Slim-Tumuch Fish-Forestry Study

1971 – 1975

Introduction

Until 1971, little information was available concerning the effects of forest harvesting on aquatic habitat and salmonid productivity in the central interior of British Columbia. Most fish-forestry studies had been conducted in coastal regions and fisheries managers in interior regions had incorporated into forest harvest plans measures for stream protection that were derived from coastal experiences. However, because coastal regions differ from interior regions with respect to climate, hydrology, soils, forest cover and logging methods, this approach was frequently questioned by both foresters and biologists who recognized the need for data applicable to interior regions.

Accordingly, in 1971 a study (generally referred to as the Slim-Tumuch Fish-Forestry study) was initiated by the federal Fisheries and Marine Service (now the Department of Fisheries and Oceans [DFO]) and the B.C. Department of Recreation and Conservation (now the Ministry of Water, Land and Air Protection) to provide short-term (< 5 years) data on the possible effects of forest harvesting on water quality and fish habitat in the central interior of British Columbia in order to use these data for the integrated management of forest and fisheries resources.

Figure 1: The Slim Creek valley looking towards the Fraser River from the Centennial Creek valley (February 1987).

Study Site Description

Slim Creek is located 80 km east of Prince George at 54° N latitude and 121° W longitude, and flows from Shandy Lake through a broad flat-bottomed valley bordered by rolling hills. Approximately 3 km below Shandy Lake, Centennial Creek and Donna Creek flow into the mainstem of Slim Creek, which then flows into Tumuch Lake.

The Slim watershed area is ~ 560 km2, although the main focus of the study during the 1971-1975 period was a smaller area (186 km2) upstream of Tumuch Lake that included Centennial Creek and its tributaries (Rosanne and Karolyn Creeks), as well as Donna Creek, as the primary streams of interest. Study sites were also established along Leaner Creek (a tributary to Tumuch Lake), as well as along two additional tributaries (Hah and Hee Creeks) to the Bowron River and one tributary (Hungary Creek) to the Fraser River.

Soils in the Slim watershed are diverse and include well-sorted sandy gravels, poorly sorted tills and silty-sandy loams, the latter occurring mainly in the valley bottoms and lower slopes of Donna, Centennial and Slim Creeks. Slopes are 20-30% on valley side-walls but are grading (Centennial, Donna) or near level (Slim) in the valley bottoms. Precipitation is ~ 100 cm annually and is about equally divided between rain and snow.

Forest cover at unharvested sites is overmature, with white spruce (*Picea glauca*) being dominant in association with subalpine fir (*Abies lasiocarpa*), western redcedar (*Thuja plicata*), alders (*Alnus spp.*), poplars (*Populus spp.*) and lodgepole pine (*Pinus contorta*). Streamside vegetation ranges from conifers to alder, willow and marsh grasses.

The streams and lake system supports large populations of chinook salmon (*Oncorhynchus tshawytscha*), rainbow trout (*O. mykiss*), Dolly Varden char (*Salvelinus malma*), kokanee (*O. nerka*), mountain whitefish (*Prosopium williamsoni*), pygmy whitefish (*P. coulteri*), and burbot (*Lota lota*), in addition to cyprinid and cottid fishes. With the exception of a reach stretching ~ 1 km upstream of its confluence with Slim Creek, Centennial Creek and its tributaries (Rosanne and Karolyn) were not inhabited by fish, owing to a waterfall obstruction. This was unknown during the planning phase of forest harvesting and the headwaters were subsequently stocked in 1972 and 1973 with rainbow trout. Leaner Creek is probably a minor spawning area for rainbow trout and kokanee that are resident in Tumuch Lake.

Streamflows peak in spring during the snowmelt-dominated freshet with a second peak in autumn, and are lowest in winter and during the month of August. For example, during 1973 and 1974, flows in Centennial and Donna Creeks peaked at 6-8 m^3/sec in May and June, gradually decreasing to 0.7 and 0.35 m^3/sec by mid-summer and winter, respectively. Flows in Rosanne Creek peaked at 1.1-1.4 m^3/sec in May and June, decreasing to 0.1-0.2 m^3/sec during the summer.

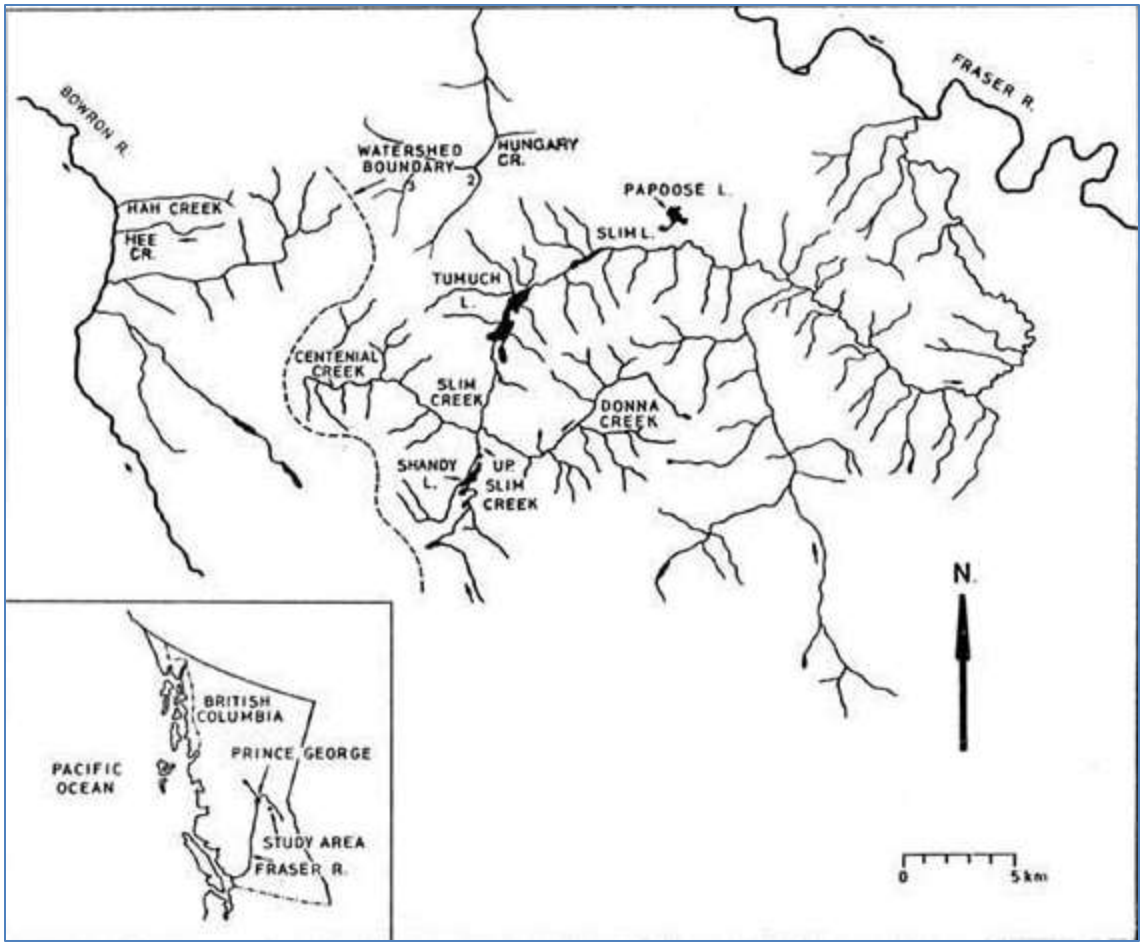

Figure 2: Overview of the Slim Creek watershed study area.

Figure 3: Slim Creek near the Yellowhead Highway.

Study Design

The primary experimental approach that was adopted for the Slim-Tumuch study consisted of an extensive post-treatment design in which logged areas were compared to unharvested (forested control) areas. Control sites included streams along which no timber harvesting had occurred (e.g., Donna Creek and the mainstem of Slim Creek), as well as sites upstream of logged reaches (e.g., Rosanne, Karolyn and Leaner Creeks). Additional pre- and post-logging surveys were also carried out in Rosanne Creek to assess changes in stream-bottom composition.

The study was initiated in 1971, but this phase entailed only photo and aerial reconnaissance for the selection of study and reference (control) sites. In the fall of 1971, a road was constructed along Centennial Creek, and logging was started near Roseanne Creek (a tributary to Centennial Creek) during the winter of 1971–1972. By the summer of 1973, six cutblocks along Centennial Creek and four cutblocks along Slim Creek to Tumuch Lake had been harvested. Additional harvesting was conducted northwest of Tumuch Lake from 1973 to 1975. Monitoring of physical and biological attributes was started in the spring of 1972 and continued until September 1975.

Figure 4.1: Slim Creek just below the Centennial Creek confluence. (Photo taken in February 1987.)

Figure 4.2: Roseanne Creek. The watershed was logged in 1971-1972. (Photo taken in February 1987.)

Figure 4.3: Roseanne Creek. This section contains little organic debris after logging. (Photo taken in February 1987, 14 years after logging.)

Timber Harvesting Treatments

Forest harvesting in the study reaches involved construction of a main haul road, clearcutting and extraction of timber using tractor and rubber-tire skidders. Standard road-building practices were utilized, in which a 30- to 45-m opening was cleared and local material used for the sub-grade.

Haul roads were more than 100 m from streams except at crossings (where steel pipe culverts were installed), and, whereas secondary roads and landings were pre-located on cutting plan permits, skidtrail layouts were largely left to the judgement of logging contractors. Clearcutting of ~ 121-ha cutting units was carried out in late 1971-1973 in the Centennial Creek watershed, although other cutting units throughout the study watersheds varied in size and ranged from 80-160 ha in the Slim and Hungary Creek watersheds to ~ 200 ha in Hah and Hee Creeks. The principal species harvested were white spruce and some subalpine fir. Cedar and subalpine fir were also cut but frequently left behind as slash owing to core decay. Whole trees were skidded to landings for bucking, sorting and loading, and logging was carried out during summer and winter months but was interrupted during spring melt and autumn freezing due to poor road conditions.

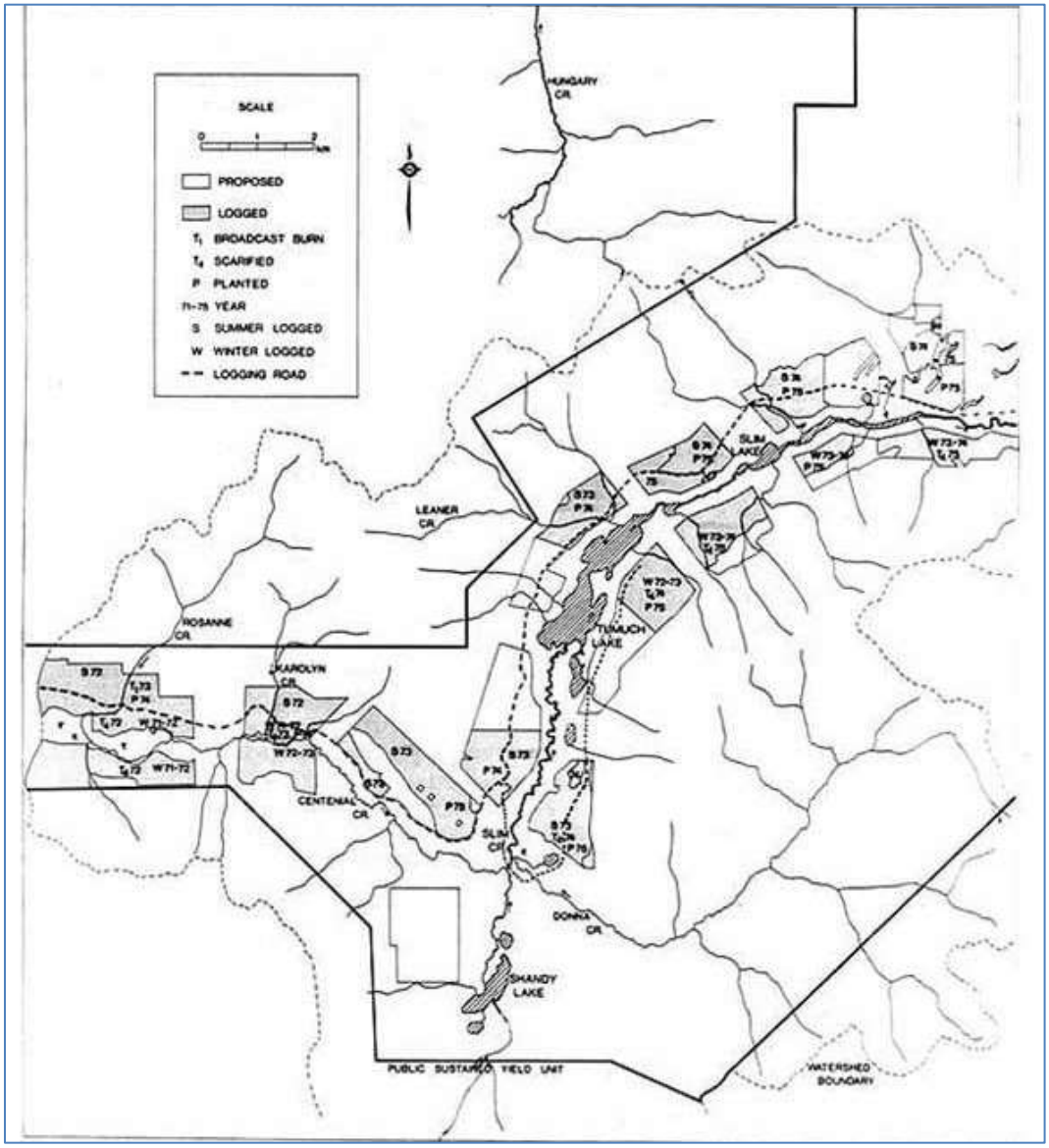

Figure 5: Detailed view of the cutting units and sampling stations in the upper Slim-Tumuch watershed showing the forest harvesting sequence.

Figure 6: Main haul road along Centennial Creek. The second growth is widely spaced and has little undergrowth (February 1987).

Streamside practices in the study reaches varied as a result of different contractors, inclusion of stream protection clauses inserted into some of the cutting permits, season of cut, and different terrain. Four main streamside logging practices were applied within the stream riparian zones:

1. Reserve strip, whereby a streamside strip varying in width from 20 to 200 m and comprising coniferous and deciduous trees was retained.
2. Selective strip, whereby a streamside 20-m strip of vegetation comprising non-commercial trees and leaning commercial conifers was left standing. Equipment operation was also restricted within this zone.
3. Directional falling and skidding, whereby timber was fallen and skidded away from streams whenever feasible. This practice also retained deciduous (e.g., alder and willow) and most non-commercial conifers. Landings tended to be located to minimize stream crossings and streambank encroachment.
4. Non-directional falling and skidding, whereby no attempt was made to control the direction in which trees were felled and skid trails were not laid out to minimize bank encroachment or the number of stream crossings.

Figure 7: Aerial photograph of Tumuch Lake (1985). An example of the logging treatments applied around the lake. (North is towards the top of the photograph.)

Adjacent to the main streams (Slim and Centennial), conifer and deciduous leave (buffer) strips of variable width were left standing. Practices near tributary streams (watersheds > 26 km2) ranged from selective cutting with few skidder crossings during summer logging in the upper reaches (e.g., Leaner Creek and the upper reaches of Karolyn Creek) to clearcutting with frequent in-stream falling and skidding during winter logging in the lower reaches (e.g., Rosanne Creek and the lower reaches of Karolyn Creek). A summary of the streamside practices undertaken along the study streams during 1972-1974 is presented below.

Stream section	Distance surveyed (m)	Season logged	Streamside logging practice
Rosanne (lower)	466	Winter	NDFS
Karolyn (lower)	315	Winter	NDFS
Karolyn (middle)	325	Summer	NDFS
Hah	366	Winter	NDFS + slash burning
Hee	366	Summer	NDFS
Hungary (#2)	805	Summer	NDFS + selective strip
Karolyn (upper)	178	Summer	DFS
Rosanne (upper)	457	Summer	DFS
Leaner (upper)	550	Summer	DFS
Hungary (#3 upper)	380	Summer	DFS
Hungary (#3 middle)	120	Summer	DFS (some non-commercial trees left)
Hungary (main)	187	Summer	Selective strip
Hungary (#3 lower)	110	Summer	Selective strip
Leaner (lower)	440	Summer	Selective strip
Centennial (upper)	1200	Winter	Reserve strip

DFS: directional falling and skidding
NDFS: non-directional falling and skidding

Response Variables

The following responses of a variety of stream physical and biological attributes to streamside logging practices were monitored as part of the Slim-Tumuch study: 1) water quality parameters (suspended sediment, discharge, water temperature, dissolved oxygen, total dissolved solids and nutrient concentrations); 2) stream channel changes (debris accumulations, bank slumpage, and habitat and substrate characteristics); 3) invertebrate responses (benthic production and drift abundance); and 4) salmonid responses (survival and growth of stocked juvenile [age-0 and age-1] rainbow trout, and the survival of trout eggs).

Limnological surveys were also carried out to compare water quality, plankton densities, and fish abundances in a lake around which logging was carried out (Tumuch Lake) and one whose riparian zone was not logged (Shandy Lake).

Figure 8.1: Slim Creek above Donna Creek.

Figure 8.2: Donna Creek, site 1.

Summary of Main Findings

The main findings of the 1971-1975 studies are summarized below:

- Suspended sediment levels downstream of logged areas were 5-10 times higher than levels in unharvested reaches during peak spring flows in Centennial, Donna and upper Slim Creeks. The main source of sediment in the Centennial Creek watershed was from a lacustrine silty loam deposit, and most of the erosion was due to disturbance of these deposits by the main haul road (although secondary roads and skidder trails were also sources).

Figure 9.1: Centennial Creek, site 1.

Figure 9.2: Centennial Creek jam, September 1990.

- Water temperatures increased in logged reaches by a few degrees when compared to unharvested reaches.
- Cation levels were similar in the logged and unharvested reaches, and some nutrient concentrations in logged reaches were up to five times those recorded in unharvested reaches.
- Of the four logging practices, non-directional falling and skidding caused the greatest channel disturbance, followed by directional falling and skidding, selective strips and reserve strips.

Figure 10.1: Donna Creek, site 2.

Figure 10.2: Rosanne Creek, above bridge (summer logging), September 1990.

Figure 10.3: Rosanne Creek, beaver pond, September 1990.

- Sediment deposition in areas downstream of logged reaches was associated with reductions in benthic invertebrate densities, particularly in riffles. A strong negative correlation was found between sediment concentrations and invertebrate densities. Invertebrate drift was also lower in the logged reach of Rosanne Creek when compared to control reaches.
- Increased sediment deposition on riffle gravels has implications for trout egg-to-fry survival rates. However, rainbow trout eggs planted in gravels downstream of logged reaches in Rosanne Creek had good survival rates to the pre-emergent stage, despite sediment loadings that were similar to those used under controlled experimental conditions at the Loon Lake Hatchery (where reductions in survival were observed). Higher water velocities in Rosanne Creek relative to the controlled experiment may have resulted in less sediment deposition.
- Rainbow trout juveniles (age-0 and age-1) stocked in Rosanne Creek were found to have higher growth rates when compared to unharvested reaches, although other intrinsic but undocumented factors (e.g., differences in flow and cover) may also have played a role in these results. However, late-summer densities of age-0 trout were lower in the logged reaches when compared to the unharvested reach, although the reverse pattern was found for age-1 trout.
- Turbidity was higher in Tumuch Lake (around which logging was conducted) when compared to Shandy Lake (control), and this was attributed to higher concentrations of suspended sediment entering the lake during the spring. Productivity was also lower in Tumuch Lake (possibly due to the higher turbidities and resulting lower transparency of the water column) despite slightly higher nutrient levels.
- There were no consistent differences in zooplankton, phytoplankton and fish populations between Tumuch Lake and Shandy Lake, although benthic invertebrate densities were lower than expected at the Slim Creek inlet to Tumuch Lake (possibly due to higher rates of sediment deposition).

Figure 11.1: Slim Creek, site 1.

Figure 11.2: Tumuch Lake / Slim Creek.

Application of Results & Future Directions

The Slim-Tumuch Fish-Forestry study was the first to examine the physical and biological responses of stream ecosystems to clearcut logging practices in the central interior of British Columbia.

The study highlighted the differences between coastal and interior stream ecosystem processes and drew attention to their potentially different responses to streamside clearcut logging. Moreover, although the study provided valuable preliminary data that were sorely needed to enable foresters and biologists to make scientifically defensible management decisions, there is an acknowledged dearth of information regarding the impacts of streamside logging in temperate, interior regions, and future fish-forestry studies in these regions of British Columbia are therefore encouraged.

In recent years (from the early 1980s to the early 1990s), the Slim Creek watershed continued to be subjected to relatively intense timber harvesting activities, in part to combat a bark beetle infestation.

The federal DFO Salmonid Enhancement Program initiated further studies in the Slim Creek watershed in 1980 and 1981 to collect information for a planned enhancement facility on the Bowron River. Data on migration timing, size distribution and morphology of adult and juvenile chinook salmon were collected along with physical and chemical observations on the streams and lakes.

In early 1987, DFO initiated a limited survey to assess channel morphological changes caused by logging as well as to gather preliminary data on the winter distribution of chinook salmon. During the period from 1990 to 1994, DFO was again involved in monitoring water quality (streamflow, suspended sediment, nutrients, dissolved oxygen, water temperature) and salmonid densities and distributions within the Slim Creek watershed, but to date these data have not yet been compiled or published.