WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Dungeness River/Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study Streamflow Summary

November 2001

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Dungeness River/Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study Streamflow Summary

by
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November 2001

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Abstract

From November 1999 through October 2000, the Washington State Department of Ecology (Ecology) monitored stream flows on selected sites within the Dungeness River basin. This monitoring project provided flow information in support of Ecology's *Dungeness River/ Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study*.

Continuous recording stage-height instruments were installed at selected sites, and a series of flow measurements were conducted at varying stage-heights on Matriotti Creek, Meadowbrook Creek, and the Dungeness River. Ten flow measurements were made on the Dungeness River at the Schoolhouse Bridge, ranging from a low of 112 cubic feet per second (cfs) to a high of 1,077 cfs. Fourteen flow measurements were made at two locations on Matriotti Creek at the Olympic Game Farm property, ranging between 9 and 25 cfs.

Regression analysis was used to develop rating curves and calculate daily discharge averages based on the continuous stage records. These regressions produced a regression coefficient (R^2) of 0.99 for the Dungeness River and an R^2 of 0.97 for Matriotti Creek.

An attempt was also made to provide a complete and accurate continuous stage-height record and corresponding flow curve on Meadowbrook Creek. However, the stream morphology and heavy in-stream vegetation presented problems. Given these limitations, the best available estimates of flow in Meadowbrook Creek may be based on in-stream work by the United States Geological Survey (USGS) and confirmed by Ecology's own instantaneous flow measurements.

Acknowledgements

The author would like to thank those who provided field assistance or contributed to the completion of this project: Brad Hopkins, Christopher Evans, Kirk Smith, Robert Garrigues, Dale Clark, Dick Carter, Art Larson, and Casey Clishe of Ecology's Stream Hydrology Unit; Shawn Hopkins of Ecology's Southwest Regional Office, Water Resources Program; Pat Hanratty of the Washington Department of Fish and Wildlife; and Johnna Higgins of the Water Resources Division of the United States Geological Survey.

Introduction

The Washington State Department of Ecology (Ecology) Stream Hydrology Unit (SHU) was requested to provide stream-flow information in support of the *Dungeness River/Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study* (TMDL), (Sargeant, 2000). Ecology's Watershed Studies Unit conducted this 2000 TMDL.

For this current study stream-flows were monitored on the Dungeness River and Matriotti Creek from November 1999 through October 2000. Meadowbrook Creek was also monitored for a portion of that time. All of the monitoring sites established for this project were located within the lower Dungeness Watershed near the city of Sequim, Washington.

Site descriptions are presented in Appendix A. Final flow data were compiled to reflect daily averages, although 15-minute and hourly time-steps are available.

Figure 1. Map of Dungeness River Basin.

The Dungeness River basin lies in the northeastern Olympic peninsula of Washington State. The Dungeness River flows in a northerly direction from the rugged mountain peaks of Olympic National Park to the Strait of Juan De Fuca at Dungeness Bay. The upper portion of the river flows through steep narrow canyons while the lower ten miles is characterized by gently sloping plains.

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Methods

Site selection for installing the flow monitoring stations was an important aspect of this project. Several sites for each stream were evaluated based on access to the site, quality of stream cross-sections, the likelihood of channel shifts, vulnerability to vandalism, potential damage from high flows and ease of station installation. The final sites selected were the most favorable considering these criteria.

Each station was equipped with a Design Analysis, Inc. model H-500 Waterlog Data Logger, and an H-310 submersible SDI-12 pressure transducer. The data logger and pressure transducer were housed in a secure shelter and stilling well assembly. Stage-height measurements from the pressure transducers, from which the flow assessments were calculated, were expressed in pounds per square inch (psi). The data loggers also recorded water temperature in degrees Celsius. The data loggers recorded water column pressure and water temperature at 15-minute intervals, storing the data on an ATA flashcard. The stations were arranged in such a manner that TMDL investigators could access the equipment and easily obtain stage-height and temperature measurements as needed.

A staff gage was also included at each site to confirm data logger measurements. Staff gage readings, noted at each site visit, were expressed in feet.

Upon each field visit by Stream Hydrology Unit staff the most recent files were downloaded from the flashcards to a laptop computer directly into Microsoft Excel© format. The downloaded files were checked for errors and the data logger and pressure transducer checked for proper operation. Maintenance procedures such as replacing batteries and transducer desiccants were done routinely.

Stream discharge measurements were also made during these field visits if the stage height was not at or near a previously measured level. Flow measurements were conducted using a Swoffer™ Model 2100 velocity meter and a 6/10th's incremental top-set wading rod. In the case of the Dungeness River, where higher discharges could not be made by wading, a bridgeboard with a Type "A" sounding reel and USGS "Columbus" sounding weight was used to measure discharge from the Schoolhouse Bridge. The wetted width of the stream channel was measured at a predetermined cross-section and divided into approximately 20 sections or cells in accordance with the United States Geologic Survey's mid-section method for instream flow measurements (USBR, 1997). An effort was made to divide the cross-section such that flow in any single measured cell did not exceed ten percent of the total flow. At cells where the depth exceeded one and 1/2 feet, two velocity measurements were taken, one at 2/10th's and one at 8/10th's of the total depth from the water surface. At depths of one and 1/2 feet or less velocity was recorded at 6/10th's depth (Hopkins, 1999).

Even under ideal flow conditions the instantaneous discharge measurements are assumed to have a built in total error of +/- five percent. To limit these assumed errors, velocities were measured at each cell at proper depths until two readings within .05 ft/second were attained or a total of four measurements were made. The mean of these values was the recorded velocity for that cell (Hopkins, 1999).

Rating curves were developed for each station using regression analysis of the stage and instantaneous flow measurements. The regression equation was applied to the continuous stage-height records to predict stream discharge. In instances when the rating curve did not cover the full range of recorded stage heights, the curve was extended to equal two times the highest measured flow and one-half of the lowest measured flow. Flows outside of this range were considered estimates and were qualified with a “J” (Hopkins, 1999).

Quality Assurance

The quality of data produced through this flow-monitoring project depends upon the precision and reliability of the equipment used, site selection, and the soundness of the methods and procedures used to collect the data. All stream-flow data collected throughout this flow monitoring project followed Stream Hydrology Unit protocol (Hopkins, 1999).

The SDI-12 pressure transducers used in this study have a theoretical precision of less than or equal to 0.02 percent within their designed range of 0 to 15 psi. Transducer accuracy is also expressed in its relation to the staff gages installed at each site. Much of the error associated with stream discharge measurement lies in velocity measurements, therefore every effort was made to minimize velocity errors. In addition to following the field methods for measuring velocities as outlined above, all propellers used in conjunction with the Swoffer velocity meter are calibrated to determine the amount of error a particular propeller may introduce to the discharge measurement. The standard calibration for these propellers is 186 revolutions. For every 10ft. of water that moves past the propeller, the propeller should rotate 186 revolutions. The propellers used for this project calibrated between 186 and 182 revolutions. A propeller with a calibration of 182 would introduce an additional two-percent error into the velocity measurement ((182/186) x 100%).

Site selection is also important in limiting error. We made every attempt to choose the best possible sites for the station structures and for pressure transducer placement. We also tried to choose the best cross-sections for stream flow measurements. Ideally, we place our cross-sections in close proximity to the stage-height recording equipment. We attempt to establish cross-sections in a straight stretch of the stream or river with few upstream and downstream obstructions with a uniform, stable channel. Cross-sections meeting all of these characteristics are difficult to find, so the cross-section is evaluated to reflect the amount of potential error introduced to the flow measurement based on cross-section quality. A good or excellent rated cross-section assumes a potential error of two to five percent. A fair cross section assumes a potential error of up to eight percent while a poor cross-section assumes an error over eight percent. The cross-sections for this flow study were all rated as good to fair with a built in error of up to eight percent.

Flow measurement replication is a method the Stream Hydrology Unit has used to assess precision. Replication in this case means measuring consecutive flows at the same location using the same equipment and methods then comparing the difference between the two measurements. Based on SHU protocols, it is assumed no substantial measurement errors were made if the difference between measurements is less than five percent. It is also assumed the measurements themselves (following SHU protocol) are with in +/- five percent of the actual flow value (Hopkins, 1999).

The Stream Hydrology Unit used replication as a technique to address flow measurement precision in two studies involving the Dungeness River in 2000. One study, the *Relationship between the Dungeness River and the Shallow Aquifer in the Sequim-Dungeness area, Clallam County, Washington* by the U.S. Geological Survey (Simonds et al, 1999) in which Stream Hydrology Unit provided field assistance, incorporated consecutive discharge measurements at select sites (including Schoolhouse bridge) along the lower 11 miles of the Dungeness River. Another such project, the *Relationship between the upper Dungeness River and the bedrock aquifer from the Gray Wolf River confluence, downstream to the U.S. Geological Survey's cableway stream gage* by the Stream Hydrology Unit (Garrigues et al, 2000), included a replicate measurement at one of the measurement sites assigned to each field team.

The first study, in association with USGS, was a two-part study; the first part was done in April, the second in October of 2000. In April SHU staff made eight replicate measurements along the lower Dungeness River and tributaries with an average difference between flows of just over two percent. In October, ten replicate measurements were done with an average difference of about 3.4 percent.

One of the measurement sites included in this study was the Dungeness River at Schoolhouse Bridge, SHU's Dungeness River flow monitoring site. In April, SHU staff did replicate measurements at this site with a difference of about two percent. In October, USGS replicate measurements had a difference of 1.4 percent. For reference purposes the Stream Hydrology Unit also did a single measurement at that same location on the same day and our measurement showed a difference of 0.7 percent from the mean of the two USGS measurements.

The second study, in the upper Dungeness watershed, included three replicate measurements. The average of these measurement differences was 1.2 percent.

Another method used in this study to assess the quality of the collected data was to compare measured flows to flows predicted by regression equations. The regression equation was applied to the observed stage height (psi) of a particular flow measurement and the measured flow was compared to the flow predicted by the regression.

Flow measurements and data compilation were reviewed by senior level staff for procedural and recording errors.

Results

Meeting the goal of providing accurate flow information for the Dungeness/Matriotti TMDL generally proved successful. However there were some situations encountered that presented unique challenges.

Dungeness River

Flows ranged from nearly 2400 cfs in November 1999 to less than 100 cfs in September and October of 2000. The average daily flow for the study period was 370 cfs. Ten discharge measurements were made during the study period ranging from 112 cfs to 1,077 cfs. The rating curve, which incorporated two regressions, produced an average R^2 of 0.99. Two separate regressions were used because we believed a single regression encompassing all of the measured discharges did not adequately predict the full range of flows encountered throughout the study period. One regression was used to better predict flows that were below the average daily flow and extrapolating to below the lowest measured discharge, while the other, we think more adequately predicts flows above the average daily flow and highest measured discharge. The highest daily flow of the study period, 2,338 cfs recorded on November 12, 1999, was qualified with a “J” and should be considered an estimated flow. The reasons for this estimate is because of the difficulty predicting flows over two times the highest measured discharge. Channel geometry and configuration is a major factor in the stage discharge relationship and since this calculated flow is more than double the highest of measured flows (1,077 cfs) used to develop the stage discharge correlation, flows at that stage-height are considered best estimates.

There were two instances over the course of the study where data were lost due to equipment malfunctions. The first occurred March 26-28 when the system lost power due to a faulty battery. The second failure caused a significant data gap in the continuous record, August 16 through September 13. This was due to an internal software problem that caused the system to shut down. In both cases the data gap was supplemented with data from the USGS station also located at Schoolhouse Bridge. This supplemented data are highlighted in the continuous record. Daily discharge averages are presented in Table 1.

A concern we had with this station and its proximity to the river mouth at Dungeness Bay was the potential influence of tidal changes on stage-height measurements. We examined tidal records against recorded stage height data and found no evidence of tidal influence.

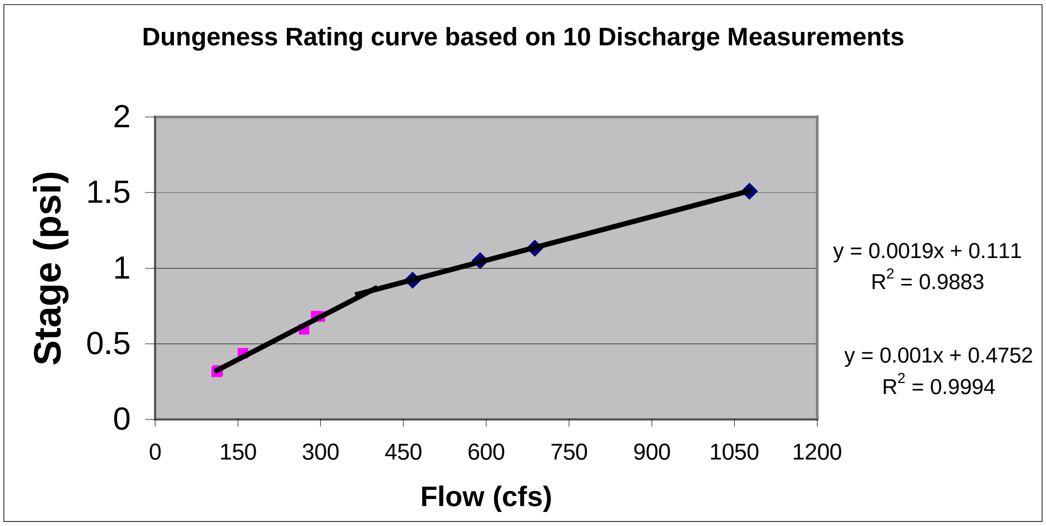

Figure 2. Dungeness River Rating Curve

Dungeness River stage (measured by pressure transducer in psi) versus flow (cfs) rating curve. Two separate regressions were used to more effectively correlate stage with flow at lower and higher discharges. The equations are applied to continuous records of stage height to predict flow at a given stage.

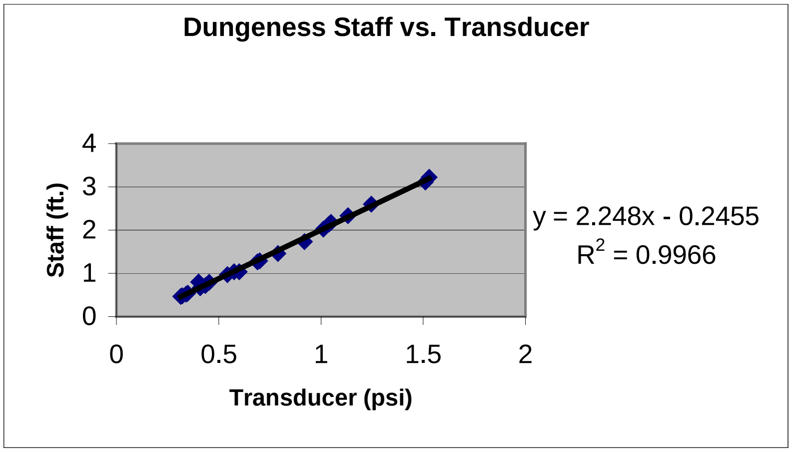

Figure 3. Dungeness River Staff Gage Versus Transducer Regression.

This regression relates all staff gage observations to corresponding transducer values and is used to correlate the accuracy of the transducer with the staff gage readings. A strong correlation adds confidence to the continuous record of calculated discharges.

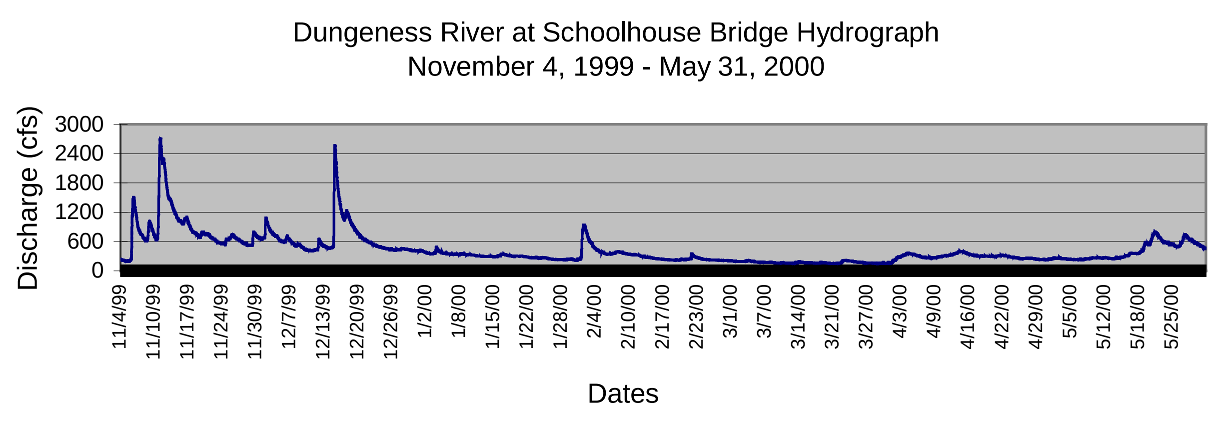

Figure 4. Dungeness River Hydrograph (November 4, 1999 - May 31, 2000).

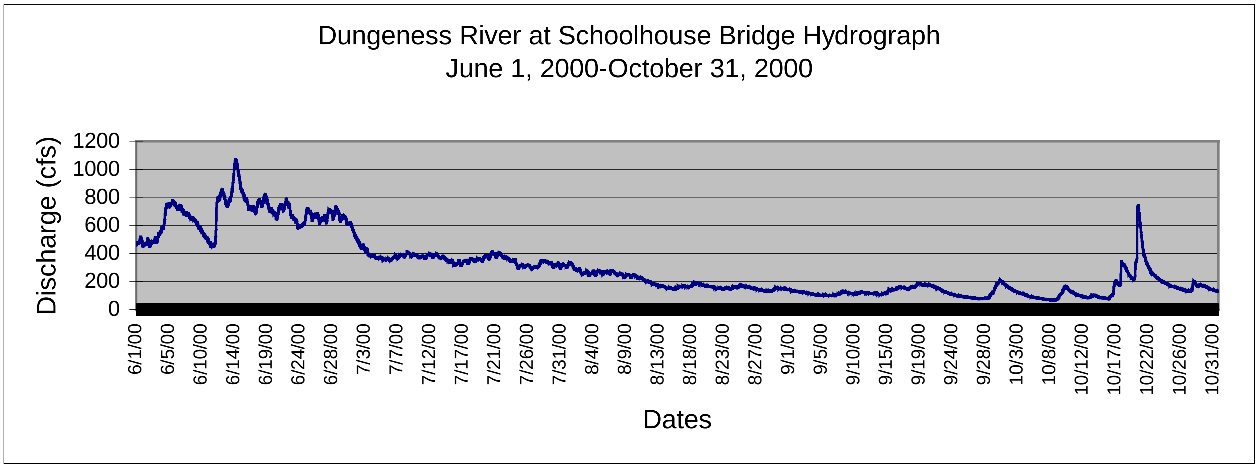

Figure 5. Dungeness River Hydrograph (June 1, 1999 - October 31, 2000).

Matriotti Creek

The stream-flow (daily discharge) of Matriotti Creek ranged from about 34 cfs in December of 1999 to 11 cfs in late September and October of 2000. The average daily flow for the period of study was about 14 cfs. The rating curve from the original upstream station from which most of the data are derived produced an R^2 of 0.97 based on seven flow measurements. These discharge measurements ranged from 11 to 25 cfs. Seven flow measurements (from 9 to15 cfs) were also done at a temporary station installed at a downstream location; the rating curve from this station had an R^2 of 0.65.

We were faced with a unique problem in the middle of the study. On April 3, 2000 a fish weir was installed by the Washington State Department of Fish and Wildlife downstream of our flow monitoring station. Apparently fish weirs have been installed annually at this location, however this was not made known to us or the TMDL study team. This temporary dam caused water to back up at the station, resulting in artificially elevated stage height data. Prior to the installation of the weir several flow measurements had been made and a strong rating curve had been established which was no longer useable while the weir was in place.

Once we became aware of this situation we installed a temporary station downstream of the fish weir and established a new rating curve. This limited the data gap in the flow record and provided flow information while the weir was in place. The new station was installed April 27th after losing 24 days of record since April 3rd. Daily discharge averages are presented in Table 2.

The new location although not ideal, was the most favorable site available. The substrate in the vicinity of the station and at the measurement cross-section was in some spots deep mud and just downstream of the site was a fair amount of woody debris in the channel that might produce backwater at the station. The site was also close to the confluence with the Dungeness River, which at high flows might influence stage readings.

The fish weir also affected the downstream site by collecting leaves and debris, hampering the flow. Department of Fish and Wildlife personnel cleaned the weir daily. When the weir was cleaned, enough water was released downstream to raise the stage. The effects of this are seen in the continuous record where sudden spikes in stage lasting about an hour are followed by quick returns to the previous level. The magnitude of the spike varied from day to day because the amount of debris removed varied.

Because of the difficulties encountered with the new monitoring site, a decision was made to keep the station in place after the weir was removed although the data for the TMDL study would come from the original upstream station. We thought with the flow pattern returning to normal after the weir was gone we may be able to collect more reliable data and improve the quality of the information collected while the weir was in place.

The measured flows at the new station suggest possible backwater effects from the woody debris accumulating downstream. Influences from the Dungeness River were ruled out because backwater effects were noticed when the river stage was declining. Comparisons of cross-sectional area and average velocity with stage height revealed that as staff readings and cross-sectional area increased, average velocity decreased. This suggests that flow was being impeded. Flow measurements conducted at the new site before the fish weir was removed show noticeable differences from those after the weir was removed. Staff gage observations indicate that cross-sectional area was higher than expected after the fish weir was removed.

In figure 6 the measurements before and after weir removal are grouped and both sets of data show area increasing with a corresponding increase in staff readings. When the weir was removed the cross-section area is higher although the staff gage levels are lower. A reference point (RP) was also established on a log above the water surface where measurements are made between the RP and the water surface. These recorded measurements do not indicate channel bed degradation that would lower the water level with respect to the staff gage.

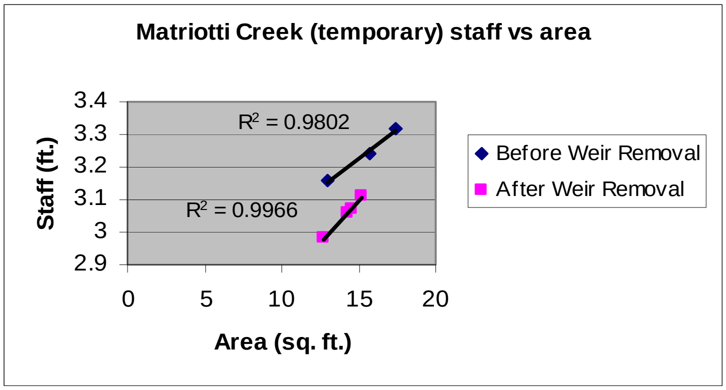

Figure 6. Matriotti Creek (Temporary Station) Staff Gage versus Cross-sectional Area Regressions.

Figure 7 shows average cross-sectional velocities at corresponding cross-sectional areas. The average velocities measured before the fish weir was removed seem to decrease as area increases. After fish weir removal, velocities decrease as cross-sectional area increases but at a greater rate. Clearly velocities would normally be expected to increase as the area increased in a free flowing system. In this case however, velocities decreased as stage height and cross-sectional area increased as would happen if there were downstream impediments to flow causing water to slow down and increase in area. We believe the differences in these parameters before and after the fish weir removal occurred because a slug of sediment was released when the weir was removed and a portion of the sediment collected around the in-stream debris.

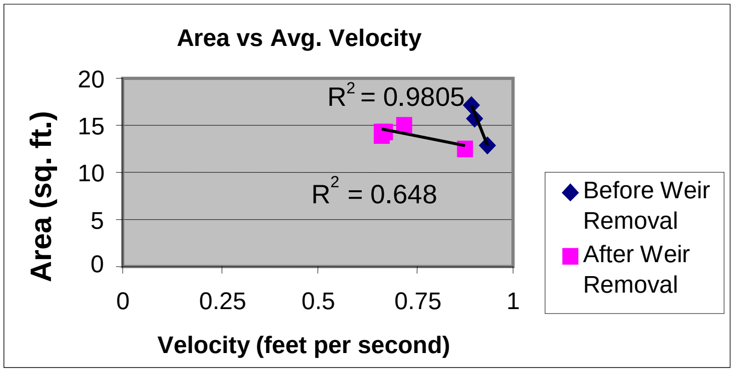

Figure 7. Matriotti Creek (Temporary Station) Cross-sectional Area Versus Average Velocity.

Figure 6 shows the cross-sectional area increasing at lower staff gage observations after the fish weir was removed. In figure 7 velocities decreased slightly as cross-sectional area increased before the weir was removed. After the weir was removed velocities generally decreased at a higher rate than they decreased before weir removal. This would indicate increased backwater effects after the weir was removed.

Although this backwater effect is reflected in the data, flows still generally increased as stage height increased. This was because cross-sectional area increased at a higher rate than reflected by the average velocity. In other words since area is multiplied by average velocity to obtain discharge, the gain in area compensated for the loss in average velocity.

Although the 77 days of flow data collected during the time the fish weir was in place are certainly not as reliable as we would like; we feel the data are a reasonable representation of the flows during this time period.

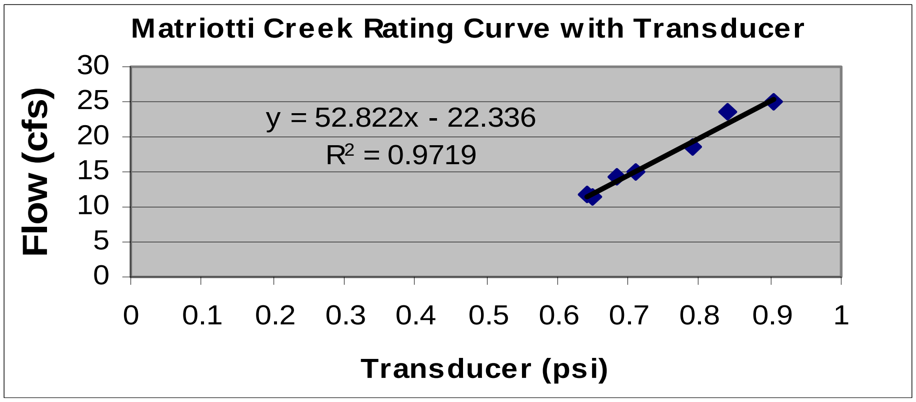

Figure 8. Matriotti Creek (Original Station) Rating Curve.

Matriotti Creek rating curve from the original monitoring station up-stream of the Washington Department of Fish and Wildlife's fish weir. This rating equation was applied to continuous stage-height records before and after the fish weir installation and removal. A temporary gage was installed downstream of this gage while the weir was in place.

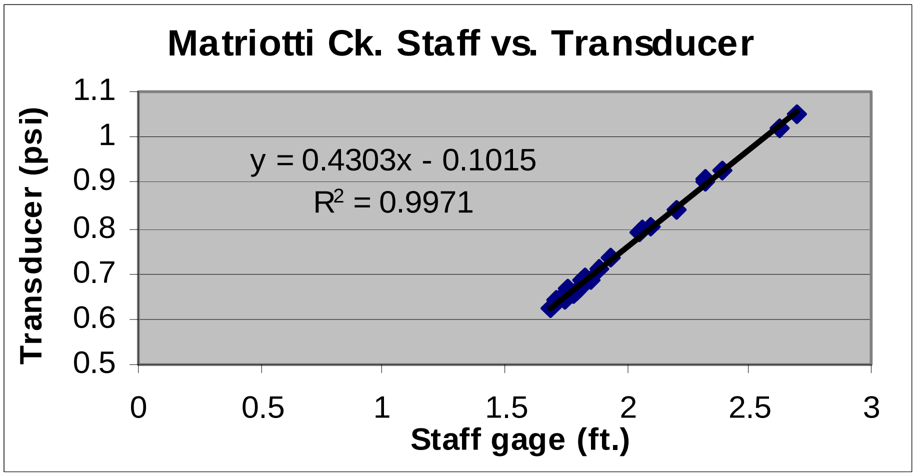

Figure 9. Matriotti Creek (Original Station) Staff Gage Versus Transducer Regression.

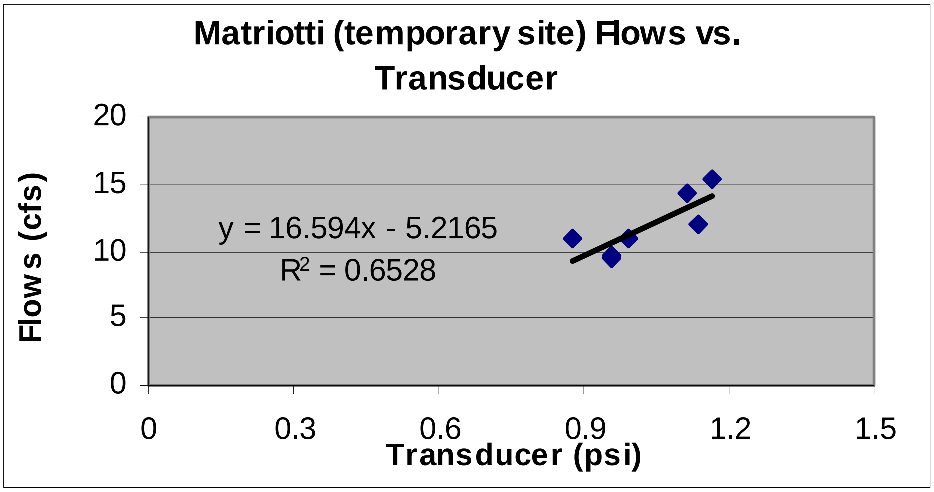

Figure 10. Matriotti Creek (Temporary Station) Rating Curve.

Matriotti Creek rating curve at the temporary monitoring station downstream of the Washington Department of Fish and Wildlife's fish weir. Because of backwater effects from in-stream woody debris, the correlation between flow and pressure transducer is not as strong as hoped.

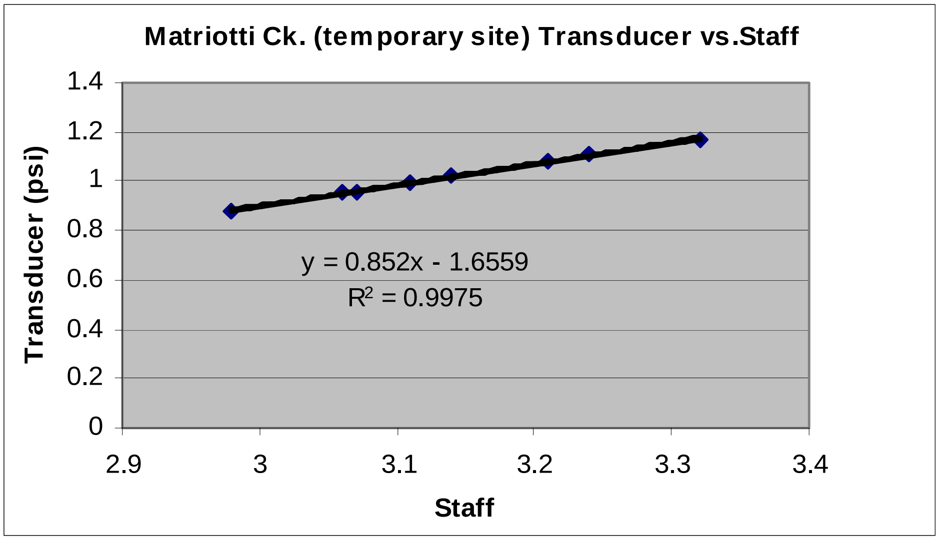

Figure 11. Matriotti Creek (Temporary Station) Staff Gage Versus Transducer Regression.

A strong correlation between the staff gage and the pressure transducer as shown above gives confidence to the function of the pressure transducer.

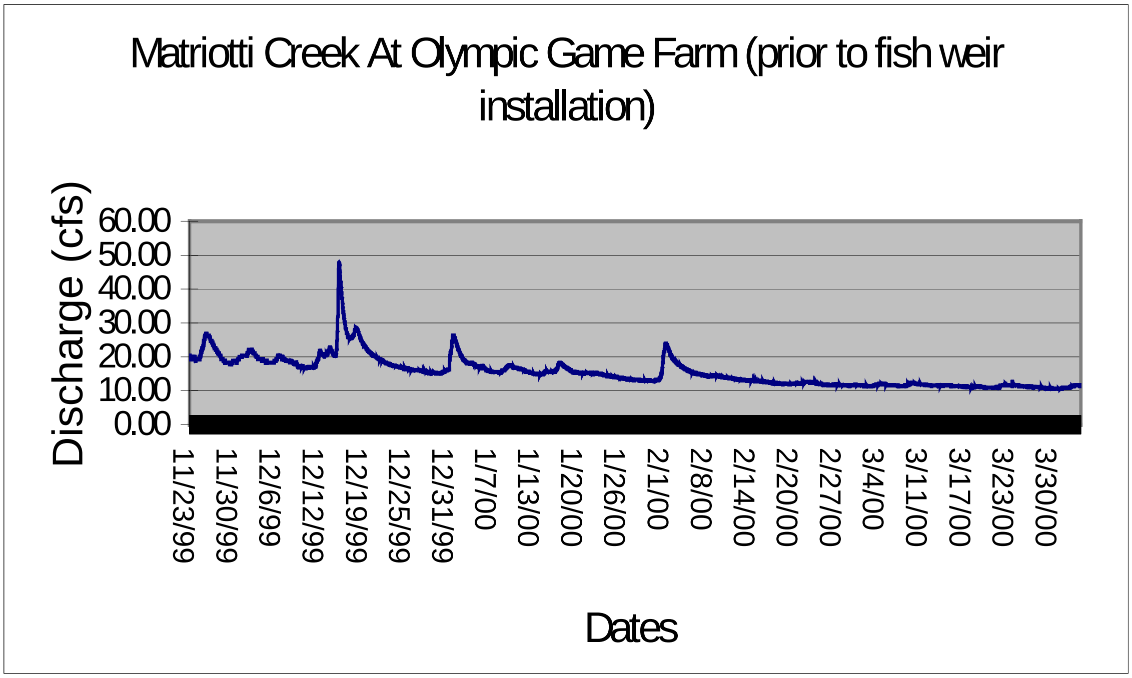

Figure 12. Matriotti Creek (Original Station) Hydrograph Prior to Installation of Fish Weir.

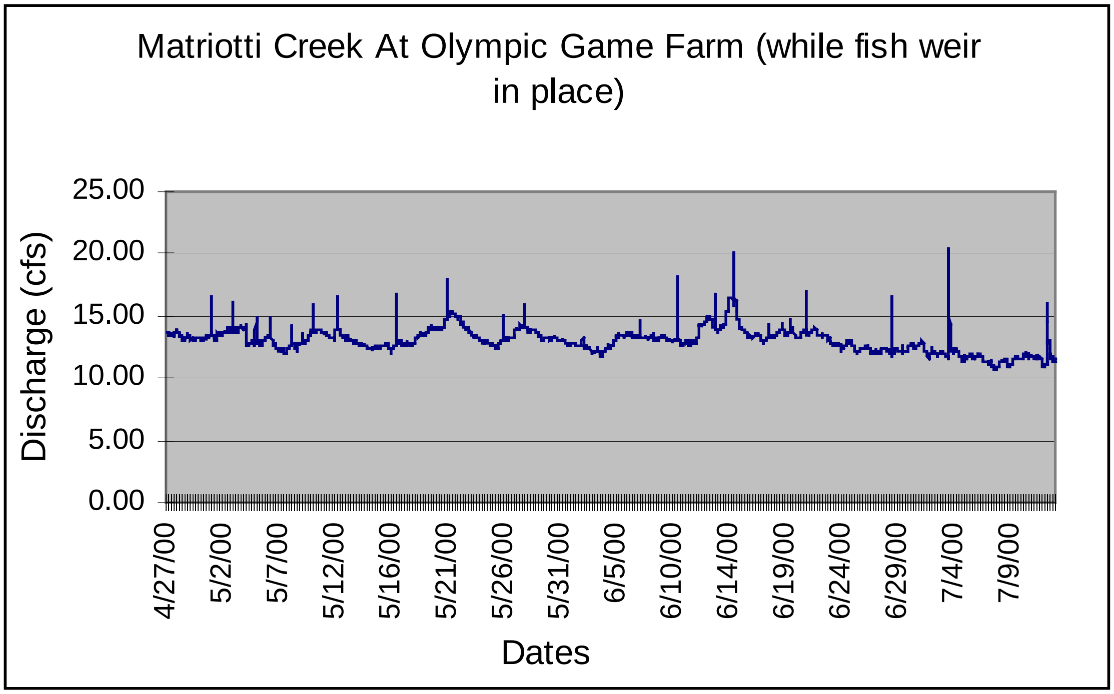

Figure 13. Matriotti Creek (Temporary Station) Hydrograph While Fish Weir in Place.

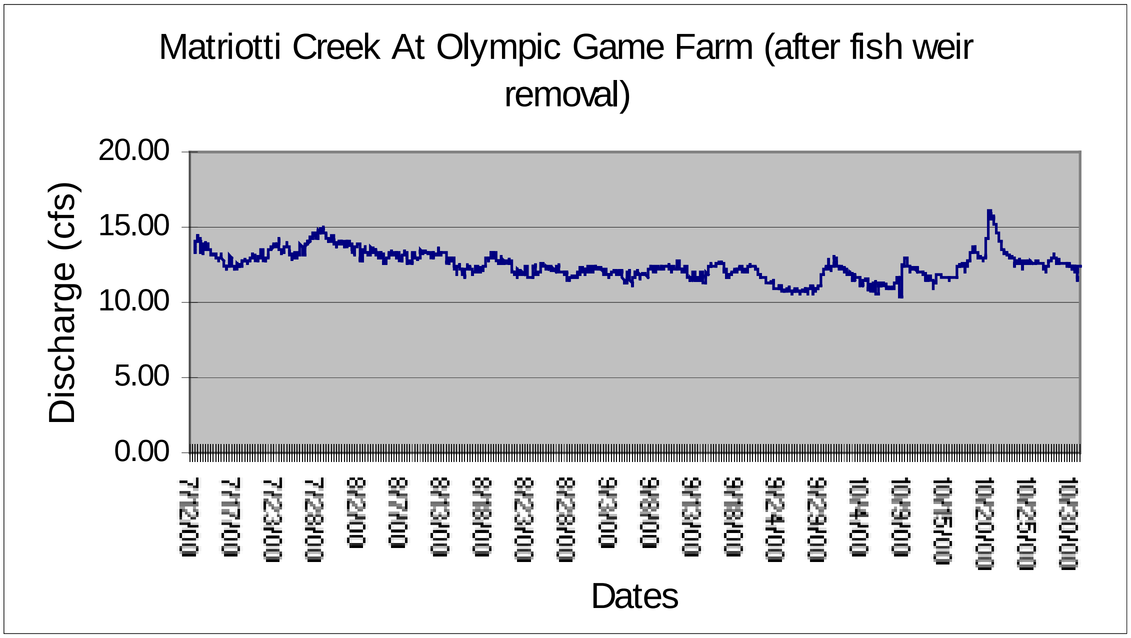

Figure 14. Matriotti Creek (Original Station) Hydrograph After Weir Removal.

Meadowbrook Creek

Initially, Meadowbrook Creek was included in the project as a stream to be monitored. However, we found only one feasible site to locate a station. The rest of the creek was heavily choked with vegetation. The chosen site was free of vegetation for a short (approximately 70 feet) distance and was the only section of the creek suitable for installing flow-monitoring equipment.

Problems became apparent after initial flow measurements were reviewed. In some instances, as the stage decreased, flow would increase and vice versa, the opposite of what one would expect. We installed an additional transducer in a deeper downstream pool believing that the original location may have been too shallow for the transducer. It was apparent that the first transducer was losing resolution at low stage, skewing the stage discharge relationship. However after additional discharge measurements, a stage vs. discharge trend could still not be established using the second transducer. The limited range of discharge measurements was another problem. Six measurements were made between 3.9 and 4.8 cfs, a range of less than one cubic feet/sec. The range of stage-heights was 0.31 to 0.80 feet. In some cases the differences between the flow measurements were within the assumed margin of error (+/– five percent) even though there was a relatively large change in the stage.

After additional analysis of the collected flow data another anomaly became apparent. Although the cross-sectional area generally decreased as stage decreased (as would be expected), the average velocity generally increased as stage and cross-sectional area went down. The increase in velocity offset the reduction of area enough to cause measured flows to increase.

One possible explanation is measurement error or faulty equipment. However, all of the measurements were performed following Stream Hydrology Unit protocol, designed to reduce measurement error. As for faulty measuring equipment, batteries and propellers were checked before and after each measurement. Since batteries and propellers are associated with velocity measurements any faults with this equipment would under-report (indicate slower) velocities. What stands out here is that velocity increased rather than decreased with a reduction of stage and cross-sectional area. Other flow measurements using the same equipment were made at other sites, often on the same day, and there were no anomalies such as were encountered at Meadowbrook Creek.

The most likely explanation is backwater during higher flows caused by aquatic vegetation downstream of the monitoring site. The vegetation may slow velocities as water is backed up so that actual flow is reduced although the volume of water in the system remains high. As the "volume" of water in the system subsides or vegetation within the stream channel is reduced, the vegetation is no longer hampering the movement of water and the water becomes freer flowing. This may explain why velocities increased while the stage and cross-sectional area decreased.

The data collected at Meadowbrook Creek do not reliably reflect stream-flow values. Since we could not collect reliable data or reasonably predict flow based on the collected data, we removed the station and equipment on June 19, 2000.

Because reliable daily flow records could not be produced does not mean that certain assumptions cannot be made about flow trends in Meadowbrook Creek. Since groundwater discharge produces most of the flow, a relatively constant flow pattern can be expected throughout the year (USGS, 1999). In a 1979 study by USGS, flow measurements were done once a month at Meadowbrook Creek and other streams in the Dungeness River watershed. The measured discharges on Meadowbrook Creek ranged from about four to six cfs (USGS, 1999). As indicated earlier our flow measurements ranged form about four to approximately five cfs. It is reasonable to assume, given the source of flow and the narrow range of discharge measurements that a flow of four to six cfs can be expected the majority of the time.

Station Descriptions

Dungeness River

The flow monitoring station for the Dungeness River is located about four miles north of Sequim Washington at the Anderson Road/Schoolhouse Bridge crossing (approximate River Mile 0.75) near the community of Dungeness. The monitoring equipment is housed in a secure shelter and stilling well assembly and is attached at the downstream side of the east concrete piling of the Anderson Road/Schoolhouse Bridge on the right edge of water (REW). At the Schoolhouse Bridge location the river channel is bound by the U.S. Army Corps of Engineers levy to the east and the Rivers End levee to the west. An abandoned road atop the east levee on the north side of Anderson Road at the Schoolhouse Bridge approach served as an access point to this station. Permission to install and access the station was granted by the Clallam County Road Department.

Matriotti Creek

The Matriotti Creek flow-monitoring site was located approximately 3/4 miles southwest of the Dungeness River station. The site is on the Olympic Game Farm property on the East Side of Ward Road across from the public entrance to the game farm. The recorder and pressure transducer structure was placed in the middle of the stream channel in a pooled segment of the creek. The station was attached to the upstream side of a wooden bridge crossing, along a private gravel road on the north end of the property.

The temporary site was approximately one-eighth of a mile downstream of the permanent station. The data logger and battery was housed in a weatherproof box and securely attached to a tree. Lloyd Beebe, owner of the Olympic Game Farm granted permission to locate the stations at these sites.

Meadowbrook Creek

The Meadowbrook site was located on Sequim-Dungeness Way about one-fourth of a mile southeast of the Dungeness River site. The structure housing the monitoring equipment was located on the REW immediately downstream of a private steel bridge, part of the driveway of a private residence. Permission to monitor flow at this site was granted by the owner of the private residence.

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Table 1. Dungeness River at Schoolhouse Bridge Daily Discharge Averages (cfs).

Dungeness River @ Schoolhouse Bridge Daily Flows (in cfs) Water Year 2000

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct WY 01
1			668	405	573	200	189	229	480	584	318	138	194
2			895	370	754	193	268	251	472	476	281	128	154
3			809	353	535	191	316	259	485	420	260	122	126
4		219	702	419	422	201	355	247	556	380	256	112	108
5		202	610	372	372	191	338	236	727	366	265	105	92
6		676	643	352	343	181	305	227	746	357	266	103	82
7		1091	579	341	358	176	276	230	710	371	264	104	74
8		730	529	339	384	171	263	232	664	382	246	114	68
9		715	484	346	366	169	266	248	619	394	241	120	94
10		857	423	335	344	162	286	262	543	384	238	114	150
11		1000	416	323	331	163	304	264	472	374	218	121	119
12		**2338J**	506	305	316	156	320	264	686	388	195	117	98
13		1654	524	296	287	159	353	253	796	384	175	113	88
14		1307	468	297	273	178	386	256	856	367	162	111	97
15		1071	1213	290	253	168	371	271	963	340	152	134	85
16		1003	1649	310	240	168	336	300	780	329	156	151	85
17		981	1121	336	228	160	315	350	717	340	165	155	171
18		798	1099	310	220	163	301	358	755	352	172	154	286
19		719	882	299	219	165	300	395	768	356	184	176	243
20		764	735	299	225	153	297	552	684	373	170	175	475
21		728	641	291	230	152	299	649	722	391	159	169	413
22		642	583	272	282	174	317	750	737	390	150	147	273
23		570	525	267	282	208	304	627	633	363	151	124	222
24		577	488	262	247	196	281	570	608	335	156	107	188
25		672	459	260	228	184	263	539	686	309	167	96	165
26		690	440	238	220	173	247	502	660	307	159	88	149
27		613	428	229	216	161	253	635	645	302	148	82	134
28		551	439	226	208	160	251	683	687	341	137	79	169
29		533	442	228	205	153	233	601	688	328	132	91	169
30		729	421	234		158	227	541	644	316	149	158	155
31			407	223		157		482		311	148		137
Avg.		**773**	**653**	**304**	**316**	**172**	**294**	**396**	**673**	**368**	**195**	**124**	**163**

**Red Colored Entries Denotes Data Gathered from USGS Gaging Station 12049000.

**J Denotes Flow Values predicted by regression equation but fall outside ranges of extrapolation based on actual measured flows

Table 2. Matriotti Creek At Olympic Game Farm Daily Discharge Averages (cfs).

Matriotti Creek @ Olympic Game Farm Daily Flows (in cfs) Water Year 2000

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct WY 01
1			20	23	16	12	11	13	13	13	14	12	13
2			21	22	22	12	11	14	13	12	13	12	12
3			20	19	19	11		14	12	12	13	12	12
4			19	18	17	12		13	12	12	13	12	11
5			18	17	16	12		13	13	12	13	12	11
6			19	16	15	12		13	13	12	13	12	11
7			20	16	15	12		12	13	11	13	12	11
8			19	16	14	12		13	13	11	13	12	11
9			18	17	15	12		13	13	11	13	12	12
10			17	17	14	12		14	13	12	13	12	13
11			17	17	14	12		13	13	12	13	12	12
12			19	16	13	12		14	14	12	13	12	12
13			21	15	13	12		13	15	14	13	12	11
14			22	15	13	12		13	15	14	13	12	12
15			30	16	13	11		12	16	13	12	12	12
16			34	16	13	11		13	14	13	12	13	12
17			26	18	12	11		13	13	13	12	12	12
18			27	17	12	11		13	13	12	13	12	13
19			24	16	12	11		13	14	13	13	12	13
20			21	15	12	11		14	14	13	13	12	15
21			20	15	12	11		15	14	13	13	12	15
22			19	15	12	11		15	14	13	12	12	13
23		20	18	15	13	12		14	13	14	12	11	13
24		20	17	15	12	12		13	13	14	12	11	13
25		22	17	14	12	11		13	13	13	12	11	13
26		26	16	14	12	11		13	12	14	12	11	13
27		23	16	13	12	11	14	14	12	14	12	11	12
28		20	16	13	12	11	14	14	12	15	12	11	13
29		18	15	13	12	11	13	14	12	15	12	11	13
30		19	15	13		11	13	13	13	14	12	12	12
31			16	13		11		13		14	12		12
Avg.		**21**	**20**	**16**	**14**	**11**	**13**	**13**	**13**	**13**	**13**	**12**	**12**

No data available from April 3 through 26 due to installation of fish weir.

** Data in red are data from temporary downstream station.

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