton Creek were based on limited data, but estimated to be approximately 0.05 cms. This represents roughly 6% of the MAF. These flows fail to meet any requirements outlined in Table 1 and would have had substantial impacts to the fisheries resource in Clapperton Creek.

Flow variability observed on Clapperton Creek in late August demonstrated how abrupt changes can occur on highly regulated systems. On August 28, during a rainless period, a discharge of .273 cms was recorded. This value was more than double the level recorded three days prior.

Upon arriving at the site on August 28 field staff could easily witness substantial visual rising and falling water levels over a one to two hour period. Substantial ramping up and down of flow from regulated diversions can potentially lead to negative fishery impacts. In cases, such as witnessed in Clapperton Creek, increases followed by rapid decreases in flows could result in stranding of juveniles that inundate edges of the channel, side channel or off-channel areas during the increased flows. No attempt was made to monitor habitat to observe if such situations occurred.

Water Quality

No continuous temperature data was taken for Clapperton Creek. Spot temperatures recorded during flow monitoring were below levels that related to substantial impacts to fish. However, in most circumstances, spot temperatures were taken in the morning well before the daily maximum to the system are expected. Photographs from Clapperton Creek show that good riparian cover was available in the section where flow gauging was conducted. This cover likely assists in maintaining adequate stream temperatures in the system.

Water Use and Irrigation

Nicola Ranch is the largest water user in the lower section of Clapperton Creek. Two diversions located approximately 1 and 2 km upstream of the highway provided water for irrigation purposes to the ranch. Field staff witnessed active irrigation that draws from Clapperton, however the amount of irrigation that occurred and dates of irrigation were not recorded. Additional water intakes were also seen for domestic use and to supply the forest fire crew facility upstream of the gauging sites.

Spawning and Migration

Chinook spawning was witnessed near the flow gauging location downstream of highway 5. No other records of spawning or migration barriers were recorded on Clapperton Creek, however very limited habitat could be observed at the flow gauging sites. Anadromous distribution in Clapperton Creek is limited to the lower few kilometres as a natural barrier impeding migration exists.

4.5.5 Coldwater River

Flow monitoring was conducted at one site on the Coldwater River, however, this site was the most commonly monitored site in the Nicola system, being monitored 13 times between August 21st and Oct 27th. The Coldwater River supports chinook and coho salmon, steelhead trout and various resident species.

Fish Presence

Adult chinook were observed near the gauging site throughout much of the flow monitoring period. Salmonid juveniles were observed at the gauging site, however, could not be identified as to species.

Fish Habitat and In-stream Flows

Existing minimum fish flow requirements in the Coldwater River are 1.42 cms. Flow measurements in the Coldwater River during the low flow period were well below the current fish flow requirements. In 2003 the 7-day average low flow calculated by Doyle (2004) from WSC gauging stations at Merritt were approximately .010 cms, which corresponded to approximately 1.2% of the MAF. Rationale from the BC modified-Tennant (Table 1) and Ptolemy methods suggest that these flows are inadequate to maintain life stage fish requirements. The Coldwater River experienced one of the highest drought recurrence intervals in any of the system monitored in the Thompson Basin.

Spawning and Migration

Although no migration barriers were identified as a result of the flow levels it can be assumed that less water would lead to increased obstructions. An example of a potential migration obstruction occurred at the site of the fish enumeration fence in Merritt. After concerns were expressed about the site, modifications were made that helped deflect flow to one side of the channel and formed a more manageable channel for fish migration. Staff from NWSFA involved with enumeration counts on the Coldwater did not report any obstruction or barriers to migrating chinook throughout the lower system.

Spawning chinook were observed downstream of the gauging site on the Coldwater in September.

Water Quality

Continuous temperature data was collected in the lower Coldwater Creek near Voght Street Bridge in Merritt. Temperatures were above critical levels for salmonids as daily maximum reaching 28 C were recorded in late July.

Anomalies in the data from August and September suggest that during extreme low flow time the temperature logger was dewatered. As a result, the data was not summarized for this report.

Spot temperatures for the Coldwater River for late August through September were generally taken in mid morning and therefore provide limited information of the thermal extremes or critical conditions that may have occurred in the Coldwater River. Additional time sorting the data from the temperature logger could provide a reasonably accurate data set.

4.5.6 Guichon Creek

Flow monitoring was conducted downstream of the Marshall Road Bridge crossing downstream of Highway 8. The site was monitored six times between August 22 and September 24.

Fish Presence

Limited observations of fish presence were made in Guichon Creek. One juvenile salmonid mortality discovered at the gauging site and, on September 18th, one pair of chinook were observed downstream of the gauging site.

Fish Habitat and In-stream Flows

Existing minimum flow requirements at the WSC station near the mouth of Guichon are set at 0.2 cms. The 7-day average low flow at this site was 0.042 cms, which equates to only 5.7% of the MAF. These flows are not enough to provide adequate rearing, migration and spawning for salmonids (Table 1).

Guichon Creek was similar to Clapperton, in that it demonstrated incidents of substantial flow variability as a result of a highly regulated system. The lowest flow of 0.034 cms was recorded on September 5th. This was just over 20% of the flow that was recorded on Aug 27th.

Spawning and Migration

The most significant limiting factor to fish production in Guichon Creek may have been access at the confluence or to the lower section below the gauging site. Although one chinook pair was observed in Guichon on September 18th the lack of fish presence prior to this suggests that fish may have had difficulty migrating into the system. The flows on September 17 (0.093 cms) were considerably higher than those obtained during the first week in September when peak migration should have been occurring.

Water Quality

Temperatures in Guichon Creek were near the upper limit for salmonids in late July and early August. Between mid August and mid September when peak chinook migration and spawning was occurring the average temperatures were considerably lower than the mainstem Nicola but, as noted above, no fish were observed with-in the creek. Although, maximum temperatures during this period were above critical levels for spawning and migration, cooler periods of the day would have provided some relief of extreme thermal conditions.

Table 6. Average and maximum temperature recording in Guichon Creek between July 25 and September 15, 2003

Period	Average Temp.	Max. Temp.
July 25-31	19.2	23.9
Aug 1-15	17.8	23.2
Aug 16-31	16.2	22.0
Sept 1-15	14.7	20.9

4.5.7 Spius Creek

Flow monitoring was conducted at two locations on Spius Creek, upstream of the hatchery and approximately 100m upstream of the confluence with the Nicola. The majority of monitoring was conducted at the downstream site.

Fish Presence

Spius Creek is an important producer of chinook and coho salmon and steelhead trout for the Nicola system. Adult chinook and pink salmon and rocky mountain whitefish were observed at various times during the flow monitoring period. Electrofishing conducted by BCCF staff during late August identified the presence of juvenile rainbow trout, coho salmon and northern-pikeminnow.

Fish Habitat and In-stream Flows

Flow gauging was conducted nine times on Spius Creek between August 21 and September 29. The minimum fish flow requirement set for Spius Creek is 2.22 cms. The 7-day average low flow calculated by Doyle (2004) was only .292 cms. This equates to less than 3% MAF. Rationale presented in Table 1 relates these values as insufficient to provide adequate fish habitat and life stage requirements. Discharge data collected during flow monitoring between August 21 and September 29 varied from 0.737 cms to 0.260 cms.

Spawning and Migration

Migration at the confluence of Spius Creek was passable as witnessed with adult salmon observed in the system. Several field staff suggested that under the extreme low flow period this would have created a potential obstruction to migration. No records of spawning were recorded in Spius Creek.

Water Quality

Continuous temperature data was not available for Spius Creek. The highest temperature recorded during flow monitoring was 18.4 C on August 21. Temperatures were typically recorded in Spius between mid-morning and early afternoon, maximum daily temperature could have potentially risen to critical or lethal levels in late afternoons.

4.5.8 Deadman River

The Deadman River was monitored at one site directly downstream of the fish enumeration fence below the Highway 1 crossing. Monitoring was conducted six times between Aug 22nd and Sept 24th.

Fish Presence

Deadman River is an important producer of two of the most threatened stocks in the Thompson watershed; interior Fraser coho and Thompson steelhead. It also produces important populations of chinook and pink salmon and rainbow trout. Adult chinook, coho and pink salmon were observed in August and September.

Fish Habitat and In-stream Flows

Recorded flows on the Deadman River were similar to the Nicola system with flow well below minimum fish flow requirements. Minimum fish flow requirements on the Deadman River for August and September are approximately 0.58 cms. Flows on the Deadman were monitored on seven occasions between August 22 and September 24. The lowest recorded flows of .386 cms were collected on September 3 and the highest of 0.521cms recorded on August 22. Average flow recorded were approximately two -thirds of the fish flow requirements.

Irrigation

The Skeetchestn Indian Band viewed drought conditions as a serious concern to the fishery resource in the Deadman River and as a result band member were asked to conserve water used for agricultural purposes (pers. comm. Don Ignace).

Water Quality

The highest recorded temperatures occurred from mid to late July with temperature only dropping slightly through the first half of August (Table 7). Maximum temperatures through this period approached the upper threshold limit for salmonids.

Table 7. Average and maximum temperature recorded in the Deadman River between July 16 and September 15, 2003

Period	Average Temp.	Max. Temp
July 16-31	18.4	23.8
Aug 1-15	17.8	23.5
Aug 16-31	15.9	21.1
Sept 1-15	14.1	19.3

During chinook and pink salmon migration in late August and September, maximum temperatures were above preferred tolerance levels and likely impacted energy efficiency for migration, spawning and egg viability.

4.6 North Thompson Basin

Doyle (2004) estimates the drought conditions in the North Thompson during the 2003 low flow period to be greater than a 25-year natural flow event. Forest fires throughout this area may have been a result of the drought conditions during 2003. Data sets from continuous loggers and spot temperatures recorded during flow monitoring showed that the threshold or tolerance temperatures for salmonids were less frequently exceeded than the Nicola system, but, even here some critical levels were exceeded.

Forest fires prevented access to gauging sites in this area for most of August and thus limited information could be collected during this period. Forest fire suppression activities likely also contributed to significant use of water resources in streams already heavily utilized for agriculture, recreation and domestic use.

4.6.1 Lemieux Creek

Lemieux Creek was monitored at two sites located upstream of the Highway 5 and the second Highway 24 bridges. Flow monitoring was conducted on August 29, September 11 and 18.

Fish Presence

Juvenile salmonids were observed at the flow monitoring site located near the second bridge on Highway 24 crossing Lemieux Creek. Electrofishing conducted by the BCCF and MWLAP staff identified presence of rainbow trout, chinook and coho salmon and non-salmonid species near the location of the downstream flow monitoring site.

Fish Habitat and In-stream Flows

Flow monitoring was conducted in the lower few kilometres of the system. Minimum fish flows have been proposed for Lemieux Creek. Coho and chinook were agreed upon as the species that would be governing in-stream flow requirement (Lemieux Creek Water Allocation Plan {Draft}, July 2002). DFO has proposed 20% MAF as a base flow for the reach from the mouth to approximately 3 km upstream of the Highway #5 bridge. This equates approximately 0.588 cms as measured at WSC Stn. 08LB078 (Kosakoski, letter on file DFO, 2002).

The current draft of the Lemieux Creek Water Allocation Plan suggests variable in-stream flow for the different species and life stage requirements:

a) 10% MAF for summer rearing

a) 25% MAF from September 15-February 15 to meet coho migration and spawning requirements.
b) 30% MAF or the mean daily discharge for the period, whichever is the lesser, but not less that 25% MAF for Chinook migration and spawning (August - October 15)

Summary of flow data for Lemieux was not addressed in Doyle's (2004) report, due to concerns regarding the accuracy of swoffers measurements in extreme low flow conditions. Flows between .029 cms and .131 cms were recorded during the monitoring program.

These numbers are considerably less than any of the suggested in-stream flows and likely resulted in substantial impacts to the fisheries resource in Lemieux Creek. Pictures of the channels upstream of the Highway 5 bridge appear to have flows adequate for rearing juvenile salmonids, however, flows diminished downstream and were nearly non-existent near the mouth.

Migration and Spawning

Access for migration chinook was an obvious impact to the fisheries resource throughout the monitoring period. Chinook migration usually begins in early to mid August and continues through to early October. Throughout the low flow period a section 75-150m at the confluence of Lemieux and the North Thompson River was dry or contained minimal flows, insufficient of providing fish passage (Figure 2).

Figure 2. Low flow impacts at the mouth of Lemieux

Water Quality

Temperatures recorded by continuous loggers and taken during flow monitoring show temperatures at sample location were below critical levels for salmonids. Table 8 summarizes temperatures from continuous loggers.

Table 8. Average and maximum temperature recorded in Lemieux Creek between July 26 and Sept 15, 2003.

Period	Average Temp.	Max. Temp.
July 26-31	15.6	19.8
Aug. 1-15	15.2	19.6
Aug. 16-31	14.3	19.0
Sept 1-15	13.3	17.5

Observation by BCCF staff involved with temperature sensitive stream monitoring also suggest that additional water quality issues may have been present. During extreme low flows pools upstream of the Highway 5 bridge were algae covered and dead salmonids were observed (pers. comm. Andy Morris BCCF).

4.6.2 Sinmax Creek

Flow monitoring was conducted eight times between August 27 and October 3 on Sinmax Creek. Sinmax supports populations of sockeye, chinook and coho salmon, rainbow trout, kokanee and bull trout. Forestry, agriculture, rural and recreational activities are the primary development activities in the watershed.

Migration and Spawning

Migration passage problems had negative impact to fish production for spawning in Sinmax Creek during the low flow period. Sediment deposition at the mouth of Sinmax Creek has created a fan that impedes migration of salmon or other species. Although this may have been amplified by the low flows encountered in 2003, residents living near the mouth noted that it is a yearly occurrence to see salmon struggling to make it into the system.

In 2003, as with previous years, residents made alterations to the channel at the mouth to try to direct flows in a single path that is passable to fish (pers. comm. Jeff Geurin, DFO). Upstream from the confluence small dams were constructed by tourists to create wading/swimming pools. These structures may have also obstructed fish migration under the low flow conditions.

Water Quality

Temperatures recorded during flow monitoring were below critical thresholds for salmonids. However, because of fire conditions, no monitoring was conducted in late July or early August when temperatures may have been at seasonal highs.

4.6.3 Louis Creek

Agriculture, recreational skiing development, forestry and rural development have had impacts to flow regimes on Louis Creek. Forest fires in 2003 put further strain on an already limited resource in the area.

Flows were measured at three locations between the confluence and Zinc Mountain Road. DFO staff observed extensive use of irrigation systems throughout the low flow period and received minimal co-operation from landowners to reduce water extraction. Louis Creek supports populations of chinook, coho and pink salmon, rainbow and bull trout.

Temperature

Temperature in Louis Creek approached the lower end of critical threshold limits for salmonids in parts of July and early August. During peak chinook migration in August and September average daily temperatures all were within preferred migration temperatures while maximum temperatures exceeded preferred migration temperature referenced in Table 2. Average and maximum temperatures are summarized in Table 9

Table 9. Average and maximum temperatures for periods between July 26 and September 15, 2003

Period	Average Temp.	Max. Temp.
July 26-31	17.0	20.9
Aug 1-15	15.9	20.4
Aug 16-31	14.3	19.8
Sept 1 -15	12.6	17.8

4.7 Shuswap Area

Natural low flows due to drought conditions combined with agricultural pressure, forestry and settlements contributed to flow concerns for the Shuswap area. Agricultural activity is concentrated along stream corridors resulting in considerable impact to stream habitat (DFO, 1997). Loss of continuous stream flow, channel dewatering, passage problems and fish mortalities were all observed impacts to the fishery resource that occurred in the Shuswap area.

Eighteen systems were monitored in the Shuswap area and of these migration or juvenile passage problems for salmonids were noted as a concern on fourteen of the systems. Similar to the other study areas, limited time was spent addressing conditions other than at the site that flow monitoring was conducted. Increased fish habitat monitoring may have resulted in identifying additional migration barriers.

Staff resources played a substantial role in the amount of information that could be collected for this area. Although sampling was conducted between July 30 and September 29 limited staff resources prevented monitoring at regular intervals within this period. As a result, significant periods have been missed.

In the Nicola and North Thompson areas the highest stream temperatures occurred in late July and early August. In the Shuswap area limited data was collected during this period. Similarly, in the other study areas, the lowest flows of the season were measured in the first two weeks of September. With the exception of the Salmon River, limited monitoring was conducted for this period as well.

For ease of summarizing information the area was divided into three sub-areas:

a) Salmon Arm
b) Lower Shuswap
c) Middle Shuswap

4.7.1 Salmon Arm Sub-Area

Monitoring in the Salmon Arm area included direct tributaries to Shuswap Lake near Salmon Arm. Sites were located on Syphon, Tappen, Canoe, Palmer and White Creeks, and the Salmon River. All these systems are believed to historically provide spawning and rearing habitat for chinook and coho salmon and/or rainbow trout (per. comm. Bruce Runciman DFO). DFO staff monitored all systems in this area with the exception of the Salmon River.

Fish Presence

Salmonids were identified in all systems within this area during the flow monitoring. Juveniles were commonly identified as salmonids by presence of parr marks but species were usually not determined. Adult chinook were observed in the Salmon River and Canoe Creek

Fish Habitat and In-stream Flow

Stream monitoring by DFO staff was conducted 4-6 times at irregular intervals between July 30 and September 29. Continuous flows were recorded in all systems within this area. However, downstream of the monitoring site on Siphon Creek isolated pools were observed (pers. comm. Holly Smith DFO).

Impacts attributed to flow levels were reported in all systems with the exception of Tappen Creek. Review of field notes and photographs of Tappen Creek suggest that this system may have been one of the watersheds least affected by drought condition in the Shuswap circuit.

The Salmon River was the only system within this area in which minimum fish flow requirements have been developed. Fish Conservation flows are summarized as follows:

1) Rearing/Overwintering - 1.17 cms
2) Short-term Survival - 0.59 cms
3) Migration/Spawning - 1.76 cms
4) Off-channel linkage - 5.86 cms

Flow monitoring on the Salmon River was conducted by the Salmon River Watershed Roundtable at ten locations between Falkland and the mouth. Intensive monitoring occurred between September 6th and 12th. In addition to flow transects, some landowners on the Salmon River assisted the program by recording daily water levels at staff gauge locations. The SRWR is compiling a report to summarize the finding of their work conducted through the 2003 drought season.

Recorded flows were consistently below rearing, overwintering, spawning and migration fish conservation flows and were often recorded significantly lower than the 0.59 cms level that represents critical short-term survival condition. During the lowest flow period, flows were less than half of the recommended levels and as anticipated by the modified BC Tennant method, inhibited migration resulted.

Spawning and Migration

Migration barriers or obstruction were reported in five of the six systems in this area, the exception being Tappen Creek. Dewatered areas in the lower section of the system limited migration at Syphon Creek. Passage concerns for adult salmon arise on a yearly basis on Canoe Creek, however even under the flow conditions experience in 2003 adult chinook were observed in the lower section of the system. Plans are currently underway to address these passage issues (pers. comm., Bruce Runciman DFO). Flow levels also limited adult fish passage in Palmer Creek (pers. comm. Bruce Runciman DFO).

Flow conditions in Salmon River were brought to the forefront of the Salmon Arm and the Shuswap area when a salvage operation to rescue adult chinook incapable of migration into the system was presented in local newspapers. Flows had dropped to impassable levels just as peak chinook migration was starting. As a result few chinook had entered to system (pers. comm. Mike Wallis). Recovery efforts such as the one that occurred on the Salmon River can be successful, however these situations require huge resources from the public and government agencies and are not feasible in other areas.

Any adult chinook that managed to negotiate the low flows at the mouth faced additional migration problems throughout the system. The SRWR reported that during monitoring several cross channel beaver dams were blocking or obstructing fish passage. Although pools created by the dams provided deeper rearing habitats for juvenile fish substantial increases in predation were noticed in pools supported by these dams (pers. comm. Mike Wallis SRWR).

Water Quality

Temperatures taken during flow monitoring on Tappen, White, Syphon and Canoe Creeks were within acceptable levels for salmonids. However, if thermal regimes were consistent with the North Thompson and Nicola systems critical temperature periods may have been missed in late July and early August when staff were unavailable for monitoring.

Continuous temperature data was collected in the Salmon River and maximum temperatures in the mid-twenties were recorded. These temperatures represent the upper threshold levels for salmonids. Similar results from the Salmon River have also been recorded in previous years when seasonal summer temperatures are above normal (pers. comm. Mike Wallis SRWR).

Dissolved oxygen recordings were taken at each monitoring site on White, Tappen, Canoe, Syphon and Palmer Creeks. Field staff observed salmonid fry in White Creek that appeared highly stressed, potentially as a result of biological oxygen demand or other water quality issues (pers. comm., Bruce Runciman DFO). White Creek is heavily impacted by agriculture and large sections of the creek have limited vegetation.

Dissolved oxygen in White Creek was the lowest of any site monitored with values as low as 2.2 PPM recorded. Dissolved oxygen did not appear to be a concern in any of the other systems. In Palmer Creek, macroalgae was abundant through the cross section of the stream raising concerns regarding biological oxygen demand in that system.

Water Use and Irrigation

Few comments were recorded regarding water use and irrigation for this area although water use for agricultural and domestic needs is known to impact flow regimes. Enforcement and stewardship played a positive role in aiding water conservation in the Salmon River and Palmer Creek.

As an attempt to increase flows in the Salmon River, “stop irrigation orders” were issued to more than 40 licence holders that had fish conservation clauses attached to licenses. Approximately two weeks later a voluntary 2 day irrigation shut down was requested of other water users by the SRWR and the DFO. Both these attempts resulted in measurable increases with more dramatic increases resulting from the voluntary shut down (pers. comm. Mike Wallis SRWR).

On Palmer Creek, fisheries staff approach one water user and suggested that continued withdraw of water could potentially result in fish mortalities. As a result, the landowner ceased irrigation in late August in an attempt to conserve flows for fish.

4.7.1 Lower Shuswap Sub-Area

The Lower Shuswap River is a major producer for chinook and an important producer of coho in the Shuswap area (DFO, 1997). Eight tributaries to the lower Shuswap River were monitored between July 30 and September 29. Monitoring occurred one to six times at irregular intervals. Of the systems that were monitored, Fortune and Trinity Creeks are known produces of both chinook and coho. Coho have also been counted in Johnson and Blurton Creeks (DFO, 1997). Other creeks that were monitored included Ashton, Brash, and Bongard.

Fish Presence

Juvenile salmonids were identified in Blurton, Fortune and Gardom Creeks. No adults were observed in any of the systems. Juvenile coho were identified on Blurton Creek.

Fish Habitat and In-stream Flows

Minimum fish conservation flows and MAF data was not available for these tributaries therefore comparison to flow gauging and in-stream requirements could not be made. Continuous stream flows were recorded on Trinity and Gardom Creeks throughout the monitoring period. All other systems in this area had dry channels or periods of non-continuous flows. Ashton and Johnson Creeks were dry during all site visits while Bongard Creek only began to produce intermittent flows in late September. Non-continuous flows were recorded at least once on the remaining systems.

Spawning and Migration

Peak spawning for chinook for the lower Shuswap area occurs between mid August and September. Insufficient flows for adult passage were recorded for all streams in the Lower Shuswap sub-area and as a result no adult migration or spawning was observed.

Water Quality

Temperatures recorded during flow monitoring suggest that temperatures did not have significant impact to fish production in the monitored streams. However, continuous data through critical periods was not available and may have revealed temperature concerns. Dissolved oxygen levels that were recorded were also within acceptable levels.

Water Use and Irrigation

Irrigation had significant impacts to flow conditions on streams in this area. One landowner identified a diversion on Ashton Creek, for the purpose of irrigation, as the cause of the dry channel at the monitoring location. On Blurton Creek a weir constructed to maintain water for irrigation created a barrier to fish. Although Bongard Creek was dry, at the monitoring site flow could be heard in irrigation pipes drawing from an upstream location.

On Trinity Creek, combined irrigation from the three water users was reported to be sufficient to dewater the creek. A co-ordinated effort was made by these landowners to time irrigation schedules to prevent this from occurring (pers. comm. Bruce Runciman DFO). Several landowners within the area were approached regarding the importance of conservative irrigation practices and the relationship to fish habitat values.

4.7.2 Middle Shuswap Sub-Area

Monitoring in the middle Shuswap sub-area was centred around Lumby on Bessette Creek and its tributaries. Five sites were monitored 6 or 7 times each between July 30th and September 25th. Sites were located on Bessette, Creighton, Harris, Duteau and Vance Creeks. The Bessette drainage supports populations of chinook and coho salmon and various resident species.

Fish Habitat and In-stream Flows

Based on the requirement of the BC modified-Tennant method (Table 1) flow conditions in the middle-Shuswap sub-area had definite impacts to the fisheries resource. Doyle (2004) estimated 2003 7-day average low flow on Vance Creek at 0.019 cms (approximately 3.7 % MAF). Field staff measured similar values with flows between 0.009 cms and 0.037 cms recorded. Similar results were obtained on Bessette Creek where the estimated 7-day average low flow calculated by Doyle was 4.7% MAF. MAF data for Duteau, Harris and Creighton Creeks was not available; therefore, similar comparisons could not be made. On Creighton Creek field staff observed substantial fluctuations in flow. As a result Creighton Creek was the only system in the middle Shuswap sub-area that did not have continuous stream flows throughout the monitoring period. Considerable increases and decreases in flow can potentially lead to stranding and fish mortalities.

Spawning and Migration

Adult passage problems were reported as a concern on Harris and Vance Creeks. Lack of continuous flows on Creighton Creek would have inhibited adult passage. In addition, a sandbag dam on Creighton Creek constructed by a landowner created another barrier to fish migration. Chinook migration and spawning should have been occurring during August and September however, no adults were observed.

Water Quality

Dissolved oxygen levels recorded at all sites were at acceptable levels and likely did not impact fish habitat. No temperature data was available between July 30 and August 19. If trends were similar to other study areas, this would have been one of the warmest periods. Temperatures above 15 C were common in August and early September with the maximum temperatures of 18.7 C being recorded on Harris Creek. Temperatures suggest there may have been some impact to migrating adults, but thresholds for salmonids were generally not a concern. Recordings on September 18th and 25th suggest that stream temperature cooled considerably around the middle of September providing adequate spawning and migration temperature.

Water Use and Irrigation

Irrigation was recorded on Bessette, Creighton and Vance Creeks. Duteau and Harris would have also had active irrigation during the monitoring period, however, this was not recorded. On September 18th increases in flows on Creighton Creek were recorded, consequently, field notes provided by DFO staff showmentioned that no irrigation was occurring at the time of monitoring. Flow increases may have been the cumulative affect of irrigation shut down, a brief rain event and cooler seasonal temperatures.

5.0 Recommendations

Flow monitoring was part of a drought strategy program that also utilized media, stewardship and enforcement to deal with the conditions during 2003. All of these sources can provide benefit to future programs and should continue to be utilized.

5.1 Media

Limited media was used to convey the impacts of drought conditions when issues arising from low flows became apparent. In late August, DFO, MWLAP, FBC, BC Cattleman's Association and the BC Agriculture Council combined efforts to release an advisory notice to water users requesting water conservation measures.

This notice was distributed in papers throughout the southern interior of B.C.; however, by the time of the release, significant impacts to the fisheries resource may have already occurred. An earlier release could have increased awareness levels before drought conditions had a significant impact. Additional opportunities to utilize media coverage to convey low flow impacts should be sought. For example, provincial media were available in Kamloops for extended periods during the wildlife fires of 2003 and no attempt was made to contact them, and, as a result, very little information reached the provincial population.

Several interior and provincial print media run environmental columns. In the past, the Outdoor Section of the Kamloops Daily News has been used as a tool to address fisheries issues. Working with local papers to providing consistent coverage of drought condition and impacts through these columns could be an effective tool. Awareness of the issues surrounding low flow conditions must be initiated by late June when water level drop significantly in most southern interior streams.

5.2 Stewardship

A number of stewardship activities were attempted to assist the drought strategy program in 2003. Success of stewardship activities varied between areas. Monitoring and assistance by the SRWR is an example of how working with local stewardship groups can benefit the drought strategy program. In a combined effort with the SWRW and DFO, a voluntary shut down request resulted in high compliance for water users and increases to in-stream flows during critical periods.

Stewardship groups are also established in the Nicola and Bonaparte areas and may be able to provide significant benefits to the program.

In the past, First Nations have demonstrated stewardship interest in the fisheries and water resources within the southern interior. These groups have the potential to be active partners in drought monitoring programs.

Industry associations can also be used to convey information to their members. The BC Cattleman's Association and the Agricultural Council joined with other groups to disseminate information to the public. Often peer to peer discussions result in actions occurring when other methods do not work.

5.3 Low Flow Monitoring

A commitment to conduct flow monitoring in the Thompson drainage was not made until July of 2003, which left limited time to organize the resources required for a comprehensive monitoring schedule.

Under the constraints of the project, valuable data was collected. DFO, MWLAP, FBC and representatives from the SRWR captured flow data during drought conditions in the Thompson watershed and provided observations on the impact to the fisheries resource that occurred as a result of these conditions.

Doyle (2004) has used data from this project, WSC gauging stations and addition sources to prepare of review of low flows in the southern interior region.

5.3.1 Doyle's Recommendations for Flow Monitoring

Recommendations to future drought monitoring programs provided in Doyle's report will assist in creating successful future monitoring programs. Condensed summaries of Doyle's recommendations are as follows:

1. Clearly state objectives of gauging at beginning of project
2. Select locations of gauging sites for specific reasons and for utility
3. Assign a project co-ordinator to insure the data meets quality standards
4. Train, equip and motivate field staff to do the work properly and ensure staff have adequate time available to complete the task.
5. Approve a budget that allocates enough funds for data reduction, checking, permanent storage and analysis in a timely fashion
6. Ensure that at least one member of each field crew knows the exact location of the gauging site being visited
7. Review and reduce field notes promptly
8. Calibrate and clearly mark metering equipment
9. Establish and uniquely describe water level reference points at each site and carefully reference them each time the discharge is measured.
10. Include field observations of water diversions and use, precipitation, channel changes that might affect stage or discharge at the measuring site.
11. Make multiple measurements rather than single measurements
12. Unless necessary do not establish gauging sites near WSC sites
13. If possible, schedule miscellaneous measurements made at different sites on the same stream to allow for flow travel time from the upstream station
14. Try to minimize the effects of diurnal patterns by measuring at the same time each day
15. Use free fall outlets of culvert or in-stream flow metering devices if they already exist near point of interest.

5.3.2 Additional Recommendations to Address Fish Impacts

No specific methods were outlined to directly address biophysical impacts to fish and fish habitat. Several of the recommendations that Doyle outlined would benefit establishing an effective monitoring program to address these requirements. To expanded on some of Doyle's recommendations and provide additional input from the perspective of addressing impacts to fish and fish habitat the following recommendations may also be taken into consideration for future monitoring:

1. Clearly state biophysical data collection objectives of the program.
    - During flow monitoring to 2003, staff were unclear as to how much time should be directed towards monitoring fish and fish habitat impacts that occurred as a result of low flow conditions. As a result very limited information was collected.
2. Allocate time and resources to collect desired biological information.
    - Expand biological sampling to include sections upstream and downstream of flow gauging stations.
    - Monitor fewer gauging sites in a circuit to allow time for monitoring biophysical conditions.
3. Collect detailed water use information (e.g. irrigation, diversions) that potentially impacts flow regimes at gauging stations and critical habitat areas
4. Identify and monitor critical habitat areas that are particularly affected by low flow regimes.
    - Migration obstructions, barriers, critical spawning areas, pool habitats are examples of critical features that were not recorded in the 2003 monitoring program.
5. Use consistent criteria to select monitoring locations and clearly reference all monitoring areas. GPS, photograph and map all sites for field staff and future reference.
6. Install continuous temperature data loggers within each system.
7. Provide brief a summary of known fisheries information within each watershed to assist field staff in addressing impacts to the fisheries resource.
    - Include species presence, life history, timing, population status, location of critical habitats

8. Provide data sheet with desired fish habitat collection data fields and summary sheet to review correct procedures for habitat assessment.
    - This will ensure consistent data collection throughout the study area
    - Existing provincial and federal habitat assessment procedures are developed and should be considered for future drought monitoring programs

5.4 Conclusion

There is no argument that information gathered during the summer of 2003 will prove to be valuable in determining future actions needed to protect the fisheries resource. However, weaknesses in the program and suggestions to improve it must be stated.

The basic weakness in the program was its lack of endorsement by government at an early date. This lack of endorsement held up training of participants, planning for and locating multi-use monitoring sites, and involvement of residents of the areas being monitored. My recommendations speak to the need to improve those areas but the key is early acceptance of the program.

The most positive aspect of the program was the joint monitoring effort of representatives of the Federal Government and the Provincial Ministries. This alone made the program worthwhile. Having both parties working toward the same goals and understanding the obstacles each needed to overcome will prove valuable in the future.

Developing consistent methodologies and data collection procedures for future drought monitoring will increase the effectiveness of the program and provide consistent year to year comparable data. Valuable information was collected during the 2003 low flow period; however, staff, equipment and time constraints limited the effectiveness of the project.

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6.0 References

Department of Fisheries and Oceans Canada,1997. Strategic Review of Fisheries Resources for the South Thompson-Shuswap Habitat Management Area. DFO, Vancouver

Department of Fisheries and Oceans Canada, 1998. Strategic Review of Fisheries Resources for the Thompson Nicola Habitat Management Area. DFO, Vancouver

Department of Fisheries and Oceans Canada, 1994. Strategic Review of Fisheries Resources for the North Thompson Habitat Management Area. DFO, Vancouver

Doyle, P.F., 2004. Summer 2003 Low Flows in the Southern Interior of British Columbia (Draft) MWLAP/DFO

Doyle, P,F., 2004. Summer Drought in the Kamloops Region. MWLAP and LWBC Inc., Kamloops BC.

Hatfield, T., A. Lewis and D. Ohlson. 2003. British Columbia In-stream Flow Standards for Fish Phase 1 – Initial Review and Consultation, MWLAP Victoria. B.C.

Kosakoski, G.T. and R.E. Hamilton, 1982. Water Requirements for the Fisheries Resource of the Nicola River, B.C. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1680

Oliver, G.G. and L.E. Fidler, 2001. Toward a Water Quality Guideline for Temperature in the Province of British Columbia. MWLAP Water Management Branch Water Quality Section.

Ptolemy, R. and A. Lewis, 2002. Rationale for Multiple British Columbia In-stream Flow Standards to Maintain Ecosystem Function and Biodiversity (Draft for Agency Review) MWLAP/MSRM

Walthers. L.C. and J.C. Nener, 1998. Water Temperature Monitoring in the Nicola River, B.C. 1995: Implications of Measured Temperatures for Anadromous Salmonids. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2443