A Department of Ecology Report

Weaver Creek (Mason County) Fecal Coliform Attainment Monitoring

Abstract

In 2007, the Washington State Department of Ecology (Ecology) published a water quality attainment monitoring report on the Skokomish River basin. The study concluded that all sites assessed, with the exception of Weaver Creek, met the 2001 Total Maximum Daily Load (TMDL) target limits for fecal coliform bacteria.

In 2009, Ecology developed an addendum to the original attainment monitoring Quality Assurance Project Plan. The goal of the resulting 2009-10 study was to provide data to determine if Weaver Creek is currently meeting the original TMDL target values for fecal coliform.

Results from the 2009-10 study indicate that fecal coliform levels in Weaver Creek have increased, and TMDL target limits for fecal coliform have not been met.

The likely source of fecal coliform in Weaver Creek is from livestock activities along the creek upstream of the Skokomish Valley Road Bridge.

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Background

Ecology's 2007 water quality attainment monitoring report on the Skokomish River Basin concluded that all sites assessed, with the exception of Weaver Creek, met the 2001 TMDL target limits for fecal coliform (Sargeant and Hempleman, 2007; Seiders et al., 2001). Although Weaver Creek met the *Extraordinary Primary Contact* classification water quality standard (50 cfu/100 ml) for recreation, an additional 20% reduction in fecal coliform levels was needed to meet the TMDL target value. Since 2007, additional water cleanup activity has occurred on Weaver Creek.

In 2009, Ecology developed an addendum (Collyard, 2009) to the original attainment monitoring Quality Assurance Project Plan (Batts, 2005). The goal of the resulting 2009-10 study was to provide sufficient data to determine if Weaver Creek is currently meeting the original TMDL target values for fecal coliform.

Project Goals and Study Objectives

The project goal was to evaluate whether TMDL implementation actions for fecal coliform have resulted in Weaver Creek meeting the TMDL target limit.

The project goal was met through the following objectives:

- Determine if fecal coliform targets set by the 2001 TMDL study have been met.
- Determine if Washington State water quality standards for fecal coliform are being met.

Study Design

Monitoring of fecal coliform was needed to assess if the additional water quality cleanup activities (post-2007 study) resulted in Weaver Creek meeting the goals set by the original 2001 TMDL. To meet these objectives, Ecology collected fecal coliform samples biweekly from two sites on Weaver Creek during the critical period of May through February. A total of 44 samples were collected over the study period. Water sampling began in May 2009 and continued through February 2010.

To stay consistent with the original TMDL analysis, water samples from all stations were analyzed by the Most Probable Number (MPN) method. Also, estimates of data precision and completeness were consistent with the TMDL study (Seiders et al., 2001).

Quality assurance and quality control results from the study are presented in Appendix A.

Sampling Locations

The 2001 TMDL study (Seiders et al., 2001) describes fecal coliform target limits for one station on Weaver Creek. In 2007, an additional site was sampled to provide better spatial identity of areas of fecal coliform pollution (Rockett, 2007). This study evaluated whether

these stations (Figure 1, Table 1) meet current water quality standards and the target limit set in the original TMDL compliance station (Table 2).

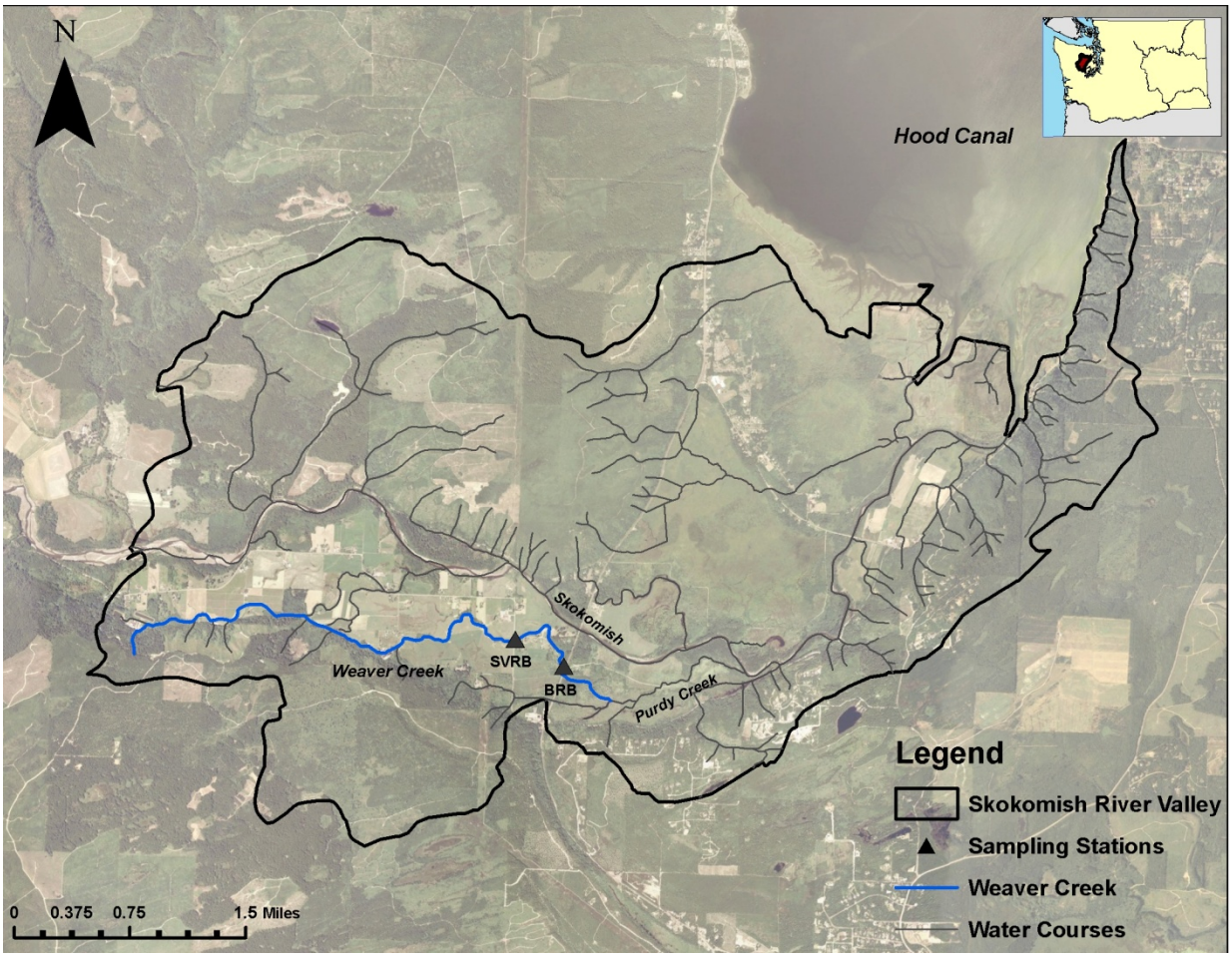

Figure 1. Weaver Creek sampling locations.

Table 1. Auxiliary information for Weaver Creek sampling locations.

Station	Description	Type	Latitude, Longitude (NAD83)
BRB	Downstream side of the Bourgault Road Bridge	TMDL	47.3060, -123.1795
SVRB	Downstream side of **S**kokomish Valley Road Bridge	Added	47.3086, -123.2024

Table 2. Weaver Creek TMDL recommended fecal coliform targets, TMDL results, and TMDL attainment monitoring results for the critical period (May – February).

Sampling Site	TMDL Target		2001 TMDL Study		2005-6 Attainment Study		Required change
	GMV FC/100ml	Geometric 90th %tile FC/100ml	GMV FC/100ml	Geometric 90th %tile FC/100ml	GMV FC/100ml	Geometric 90th %tile FC/100ml	
Weaver Creek (BRB)	17.5	100.0	55.0	314.6	22.0	64.4	-20%

Results

During the 2009-10 attainment monitoring study, fecal coliform concentrations did not meet the geometric mean and 90th percentile water quality standard at both Weaver Creek sampling stations (Figure 2). The fecal coliform geometric mean and 90th percentile were slightly higher at the most upstream sampling station, **S**kokomish Valley Road Bridge (SVRB).

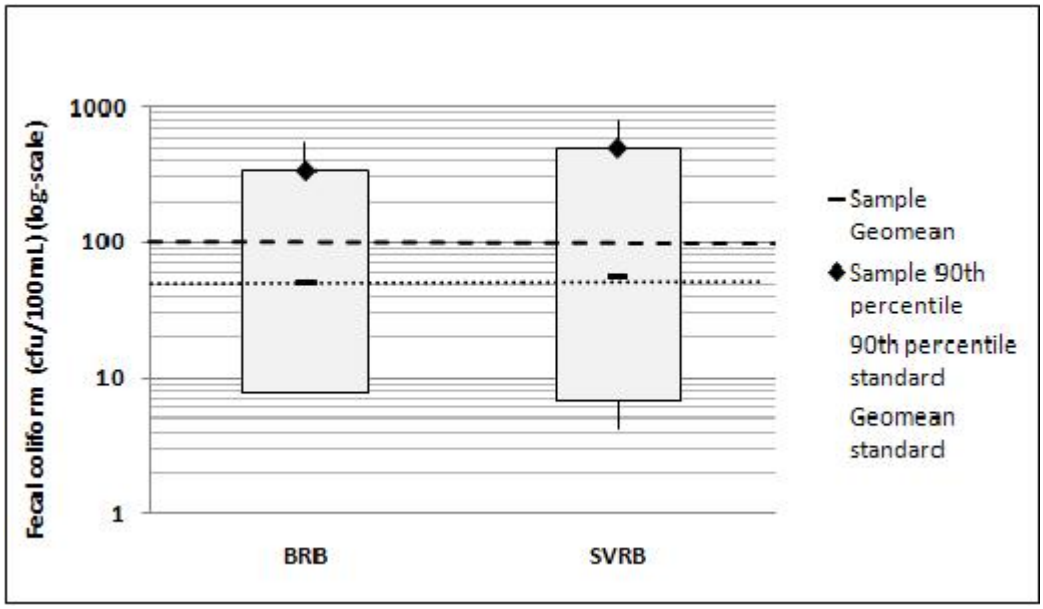

Figure 2. Weaver Creek fecal coliform results for the 2009-10 attainment monitoring stations.

Fecal coliform levels at Bourgault Road Bridge (BRB) failed to meet TMDL targets. These levels require a 34% reduction in the geometric mean to meet the targets (Table 3). The 2009-10 fecal coliform geometric mean at BRB more than doubled when compared to the 2005-06 attainment monitoring study. Target limits were not established for SVRB.

Table 3. Weaver Creek TMDL recommended fecal coliform targets, TMDL results, and TMDL attainment monitoring results for the critical period (May – February).

Sampling Site	TMDL Target		2005-06 Attainment Monitoring Study		2009-10 Attainment Monitoring Study		Required change
	GM* FC/100ml	Geometric 90th %tile FC/100ml	GM FC/100ml	Geometric 90th %tile FC/100ml	GM FC/100ml	Geometric 90th %tile FC/100ml	
BRB	17.5	100.0	22.0	64.4	51.2	337.6	-34%
SVRB	-	-	-	-	57.5	496.1	-

- not determined.

Figure 3 presents box plots summarizing fecal coliform results for the 1999 TMDL study (Seiders et al., 2001) and both attainment monitoring studies (Sargeant and Hempleman, 2007; current study). To stay consistent with the TMDL (Seiders et al., 2001), monthly data were averaged and log-transformed before calculating the geometric mean for the critical period (May through February).

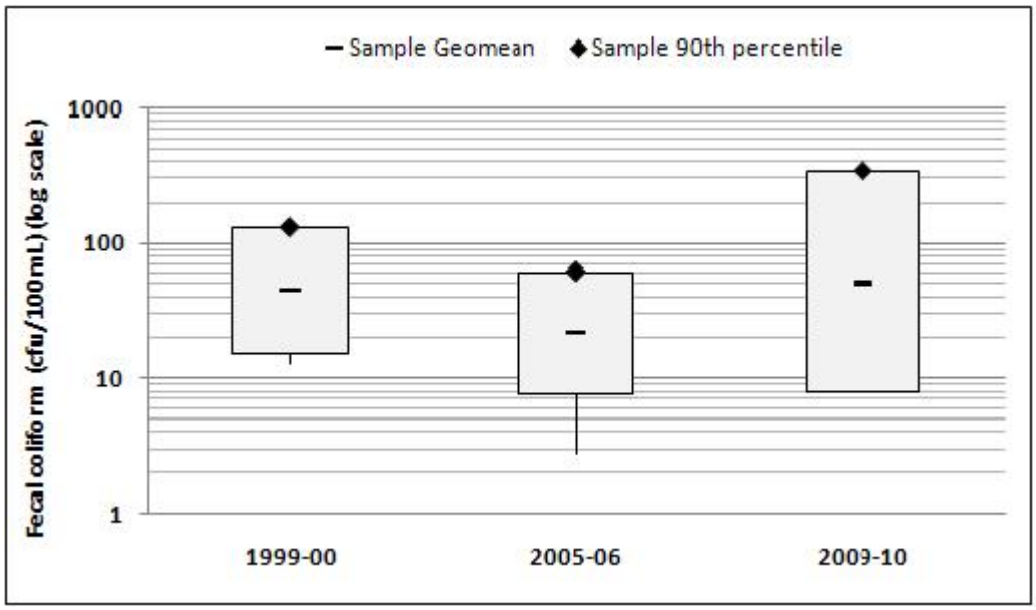

Figure 3. Study results comparison for fecal coliform at the Bourgault Road Bridge sampling station: 1999 TMDL and 2005-06 and 2009-10 attainment monitoring.

Results show that fecal coliform levels for Weaver Creek at BRB site decreased from 2000 to 2006, then increased from 2006 to 2010.

Fecal coliform data collected by the Skokomish Tribe were analyzed over the same time period as the TMDL and the attainment monitoring studies (Figure 4). The Tribe has been collecting monthly fecal coliform data at SVRB from 1995 through the present. The Tribe conducts membrane filter analysis to determine fecal coliform counts, and samples are collected under the guidance of a Quality Assurance Project Plan (Dublanica, 2005).

Results indicate a slight decrease in fecal coliform levels from 2000 to 2005 and an increase from 2005 to 2010 (Figure 4). These results are consistent with results presented in Figure 3.

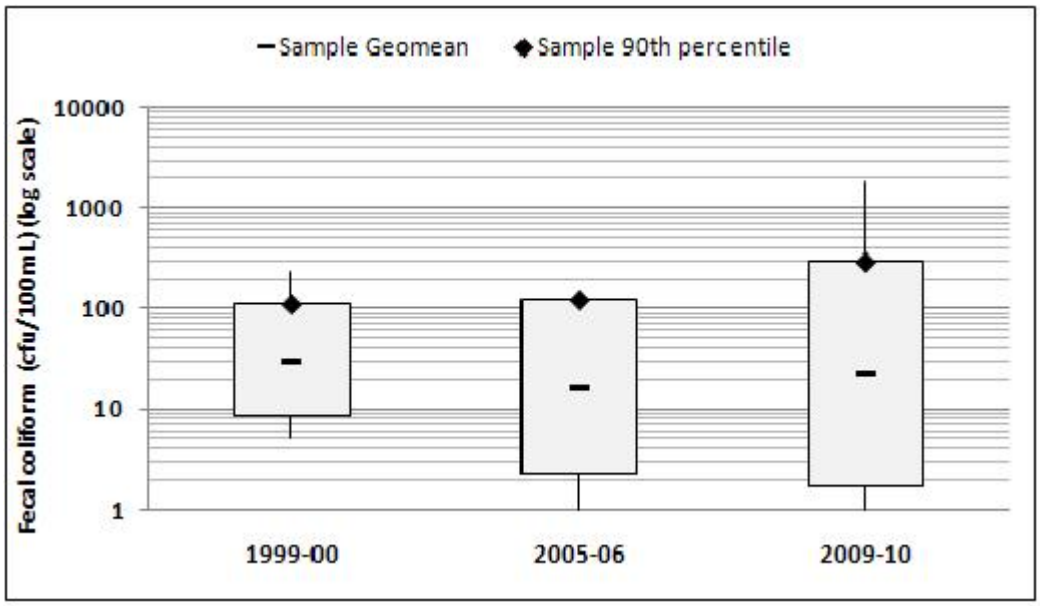

Figure 4. Skokomish Tribe fecal coliform results from selected years at the **S**kokomish Valley Road Bridge sampling station.

Conclusions and Recommendations

Conclusions

Fecal coliform levels on Weaver Creek have increased since the 2005-06 attainment monitoring study. Fecal coliform concentrations did not meet the geometric mean and 90th percentile water quality standard at both sampling stations. Also, a 34% reduction in fecal coliform levels is required to meet the TMDL target values established on Weaver Creek at Bourgault Road Bridge (BRB).

Fecal coliform levels on Weaver Creek decreased slightly from upstream to downstream sampling stations. This suggests the majority of the bacteria sources are upstream of the **S**kokomish Valley Road Bridge (SVRB).

At the time of the 2009-10 study, land use above SVRB was predominately hay land and seasonal livestock grazing. A large percentage of the land surrounding Weaver Creek above SVRB is under the management of one land owner. Aerial photos taken in 2009 of this area show little or no riparian vegetation along Weaver Creek (Figure 5).

During the 2009-10 study, field personnel noted a lack of riparian vegetation and fencing along the banks of Weaver Creek just above SVRB. Also, vegetation was observed to be grazed to the water surface, and cattle were observed grazing along the streambanks on five occasions during the study.

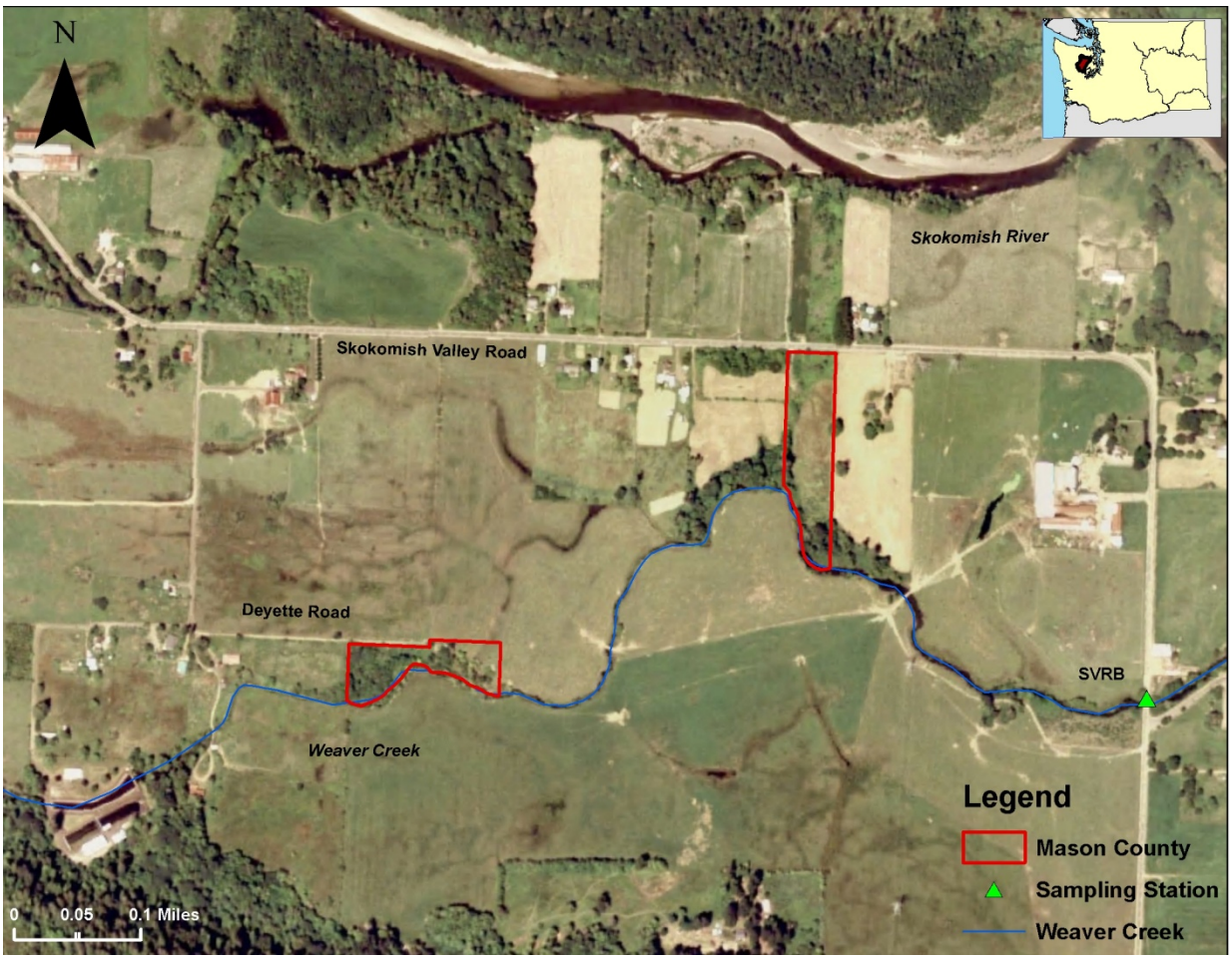

Figure 5. Weaver Creek land use above the Skokomish Valley Road Bridge sampling station.

Recommendations

- Work with land owners to remove cattle access and protect riparian areas to Weaver Creek upstream of the Skokomish Valley Road Bridge.
- Future fecal coliform monitoring on Weaver Creek should include additional sampling stations for source identification purposes. These additional stations could be established on property belonging to Mason County, as shown in Figure 5.

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Appendix A. Quality Assurance and Quality Control Results

Data Quality Results

Ecology's Manchester Environmental Laboratory analyzed fecal coliform samples in accordance with their quality assurance/quality control procedures (MEL, 2006). The laboratory used the fecal coliform most probable number (MPN) method 9221 EW (APHA, 1998).

All data quality objectives specified in the original Quality Assurance Project Plan (Batts, 2005) were met for the 2009-10 study (Table A-1). The TMDL specified acceptable precision for the total data set of duplicate pairs as root mean square of the coefficient of variation (RMSCV%) equal to or less than 45%. Table A-1 presents the precision estimates for fecal coliform data.

Table A-1. Precision estimates for fecal coliform field duplicates.

Parameter	Replicate Pairs	Number of Samples	Duplicate Rate	Completeness	RMSCV[1]
Fecal coliform	11	44	25.0%	100%	38.8%

[1] Root mean square coefficient of variation; consistent with Seiders et al. (2001).

Appendix B. Glossary, Acronyms, and Abbreviations

Glossary

Extraordinary Primary Contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Fecal Coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. FC are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Geometric Mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from ten to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Riparian: Relating to the banks along a natural course of water.

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Acronyms

BRB	Bourgault Road Bridge sampling site
FC	(See Glossary above)
Ecology	Washington State Department of Ecology
SVRB	**S**kokomish Valley Road Bridge sampling site
TMDL	(See Glossary above)