DEPARTMENT OF ENVIRONMENTAL CONSERVATION
NONPOINT SOURCE POLLUTION PROGRAM
ACWA NPS WATER QUALITY GRANT

FY 2006
FINAL REPORT

PROJECT #: ACWA-06-10

Watershed Protection and Recovery for Jordan Creek, Juneau, AK

July 2006

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Project Description and Purpose

The purpose of this monitoring effort was to characterize the water quality of Jordan Creek in the Mendenhall Watershed (Figure 1), to compare the water quality to Alaska state standards, to evaluate the effects of urbanization in the watershed (e.g. sediment and road salt inputs), and to conduct a bioassessment of the stream. The stream corridor of Jordan Creek has undergone extensive development, and it has been suffering from low flow levels, including complete drying out at some sites, and declines in salmon usage. A suite of water quality parameters was collected at three representative sites on Jordan Creek every two weeks from August 2005-June 2006 and a bioassessment was conducted in May, 2006.

Jordan Creek flows through the eastern edge of the Mendenhall Valley and drains an area of about 3 mi^2 (Host and Neal, 2004). The upper reaches of Jordan Creek originate along the western edge of Thunder Mountain and are relatively undeveloped, while the lower reaches downstream from Egan Drive are bounded by parking lots apartment complexes and professional malls. Degradation of the riparian zone has occurred where buildings, parking lots, and roads have encroached on the stream channel.

The specific goals of this project included:

- To document existing water quality conditions in Jordan Creek and make comparisons to historic data
- To use water quality data for Jordan Creek to differentiate natural versus anthropogenic inputs
- To assess the impacts of road salt and sediment dumping on the water quality of Jordan Creek
- Conduct a bioassessment of Jordan Creek and make comparisons to historic data

This report is arranged into 3 sections:

Part I: Water Quality Monitoring Project
Part II: Sediment loading to Jordan Creek
Part III: Benthic Macroinvertebrate Bioassessments in Jordan Creek, 1995 and 2006

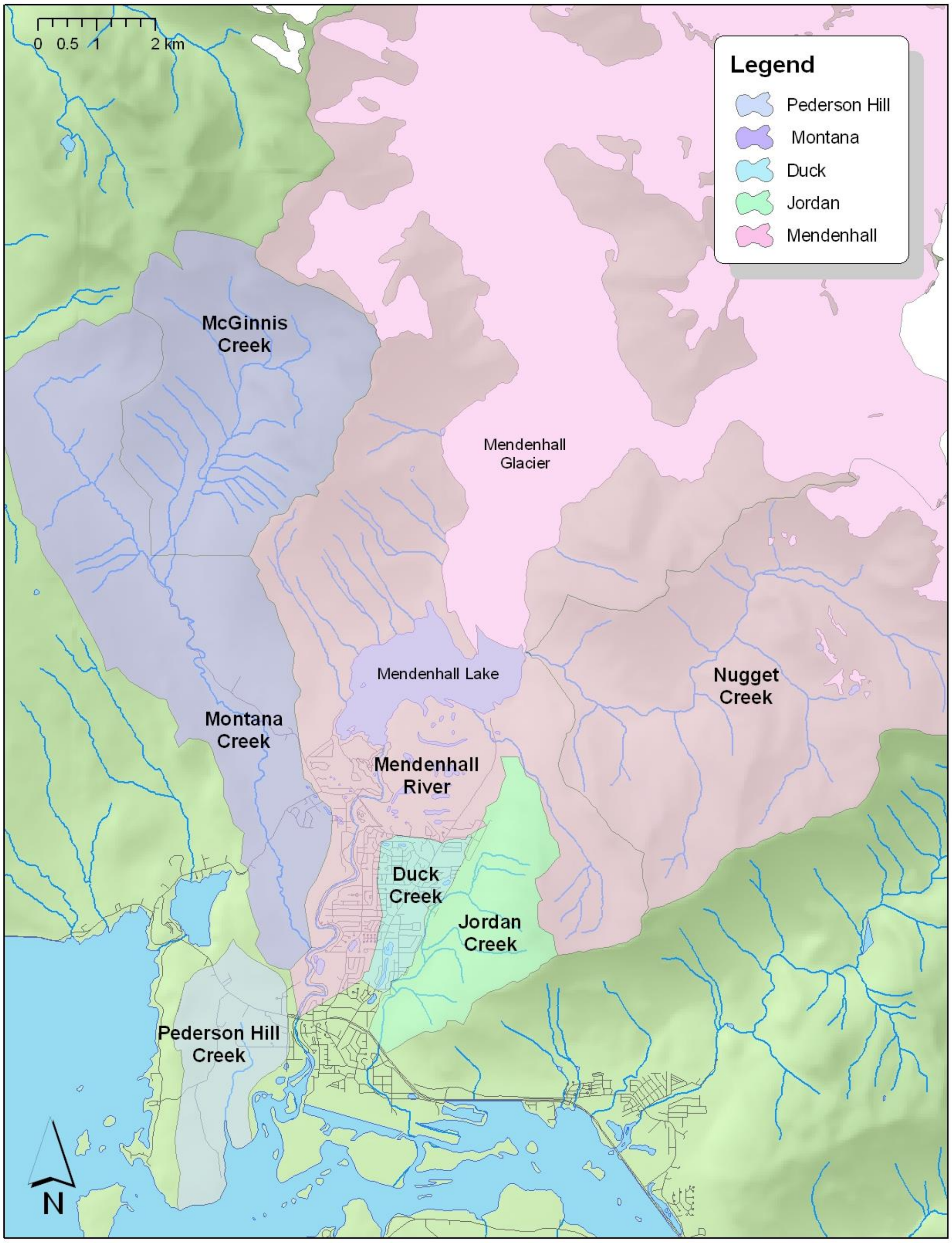

Figure 1: *Location of Jordan Creek watershed and other watersheds in the Mendenhall Valley, Juneau.*

I. Water Quality Monitoring Project

Research Design

The location of the Jordan Creek water quality monitoring sites was kept consistent with previous years' efforts, with three sites along the stream (Table 1, Figure 2). Jordan Creek watershed is 2.6 square miles (above the Jordan C sample site), a large portion of which is suburban development in the Mendenhall Valley.

Table 1. *Stream sample locations along Jordan Creek. Latitude and longitude coordinates were measured using GPS in April, 2006 and are reported in the North American Datum 1983.*

Site Code	**Site Description**	**Latitude**	**Longitude**
JC-A	Jord C @ Amalga Dr	58.38726067004	-134.56351114001
JC-B	Jord C @ Super 8 Motel	58.36616032005	-134.57784830000
JC-C	Jord C @ Yandukin Footbridge	58.35917610005	-134.57835674000

Sample sites on Jordan Creek represent differently impacted areas of the watershed. The JC-A site is upstream, closest to the headwaters of Jordan Creek on the western flank of Thunder Mountain, at the bridge crossing on Amalga Drive. JC-B is located immediately downstream of where Jordan Creek flows under Egan Drive at the site of the US Geological Survey streamgage. JC-C is located at the edge of the Juneau airport property, just upstream from the fish weir operated by the Alaska Department of Fish and Game.

Stream sampling was conducted from July 2005 to June 2006. Samples were collected in the morning (between 8am and 1 pm) in the same sequence each time, in order to minimize compounding diel variations in water quality parameters. No operating stream gauge was available past January, 2006 (before that the USGS operated a stream gage at JC-B); and we manually gaged the discharge at JC-B. Water quality data collected for Jordan Creek during the project is shown in Appendix A of this report.

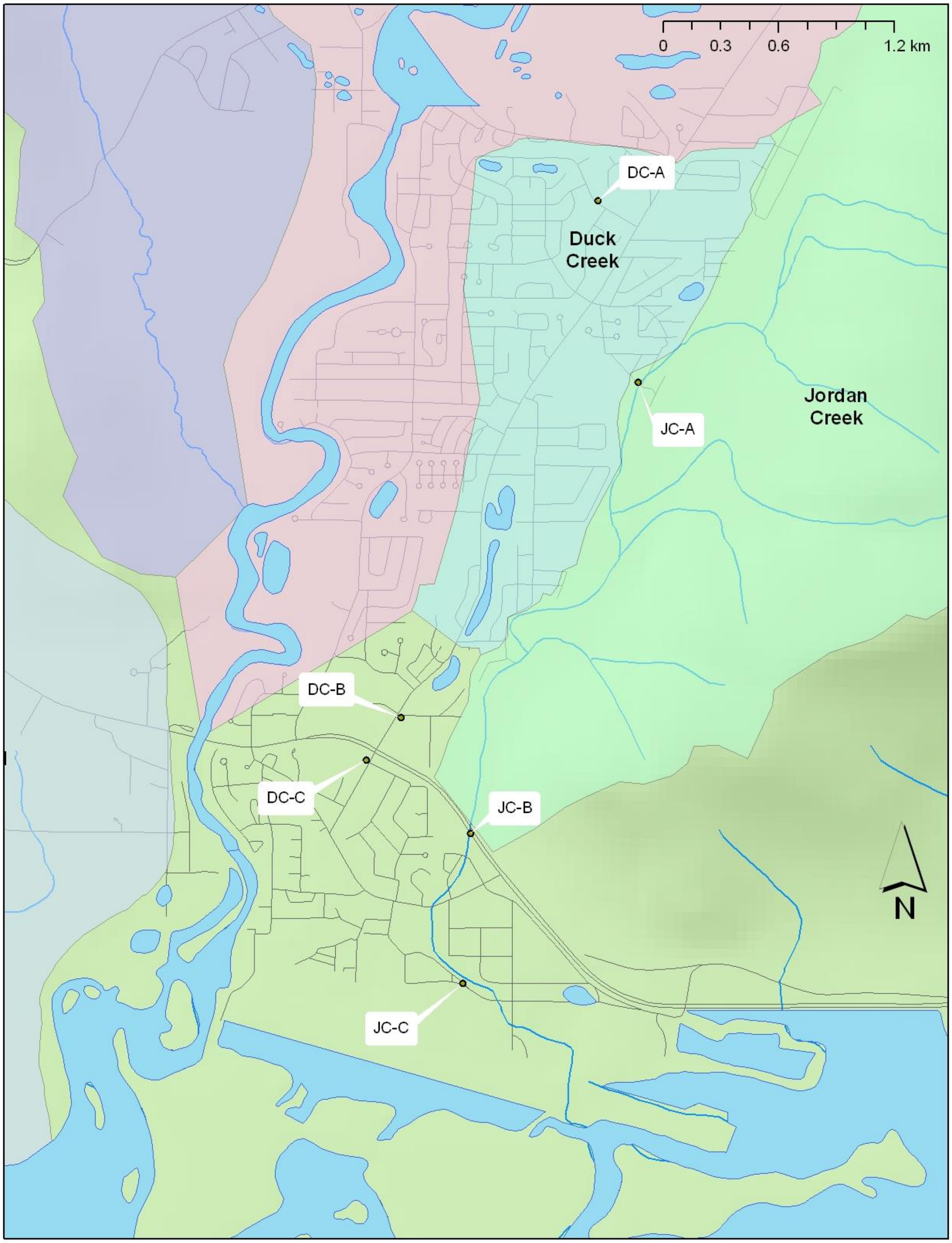

Figure 2. *Map of the Mendenhall Valley and sample sites used in the study on Jordan Creek. Also shown are sample sites for the companion study along neighboring Duck Creek (DC-A,B,C).*

Water quality parameters at the three sample sites were measured bi-monthly throughout the project period (except for one bi-monthly sample missed on 12/30/2005). Water temperature, conductivity, and pH were measured in the field using a YSI multi-probe unit. Dissolved oxygen was measured using a dedicated D.O. meter. Both meters were calibrated in the laboratory at the beginning of each sampling event. All in situ parameters were measured and recorded 3 times; averages of the triplicate values are presented in this report. Grab samples were also collected and returned to the UAS lab for analysis of turbidity, and total suspended sediment (TSS). Turbidity measurements for each event were bracketed by standard checks and were made within 6 hours of sample collection. TSS samples were obtained by weighing the mass of particulates retained on a glass microfiber filter following a vacuum driven filtration of at least 300 mL of sample. TSS filtrations were made within 48 hours of sample collection. Duplicate analyses were performed on 10% of samples to check for precision. Additional waters samples were taken in separate bottles in the field, filtered in the lab within 6 hours through 0.45 μm membrane filter into 125 mL polyethylene bottles, and frozen until analysis by Ion Chromatograph for cations and anions, as described below:

Analysis by Ion Chromatograph:

a) Anions. A 25 μL aliquot of the neutral sample was analyzed for chloride, nitrate, nitrite, sulfate and phosphate concentrations on a Dionex DX500 Ion Chromatography system with ion suppression and conductivity detection. The analytes were separated on an IonPac AS12 4 mm x 250 mm column preceded by an IonPac AG12 guard column using sodium carbonate (Na2CO3)/sodium hydrogen carbonate (NaHCO3) eluent at 1.5 mL min-1. Peaks were identified and quantified by comparison of retention times and peak areas with standards.

b) Cations. A 25 μL aliquot of the neutral sample was analyzed for sodium, potassium, ammonium magnesium and calcium concentrations on a Dionex DX500 Ion Chromatography system with ion suppression and conductivity detection. The analytes were separated on an IonPac CS12 4 mm x 250 mm column preceded by an IonPac AG12 guard column using sulfuric acid eluent (30 mM) at 1 mL min-1. Peaks were identified and quantified by comparison of retention times and peak areas with standards.

Water Quantity and Quality on Jordan Creek

Water Quantity

Although continuous discharge data were unavailable for Jordan Creek in 2006, examination of historic data at the site and on neighboring Duck Creek, as well as field observations and occasional measurements, indicates that Jordan Creek is generally a small, flashy stream that responds to and recovers quickly from local precipitation events. The Jordan Creek watershed is comprised largely of suburban development in the Mendenhall Valley, although the creek also receives water from the northwest side of Thunder Mountain. Streamflow in Jordan is derived primarily from rainfall and shallow groundwater, as a result, streamflow is relatively flashy, responding quickly to the large frontal rainstorms typical of fall and winter in the Juneau area. Large winter storms, particularly rain on snow events, can also cause streamflow to rise dramatically as evidenced by the discharge record in November, 2005, when record rainfalls fell on Juneau. Streamflow in Jordan decreases dramatically during the late spring and early summer during periods of low rainfall.

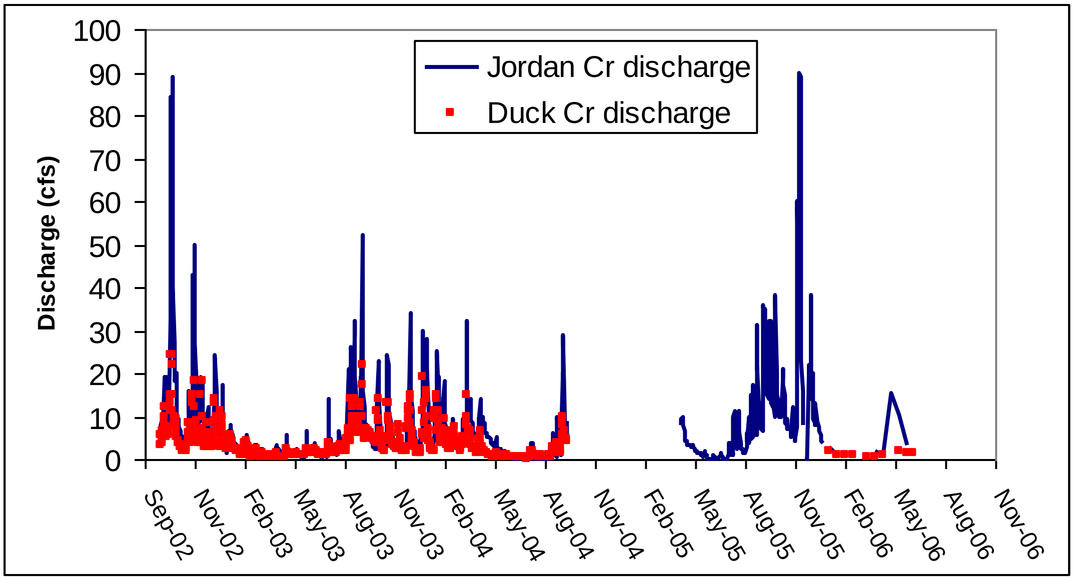

Figure 2. *Discharge on Duck and Jordan Creeks. Data based on USGS stream gage data, until January, 2006. (Data from September, 2005 on are provisional). Measurements since January 2006 are based on manually gaging using a pygmy flow meter.*

At the uppermost site (JC-A), water was almost always present. JC-B was iced over for much of the winter, and JC-C was icy or completely dry during the winter and spring of 2006. Upper Jordan Creek upstream of JC-A was observed to be running dry during each of several visits in April; these upper sites are thought to be the best areas for fish use and have historically sustained perennial flow (K. Koki, personal communication, 2006). JC-A clearly had significant groundwater contributions that maintained consistent base flows in the channel. The only time flow was not noted (although ice was present in the channel) was during an exceptionally cold spell in the spring when air temperatures fell to as low as -15ºC (in March, 2006) (Figures 3a-c). JC-C site had no surface flow during portions of the late spring and summer. It froze sometime between 2/25/06 and 3/15/06, and no water was present on 3/25/06 and on 4/7/06 (Figure 3c). Loss of flow is an obvious major concern for salmonids attempting to utilize Jordan Creek as habitat for rearing, spawning, and egg incubation.

Discharge during the study year was measured by the USGS through December, 2006 (provisional data) and by the authors from January- June, 2006 on each sampling event. Measurements indicate that flow reached 90 cfs during record rains in November, 2005; but otherwise tended to be less than about 15 cfs. On all dates measured between January and June, 2006, flow did not exceed 15 cfs and was either frozen or flowing at <3 cfs during much of the spring.

Figure 3a. *Site JC-A, showing the frozen stream channel on 3/15/06, when the air temperature was -15ºC in Juneau.. Flowing water was present at the site on all other sampling events. Also visible is a house situated within a few meters of the streambank, exemplifying the rising encroachment of urbanization along Jordan Creek.*

Figure 3b. *Site JC-B, showing frozen conditions on 3/15/2006. The ice was too thick to break manually.*

Figure 3c. *Site JC-C, showing broken ice (with no water underneath), on March 15, 2006 when air temperatures reached -15ºC in Juneau. No flow was observed at the site for approximately 2 months, from late February to late April, 2006. During this no-flow period, the channel was either completely dry or contained disconnected pockets of ice and/or snow.*

Water Quality

a) Dissolved oxygen, conductivity, and pH

Dissolved oxygen was generally good at the 3 Jordan Creek sites, and typically ranged between 10 and 15 mg/L (Table 2, Figure 4). The only violations occurred at JC-A, where dissolved oxygen levels fell below the State of Alaska water quality limit of 7.0 mg/L for the growth and propagation of fish, shellfish, and other aquatic life on two occasions (3/25/06 and 4/7/06) (DEC, 2006). On these dates, ice formed a surface layer on the stream and limited oxygenation of the water, which was clearly derived from groundwater a short distance upstream. Average dissolved oxygen concentrations increased in a downstream direction (Table 2).

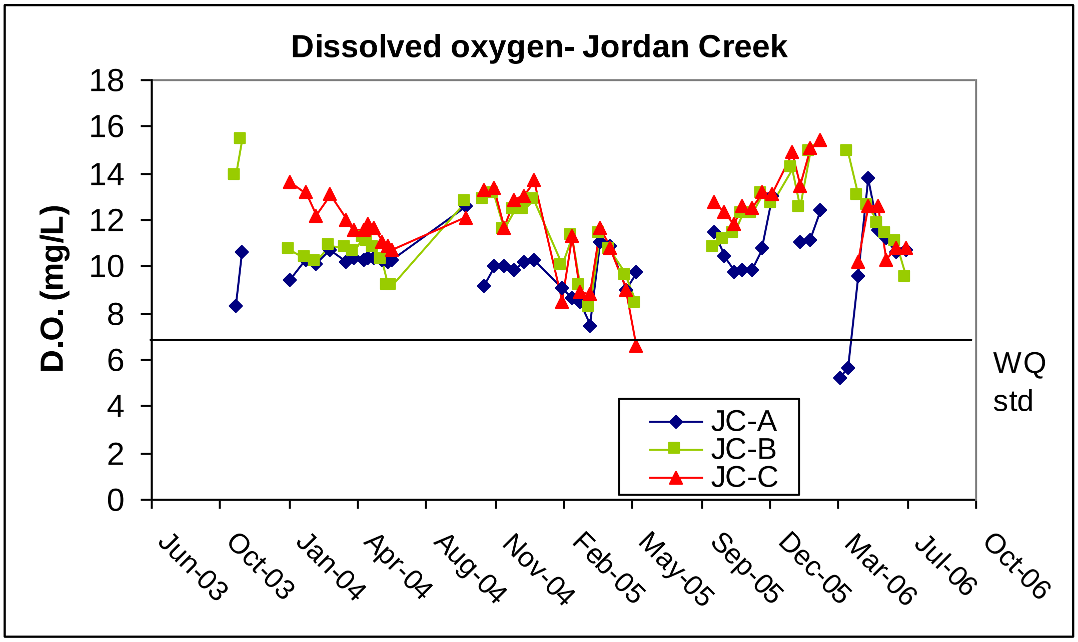

Figure 4. *Dissolved oxygen at the 3 Jordan Creek sites. Graph shows D.O. data for this project (July 2005- June 2006) and previous data collected by UAS (beginning in 10/2003).*

Conductivity is a measure of ionic strength and, as such, reflects the load of total dissolved solids in the water column. Conductivity values measured on Jordan Creek were generally about 50% of the values measured in Duck Creek but are substantially higher than conductivity on more pristine local streams like Montana Creek (Hood, unpublished data). Conductivity tended to decrease moving downstream in Jordan Creek, which suggests that either inflows to the Creek below the JC1 site have a lower ionic strength or that that dissolved solids are removed by precipitation or biological uptake. The relatively high conductivity in upper Jordan Creek is a likely a result of inputs of ions such as nitrate and sulfate from anthropogenic sources as well as inputs of iron from groundwater. Conductivity concentrations in FY06 were in the same range as values measured the two years prior (Figure 5). Average conductivity was highest at JC-A, reflected the larger influence of groundwater (typically higher in ionic strength than surface water) compared with the other 2 sites (Table 2).

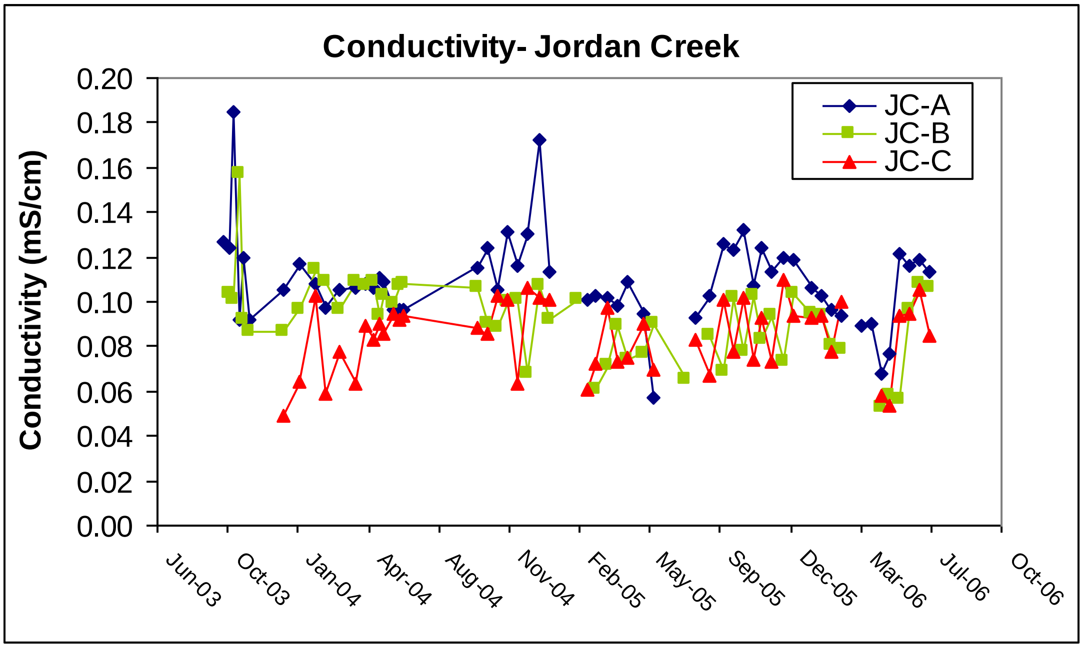

Figure 5. *Conductivity values at the 3 sampling sties on Jordan Creek. Graph includes data (10/2003-6/2005) from prior to the current study year (7/2005-6/2006).*

Table 2. Average values (standard deviation in parentheses) for water quality parameters during the period August, 2005 to June, 2006 at 3 sites on Jordan Creek.

site	DO (mg/L)	Cond (µS/cm)	pH	Turb (NTU)	TSS (mg/L)
JC-A	10.5 (2.2)	0.107 (0.017)	6.6 (0.5)	2.9 (3.9)	2.2 (2.9)
JC-B	12.3 (1.3)	0.085 (0.017)	6.7 (0.3)	4.6 (3.2)	2.6 (2.8)
JC-C	12.6 (1.5)	0.087 (0.016)	6.7 (0.3)	4.2 (3.1)	2.1 (2.6)

Values for pH varied mostly between 6.0 and 7.0 during the study period, which is generally consistent with values from the previous years (Figure 6). pH values showed no seasonal signal and average values were similar at the three sites (Table 2). Greater effort was placed in the FY06 sampling year to visit sites at approximately the same time of day; this likely accounts for the lower amount of scatter compared to the previous 2 years. Many pH measurements showed values of <6.5, the state water quality standard for the growth and propagation of fish, shellfish, and other aquatic life. Lower pH values are likely caused by iron-rich groundwater intrusion, which becomes the dominant source of water during cold and dry climatic periods. The oxidation of reduced species prevalent in anaerobic groundwater produces significant acidity as a side-product. Values for pH tended to be lowest at JC-A, which is the uppermost site heavily influenced by groundwater input.

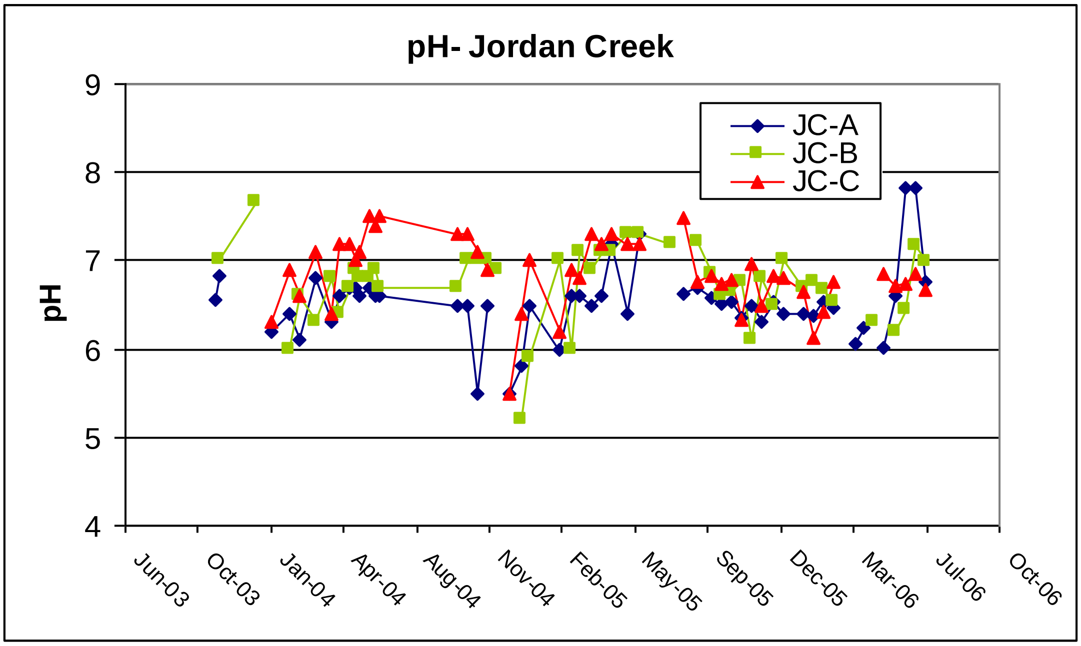

Figure 6. *pH values at the 3 sampling sties on Jordan Creek. Graph includes data from year (2004-2005) prior to the current study year (2005-2006).*

It is important to note that stream pH variability on a diel scale can be substantial, with levels lowest during the nighttime; as a result, it is recommended that pH and D.O. levels are measured in the future both nocturnally and diurnally to better characterize the levels present in the stream during various parts of the day. Data from the mornings-only samplings (presented here) may not be accurate representation of daily average values.

b) Interstitial dissolved oxygen

In an effort to evaluate the dissolved oxygen conditions in the Jordan Creek hyporheic zone, at depths at which fish eggs incubate and are used by macroinvertebrates that require oxygenated water, we installed 10 interstitial DO samplers in upper Jordan Creek. Pipes were spaced approximately evenly along in the 1 km reach above site JC-A. K. Koski (of The Nature Conservancy), an aquatic ecologist who has been heavily involved in Jordan and Duck Creek research, participated in 2 site visits to provide expertise on locating salmon spawning sites into which we installed the pipes. Pipes were constructed of 1 inch diameter x 4 foot long PVC pipes that were slotted between 6-12 inches below the surface water- streambed boundary.

We measured the dissolved oxygen on 9 occasions between 5/15/06 and 7/8/06 by lowering a calibrated D.O. probe into the standpipe and taking 3 readings of dissolved oxygen, and taking another triplicate reading of the adjacent surface water dissolved oxygen for comparison. Results are presented in Table 3 below, which shows that interstitial dissolved oxygen levels were typically in the range of 40-70% saturation (5-8 mg/L). Alaska water quality standards state that in no case may DO be less than 5 mg/L to a depth of 20 cm in interstitial waters of gravel used by anadromous or resident fish for spawning. Based on our results, the water quality standards were achieved on 81 of the

89 measurements of interstitial D.O. Violations occurred in 2 of the 10 pipes on 4 of their 9 measurements; however, most of those violations were slight (between 4-5 mg/L in Pipe #4), and the violations in Pipe #5 were composed of measurements between 1.6-4.2 mg/L.

Table 3. Interstitial DO in 10 standpipes at 6 inches below the streambed of upper Jordan Creek. Values highlighted in yellow are those than fell below the water quality standard of 5 mg/L.

	5/15/06	5/20/06	5/30/06	6/6/06	6/13/06	6/21/06	6/24/06	6/27/06	7/8/06
(% saturation)									
Pipe 1	57.0	57.0	49.1	48.7	51.6	53.9	48.9	49.2	58.2
Pipe 2	50.3	52.6	49.7	51.9	53.7	50.8	50.1	54.2	52.6
Pipe 3	43.3	48.3	47.8	44.5	46.2	47.1	46.5	44.5	45.8
Pipe 4	32.6	29.6	30.9	34.0	38.4	45.4	44.9	45.1	43.2
Pipe 5	12.8	12.5	18.3	32.8	38.7	44.6	44.8	50.0	44.6
Pipe 6	67.6	76.6	80.7	51.8	74.6	77.1	75.5	74.8	73.5
Pipe 7	49.5	52.8	56.7	54.5	59.2	55.7	51.6	47.8	41.9
Pipe 8	60.2	61.6	67.0	64.4	66.9	60.9	N/A	60.3	53.6
Pipe 9	44.5	50.3	55.4	52.6	52.0	54.7	54.0	52.4	53.9
Pipe 10	44.9	53.9	58.3	56.9	55.4	52.6	52.3	49.6	45.8
Surface water	77.8	78.1	82.6	80.8	76.1	77.3	73.8	75.7	73.4
(mg/L)									
Pipe 1	7.3	7.1	6.2	6.1	6.4	6.5	6.1	6.1	7.2
Pipe 2	6.4	6.4	6.2	6.4	6.6	6.1	6.8	6.7	6.5
Pipe 3	5.6	6.1	6.1	5.7	5.9	6.2	5.8	5.6	5.8
Pipe 4	4.2	9.8	4.0	4.4	4.9	5.8	5.7	5.7	5.5
Pipe 5	1.7	1.6	2.4	4.2	5.0	5.8	5.8	6.4	5.7
Pipe 6	8.9	9.8	10.2	6.6	9.1	9.6	9.5	9.1	9.1
Pipe 7	6.6	8.9	7.4	7.1	7.6	7.1	6.4	6.1	5.3
Pipe 8	8.1	8.2	8.8	8.4	8.7	7.9	N/A	7.7	6.7
Pipe 9	5.8	6.5	7.2	6.9	6.7	7.1	6.9	6.7	6.9
Pipe 10	5.9	7.0	7.5	7.4	7.3	6.8	6.8	6.4	5.8
Surface water	10.0	9.7	10.4	9.8	9.4	9.6	8.8	9.1	9.1

c) Turbidity and Total Suspended Solids (TSS)

The state of Alaska water quality standards for turbidity dictate that to protect fish and wildlife, turbidity may not exceed 25 nephelometric turbidity units (NTUs) above natural background conditions. Turbidity is not a direct measurement of solids, but is related to the amount of suspended material in the water column because it is a measure of light attenuation due to absorption and reflection by solids. Turbidity can be expected to closely parallel total suspended solids (TSS).

On Jordan Creek, water clarity is generally quite high and well within water quality standards for the state of Alaska. Average turbidity at the sample sites ranged from 2.9 to

4.6 NTU, which are well below levels of water quality concern. Turbidity generally increased moving downstream on Jordan Creek. Turbidity also tended to be more erratic than in the previous 2 years (Figure 7). It is important to note that weekly sampling is not always adequate for characterizing problems with high turbidity because turbidity impairments can be highly time-specific and are often associated with periods of intense rainfall and high discharge. These results do however show that Jordan Creek does not have chronic problems with high turbidity.

Total suspended solids (TSS) refers to solids that are not dissolved in solution and can be removed by filtration. Suspended solids include both organic particles and inorganic, mineral particles, both of which can contribute to turbidity. Similar to the trends in turbidity, values for TSS were relatively low (average 2.1-2.6 mg/L at the three sites) on Jordan Creek (Table 2) and consistently about 50% of TSS values measured on Duck Creek. Both turbidity and TSS were highest during the fall, when large rain events were more common and likely resulted in greater influxes of adjacent sediment and other particles into the stream.

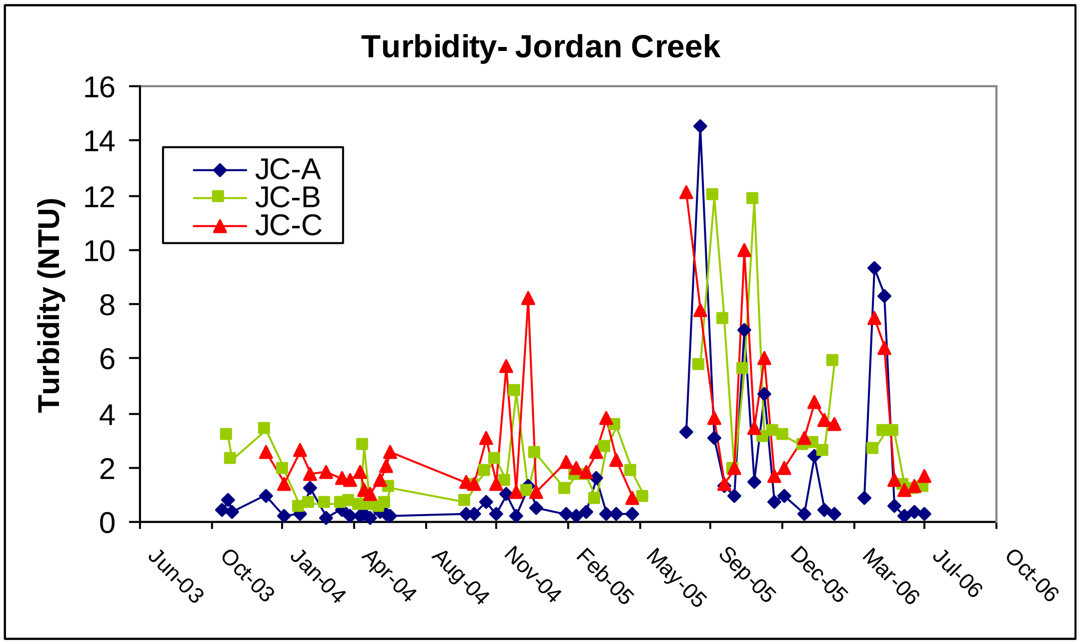

Figure 7. *Turbidity (NTU) at the three Jordan Creek sites.*

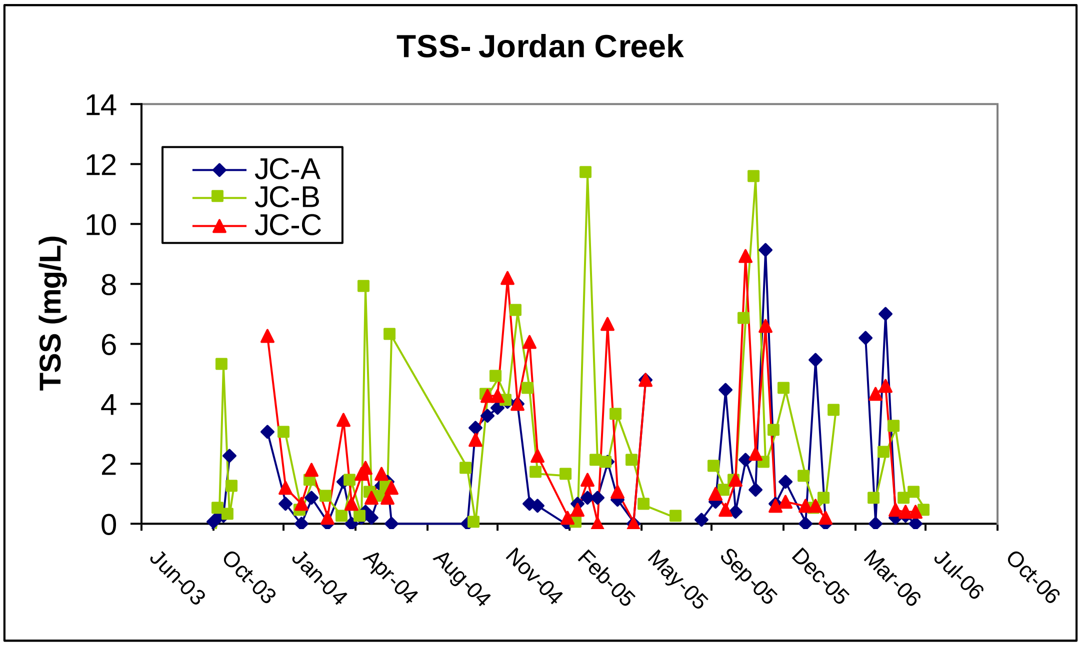

Figure 8. *Total suspended solids (TSS, in mg/L) at the 3 Jordan Creek sites.*

d) Water temperature

Water temperature in Jordan Creek shows strong seasonal variation, despite the flashy (event-controlled) discharge patterns on the stream. Figure 9 shows the temperature at the 3 Jordan Creek sites compared to Juneau air temperature. Comparison of water temperature at the three locations along Jordan Creek indicates that upstream site JC-A has generally lower summertime and warmer wintertime temperatures than does JC-B (Table 2),which is further indication of the groundwater upwelling at the sites because groundwater maintains a more stable temperature than does surface water. No exceedances of the Alaska water quality standard for spawning and incubation areas (13 ºC) (DEC, 2006).occurred during this study year, although they have been documented in the past.

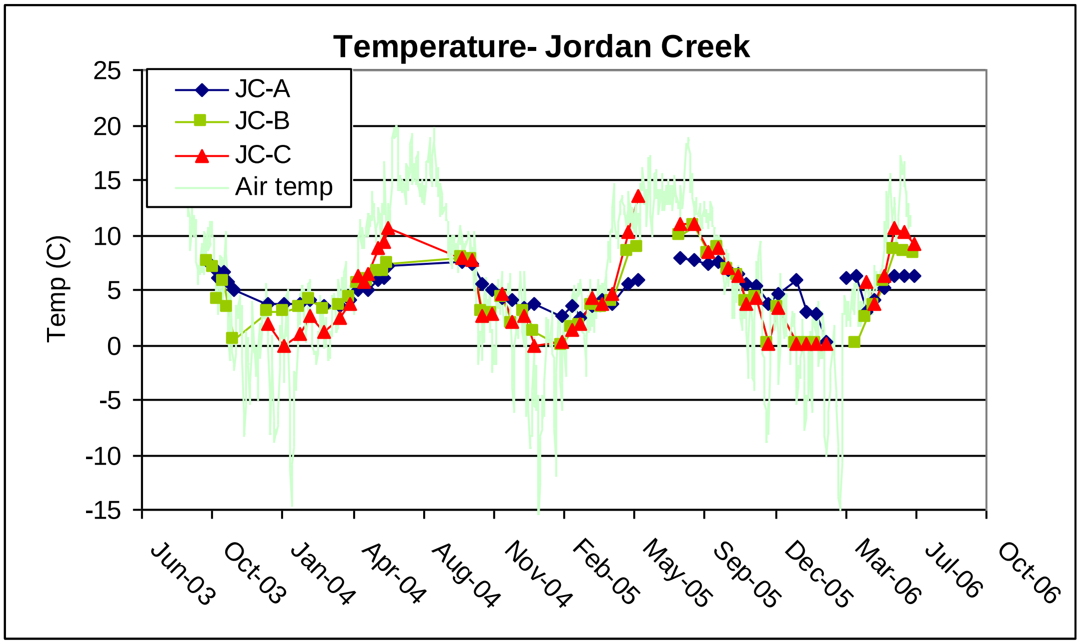

Figure 9*: Water temperature at the three sampling locations on Jordan Creek, with Juneau airport air temperatures overlain to show the close relationship between air and water temperatures. Data shown include data collected in FY 05 as well from October 2003- June 2005.*

e) Anions and cations

The extent to which the application of salts on roads in the Mendenhall Valley may be affecting water quality was evaluated by examination of dissolved ion data. Road salts used in the City and Borough of Juneau include NaCl, and $MgCl_2$; therefore Cl, Na, and Mg concentrations should be good indications of the salting. While increases in ionic concentrations are evident at JC-B and JC-C in the spring, concentrations are low (<4 mg/L) and far below levels of concern (Figures 10-12). The US Environmental Protection Agency sets the secondary maximum contamination level for chloride at 250 mg/L, the chronic freshwater criterion at 230 mg/L, and the acute freshwater criterion is 860 mg/L (EPA, 2006). Yet they do indicate that road runoff is reaching the creek and other contaminants associated with road runoff not analyzed as part of this study are likely also entering Jordan Creek at unknown concentrations.

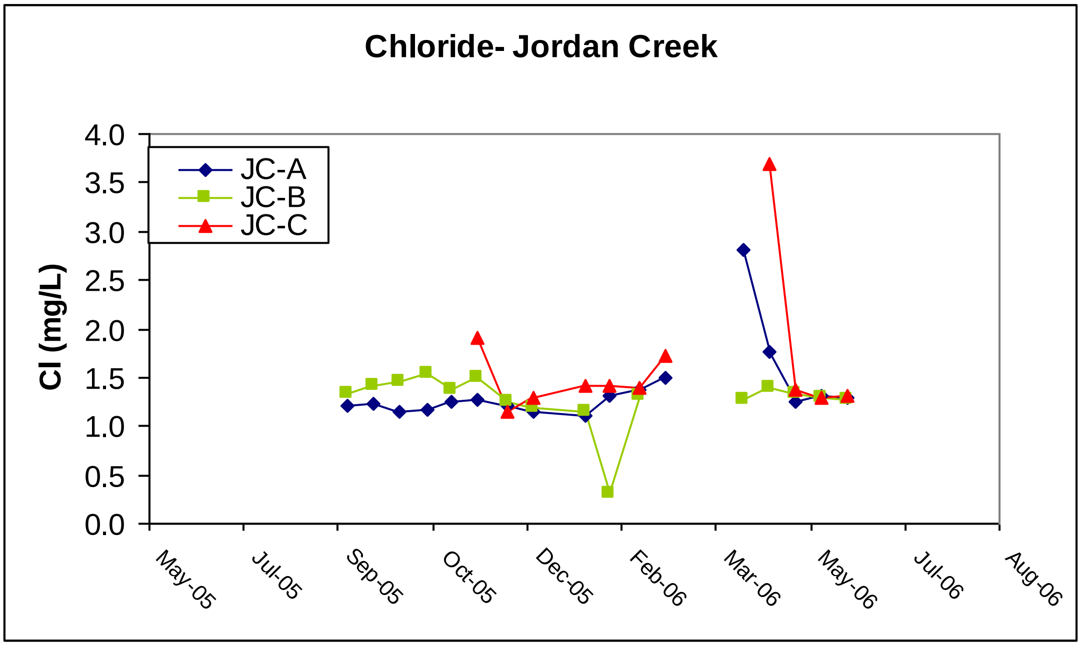

Figure 10. *Chloride concentrations in Jordan Creek August 2005-June 2006.*

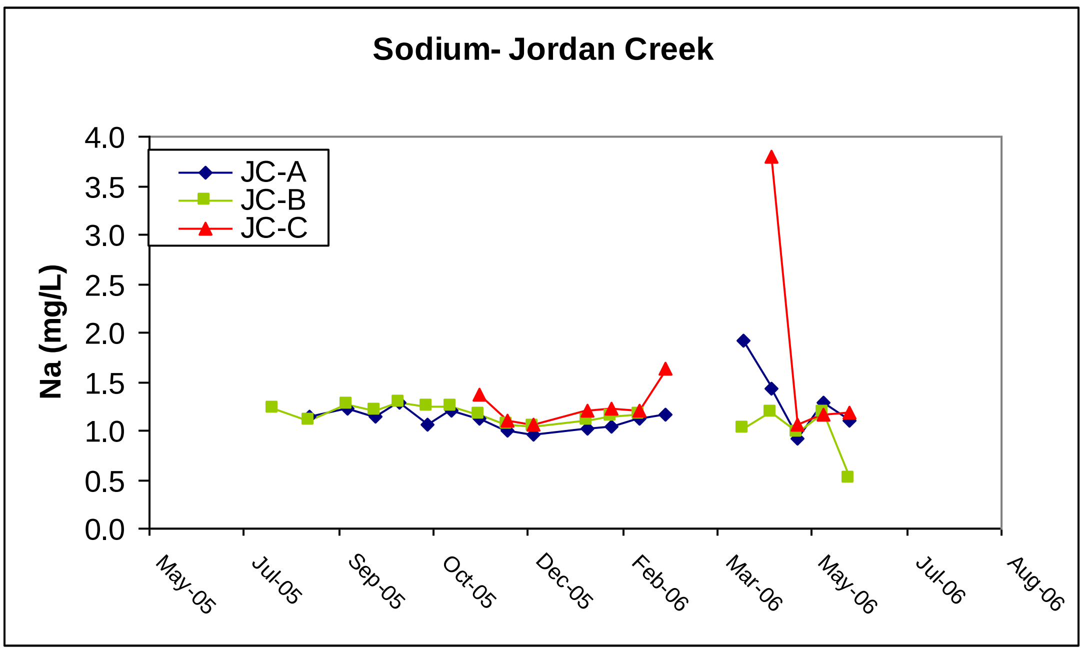

Figure 11. *Sodium concentrations in Jordan Creek August 2005-June 2006.*

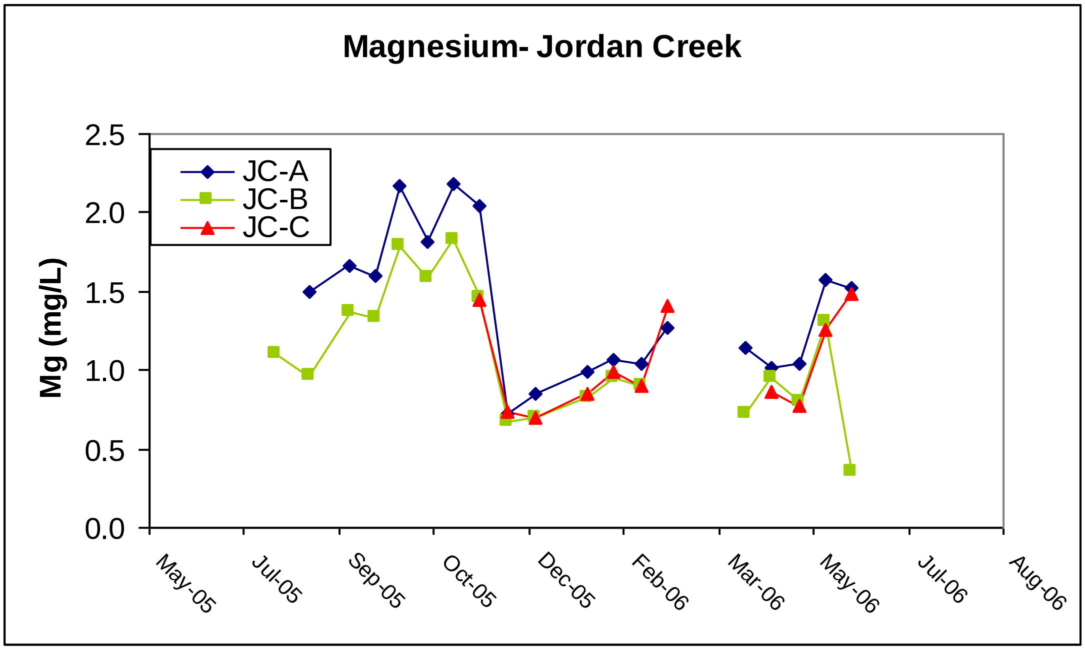

Figure 12. *Magnesium concentrations in Jordan Creek August 2005-June 2006.*

Other anions and cations measured indicated that fluoride concentrations in Jordan Creek are <0.2 mg/L; nitrate concentrations are 0.1-0.7 mg/L; sulfate concentrations were consistently between 3-8 mg/L; ammonium concentrations were <0.2 mg/L; potassium was consistently between 1.0-2.6 mg/L; magnesium levels were between 0.6-2.2 mg/L; and calcium was between 9-20 mg/L.

Field audit by DEC

On March 7, 2006, Jim Gendron of the ADEC conducted a field audit of this project and found that with three exceptions, the sampling and analysis protocols for this project are being performed according to the quality assurance procedures and objectives that are listed in the QAPP (Gendron, 2006). The first exception was that identification of an incorrect labeling of a site on Duck Creek (please see Duck Creek report). The second exception cited in the field audit is that the new dissolved oxygen meter be intercalibrated using the Winkler titration method; this has been done and results are satisfactory. Finally, the audit recommended that we make note of the presence of any oil sheen in the streams, and as a result, we began to note this.

Jordan Creek water quality summary and conclusions

Water quality monitoring in Jordan Creek indicates that the stream water quality is similar to that of previous years and continues to be better than in neighboring Duck Creek. However, like Duck Creek, Jordan Creek suffers from low water levels during much of the year, and both upper (above JC-A) and lower segments (at JC-C) of the stream have sections that go completely dry during the late winter and spring. Conductivity was highest and pH and D.O. were lowest at site JC-A, which derives the majority (or at times the entirety) of its streamflow from groundwater. Dissolved oxygen levels in the streamwater were above state water quality standards, and D.O. levels in 10 interstitial DO standpipes (open at 6-12 inches below the streambed) were above water quality standards for 91% of the measurements. Many pH measurements showed values at or below 6.5, the state water quality standard for the growth and propagation of fish, shellfish, and other aquatic life—at least during the mornings-only sampling times employed during this monitoring effort. pH values are known to vary on a daily scale, and as a result, we recommend some intensive diurnal-nocturnal sampling in the future to assess the full magnitude of pH variations in Jordan Creek. Turbidity and TSS levels in Jordan Creek were low (far lower than the water quality standards for turbidity), and water temperature was acceptable at all sites during the study year (despite some exceedances in the past). The effects of road salt in the Mendenhall Valley appear to be insignificant on Jordan Creek water quality.

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Appendix A. Water quality data collected on Jordan Creek during the period August 2005 – July, 2006. Field parameters, TSS, turbidity, discharge, and oil sheen presence (notation of oil sheen began 4/7/06).

Date	Time	Site	D.O. (% sat.)	D.O. (mg/L)	Temp (ºC)	Cond (mS/cm)	pH	Turb (NTU)	TSS (mg/l)	Discharge (cfs)	Oil sheen?
8/2/05	11:30	JC-A			7.8	0.093	6.6	3.3			
8/20/05	12:40	JC-A			7.7	0.103	6.7	14.5	0.1		
9/10/05	9:00	JC-A			7.3	0.126	6.6	3.1	0.7		
9/24/05	9:50	JC-A	95.7	11.5	7.6	0.123	6.5	1.3	4.5		
10/7/05	11:35	JC-A	90.1	10.5	6.8	0.132	6.5	1.0	0.4		
10/22/05	9:30	JC-A	79.3	9.8	6.5	0.107	6.4	7.0	2.1		
11/4/05	11:50	JC-A	78.3	9.9	5.5	0.124	6.5	1.5	1.1		
11/18/05	12:15	JC-A	77.9	9.8	5.3	0.113	6.3	4.7	9.1		
12/3/05	9:50	JC-A	82.0	10.8	3.7	0.12	6.5	0.8	0.7		
12/17/05	11:08	JC-A	95.5	13.0	4.6	0.119	6.4	1.0	1.4		
1/14/06	12:20	JC-A	88.8		5.9	0.106	6.4	0.3	0.0		
1/27/06	12:55	JC-A	82.1	11.1	2.9	0.103	6.4	2.4	5.4		
2/11/06	11:00	JC-A	82.4	11.2	2.8	0.096	6.5	0.4	0.0		
2/25/06	10:30	JC-A	85.5	12.4	0.3	0.094	6.5	0.3			
3/15/06		JC-A									
3/25/06	9:55	JC-A	36.0	5.2	6.1	0.089	6.1				
4/7/06	10:30	JC-A	41.8	5.7	6.2	0.09	6.2	0.9	6.2		no
4/21/06	10:07	JC-A	71.6	9.6	3.0	0.068		9.3	0.0		no
5/5/06	10:15	JC-A	105.5	13.8	4.1	0.077	6.0	8.3	7.0		no
5/19/06	11:30	JC-A	91.4	11.6	5.2	0.121	6.6	0.6	0.2		no
6/2/06	11:59	JC-A	90.7	11.2	6.3	0.116	7.8	0.3	0.3		no
6/16/06	10:59	JC-A	85.7	10.6	6.2	0.119	7.8	0.4	0.0		no
6/30/06	11:25	JC-A	86.3	10.7	6.2	0.113	6.8	0.3			no
8/2/05	10:55	JC-B			10.0	0.085	7.2	5.7		2	
8/20/05	11:50	JC-B			10.8	0.069	6.9	12.0	1.9	6	
9/10/05	8:30	JC-B			8.3	0.102	6.6	7.4	1.1	9	
9/24/05	9:35	JC-B	92.8	10.8	8.8	0.078	6.6	1.9	1.4	29	
10/7/05	11:20	JC-B	91.8	11.2	6.9	0.103	6.8	5.6	6.8	13	
10/22/05	9:00	JC-B	92.5	11.4	6.2	0.083	6.1	11.8	11.5	19	
11/4/05	11:20	JC-B	93.4	12.3	3.8	0.094	6.8	3.1	2.0	7	
11/18/05	11:45	JC-B	94.7	12.3	4.3	0.073	6.5	3.3	3.1	35	
12/3/05	9:20	JC-B	89.9	13.1	0.1	0.104	7.0	3.2	4.4		
12/17/05	10:30	JC-B	95.6	12.7	3.4	0.095	6.7	2.8	1.5		
1/14/06	10:50	JC-B	97.5	14.2	0.1	0.094	6.8	2.9	0.5	2.7	
1/27/06	10:45	JC-B	86.4	12.6	0.1	0.080	6.7	2.6	0.8	1.1	
2/11/06	9:35	JC-B	102.1	14.9	0.1	0.078	6.5	5.9	3.7		
2/25/06		JC-B								(Frozen)	
3/15/06		JC-B								(Frozen)	
3/25/06		JC-B								(Frozen)	
4/7/06	8:51	JC-B	102.4	14.9	0.1	0.053	6.3	2.6	0.8	1.9	no
4/21/06	9:06	JC-B	95.7	13.0	2.4	0.058		3.3	2.3	0.7	no

5/5/06	9:30	JC-B	94.6	12.6	3.5	0.056	6.2	3.3	3.2	15.5	no
5/19/06	10:05	JC-B	94.7	11.9	5.7	0.096	6.5	1.3	0.8	10.3	no
6/2/06		JC-B	98.2	11.4	8.7	0.108	7.2	1.2	1.0	3.2	no
6/16/06	9:30	JC-B	94.6	11.1	8.5	0.106	7.0	1.2	0.4		no
6/30/06	10:15	JC-B	85.0	9.5	8.3	0.088	6.8	11.6			no

8/2/05	10:45	JC-C			10.9	0.083	7.48	12.14			
8/20/05	11:35	JC-C			11.0	0.067	6.8	7.8			
9/10/05	8:15	JC-C			8.5	0.101	6.8	3.9	1.0		
9/24/05	9:25	JC-C	110.6	12.8	8.9	0.078	6.7	1.4	0.5		
10/7/05	10:55	JC-C	101.9	12.3	7.1	0.102	6.8	2.0	1.5		
10/22/05	8:45	JC-C	95.4	11.8	6.3	0.074	6.3	10.0	8.9		
11/4/05	11:05	JC-C	95.6	12.6	3.7	0.093	7.0	3.4	2.3		
11/18/05	11:30	JC-C	96.3	12.5	4.3	0.073	6.5	6.0	6.6		
12/3/05	9:05	JC-C	90.8	13.2	0.1	0.110	6.8	1.7	0.6		
12/17/05	10:25	JC-C	98.4	13.1	3.4	0.094	6.8	2.0	0.8		
1/14/06	10:30	JC-C	102.6	14.9	0.1	0.093	6.7	3.1	0.6		
1/27/06	10:05	JC-C	92.2	13.5	0.1	0.093	6.1	4.4	0.6		
2/11/06	9:10	JC-C	103.3	15.1	0.1	0.078	6.4	3.7	0.2		
2/25/06	9:00	JC-C	105.7	15.4	0.1	0.100	6.8	3.6			
3/15/06		JC-C								(Frozen)	
3/25/06		JC-C								(Dry)	
4/7/06		JC-C								(Dry)	no
4/21/06	9:00	JC-C	79.2	10.2	5.8	0.058		7.5	4.3		no
5/5/06	10:35	JC-C	95.5	12.6	3.7	0.054	6.8	6.4	4.6		no
5/19/06	10:00	JC-C	102.2	12.6	6.3	0.094	6.7	1.5	0.5		no
6/2/06	10:00	JC-C	93.1	10.3	10.7	0.095	6.7	1.2	0.4		no
6/16/06	8:53	JC-C	96.3	10.8	10.3	0.105	6.9	1.3	0.4		no
6/30/06	9:55	JC-C	93.7	10.8	9.1	0.085	6.7	1.7			no

Appendix B. Water quality data collected on Jordan Creek during the period August 2005 – July, 2006. Anions and cation data.

Date	**Time**	**Site**	Cl (mg/L)	SO4 (mg/L)	Na (mg/L)	K (mg/L)	Mg (mg/L)	Ca (mg/L)
8/2/2005	11:30	JC-A			1.1	1.3	1.2	14.7
8/20/2005	12:40	JC-A			1.1	1.5	1.5	16.9
9/10/2005	9:00	JC-A	1.2	7.8	1.2	2.1	1.7	20.3
9/24/2005	9:50	JC-A	1.2	7.4	1.1	2.6	1.6	22.4
10/7/2005	11:35	JC-A	1.2	5.6	1.3	2.3	2.2	22.0
10/22/2005	9:30	JC-A	1.2	5.5	1.1	2.0	1.8	17.7
11/4/2005	11:50	JC-A	1.2	7.1	1.2	2.0	2.2	19.9
11/18/2005	12:15	JC-A	1.3	6.2	1.1	1.9	2.0	18.4
12/3/2005	9:50	JC-A	1.2	7.6	1.0	1.8	0.7	17.8
12/17/2005	11:08	JC-A	1.2	6.5	1.0	1.8	0.8	17.9
1/14/2006	12:20	JC-A	1.1	6.1	1.0	1.4	1.0	16.1
1/27/2006	12:55	JC-A	1.3	7.7	1.0	1.3	1.1	15.4
2/11/2006	11:00	JC-A	1.4	6.5	1.1	1.1	1.0	14.1
2/25/2006	10:30	JC-A	1.5	4.5	1.2	1.0	1.3	13.0
3/15/2006		JC-A						

3/25/2006	9:55	JC-A						
4/7/06	10:30	JC-A	2.8	3.2	1.9	1.0	1.1	10.3
4/21/2006	10:07	JC-A	1.8	3.4	1.4	0.8	1.0	10.0
5/5/2006	10:15	JC-A	1.2	3.8	0.9	1.1	1.0	10.7
5/19/2006	11:30	JC-A	1.3	5.8	1.3	1.6	1.6	17.9
6/2/2006	11:59	JC-A	1.3	5.8	1.1	1.4	1.5	16.3
6/16/2006	10:59	JC-A						
6/30/2006	11:25	JC-A						

8/2/2005	10:55	JC-B			1.2	0.7	1.1	12.6
8/20/2005	11:50	JC-B			1.1	0.9	1.0	11.3
9/10/2005	8:30	JC-B	1.3	6.6	1.3	1.4	1.4	16.3
9/24/2005	9:35	JC-B	1.4	5.4	1.2	1.2	1.3	12.9
10/7/2005	11:20	JC-B	1.5	6.1	1.3	1.5	1.8	16.8
10/22/2005	9:00	JC-B	1.5	4.1	1.2	1.4	1.6	13.5
11/4/2005	11:20	JC-B	1.4	5.3	1.2	1.2	1.8	15.1
11/18/2005	11:45	JC-B	1.5	4.9	1.2	0.9	1.5	11.7
12/3/2005	9:20	JC-B	1.3	6.7	1.1	1.2	0.7	15.9
12/17/2005	10:30	JC-B	1.2	5.4	1.0	1.2	0.7	14.5
1/14/2006	10:50	JC-B	1.1	6.3	1.1	0.9	0.8	13.7
1/27/2006	10:45	JC-B	0.3	0.0	1.1	0.8	1.0	13.5
2/11/2006	9:35	JC-B	1.3	4.1	1.2	0.6	0.9	11.6
2/25/2006		JC-B	(Frozen)					
3/15/2006		JC-B	(Frozen)					
3/25/2006		JC-B	(Frozen)					
4/7/06	8:51	JC-B	1.3	2.9	1.01	0.43	0.73	7.14
4/21/2006	9:06	JC-B	1.4	3.3	1.19	0.44	0.96	8.78
5/5/2006	9:30	JC-B	1.3	3.4	0.98	0.53	0.80	7.61
5/19/2006	10:05	JC-B	1.3	5.1	1.18	0.92	1.30	13.67
6/2/2006		JC-B	1.3	5.6	0.52	0.96	0.35	6.54
6/16/2006	9:30	JC-B						
6/30/2006	10:15	JC-B						

8/2/2005	10:45	JC-C			1.22	0.679	1.1084	12.67
8/20/2005	11:35	JC-C			1.113	0.986	0.9135	10.68
9/10/2005	8:15	JC-C	1.327	6.542	1.26	1.42	1.44	16.43
9/24/2005	9:25	JC-C	1.394	5.272	1.20	1.21	1.36	12.90
10/7/2005	10:55	JC-C	1.503	6.02	1.32	1.52	1.79	16.70
10/22/2005	8:45	JC-C	1.715	4.392	1.39	1.25	1.40	11.84
11/4/2005	11:05	JC-C	1.457	5.261	1.29	1.23	1.79	14.65
11/18/2005	11:30	JC-C	1.91	4.92	1.37	0.94	1.45	11.25
12/3/2005	9:05	JC-C	1.142	6.812	1.101	1.285	0.7325	15.3
12/17/2005	10:25	JC-C	1.302	6.059	1.051	1.167	0.698	14.01
1/14/2006	10:30	JC-C	1.42	5.919	1.194	0.865	0.8478	13.63
1/27/2006	10:05	JC-C	1.424	6.345	1.223	0.819	0.9913	14.17
2/11/2006	9:10	JC-C	1.386	4.807	1.202	0.611	0.9046	11.38
2/25/2006	9:00	JC-C	1.725	4.406	1.62	0.68	1.41	13.67
3/15/2006		JC-C						
3/25/2006		JC-C						
4/7/06		JC-C						

4/21/2006	9:00	JC-C	3.697	2.39	3.81	0.71	0.87	5.96
5/5/2006	10:35	JC-C	1.378	3.203	1.07	0.54	0.77	7.27
5/19/2006	10:00	JC-C	1.3	5.116	1.16	0.88	1.26	13.95
6/2/2006	10:00	JC-C	1.31	5.658	1.19	0.99	1.48	15.52
6/16/2006	8:53	JC-C						
6/30/2006	9:55	JC-C						

Part II. Sediment loading to Jordan Creek

a) Purpose and statement of problem

Jordan Creek provides aquatic habitat for chum, coho, and pink salmon; cutthroat and steelhead/rainbow trout; and Dolly Varden. In 2002, the Alaska Department of Fish and Game (ADF&G) counted 1,396 adult coho salmon within the Jordan Creek watershed (Judy Lum, ADF&G, written common., 2003) In the spring of 2001, ADF&G counted 26,600 out-migrating Coho salmon smolt in the stream. Channel process groups and types were identified and mapped by Alaska Department of Fish and Game Division of Sport Fish during the 2003 habitat survey of Jordan Creek. These survey data indicate the main channel may have a tendency to retain sediment transported from steeper reaches or tributaries. The low gradient of the channel suggests Jordan Creek may be extremely sensitive to sediment input as mobilization of accumulated sediments may be limited by the low gradient (Gavel, 1996).

The Jordan Creek Watershed Recovery and Management Plan (Gavel, 2006) identified the following sediment sources within the watershed:

- Sand applied to roads and parking areas for traction during winter months
- Development induced riparian disturbance in the lower stream corridor
- Streambank, floodplain, and upland erosion due to off-road vehicle use in the upper watershed

a) Methods

Channel cross-sections were surveyed at several locations on Jordan Creek downstream from the Egan Drive stream crossing in November 2004. The location of elevation reference benchmarks established by the USGS, as well as cross-section locations were obtained from Janet Curran of the USGS Alaska Science Center. Cross-sectional surveys were repeated at 3 of the previously surveyed cross sections using a Wild T1610 total station and logged using installed firmware and flash card. Cross-section data were projected to a line connecting left and right bank stations.

b) Results

Figures 1-3 depict the changes in channel geometry from November 2004 to June 2006 at the 3 locations surveyed. Cross section 1 exhibited the least amount of channel change between the two surveys. Cross section 2 appears to have scoured near the left bank. Cross section 3 maintained a similar channel configuration near the thalweg and appears to have deposited a small amount near the right bank. In general all three cross-sections surveyed maintained similar channel configurations despite relatively large flood events occurring in November of 2005. The USGS discontinued the Jordan Creek gaging station on October 1, 2005, however, a single discharge measurement of 90 ft3/s was made on Nov. 22 which approaches the maximum discharge recorded on Jordan Creek. While the cross sections surveyed indicates this reach of Jordan Creek may be relatively stable there may be other reaches within the drainage subject to sediment deposition.

Figure 1. Cross section 1 showing changes over time in channel geometry.

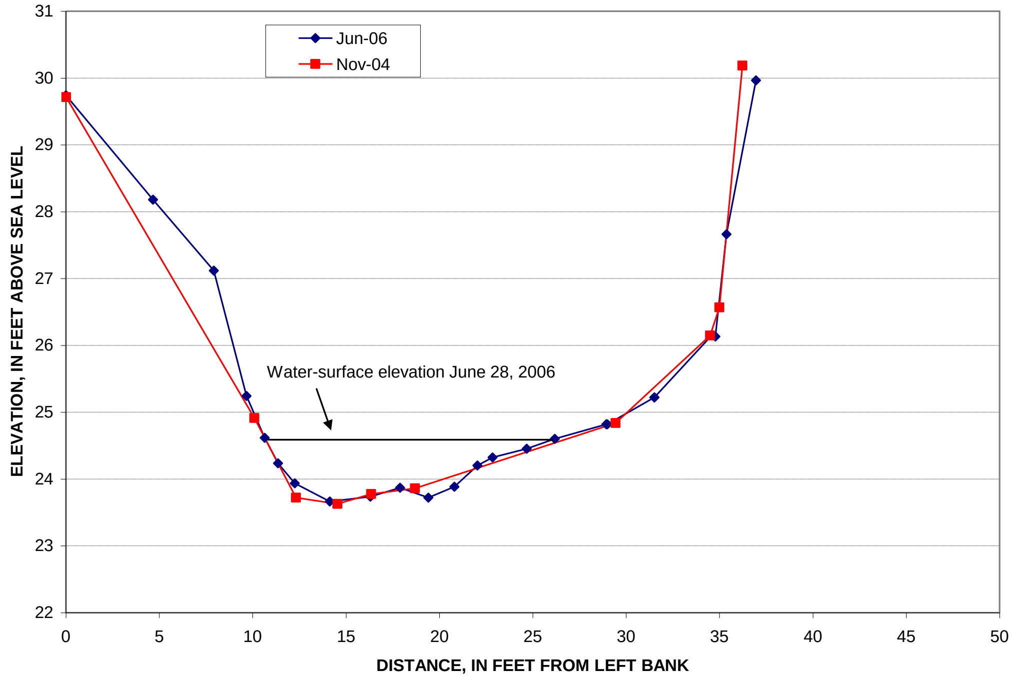
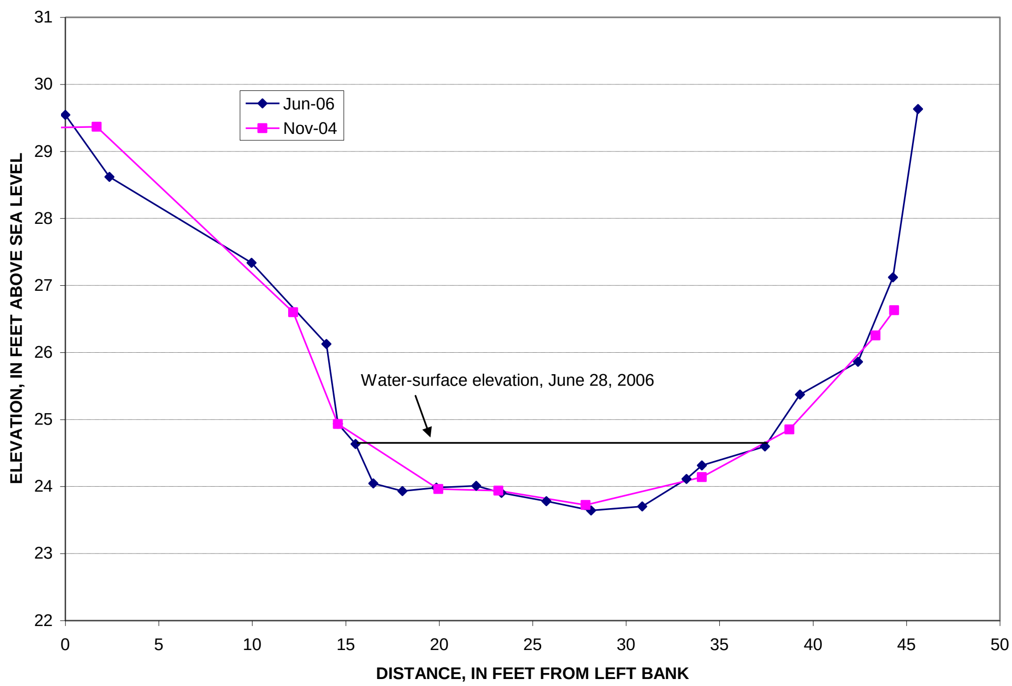


Figure 2. Cross section 2 showing changes over time in channel geometry.



c) Conclusion

Selected channel cross sections of Jordan Creek were surveyed to determine rates of channel aggradation/degradation. Results of these surveys indicate no clear trend in either aggradation or degradation with the exception of cross section which eroded a portion of the left bank.

Part III. Benthic Macroinvertebrate Bioassessments in Jordan Creek, 1995 and 2006

Introduction

Benthic macroinvertebrates play an important role in aquatic and riparian food webs transferring energy from primary producers to consumers such as fish, waterfowl, and other birds. A diverse and productive invertebrate community is critical to overall stream health. Aquatic macroinvertebrate communities are also unique indicators of water and habitat quality in streams because they integrate the impacts of multiple stressors over time (Rinella et al. 2003), including episodic and short-lived stressors that are difficult to document in water quality monitoring programs.

From 1994-1996 personnel from the University of Alaska's Institute of Arctic Biology in Fairbanks conducted macroinvertebrate bioassessments on Duck and Jordan Creeks in Juneau's Mendenhall Valley (Milner 1996). The Duck Creek watershed has been impacted by urban development since the1960s and is currently listed as an impaired water body by the Alaska Department of Environmental Conservation. At the time Jordan Creek was considered an ideal reference site because it was in close proximity to Duck Creek and similar in size. Furthermore, the water quality of Jordan Creek was considered high at that time. The purpose of the assessments was to provide baseline information to evaluate future watershed and in-stream restoration projects. Until recently Jordan Creek was one of the most productive coho salmon streams in southeastern Alaska. However, in recent years natural (e.g. isostatic rebound) and anthropogenic (e.g. urban encroachment, sedimentation, urban run-off) factors appear to have diminished the health of this once productive salmon stream. The purpose of this study was to determine whether the macroinvertebrate community in Jordan Creek has changed over the last 11 years in response to these potential stressors.

Methods

Macroinvertebrate assessments in 2006 were conducted at the same sites surveyed in 1995: near the Super 8 Motel (between Eagan Drive and Trout Street; 58.3657 N, -134.5779 W) and at Amalga Street[1] (58.3869 N, -134.5634 W) on 19 and 25 May, respectively. Water temperature at the time of sampling was 7.0 C at Amalga Street and 8.5 C at Trout Street. At each site a D-frame kick net (350 micron mesh) was used to collect 20 benthic samples from a 100 m reach according to standard macroinvertebrate bioassessment procedures for Alaska (AK SOP Methods 1-4). Samples were combined into a single composite sample and preserved in 80% ethanol. On 25 May 1995 five samples were collected at each site using a Surber sampler (335 micron mesh) and preserved in 80% ethanol. For the purpose of this study, data from the five samples collected at each site in 1995 were combined and metrics were calculated from the

[1] This site is erroneously referred to as "Totem Park Drive" in earlier reports.

resulting dataset. Macroinvertebrates were identified to the lowest reliable taxonomic level, generally family or genus for insect taxa and class for non-insect taxa.

Aquatic macroinvertebrate data were summarized using three bioassessment metrics: percent EPT taxa, EPT taxa richness, and percent dominant taxon. EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera or mayflies, stoneflies, and caddisflies) are generally most sensitive to water quality degradation in streams.

Percent EPT Taxa – The number of EPT individuals divided by the total number of individuals in a sample. In southeastern Alaska percent EPT taxa values range from 65 to 75% in unimpaired streams and from 5 to 40% in urban streams (Rinella et al. 2003).

EPT Taxa Richness – The number of EPT genera in a sample. In southeastern Alaska EPT taxa richness ranges from 13 to 18 for unimpaired streams and from 0 to 4 in urban streams (Rinella et al. 2003).

Percent Dominant Taxon – The most abundant taxon as a percentage of the total number of organisms in a sample. Numerical dominance by one or two taxa in a community can indicate environmental stress. In southeastern Alaska, percent dominant taxa values range from 25 to 40% in unimpaired streams and from 45 to 60% in urban streams (Rinella et al. 2003).

Results

Several taxa were found in Jordan Creek in May 2006 that were not reported in the 1995 bioassessment: Nematoda (round worms), Ostracoda (seed shrimps), Gastropoda (snails), Bivalvia (clams), Hydroida (hydroids), and Hydrachnida (water mites) (Table 1). Since many of these non-insect taxa are commonly found in streams in the area, yet are small and difficult to distinguish from sediment and organic debris common in benthic samples, they may have been overlooked in 1995. Alternatively, these taxa may have been intentionally ignored during sample processing. These taxa comprised a large proportion (31-37%) of the total invertebrate community in 2006. If they were present in 1995, comparisons to 2006 metrics would not be valid. Thus, the 2006 metrics were calculated in two ways - including and excluding these taxa (Table 1).

The macroinvertebrate community in Jordan Creek appeared to change from 1995 to 2006. Changes in the three metrics varied in magnitude and direction depending on the site (Table 1). EPT taxa represented a small portion of the total invertebrate community at both sites and in both years, and percent EPT taxa values were consistent with those for other impaired water bodies in southeastern Alaska. The percentage of EPT taxa at Amalga Street was generally stable over the period (Table 1). Values ranged from 8.8% (12.7% excluding taxa) in 2006 to 12.1% in 1995. However, the number of EPT taxa doubled over the period from 4 to 8 genera with the appearance of four new Trichoptera genera in 2006 samples (Table 1). Although chironomids were numerically dominant at

Amalga Street in both years, they comprised a smaller proportion of the total invertebrate community in 2006 (34.3%, 49.9% excluding taxa) than in 1995 (81.1%).

The macroinvertebrate community at the Super 8 site also exhibited signs of stress. The percentage of EPT taxa at this site declined dramatically from 1995 to 2006, even when most non-insect taxa were excluded from the analysis (Table 1). In 1995 EPT taxa comprised 35% of the macroinvertebrate community compared with 7.2% (11.4% excluding taxa) in 2006. Remarkably, Ephemeroptera were virtually absent from samples collected in 2006 despite the presence of 4 genera at this site in 1995. One of the mayfly genera present at this site in 1995, *Baetis*, is the most common and widely distributed mayfly in the region. The loss of mayfly diversity at this site was offset by an increase in caddisfly taxa richness from 0 genera in 1995 to 4 genera in 2006. Thus, despite a major shift in EPT species composition from Ephemeroptera to Trichoptera, EPT taxa richness (7 genera) did not change over the period. While the stonefly *Podmosta* and chironomids were the most dominant taxa in 1995, by 2006 chironomids were by far the most common taxon comprising 50.0% (78.8% excluding taxa) of all invertebrates.

Discussion

Excluding non-insect taxa (except Oligochaeta) from metric scores in 2006 influenced the magnitude of change in certain metrics, but did not alter the direction of change. Nonetheless, future bioassessments should take great care in documenting all macroinvertebrate taxa present in a sample. If certain taxa are excluded from counts, for example, because their small size makes them difficult to find, excluded taxa should be mentioned in reporting the results.

Of the two sites surveyed in 2006, only the macroinvertebrate community at Amalga Street showed signs of improved EPT taxa diversity and a more balanced species composition. Although 4 new caddisfly genera were found at this site, EPT taxa richness continues to be much lower than values from reference (unimpaired) streams in the region. High levels of fine sediment at this site may be limiting the presence of certain EPT taxa. Eighty-three percent (83%) of all taxa found were chironomids, oligochaetes, and ostracods, taxa that are tolerant of fine sediment in streams. Relatively low water velocities and high fine sediment loading at this site may prevent new EPT taxa from colonizing this site, especially mayflies.

A major shift in the EPT community occurred at the Super 8 site between 1995 and 2006. Mayfly taxa richness declined dramatically since 1995 with the loss of 3 taxa that prefer fast-flowing riffle habitat and cobble and boulder substrates. High sediment loading and low water velocities at this site appear to have eliminated habitat for these taxa. The most dominant taxon at this site shifted from a stonefly to chironomids between 1995 and 2006. Stoneflies are generally indicators of good water quality. Chironomids are generally tolerant of poor water quality and high sediment loading in streams.

Clearly Jordan Creek is no longer suitable as a reference site for gauging the success of restoration projects in nearby impaired water bodies such as Duck, Pederson Hill, and Vanderbilt Creeks. Future studies on Jordan Creek should focus on identifying the sources and types of stressors that may be suppressing the macroinvertebrate community. The results of this study suggest that reduced water velocity and high sediment loads, whether natural or related to urbanization in the watershed, may be limiting macroinvertebrate diversity and production in this stream.

This study examined changes in the macroinvertebrate community of Jordan Creek in the month of May. Assessment data from the mid 1990s are available for the months of April, June, and July. Future work should consider sampling during these months because species composition changes naturally over time due to the unique life history characteristics of individual taxa. Furthermore, establishing additional study sites for future assessments will help to isolate the source and location of various stressors within the watershed. Establishing sampling stations in the highly urbanized lower reaches and in salmon spawning habitat in the upper reaches should be priorities in future assessments.

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Table 1. Number of individuals collected by taxon and standard bioassessment metrics from two sites in Jordan Creek in May 1995 and 2006[1].

	Amalga Street		Super 8 Motel	
Sampling date	**5/25/95**	**5/25/06**	**5/25/95**	**5/19/06**
Insect taxon				
Ephemeroptera				
Baetidae				
Baetis			42	
Ameletidae				
Ameletus			2	1
Heptageniidae				
Epeorus			3	
Cinygmula			4	
Plecoptera				
Chloroperlidae				1
Plumiperla	12		8	
Sweltsa		6		
Capniidae		5		1
Capnia	7		10	
Nemouridae				
Zapada	39	2		
Podmosta		8	254	46
Trichoptera		54[2]		4[2]
Limnephilidae				
Onocosmoecus	1			1
Limnephilus		23		21
Psychoglypha		4		1
Lenarchus		6		
Lepidostomatidae				
Lepidostoma		1		
Diptera				
Ceratopogonidae		1	1	5
Chironomidae	424	427	237	527
Empididae				
Chelifera		10		1
Clinocera		3		
Tipulidae	21		13	
Dicranota		2		

Table 1 Continued

Table 1 Continued	**Coho Park**		**Super 8 Motel**	
	5/25/95	**5/25/06**	**5/25/95**	**5/19/06**
Limnophila		9		1
Molophilus				1
Simuliidae	1	2	197	
Unidentified Diptera A				1
Unidentified Diptera B				1
Coleoptera				
Dytiscidae		2		
Collembola		2		
Non-Insect taxon				
Oligochaeta	18	288	10	56
Nematoda				13
Ostracoda		314		86
Gastropoda		26		77
Bivalvia		34		172
Hydroida		1		
Hydrachnida		11		36
Total number of individuals	**523**	**1245**	**781**	**1053**
% EPT taxa[3]	**12.1**	**8.8 (12.7)**	**35.0**	**7.2 (11.4)**
EPT taxa richness	**4**	**8**	**7**	**7**
% dominant taxon[3]	**81.1**	**34.3 (49.9)**	**33.0**	**50.0 (78.8)**

[1]The number of individuals in a taxon are given below to show raw data used in calculating metrics and should not be used to make comparisons between years because of differences in sampling effort

[2] Early instar larvae, too small to identify to species

[3] Values in parentheses were calculated using only insect taxa with the exception of Oligochaeta