TRIBUTARIES TO LOWER SNOQUALMIE RIVER MAINSTEM

University of Washington Temperature Survey (1999-2001)

King County WLRD staff and Snoqualmie Watershed residents participated in a Puget Sound Lowland stream temperature monitoring study that was designed by the University of Washington Center for Urban Water Resources Management (CUWRM) and Center for Streamside Studies. The goals of the study were to determine if stream temperatures during the middle of the historically hottest week of the year (i.e., first Wednesday of August) are in compliance with State of Washington water quality standards for temperature and to determine the influence of riparian canopy and urban development on stream temperatures.

Methods

In the Snoqualmie Watershed, four tributaries to the Lower Snoqualmie River mainstem were selected for temperature measurements in 1999 to 2001: Harris, Griffin, and Patterson Creeks, and the Raging River. King County WLRD staff and Snoqualmie Watershed residents monitored temperature at several sites in Harris and Patterson Creeks, and in the Raging River on August 4, 1999, August 2, 2000, and August 1, 2001. Temperature in Griffin Creek was also monitored on the 1999 and 2001 dates. To ensure accuracy of temperature measurements, each team calibrated their thermometer in an ice-water bath early in the afternoon of the monitoring day. Temperature measurements were collected once at each site between 3 and 5 PM, which is statistically the hottest part of a summer day. At each site, a data sheet was filled out indicating site number, location, air temperature, water temperature, riparian canopy, flow conditions, water depth, and estimated water flow speed. The project cover sheet and a field sampling site data form are found in Appendix B. Completed cover and data sheets were submitted to the University of Washington research team for compilation with temperature data from streams in other Puget Sound Lowland watersheds. Following is a summary of the findings for the four tributaries to the lower Snoqualmie River. The report of the entire study, including descriptions of the specific monitoring sites for the Snoqualmie River tributaries, can be accessed through the CUWRM web site (http://depts.washington.edu/cuwrm/).

Results and Discussion

Table 9 indicates the number of temperature monitoring sites and the mean, minimum, and maximum temperatures recorded for each tributary on the monitoring day of each monitoring year. The overall mean temperature for each tributary on the three monitoring days is also shown.

Table 9. Summary of Temperature Survey Data in Snoqualmie River Tributaries

	1999			2000			2001			
Tributary	**Number of Sites**	**Mean Temperature**	**Range (degrees C)**	**Number of Sites**	**Mean Temperature**	**Range (degrees C)**	**Number of Sites**	**Mean Temperature**	**Range (degrees C)**	**Overall Mean Temp.**
Raging River	4	17.6	15–19.5	5	20.8	16.5–24.5	6	15	13–16	**17.6**
Patterson Creek	9	15.6	15–16	8	16.1	15–17	5	13.2	13–13.5	**15.2**
Griffin Creek	7	17.1	11–20	*no measurements*			7	14.3	11–16.5	**15.7**
Harris Creek	4	19.1	17–22	8	17.4	14–21	7	14.8	13–20.5	**16.8**

Juvenile salmonids rear in the Raging River and in Patterson, Griffin, and Harris Creeks during the summer months. The optimal temperature for rearing is 10 to 13.9°C (50 to 57°F) for species other than bull trout and less than 10°C for bull trout (Bjornn and Reiser, 1991). These temperatures were exceeded at most monitoring sites on all four tributaries. The overall mean temperature for each tributary also exceeded the optimal temperature range. Some temperature measurements in the Raging River, Griffin Creek, and Harris Creek also exceeded 18°C, thereby violating the State of Washington water quality standard for temperature in Class A waterbodies. Water temperatures that are this high can affect salmonid survival and can also have sublethal physiological and behavioral effects such as decreased growth rate, decreased enzymatic activity needed for smoltification, less resistance to disease, and increases in disease virulence (Berman, 1998). The effects of habitat perturbations during freshwater rearing of salmonids can persist into the marine phase of the life cycle. Therefore, sublethal temperatures experienced during any one life stage may have repercussions for individual fitness and ultimately population and species viability (Holtby, 1988).

There was no consistent correlation between water temperature and the presence or absence of riparian canopy in the four streams. At a few sites (e.g., Raging River 2000, Patterson Creek 1999, Griffin Creek 2001, and Harris Creek 2000), temperatures were lower when the stream was fully shaded by riparian vegetation. However, at other sites, water temperatures in full shade were higher than temperatures in partial shade or full sun. Groundwater influx may have been a confounding factor at these sites.

Water temperatures were higher at the downstream sites than the upstream sites in the Raging River on the monitoring days in 2000 and 2001. The range was from 16.5°C at the most upstream site to 24.5°C at the most downstream site in 2000 and from 13°C at the most upstream site to 16°C at the most downstream site in 2001. These temperature measurements follow the same pattern that was observed with the temperature logger data in the mainstem Snoqualmie River in the summers of 2000 and 2001. However, this pattern was not observed in the other tributaries; underground spring input may be a complicating factor in those systems.

High summer water temperatures in tributaries to the Snoqualmie River are a factor contributing to the high summer water temperatures in the mainstem Snoqualmie that were cited earlier in this report. The mainstem Snoqualmie is warm, in part because the tributaries are warm. To reduce temperatures, solutions must be found starting high in the headwaters to ensure that feeder tributaries are well-shaded and riparian canopy is restored to the maximum extent practicable all the way downstream in the watershed.

Stream Walks in 2001

In summer 2001, King County WLRD staff began a qualitative habitat inventory of tributaries to the Snoqualmie River. Fieldwork conducted in 2001 included reaches of the Raging River (RM 0-8.2), Tolt River (RM 2.8-5.9), and Griffin Creek (RM 0-3.1). The survey of the Snoqualmie River tributaries was modeled after a survey performed for the Cedar River Watershed in the early 1990s, in which baseline data were collected in qualitative form for most of the watershed.

Methods

Parameters observed for the Snoqualmie tributaries included riparian vegetation, LWD, substrate type, bank hardening and erosion, presence of pools, fish, wildlife, and benthic macroinvertebrates, adjacent land use, and general habitat condition. Two-person field teams walked each tributary and took notes and photographs on the above parameters about every 0.1 mile. The information from these stream walks will be used to make habitat and aquatic resources management decisions in King County and to identify potential areas for conservation or restoration. The information will also provide a baseline for developing a quantitative monitoring program to detect trends in habitat quality over time and for adaptive management as habitat protection and restoration actions are implemented in the Snoqualmie Watershed. Furthermore, the data will be shared with the WRIA 7 Technical Committee and used to inform the strategic assessment and the long-term salmon conservation and recovery plan for WRIA 7.

Results and Discussion

The dates of the stream walks were August 27 and 29 for the Raging River, September 5 for Griffin Creek, and October 2 for the Tolt River. Field observations are summarized and interpreted below. More detailed field notes are available upon request from King County WLRD (Boles, 2001).

Raging River (RM 0-8.2)

The Raging River is confined in a narrow channel between containment levees for the lower 1.3 river miles before it flows into the Snoqualmie River. This reach is choked with sediment and gravel bars are built up as much as 4 feet above the summer low-flow channel. The riverbed is higher than the surrounding topography as gravel has accumulated within the levees, and the gravels are generally embedded with fine sediments. Riparian vegetation through this reach is dominated by invasive shrubs. However, tall cottonwoods align the RB of the channel and provide shade. Habitat conditions are poor with relatively fast flows as the wetted stream navigates around the tall gravel bars. There is no LWD or other types of cover in this reach, and very little slow water habitat. Therefore, salmonid rearing and refuge habitat is limited here.

Upstream from the containment levees, the habitat conditions in the Raging River improve greatly, except for specific areas around RM 6.2 and 7.5 where land development has confined the river and the riparian forest has been removed. However, in most other locations where there is development on the Raging River, the residents have left healthy riparian vegetation on their

properties. Many of the homes have mature trees and native shrubs on their properties, and lawns are contained to small areas that do not extend to the edge of the river. Some invasive nonnative trees and shrubs were also seen above RM 1.3. The upstream extent of butterfly bush invasion was at RM 5.0 and the farthest upstream sighting of Japanese knotweed was at RM 7.4.

A logjam at RM 7.8 comprised most of the LWD encountered in the survey. Bank hardening occurred sporadically. Typically, banks are hardened with riprap, but an approximately 200 foot long revetment comprised of LWD was found on the RB at RM 5.1.

The substrate was cobble (64-256 mm diameter) dominated and gravel (2-64 mm diameter) subdominated for most of the surveyed river; these gravels provide potential material for spawning salmon to construct redds. A landslide on the RB at RM 3.7 was contributing a lot of fine sediment to the river. Alders growing in the area appeared to be about 10 years old, possibly dating the origin of the slide or the last big movement of the mass. The embeddedness of fine sediments in the substrate appeared to be the most impacting feature to fish habitat in the Raging River.

The overall observations of LWD were consistent with previous findings. Logging, residential development, recreation, and road construction have reduced the amount of mature forested riparian area and therefore the potential for LWD recruitment in the lower Raging River. LWD that was formerly present in the river was removed for flood protection and navigation purposes (Herrera Environmental Consultants, 1995). The *Snohomish River Basin Salmonid Species Habitat Conditions Review* (Snohomish Basin Salmonid Recovery Technical Committee, 2002) rates the Raging River as "degraded" for LWD based on the paucity of LWD (i.e., less than 0.2 piece LWD per channel width which generally ranged from 10 to 20 meters wide).

Griffin Creek (RM 0-3.1)

A wetland complex at the mouth of Griffin Creek provides excellent slow-water habitat for fish in both Griffin Creek and the Snoqualmie River. Juvenile salmonids rear and take refuge from predators in this area. However, horses were observed grazing near the mouth of Griffin Creek, so all of the streambanks were trampled and riparian vegetation was absent in the summer of 2001. Even so, the waters in this area were observed to support a high density of fish. Habitat at this location would benefit from planting of riparian vegetation and fencing the land to prevent animals from grazing the banks.

The mouth of Griffin Creek to RM 0.7 is adjacent to agricultural land that is downstream of the SR 203 crossing. This reach of Griffin Creek has a history of dredging and straightening. The substrate was predominantly fine sediment, with some coarser sediment up to cobble-sized.

LWD placed by King County in this reach in 1998 (see section on Restoration Project Monitoring for details) has moved during high flow events, and has concentrated in a few areas. Some of the LWD has collected in naturally occurring small jams. A fence post in the creek at RM 0.2 indicates that some recent channel avulsion has occurred. In the summer of 2001, riparian vegetation was predominantly invasive, except for where plantings had occurred. The plantings were still very immature so the riparian density was very poor. There were very few trees. Beaver (*Castor canadensis*), blacktail deer (*Odocoileus hemionus*), and some sculpins (*Cottus spp.*) and other fish were observed in this reach.

RM 0.8-1.6 has a lower stream gradient than the reaches of the creek upstream from here. The sediment sizes are mixed as the coarser materials deposit in the channel as the gradient decreases.

This reach is developed with homes on both banks, so has occasional revetments on both banks. In the summer of 2001, at least 50% of the riparian vegetation in this reach was invasive shrubs and was mowed for yards. Some dense pockets of native, riparian vegetation were present, including some mature deciduous and coniferous trees. Water withdrawal pipes, rock weirs, and diversion structures occurred sporadically.

RM 1.6-2.7 encompasses the upper extent of home development. Stream gradient increases as the creek moves down the hillslope, so the substrate is generally coarser and is dominated by gravel and cobbles. Some step pool morphology and deep scour pools create good fish habitat. Riparian vegetation was generally good to excellent with thick, mostly deciduous trees and native shrubs. In places the riparian vegetation was cleared or consisted entirely of invasive shrubs including blackberries, Japanese knotweed, and even bamboo (species unknown). Occasional LWD was found in this reach of Griffin Creek.

RM 2.7 to 3.1 is located within the FPD. Small tributaries on the RB deposit deltas of fine sediments washed down from East Griffin Creek Road NE. The riparian vegetation was generally excellent, with occasional patches of immature but native vegetation. Channel spanning LWD jams occurred frequently. They sort sediment, scour pools, and provide excellent cover and refuge habitat. Fish (most likely juvenile coho) were observed in pools created by these LWD jams.

Tolt River (RM 2.9-5.8)

This reach is upstream of the narrow containment levees and covers the upper extent of residential land development on the Tolt River. A property at RM 5.8 contains the furthest upstream house.

Riparian areas on the Tolt River have been consistently cleared by land development. Bank hardening occurs on the properties developed with homes, and at the King County facility at RM 2.8. On lots without homes, the riparian vegetation was generally very good, with mature trees and dense native shrubs. Cottonwood and big leaf maple were the most frequently occurring deciduous trees. Conifers occurred infrequently, but were observed to overhang the river in places, providing cover. Invasive plants, particularly butterfly bush and blackberries, occurred infrequently in the healthy riparian areas and frequently on developed properties.

Mayflies (Order *Ephemeroptera*), caddisflies (Order *Trichoptera*), and stonefly (Order *Plecoptera*) exoskeletons were observed in the substrate, which is cobble (64-256 mm diameter) dominated and gravel (2-64 mm diameter) subdominated. However, fine sediments embedded the gravels throughout the reach. This observation is consistent with previous findings. The *Snohomish River Basin Salmonid Species Habitat Conditions Review* (Snohomish Basin Salmonid Recovery Technical Committee, 2002) rates the Lower Tolt River as "moderately degraded" for sediment, based on the occurrence of 12% to 17% surface fine sediments in spawning areas (Washington Forest Practices Board, 1997).

LWD was prevalent throughout the river in the summer of 2001. There were a few jams with excellent salmonid rearing and refuge habitat at RM 3.3, 5.2, and 5.8. The channel was braided in locations throughout this reach, with smaller side channels containing slow water fish habitat, which is especially valuable as refuge during high water events. Instream habitat was generally very good in this reach of the Tolt River, with over-wintering habitat, off-channel habitat, and deep pools occurring regularly. A bedrock outcrop at RM 5.2 had scoured a large, deep pool with an adjacent LWD jam. Some of the pools were being used by fish, presumably juvenile coho.

Pink salmon were observed spawning throughout the reach. Chinook spawners were observed at a couple of sites in the reach and chinook carcasses occurred throughout. Pink and chinook salmon were observed spawning in the same pool tailout at RM 3.3.

Restoration Project Monitoring

Three restoration projects completed by King County in the Snoqualmie Watershed were monitored for fish use during 2000 and 2001. The projects were on the Tolt River, Griffin Creek, and Patterson Creek, and involved stream habitat improvement and native vegetation plantings. A culvert placed in a levee on the Tolt River reconnected the existing Frew side channel to the mainstem Tolt River for fish access. This project also involved LWD addition to the side channel and the excavation of ponds at the downstream extent of the project area. A fencing and LWD addition project on Griffin Creek was designed to keep livestock out of the creek, improve instream habitat through the creation of pools for salmonid rearing and refuge, and discourage channel dredging by the property owners. The Korn project on Patterson Creek involved the construction of off-channel ponds and addition of LWD to the ponds and adjacent reach of the creek. Each of these three project sites was monitored for fish use every other month throughout the year to track the seasonal use of the habitat by juvenile and spawning salmon. The monitoring results will be summarized in an upcoming report by King County.