AQUATIC RESOURCES MONITORING PLAN

PLAN OF OPERATIONS – Volume VII C

Donlin Gold Project

Revised March 2020

Prepared By:

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ACRONYMS

ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish & Game
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
ARMP	Aquatic Resources Monitoring Plan
BGC	BGC Engineering Inc.
CCAA	Crooked Creek above American Creek
CCAC	Crooked Creek above Crevice Creek
CCAK	Crooked Creek above Kuskokwim River
CCBC	Crooked Creek below Crevice Creek
CCBW	Crooked Creek just below the confluence of Donlin Creek and Flat Creek
CMP	Compensatory Mitigation Plan
CPUE	catch per unit of effort
Donlin Gold	Donlin Gold LLC
FWD	Fresh Water Dam
GPS	Global Positioning System
GVT	glass vial tubes
HMU	habitat mapping unit
HR	Habitat Reach
OtterTail	OtterTail Environmental, Inc.
Project	Donlin Gold Project
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
SRK	SRK Consulting
TSF	tailings storage facility
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WRF	waste rock facility
WTP	water treatment plant

UNITS OF MEASURE

ft	feet/foot
ha	hectare
hr	hour
km	kilometer
m	meter
mg/L	milligrams per liter
ml	milliliter

1.0 INTRODUCTION

Donlin Gold LLC[1] (Donlin Gold) is planning to develop an open pit, hardrock gold mine in southwestern Alaska, 277 miles (446 kilometers [km]) west of Anchorage, 145 miles (233 km) northeast of Bethel, and 10 miles (16 km) north of the village of Crooked Creek (distances are approximate). This Aquatic Resources Monitoring Plan (ARMP) describes Donlin Gold's plans for continued data collection and monitoring during the following Donlin Gold Project (Project) activities: construction, operations, closure, and post-closure.

The ARMP will be revised as appropriate to respond to regulatory changes, the results of periodic agency reviews, potential Project changes, and monitoring result outcomes, consistent with an adaptive management plan approach (Section 4.2). Revisions will be listed in Table 1-1 as they are finalized.

Table 1-1 Record of Revisions and Amendments

Date	Section (s) Revised or Amended

1.1 Purpose

The purpose of the ARMP is to collect information throughout the Project life cycle to assess aquatic life and hydrologic conditions in the Crooked Creek watershed that have the potential to be affected by the Project. OtterTail Environmental, Inc. (OtterTail) collected detailed aquatic biomonitoring baseline data in the mine site area from 2004 through 2014 (OtterTail Environmental, Inc. 2014a). Baseline data collection focused on identifying fish species distribution and relative abundance and describing aquatic invertebrate and periphyton communities. Numbers of returning salmon and spawning distributions were also determined within the Crooked Creek drainage. In 2009 and 2014, habitat mapping was conducted in Crooked Creek from its origin at the Donlin Creek confluence with Flat Creek to its mouth at the Kuskokwim River (OtterTail 2009, OtterTail 2014b). Since 2006, numerous hydrologic studies (surface water and groundwater) have been carried out to establish flow and water quality conditions, and support surface water and groundwater modeling. The ARMP presents rationales for each monitoring site, describes data collection methodologies by discipline, and provides sampling

[1] Donlin Gold LLC is a limited liability company equally owned by Barrick Gold U.S. Inc. and NovaGold Resources Alaska, Inc.

frequencies for monitoring activities. Appropriate reference sites will be monitored for comparison and select hydrologic information critical to aquatic habitat evaluations also will be collected. Specific methodologies, analytical methods, and comparative methodologies will be further determined in coordination with the Alaska Department of Fish and Game (ADF&G) and subject matter experts.

The aquatic monitoring described in the ARMP is in addition to other Project monitoring activities associated with dam safety, air emissions, waste management, and water discharges that are mandated by specific permit requirements or other monitoring plans. For example, the Project's Alaska Pollutant Discharge Elimination System (APDES) permit contains monitoring requirements applicable to operation of the water treatment plant (WTP) to demonstrate compliance with the APDES permit conditions.

Data collected under the ARMP will be used to demonstrate compliance with conditions in the Title 16 Permits issued by the ADF&G. The data will also be used to support the Project's Water Rights and Temporary Water Use Permit applications filed with the Alaska Department of Natural Resources (ADNR).

Appendix A of the ARMP outlines specific monitoring plans to be implemented in conjunction with mitigation habitats that would be constructed in upper Crooked Creek in association with the U.S. Army Corps of Engineers (USACE) approved Compensatory Mitigation Plan (CMP). Site-specific mitigation performance monitoring would occur in each of the following reclaimed habitat areas:

- Lower Quartz Gulch
- Lower Snow Gulch
- Wash Plant Area (tailings) along Crooked Creek, between Snow and Ruby gulches
- Lower Ruby and Queen gulches

Sampling and analytical methodologies for aquatic organisms and habitat metrics associated with the CMP monitoring would be conducted as described in the ARMP unless otherwise specified in Appendix A.

ADMINISTRATIVE INFORMATION

Name of Facility:	Donlin Gold LLC
Type of Facility:	Proposed Gold Mine and Process Plant Operation
Location:	Latitude 62º01’36” North, Longitude 158º13'15” West
Corporate Information:	A Delaware Limited Liability Company jointly owned by NovaGold Resources Alaska, Inc. and Barrick Gold U.S. Inc.
Business Name:	Donlin Gold LLC
Address:	2525 C Street, Suite 450 Anchorage, Alaska 99503
Telephone:	(907) 273-0200
General Manager:	Andrew Cole
Operations Manager:	______________________________

Designated Contact Person for Regulatory Issues:

Dan Graham, PE, Permit and Environmental Manager
Donlin Gold LLC
2525 C Street, Suite 450
Anchorage, AK 99503

Telephone: (907) 273-0200

1.2 Project Description

The Project will require approximately 3 to 4 years to construct, with the active mine life currently projected to be approximately 27 years. The mine is proposed to be a year-round, conventional "truck and shovel" operation using both bulk and selective mining methods.

The Donlin Gold Project Description (SRK 2016a) provides a detailed description of the overall Project area and infrastructure necessary to support the development, operation, and closure of the Project.

1.3 Objectives

The objectives of the ARMP are to:

1. Extend aquatic life and hydrologic monitoring initiated during baseline studies to subsequent phases of the Project.

2. Collect data suitable for detecting changes to aquatic communities and habitat.

3. Identify a range of conditions such that future monitoring results can be evaluated for shifts in species composition, populations, and habitat quality.

4. Establish reference locations as part of the monitoring network to allow differentiating natural changes from Project-related changes.

5. Document aquatic habitat conditions at restoration sites addressed by the CMP using the same methods associated with Objectives 1 through 3.

2.0 AQUATIC MONITORING

Over 30 individual sites were sampled for fish, aquatic invertebrates, and periphyton communities during the detailed and long-term aquatic biomonitoring baseline program conducted between 2004 and 2014. The Project also established a network of surface water and groundwater monitoring sites as part of the baseline data collection over the same timeframe to understand the watershed hydrology that supports the aquatic habitat. The ARMP proposes to continue monitoring at a number of these sites using the same or similar methods as used in the baseline program. Some monitoring methods have been modified to accommodate the long-term nature of the ARMP as described in Section 2.1.

The ARMP includes the following biological and physical sampling categories of aquatic resource monitoring:

1. Biological:
    a. Aquatic biomonitoring consisting of a combination of sampling for fish presence and/or abundance, aquatic invertebrate community characterization, periphyton standing crop estimates, and, for some sites, sediment and fish whole body element concentrations (Sections 2.1 and 2.2).
    b. Aerial salmon spawning surveys (Section 2.3).
2. Physical:
    a. Crooked Creek stream flow monitoring stations, including winter stream flow and substrate freeze-down surveys (Sections 2.4.1 and 2.4.3).
    b. Aquatic physical habitat monitoring involving supplementing the baseline characterization and conducting effects monitoring including groundwater monitoring focused on shallow water in the alluvium and colluvium (Sections 2.4.2 and 2.5). (Additional groundwater monitoring of the weathered bedrock and deeper [pit-depth] aquifer would be conducted in conjunction with the Waste Management Permit (WMP) with data available for analysis as appropriate.) This information will provide critical input to determine any actions needed under adaptive management (Section 4.2).

Surface water quality and flow data collected under the ARMP and as required by the APDES and WMP permits would be augmented with sediment quality monitoring. These data would be used in conjunction with the co-located fish tissue sampling to identify any changes in element levels and to aid understanding of how they could be affecting aquatic resources.

In selecting monitoring sites, a subset of the baseline data stations was identified to achieve the following goals: (1) identify at least one site located upstream from all mining activities (DCBO); (2) select at least one site downstream from all planned mine activity (CCBC); and (3) select at least one site from a major tributary to Crooked Creek that is not anticipated to be impacted directly by mine activity (i.e., as a control or reference) (GM3). Other sites were selected based on the need to evaluate the potential impacts of specific project activities throughout the watershed, e.g., CV1 will provide monitoring results downstream of the post-closure discharge from the collection pond that will be used to manage runoff from the covered tailings storage facility (TSF) surface. The sites selected for the ARMP are summarized in Table 2-1 and described in detail in Sections 2.1 and 2.2. The sampling locations are shown on Figure 2-1.

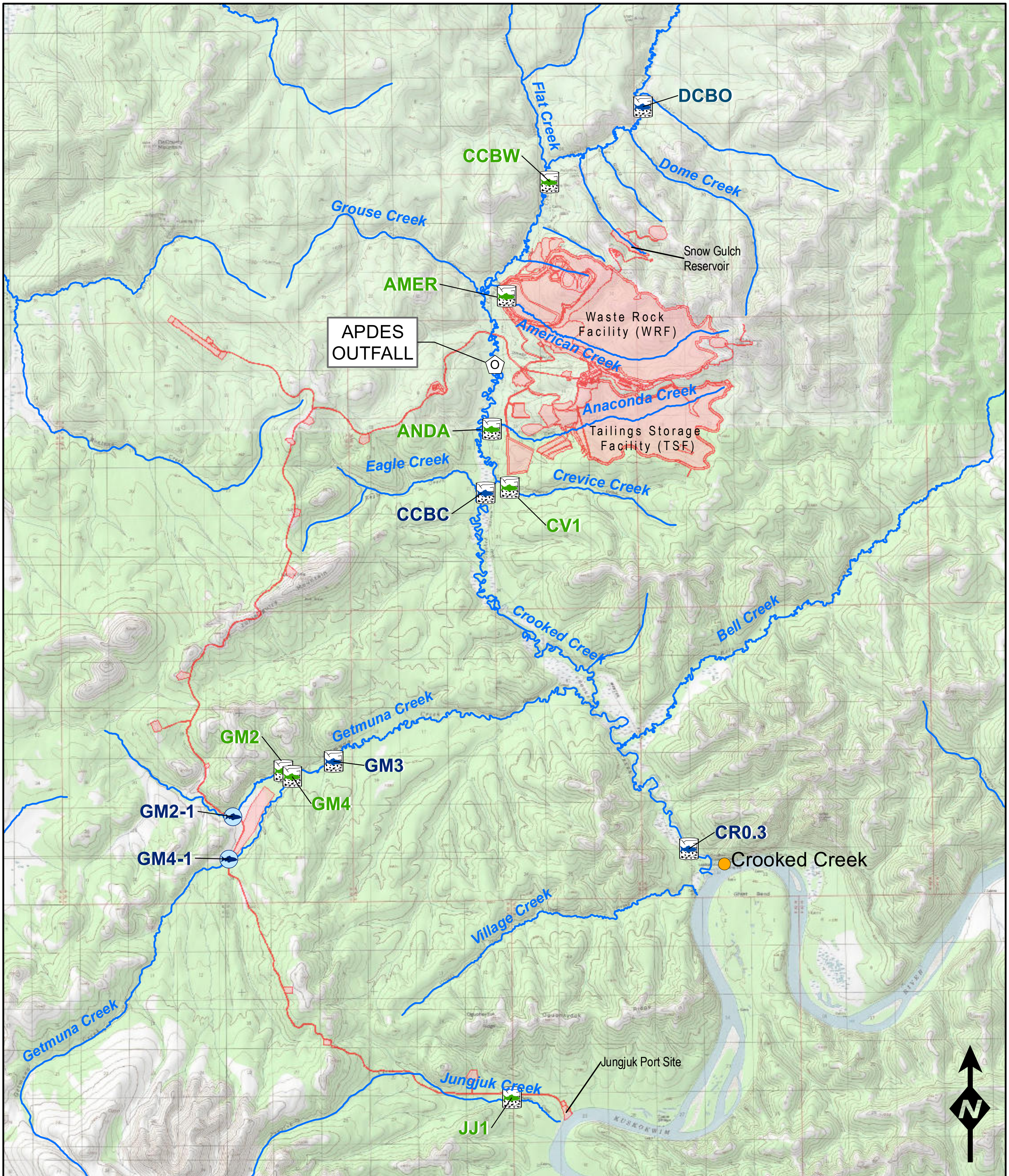
Under the Clean Water Act Section 404 permit issued by the USACE, Donlin Gold's required compensatory mitigation includes fish habitat restoration projects in four drainages in the Upper Crooked Creek watershed impacted by historic placer mining activities. The requirements include monitoring to document the performance and success of the restoration work. This mitigation is also addressed by Fish Habitat Permits FH18-III-0192 and 0193 issued by the ADF&G. After this monitoring is finalized and approved by USACE and ADF&G, it will be incorporated into the ARMP. Because this monitoring has different requirements and goals from the other monitoring requirements, it is described separately in Appendix A.

Table 2-1 Donlin Gold Aquatic Biomonitoring Plan Summary by Monitoring Site

	Monitoring Sites												
Aquatic Biomonitoring	**DCBO**	**CCBW**	**AMER**	**ANDA**	**CCBC**	**CV1**	**GM3**	**GM2**	**GM4**	**GM2-1**	**GM4-1**	**CR0.3**	**JJ1**
Fish Presence and Abundance	X	X	X	X	X	X	X	X	X	X	X	X	X
Aquatic Invertebrates	X	X	X	X	X	X	X	X	X			X	X
Periphyton	X	X	X	X	X	X	X	X	X			X	X
Juvenile Fish Whole Body Element Concentrations	X				X		X					X	
Surface Water Quality Monitoring/Long List*	X	X	X	X	X	X	X	X	X			X	X
Sediment Quality Monitoring	X				X		X					X	

Notes:

DCBO = Upper Donlin Creek (above mining)
CCBW = Crooked Creek below Wash Plant (above mining)
AMER = American Creek (open pit area)
ANDA = Anaconda Creek (downstream of TSF)
CCBC = Crooked Creek below Crevice Creek (below mining)
CV1 = Crevice Creek (below post-closure TSF area discharge point)
GM3 = Getmuna Creek (below material site and road crossing)
GM2 = North Fork Getmuna Creek (below material site and road crossing)
GM4 = South Fork Getmuna Creek (below material site and road crossing)
GM2-1 = North Fork Getmuna Creek upstream from road
GM4-1 = South Fork Getmuna Creek upstream from road
CR0.3 = Lower Crooked Creek (well below mining)
JJ1 = Lower Jungjuk Creek (below road)
* – Long List as specified in Appendix B



Fish Sampling Only

Fish/Invertebrate/Periphyton/ Surface Water

Fish/Invertebrate/Periphyton/ Surface Water/Fish Whole Body/Sediment

APDES Outfall

Streams

Proposed Facilities

Monitoring at CV1 to start after closure

Seward Meridian, UTM Zone 4 NAD83

DONLIN GOLD

AQUATIC BIOMONITORING LOCATIONS

DONLIN GOLD PROJECT

SCALE:

0 1 2 4 mi

0 1.5 3 6 km

FIGURE:

2-1

ORNRC: DGP0002.mxd, 3/24/2020, R19

2.1 Aquatic Biomonitoring Methods

2.1.1 Fish Presence and Abundance

Long-term biomonitoring reaches will be established to provide annual measures of catch per unit of effort (CPUE) based on sampling by minnow trap. Fish sampling will be conducted between mid-July and late July of each sampling year to maintain consistency with baseline sampling periods and long-term consistency during monitoring. Ten minnow traps will be set in established stream reaches and fished for up to 24 hours. The length of each stream reach will be set at roughly 50 times the bank-full width of the stream. Historically, baseline data collection for estimating relative fish abundance typically relied on either single or multi-pass electrofishing of nonblocked sample reaches. However, in streams with mixed size and age classes of fish, electrofishing can injure larger fish, and repeated annual exposure can be detrimental to resident fish populations. Establishing defined minnow trap reaches will provide sufficient data to evaluate trends in CPUE for species susceptible to minnow traps.

Because larger individuals of some fish species such as Dolly Varden and burbot are too large to enter minnow traps, and because some species such as Arctic grayling are not typically caught by minnow traps, fish sampling to document continued general distribution within drainages of the Project area could employ any number of other methods used during baseline sampling, including electrofishing, fyke netting, angling, and visual observation.

2.1.2 Aquatic Invertebrates

Aquatic invertebrate sampling will be conducted using the methods used for baseline data collection (Appendix C). Surber samplers will be used to collect five replicate samples per site. The analysis will include identifying taxa present; estimating aquatic invertebrate density and taxa richness; and calculating ratios of mayflies, stoneflies, and caddisflies versus all other aquatic invertebrate taxa.

2.1.3 Periphyton

Periphyton sampling will be conducted at all biomonitoring sites, similar to baseline data collection methods (Appendix C). However, during biomonitoring under the ARMP, sample sizes will be increased to 10 rocks per site. Samples will be processed to measure chlorophyll a, b, and c concentrations to produce an estimate of periphyton standing crop. Chlorophyll analysis will show overall productivity of the community as well as potential shifts in community structure by tracking the relative ratios of chlorophyll a, b, and c over time. If results suggest a community shift is occurring, further sampling could be conducted to identify taxa structure within the periphyton community for comparison to baseline conditions.

2.1.4 Juvenile Fish Whole Body Element Concentrations

Juvenile Dolly Varden or coho salmon will be captured with minnow trapping, and with supplemental fish sampling as needed, to collect enough fish to produce 15 composite samples with adequate mass for laboratory analysis of whole body element concentrations. Initial monitoring will assess whether adequate numbers of juvenile Dolly Varden or coho salmon are present at all monitoring sites to make it practical to collect these species instead of juvenile slimy sculpin for whole body element analysis. The proposed sampling to ascertain the feasibility of using age-0 to age-1 Dolly Varden or age-0 to age-1 coho salmon for whole body element analysis would be conducted before Project construction begins and would also be used to establish a baseline for these species. If neither Dolly Varden nor coho salmon monitoring is practicable, slimy sculpin would be collected and analyzed.

During baseline sampling composite samples of primarily juvenile slimy sculpin were evaluated for whole body concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, and zinc. Under the ARMP, juvenile fish will be analyzed for specific elements based on their potential presence in releases, existing levels in the watershed, and risk of possible effects. Specific elements to be monitored and rationales include:

- Arsenic – elevated in the Crooked Creek drainage and can have food chain level effects.
- Antimony - elevated in the Crooked Creek drainage and can have food chain level effects.
- Copper – copper concentrations in juvenile slimy sculpin were significantly higher in Getmuna Creek than in other Crooked Creek drainage sites; sampling will continue in order to track these differences between Getmuna Creek and the remainder of the drainage.
- Mercury/methyl mercury – mercury is regionally high in this reach of the Kuskokwim River drainage and the potential increases in fish during mining have been modelled; mercury concentrations in juvenile slimy sculpin were significantly higher in Getmuna Creek than in other Crooked Creek drainage sites; sampling will continue to monitor for changes in mercury.
- Selenium – selenium concentrations in fish can have survival and reproductive effects and the EPA has whole body and ovarian tissue criteria.

Element concentrations will be determined on a dry-weight basis to ensure comparability between fish of differing size, age, and condition. Percent moisture will be reported for each sample to allow direct calculation of wet-weight concentrations without the need to estimate moisture content, which can vary widely based on season and fish condition at the time of sample collection.

2.1.5 Surface Water Quality and Sediment Monitoring

Surface water quality data collected as required by the APDES permit would be augmented with sampling results from the additional sites as shown on Figure 2-1 and in Table 2-1. Four of the sites will also include co-located sediment sampling. These data will be considered in analyzing and interpreting biological data collected under the ARMP. The Donlin Gold Plan of Operations Integrated Waste Management Monitoring Plan (Appendix A) includes the *Donlin Gold Quality Assurance Project Plan (QAPP) Water Quality Monitoring, Sampling and Analysis Activities – December 2016* (SRK 2016b). The QAPP describes the water quality sampling methods and would be amended in the future to include sediment sampling.

2.2 Aquatic Biomonitoring Sample Collection Plan

The sites selected for aquatic biomonitoring are shown in Table 2-2 and on Figure 2-1. The biomonitoring history and rationale for each site are summarized in Table 2-2. The proposed sampling frequency for each site by Project phase is summarized in Table 2-3.

Table 2-2 Donlin Gold Site Biomonitoring History and Rationale

Location	Site	Biomonitoring History[1]	Biomonitoring Rationale
Donlin Creek	DCBO	Fish, invertebrate, periphyton, and fish element sampling 2004-2012	• Reference site for fish, invertebrates, and periphyton communities, including sediment and fish element concentrations. • Upstream from all proposed and historic mining activity.
Crooked Creek	CCBW	None - New Site - ~ 3 linear miles upstream from CR2, below the former Lyman placer Wash Plant - Fish, invertebrate, periphyton and fish element sampling at CR2, 2004-2012	• Reference site for fish, invertebrate, and periphyton communities. • Upstream from all proposed mine activity (except the Snow Gulch Freshwater Reservoir). • Upstream water quality monitoring also required under APDES permit.
American Creek	AMER	Fish, invertebrate, and periphyton sampling 2004-2012	• Essentially all lower American Creek will ultimately be covered by mine facilities. • Effects monitoring site for fish, invertebrates, and periphyton communities. • Will be monitored until creek is covered or the flow no longer supports sampling.
Anaconda Creek	ANDA	Fish, invertebrate, and periphyton sampling 2004-2009 and 2011	• The majority of Anaconda Creek occurs within the proposed TSF. • Effects monitoring site for fish, invertebrates, and periphyton communities. • Downstream from the TSF. • Potential for inadequate flow to support viable fish habitat. Site will be eliminated if/when flow is reduced to the point that it no longer supports aquatic habitat.
Crevice Creek	CV1	Fish, invertebrate, and periphyton sampling 2006-2009	• Post-closure effects monitoring site for fish, invertebrates, and periphyton communities. • Outside of the direct influence of most mining activity; however, would be the receiving waters for flows from the TSF cover area after closure.
Crooked Creek	CCBC	Fish, invertebrate, periphyton and fish element sampling 2006-2012	• Primary effects monitoring site for fish, invertebrates, and periphyton communities, including sediment and fish element concentrations. • Downstream from all mining activity (pit, waste rock facility [WRF], TSF, APDES discharge point) including the eventual diversion of upper Anaconda Creek drainage into Crevice Creek after closure. • Downstream water quality monitoring also required under APDES permit.
Getmuna Creek	GM3	Fish, invertebrate, periphyton and fish element sampling 2012-2013	• Effects monitoring control site for fish, invertebrates, and periphyton communities, including sediment and fish element concentrations. • Upstream from all mining activity, but downstream from two Donlin-Jungjuk Road crossings, and a material source. • Baseline concentrations for some elements were higher in fish captured in Getmuna Creek than in fish captured in Crooked Creek.
Getmuna Creek, North Fork	GM2	Fish, invertebrate, and periphyton sampling 2012	• Baseline/effects monitoring control site for fish, invertebrates, and periphyton communities. • Upstream from all mining activity, but downstream from Donlin-Jungjuk Road crossing and a material source. • Biomonitoring sampling would be conducted in at least one year, preconstruction, to establish an updated baseline for future comparisons (if there is a need to distinguish whether impacts are occurring in either fork or both). Fish sampling would continue annually.
Getmuna Creek, South Fork	GM4	Fish, invertebrate, and periphyton sampling 2012	• Baseline/effects monitoring control site for fish, invertebrates, and periphyton communities. • Upstream from all mining activity, but downstream from Donlin-Jungjuk Road crossing, and potential outflow from a material source. • Biomonitoring sampling would conducted in at least one year, preconstruction, to establish an updated baseline for future comparisons. Fish sampling would continue annually.
Getmuna Creek, North Fork	GM2-1	None - New Site	• Reference monitoring site, fish community only. • Upstream from Donlin-Jungjuk Road crossing.
Getmuna Creek, South Fork	GM4-1	None - New Site	• Reference monitoring site, fish community only. • Upstream from Donlin-Jungjuk Road crossing.

Table 2-2 Donlin Gold Site Biomonitoring History and Rationale (continued)

Location	Site	Biomonitoring History[1]	Biomonitoring Rationale
Crooked Creek	CR0.3	Fish, invertebrate, and periphyton sampling 2006-2010	• Primary effects monitoring site for fish, invertebrates, and periphyton communities, including sediment and fish element concentrations. • Downstream from all mining activity, near the mouth of Crooked Creek. Located just upstream from background water quality site (CCAK).
Jungjuk Creek	JJ1	Fish, invertebrate, and periphyton sampling 2007-2008	• Baseline/effects monitoring site for fish, invertebrates, and periphyton communities. • Separate drainage from all mining activity but downstream from Donlin-Jungjuk Road crossings of Jungjuk Creek and tributaries. • Biomonitoring sampling would be conducted in at least one year, preconstruction, to establish an updated baseline for future comparisons. Fish sampling would continue annually.

Notes:
1 - Biomonitoring history compiled from OtterTail 2014a

Table 2-3 Donlin Gold Detailed Biomonitoring Plan by Site

Location	Site	Latitude[1]	Longitude	Target	Monitoring	Frequency	
						Construction/Operation	Closure
Donlin Creek	DCBO	62.08788	-158.16669	Reference site	Fish Presence/Abundance Estimate	Annually	Annually for 5 years, then every 5 years
					Aquatic Invertebrates	Annually	Annually for 5 years, then every 5 years
					Periphyton (community and standing crop estimates)	Annually	Annually for 5 years, then every 5 years
					Fish Whole Body Element Concentrations (juvenile coho salmon or Dolly Varden)	Annually	Annually for 5 years, then every 5 years
					Surface Water Monitoring/Long List	Quarterly	Quarterly for 5 years, then every 5 years
					Sediment Sampling	Annually for first 3 years	At closure, then as needed based on fish elements
Crooked Creek	CCBW	62.07336	-158.21853	Reference site for proposed mining activities, downstream from historic placer mining/mitigation areas	Fish Presence/Abundance Estimate	Annually	Annually for 5 years, then every 5 years
					Aquatic Invertebrates	Annually	Annually for 5 years, then every 5 years
					Periphyton (community and standing crop estimates)	Annually	Annually for 5 years, then every 5 years
					Surface Water Monitoring/Long List	Quarterly	Quarterly for 5 years, then every 5 years
American Creek	AMER	62.03977	-158.248056	Potential effect from proposed mining Pit and Waste Rock Facility, sampled until fish habitat is no longer present	Fish Presence/Abundance Estimate	Annually	NA
					Aquatic Invertebrates	Annually	NA
					Periphyton (community and standing crop estimates)	Annually	NA
					Surface Water Monitoring/Long List	Quarterly	NA
Anaconda Creek	ANDA	61.99957	-158.25700	Potential effects from TSF, only sampled if/when viable fish habitat is present	Fish Presence/Abundance Estimate	Annually	Annually for 5 years, then every 5 years
					Aquatic Invertebrates	Annually	Annually for 5 years, then every 5 years
					Periphyton (community and standing crop estimates)	Annually	Annually for 5 years, then every 5 years
					Surface Water Monitoring/Long List	Quarterly	Quarterly for 5 years, then every 5 years
Crooked Creek	CCBC	61.98087	-158.26126	Potential effects from Pit, TSF, WRF, APDES permitted discharge	Fish Presence/Abundance Estimate	Annually	Annually for 5 years, then every 5 years
					Aquatic Invertebrates	Annually	Annually for 5 years, then every 5 years
					Periphyton (community and standing crop estimates)	Annually	Annually for 5 years, then every 5 years
					Fish Whole Body Element Concentrations (juvenile coho salmon or Dolly Varden)	Annually	Annually for 5 years, then every 5 years
					Surface Water Monitoring/Long List	Quarterly	Quarterly for 5 years, then every 5 years
					Sediment Sampling	Annually for first 3 years	At closure, then as needed based on fish elements

Table 2-3 Donlin Gold Detailed Monitoring Plan by Site (continued)

Location	Site	Latitude[1]	Longitude	Target	Monitoring	Frequency	
						Construction/Operation	Closure
Crevice Creek	CV1	61.98334	-158.25012	Post-closure effects of Anaconda Creek Diversion	Fish Presence/Abundance Estimate	NA	Annually for 3 years prior to initiating the discharge then annually for 5 years, after initiation of discharge, then once every 5 years
					Aquatic Invertebrates	NA	Annually for 3 years prior to initiating the discharge then annually for 5 years, after initiation of discharge, then once every 5 years
					Periphyton (community and standing crop estimates)	NA	Annually for 3 years prior to initiating the discharge then annually for 5 years, after initiation of discharge, then once every 5 years
					Surface Water Monitoring/Long List	NA	Quarterly during years when aquatics biomonitoring is performed
Getmuna Creek	GM3	61.90128	-158.35944	Getmuna Reference Site, potential effects from Donlin-Jungjuk Road, MS-10 Material Source, Fish Whole Body Elements Reference Site	Fish Presence/Abundance Estimate	Annually	Annually for 5 years, then every 5 years
					Aquatic Invertebrates	Annually	Annually for 5 years, then every 5 years
					Periphyton (community and standing crop estimates)	Annually	Annually for 5 years, then every 5 years
					Fish Whole Body Element Concentrations (juvenile coho salmon or Dolly Varden)	Annually	Annually for 5 years, then every 5 years
					Surface Water Monitoring/Long List	Quarterly	Quarterly for 5 years, then every 5 years
					Sediment Sampling	Annually for first 3 years	At closure, then as needed based on fish elements
Getmuna Creek (NF)	GM2	61.89871	-158.39138	Getmuna Reference Site, potential effects from Donlin-Jungjuk Road, MS-10 Material Source	Fish Presence/Abundance Estimate	Annually	Every 5 years
					Aquatic Invertebrates	Annually for at least one year	NA
					Periphyton (community and standing crop estimates)	Annually for at least one year	NA
					Surface Water Monitoring/Long List	Quarterly during years of aquatic invertebrate and periphyton sampling	NA
Getmuna Creek (SF)	GM4	61.89695	-158.38565	Getmuna Reference Site, potential effects from Donlin-Jungjuk Road, MS-10 Material Source	Fish Presence/Abundance Estimate	Annually	Every 5 years
					Aquatic Invertebrates	Annually for at least one year	NA
					Periphyton (community and standing crop estimates)	Annually for at least one year	NA
					Surface Water Monitoring/Long List	Quarterly during years of aquatic invertebrate and periphyton sampling	NA

Table 2-3 Donlin Gold Detailed Monitoring Plan by Site (continued)

Location	Site	Latitude[1]	Longitude	Target	Monitoring	Frequency	
						Construction/Operation	Closure
Getmuna Creek (NF)	GM2-1	61.88514	-158.42350	Getmuna Reference	Fish Presence/Abundance Estimate	Annually	Every 5 years until bridge is removed
Getmuna Creek (SF)	GM4-1	61.87244	-158.42619	Getmuna Reference	Fish Presence/Abundance Estimate	Annually	Every 5 years until bridge is removed
Crooked Creek	CR0.3	61.87118	-158.12645	Potential effects of mine	Fish Presence/Abundance Estimate	Annually	Annually for 5 years, then every 5 years
					Aquatic Invertebrates	Annually	Annually for 5 years, then every 5 years
					Periphyton (community and standing crop estimates)	Annually	Annually for 5 years, then every 5 years
					Fish Whole Body Element Concentrations (juvenile coho salmon or Dolly Varden)	Annually	Annually for 5 years, then every 5 years
					Surface Water Monitoring/Long List	Quarterly	Quarterly for 5 years, then every 5 years
					Sediment Sampling	Annually for first 3 years	At closure, then as needed based on fish elements
Jungjuk Creek	JJ1	61.79950	-158.24500	Jungjuk Reference/Road Monitoring Site	Fish Presence/Abundance Estimate	Annually	Every 5 years until the bridge is removed
					Aquatic Invertebrates	Annually for at least one year	NA
					Periphyton (community and standing crop estimates)	Annually for at least one year	NA
					Surface Water Monitoring/Long List	Quarterly during years of aquatic invertebrate and periphyton sampling	NA

Notes:
1 - Exact locations of sampling sites and reaches will be determined in the field.
2 - NA = Not Applicable

Most sites would be sampled annually as described in Table 2-3; however, some components of sampling at some sites would occur only long enough to establish baseline conditions. The thirteen sites will be sampled as follows:

- Eleven (11) sites would include annual sampling for fish CPUE, aquatic invertebrates, and periphyton, and quarterly sampling for surface water quality as is required under the APDES permit.
- Four (4) of the sites would add sediment element sampling and fish sample collection for fish whole body element concentrations.
- Two (2) sites, located upstream of the Donlin-Jungjuk Road stream crossings in Getmuna Creek, would include sampling only for continued fish presence.

Two components of the sampling program not previously discussed are: the collection of quarterly surface water quality samples from each site with aquatic invertebrate and periphyton sampling; and, baseline sediment element sampling at sites with fish whole body element burden sampling. Surface water quality will be sampled in conjunction with aquatic invertebrate and periphyton sampling as it often correlates well with periphyton production. However, surface water quality can correlate poorly with fish element concentrations. Therefore, sediment sampling will be performed in conjunction with or immediately after fish element sample collections at sites for the first several years of monitoring. This will identify the baseline and evaluate whether sediment element concentrations can be correlated to fish body element burdens. Sediment element sampling will then be conducted as needed based on the results of fish element analyses.

Donlin Creek (DCBO) and Upper Crooked Creek (CCBW) have been selected as reference sites representing varying fish-bearing habitats within the Project area and would be sampled annually to aid in future data interpretation. Fish and aquatic invertebrates would be sampled at both sites, but fish element sampling would occur only at the Donlin Creek site. Getmuna Creek, although out of the influence of all proposed mining, is crossed by the Donlin-Jungjuk Road at both the North Fork and South Fork of Getmuna Creek. A material source, MS-10 is also proposed to be developed between the North and South forks of Getmuna Creek and once reclaimed, would flow into the South Fork of Getmuna Creek. Therefore, GM2, GM3, and GM4 will function as effects monitoring sites for those activities and GM3 will serve as a sediment and fish element reference site. Sites GM4-1 and GM2-1 will provide fish distribution and relative abundance data upstream of each crossing of the North and South forks of Getmuna Creek and will serve as reference sites to identify any natural changes occurring to the habitat and fish populations. CCBC and CR0.3 are both downstream of mining activity and facilities and will be used to monitor for effects from mining operations.

During closure and post-closure, biomonitoring would be conducted using the same methods. Monitoring at the CV1 site in Crevice Creek will begin after closure when discharges from the TSF area are initiated in this drainage; three years of updated baseline monitoring would be performed before the discharge begins. At all sites, the sampling frequency would be reduced from annually after the first 5 years post-closure to once every 5 years. Ultimately, as reclamation and closure goals are achieved, it is anticipated that sampling frequency would be proposed to be further reduced. Any proposed reductions would be consistent with Alaska Department of Environmental Conservation (ADEC) monitoring requirements mandated by the WMP.

2.3 Aerial Salmon Spawning Surveys

Aerial salmon surveys were conducted by helicopter within the Crooked Creek drainage from 2004 to 2014 (OtterTail 2014a). Target species included Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*Oncorhynchus keta*), and coho salmon (*Oncorhynchus kisutch*). Counts were timed to coincide with the end of the migration peak to count the maximum number of adult salmon in the system and to determine how far upstream into the drainages each species migrates. The peak migration dates for Crooked Creek were determined to be late July for Chinook and chum salmon, and mid- to late September for coho salmon. Redd counts were added to the survey in 2009. Redds were visually identified from the air by a fisheries biologist. A redd was counted if it had a defined pit and downstream tail spill. From 2009 to 2011, no attempt was made to associate salmon species with redds.

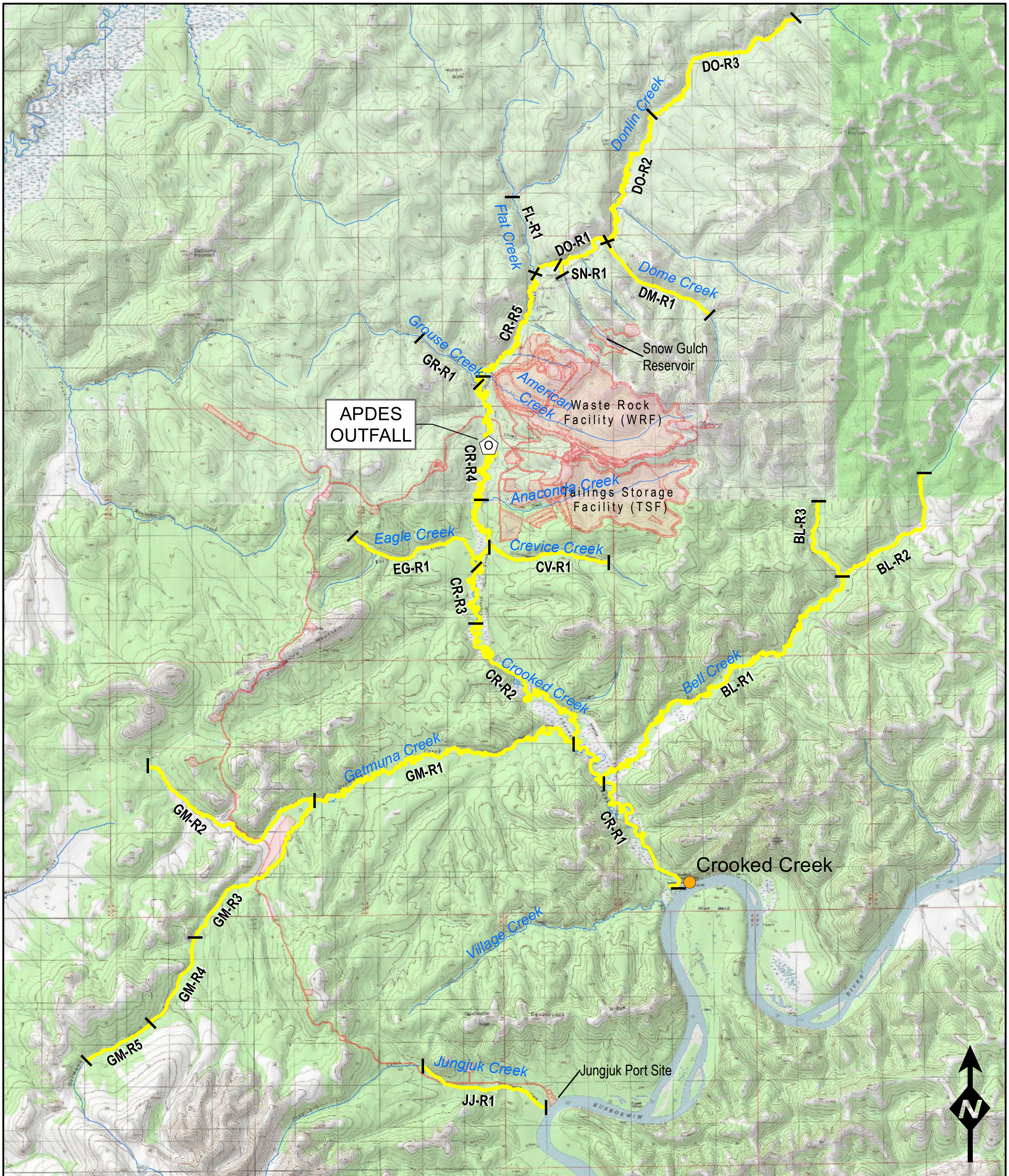
The aerial salmon count and redd surveys started at the mouth of Crooked Creek (confluence with the Kuskokwim River) and continued upstream to an unnamed but recognizable tributary located approximately 12.1 river miles (19.5 km) upstream of the confluence of Donlin Creek and Dome Creek. Three reaches were delineated within Donlin Creek (DO-R1, DO-R2, and DO-R3) and five reaches within Crooked Creek (CR-R1, CR-R2, CR-R3, CR-R4, and CR-R5).

The following tributaries were also aerially surveyed: Flat Creek (FL-R1), Dome Creek (DM-R1), Snow Gulch (SN-R1), American Creek (AM-R1), Grouse Creek (GR-R1), Anaconda Creek (AN-R1), Crevice Creek (CV-R1), Eagle Creek (EG-R1), five reaches in Getmuna Creek (GM-R1, GM-R2, GM-R3, GM-R4, and GM-R5), and three reaches in Bell Creek (BL-R1, BL-R2, and BL-R3). In addition, one reach in Jungjuk Creek (JJ-R1) was surveyed.

For the purpose of long-term aquatic biomonitoring, all previous protocols for aerial surveys of salmon migration and redds will continue. Up to two observers will be present during the surveys. Annual surveys will be conducted during construction, operations, and through the first 5 years post-closure in the reaches shown in Figure 2-2 and listed in Table 2-4. Annual survey frequency will then be reduced to every 5 years. Aerial surveys at AM-R1 and AN-R1 will not be conducted as those streams will generally be removed by the construction of the Project. Timing of the surveys will remain the same to maintain a long-term data set that has minimal variation in methods. Global Positioning System (GPS) data will continue to be obtained for redds – both from the air and, when possible, from the ground.

Table 2-4 Aerial Salmon Spawning Survey Frequency by Reach

Stream	Reach	Survey Reach End-Points		Target	Survey Frequency	
		Latitude	Longitude		Construction/Operation	Closure
Donlin Creek	DO-R1	62.087879	-158.166685	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	DO-R2	62.131380	-158.131770	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	DO-R3	62.162945	-158.029950	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Dome Creek	DM-R1	62.068616	-158.113832	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Snow Gulch	SN-R1	62.051429	-158.157587	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Flat Creek	FL-R1	62.103159	-158.235034	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Crooked Creek	CR-R1	61.902270	-158.176173	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	CR-R2	61.958731	-158.265537	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	CR-R3	61.999110	-158.262680	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	CR-R4	62.043531	-158.256020	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	CR-R5	62.076790	-158.220740	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Grouse Creek	GR-R1	62.04975	-158.285639	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Crevice Creek	CV-R1	61.981586	-158.148565	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Eagle Creek	EG-R1	61.988972	-158.354417	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Getmuna Creek	GM-R1	61.898097	-158.383824	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	GM-R2	61.910630	-158.503307	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	GM-R3	61.866602	-158.448412	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	GM-R4	61.820653	-158.507024	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	GM-R5	61.843233	-158.418049	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Bell Creek	BL-R1	61.972745	-157.999267	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	BL-R2	62.007668	-157.938375	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
	BL-R3	61.998731	-158.016078	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years
Jungjuk Creek	JJ-R1	61.807679	-158.308985	Salmon Distribution and Redd Counts	Twice Annually, Late July and Mid to Late September	Twice Annually for 5 years, then Twice Every 5 years



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AERIAL SURVEYS

DONLIN GOLD PROJECT

SCALE: 0 1 2 4 mi; 0 1.5 3 6 km

FIGURE: 2-2

ORNRC: DGP0003.mxd, 05/08/2019, R07

2.4 Crooked Creek Physical Stream Monitoring

In addition to monitoring the biological health of the Crooked Creek drainage, the ARMP includes monitoring activities focused on the physical and hydrologic conditions of the system. Changes to flows in the Crooked Creek watershed were a major concern raised during the EIS scoping and permit review processes. Such changes in the surface and subsurface flow regimes were analyzed in the EIS and it was determined the changes to flow will not result in significant impacts to aquatic habitat[2]. To describe actual changes and allow Donlin Gold and the agencies to compare predicted versus actual flow patterns, and to help identify the causes of any identified flow reductions, several parameters will be measured, tracked and used to update and recalibrate both the project water balance model as well as the surface water and groundwater models. These modeling tools have been used in the EIS review and permitting processes and will continue to be used during construction, operations, closure, and post-closure. If it is determined that the observed and/or predicted future reductions in flow are greater than the current estimates, and these reductions could have significant impacts on Crooked Creek aquatic habitat, then adaptive management practices may be employed to identify mitigation options available to help reduce the adverse effects.

2.4.1 Stream and Surface Flow Monitoring

In addition to discrete stream flow measurements collected at biomonitoring sites during fish and aquatic sampling, several continuous stream flow gages, including existing and new gages, would be maintained in Crooked Creek to monitor potential effects to Crooked Creek baseflow (Figure 2-3). Gages to be installed/maintained are:

- CCBW (Crooked Creek just below the confluence of Donlin Creek and Flat Creek): This location represents relatively undisturbed conditions in Crooked Creek above proposed mining; located outside of the predicted drawdown at the end of mining. While operation of the Snow Gulch Fresh Water Dam (FWD) may have some impact on Donlin Creek flows, such impacts are expected to be very minor (BGC Engineering Inc. [BGC] 2016).

- CCAA (Crooked Creek above American Creek): The second proposed location for a gage is immediately upstream of the American Creek confluence with Crooked Creek. This gage is intended to monitor stream flow changes due to pit dewatering activities. The open pit will eventually become large enough to include portions of the Lewis Gulch and Queen Gulch drainages. Both gulches are minor tributaries to Crooked Creek located between CCBW and CCAA.

- CCBO (Crooked Creek Below Omega Creek): This gaging station is part of the original monitoring network with open water season (generally June through September) stream

[2] See Donlin Gold Project Final EIS, April 2018, Chapters 3.5 and 3.13

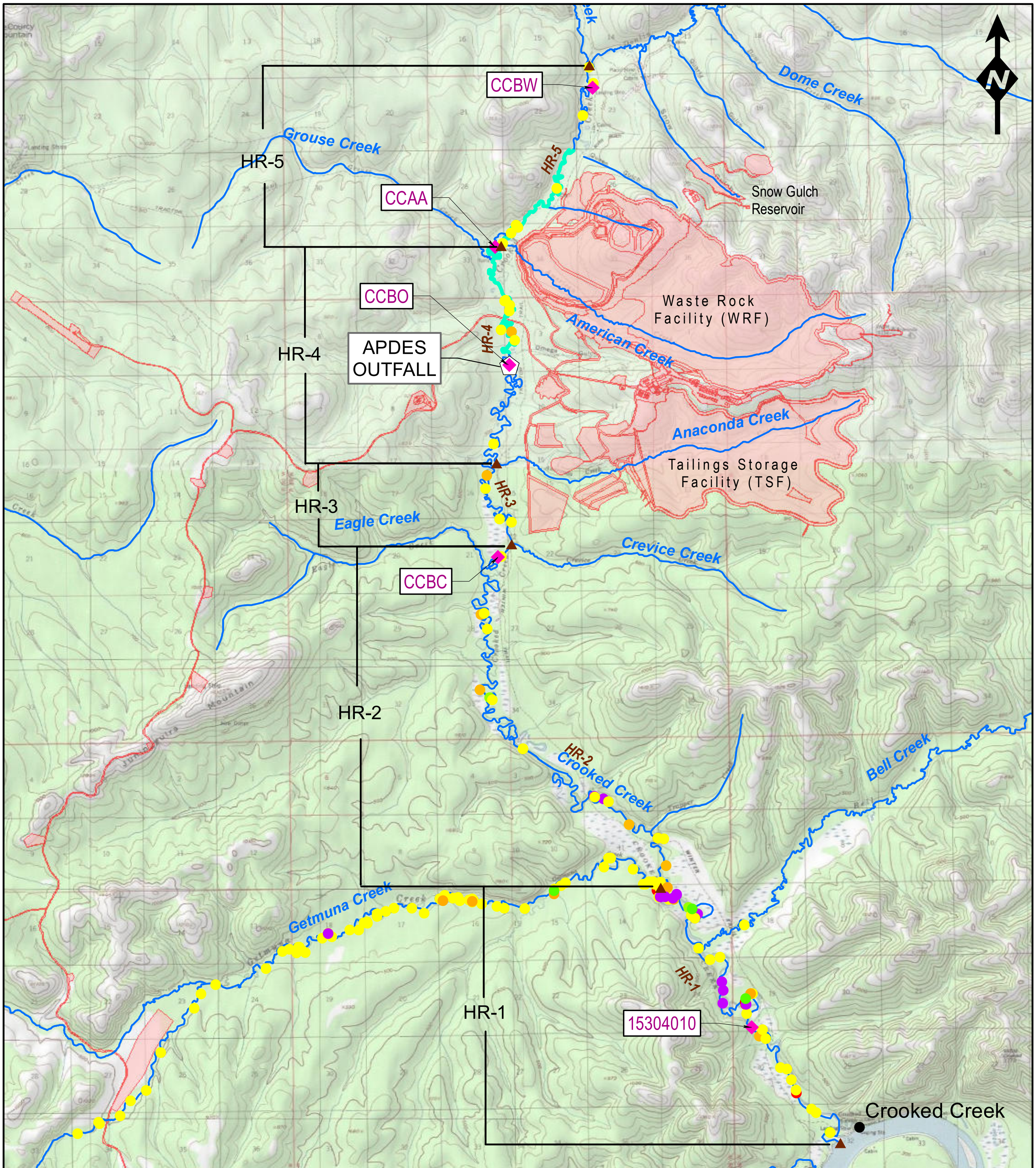
flow data available for the period 2005-2011 (BGC 2012). This gage will monitor impacts to Crooked Creek flows due to Project activities in the tributaries above and including American Creek, as well as pit dewatering.

- CCBC (Crooked Creek below Crevice Creek): The gage at CCBC will be installed downstream from all Project mine site operations and will monitor impacts to Crooked Creek flows due to those activities, including pit dewatering.

- 15304010 (the U.S. Geological Survey [USGS] operates this gaging station near the mouth of Crooked Creek where it discharges into the Kuskokwim River): Donlin Gold is currently funding the maintenance and operation of this station. Donlin Gold will continue to fund operation of this station during all Project phases. This station provides year-round stream flow data and began operation in July 2007.

The stations will be installed at relatively straight sections of the channel with stable bed and banks and easy access. At each station, a pressure transducer will be housed within protective polyvinyl chloride (PVC) piping and installed within a narrow trench excavated perpendicular to the channel and below the water table (Figure 2-4). The pressure transducer will be connected to a data recorder to record stage height. The stage height will be post-processed into a flow value using calibrated flow equations specific to that station. A staff gage attached to a steel angle iron will be installed in proximity to the trench in the main channel to manually record stage heights whenever the data are downloaded. Manual stream flow measurements will be taken six to eight times a year over a range of stream flow conditions to develop and fine tune the rating curve at each station.

For winter stream flow measurements, pressure transducers can have difficulty in providing an accurate flow depth as a thick layer, or multiple layers, of ice often forms in portions of Crooked Creek, both on the water surface and channel substrate (anchor ice). This can result in pockets of winter stream flow. The following method will be employed for helping determine the accuracy of pressure transducer stream flow measurements under ice. A series of holes will be augered into the ice across the width of the channel. Water depth and velocity will be measured in each hole where water is encountered to estimate stream flow discharge. Data collection will be per the methods presented in Nolan and Jacobson (2000). Experience has shown that the most desirable location for stream flow measurements under ice is just upstream from a riffle. The Crooked Creek gaging stations will therefore be preferentially located at these geomorphic locations. Tracer dilution techniques may also be used to estimate winter stream flow (Capesius et al., 2005) if needed. At a minimum, winter stream flows at the Crooked Creek gages will be field measured three times per winter (e.g., November, January, and March) during the initial winter seasons to calibrate the gage stations and determine the accuracy of the winter measurements being recorded. If it is found the gage station readings are reliable under winter flow conditions, the frequency of manually monitoring flow may be reduced.



Habitat Reach (HR) Boundaries
APDES Outfall
Flow Gaging Station
Freeze-down Study Reach
Streams
Proposed Facilities

Redds by Count

- 0 - 5
- 6 - 10
- 11 - 15
- 16 - 30
- 31 - 60

Seward Meridian, UTM Zone 4 NAD83

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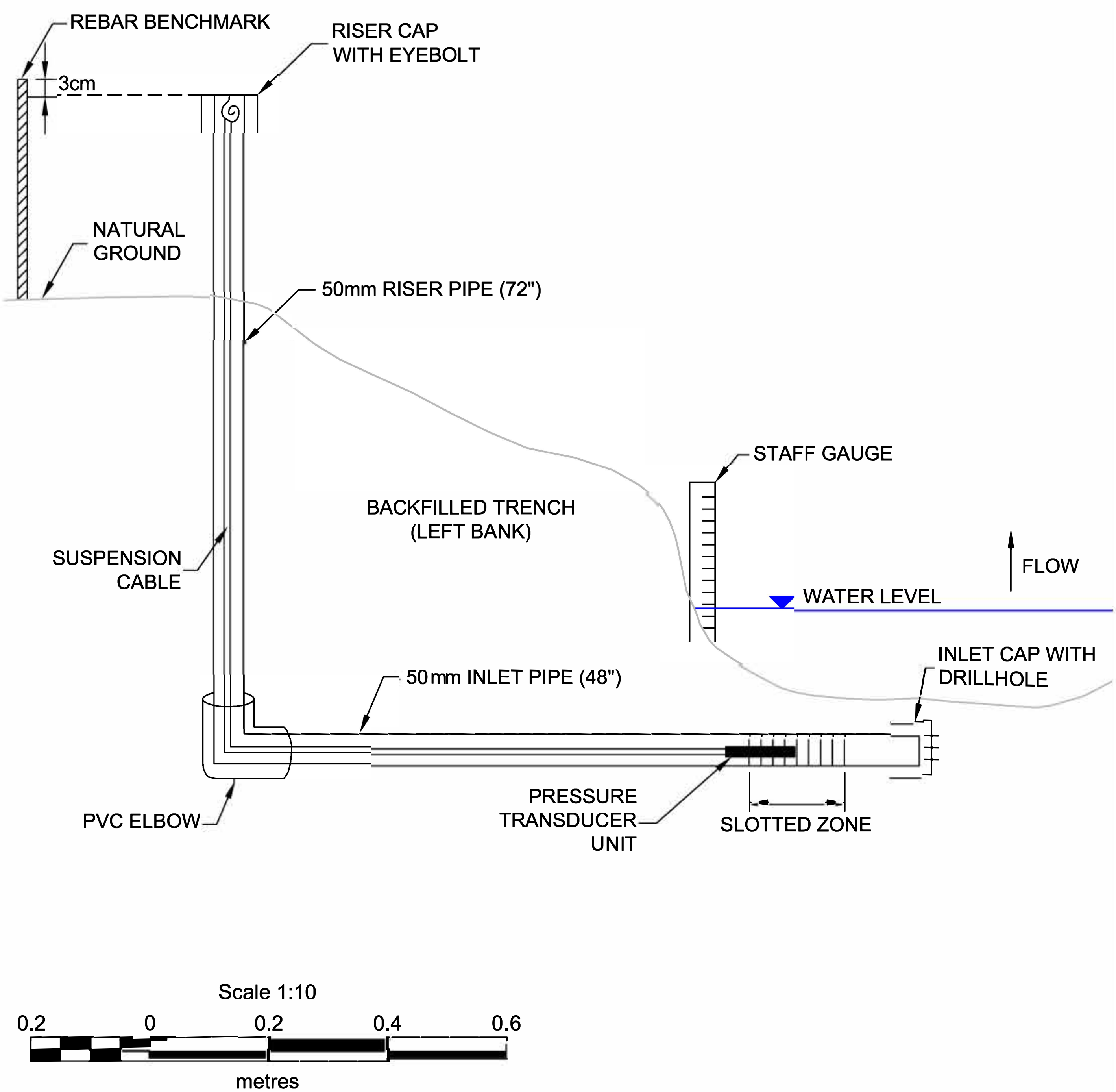
Stream Flow and Substrate Freeze-Down Monitoring Locations

DONLIN GOLD PROJECT

SCALE: 0 0.5 1 2 mi; 0 1 2 4 km

FIGURE: **2-3**

ORNRC: DGP0001.mxd, 09/04/2019, R11



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DRAWN:	LS	APPROVED:	-

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

PROJECT:
DONLIN CREEK GOLD PROJECT

TITLE:
TYPICAL GAGING STATION SCHEMATIC
HYDROMETRIC STATION SCHEMATIC FOR CREVICE CREEK

CLIENT:
DONLIN GOLD LLC

PROJECT No.:	FIG No.:	REV.:
0011-096	3-1 ARMP Figure 2-4	A

DWG TO BE READ WITH BGC MEMO TITLED "CREVICE CREEK HYDROMETRIC STATION INSTALLATION" DATED OCT 2009

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In addition to stream flow monitoring, pumping data (volumes and flow rates) will be recorded at the following stations:

- Snow Gulch Freshwater Reservoir: This reservoir is part of the fresh water supply proposed for processing operations and may be needed in periods of extended low precipitation. The reservoir FWD is designed with a spillway. Once the reservoir is full, all water will flow through the reservoir and into Lower Snow Gulch. This water will be part of the flows reported by the CCBW gage station. In addition to the pumping data, staff gages will be used to report the estimated volume of water stored in the Snow Gulch reservoir. Pumping rates, volumes and any changes in annual storage volume will be documented in the annual reports (Section 3.2).

- TSF Seepage Recovery System (SRS): The volume of water recovered by the SRS system under the TSF in Anaconda Creek and pumped back to the TSF pond, to the process facilities as make-up water, or to the WTP for discharge to Crooked Creek represents a portion of the surface flow and baseflow that would normally report to the lower reaches of Anaconda Creek and into Crooked Creek. This volume will be recorded and included in the annual reports (Section 3.2).

- WTP discharge: APDES Permit AK0055867 requires continuous monitoring and reporting of the volume of water treated and discharged into Crooked Creek. The permit allows for up to 4,500 gallons per minute (gpm). The source of this water is a combination of American Creek baseflow, groundwater from the pit dewatering system, and surface run-off collected from disturbed areas within the pit area, WRF, TSF and process facility footprint.

2.4.2 Shallow Groundwater Monitoring and Hydrogeologic Properties Characterization from Pre-construction through Operations

Donlin Gold developed a detailed groundwater model (BGC 2014) to predict the pumping requirements to reduce hydrologic pressure on the open pit and to evaluate the effects of that depressurization on local and regional groundwater elevations during and after Project operations. The groundwater model also was used in conjunction with a surface water flow model to evaluate potential effects of groundwater drawdown on Crooked Creek flows (BGC 2016). The groundwater system adjacent to and beneath the Crooked Creek streambed can affect overall stream flow and influences gaining and losing reaches as well as more local upwelling and downwelling within the hyporheic zone. Calibration of the groundwater model indicates that model results depend most significantly on the groundwater levels and hydraulic conductivity within three main zones: (1) the deep aquifer hosted in the underlying bedrock which contains the ore body and from which depressurization activities will be conducted ahead of pit excavation; (2) the upper weathered bedrock (up to 100 feet thick) which may also be targeted for depressurization near the pit; and (3) the alluvium and colluvium, typically located in the valley floor, in the adjoining tributaries as they enter into Crooked Creek, and some terrace deposits on the valley sidewalls. The following describes the monitoring of each of these component areas.

- *Deep Aquifer* – Pit dewatering wells will be installed into the bedrock to initiate depressurization and dewatering activities ahead of mining. Wells in the general pit area together with geotechnical instrumentation installed as part of pit slope monitoring activities will be monitored to measure the drawdown effect as dewatering efforts begin. This information will be used to further calibrate the groundwater model thereby improving the model's accuracy. Final locations and installation details of the deep aquifer monitoring well network will be provided to the agencies as they are installed and become available.

- *Weathered Bedrock* – Three wells (existing and/or new) located between Crooked Creek and the open pit will be monitored in the weathered bedrock layer to track changes in groundwater levels as pit dewatering efforts are initiated and advanced. This information will provide additional data for calibration of the predictive groundwater flow model. Final locations and well details will be provided to the agencies prior to installation and monitoring.

- *Alluvium and Colluvium* – A series of shallow (<40 feet) piezometers will be installed or reactivated from past testing in the floodplain alluvium and colluvium to measure and track changes in groundwater levels in the alluvial deposits adjacent to Crooked Creek. These levels will be key indicators for potential changes to the surface water/groundwater interactions for the main stem of Crooked Creek. As with the other data, this information will be used to calibrate the groundwater model. The wells will cover a nominal four mile stretch of the Crooked Creek floodplain located between Queen Gulch to the north and Omega Creek to the south. This monitoring may be adjusted based on the results of the annual reporting and plan assessment.

Instrumentation used to measure groundwater levels will include monitoring wells (existing and/or new) equipped with submersible pressure transducers and data loggers (e.g., Solinst Leveloggers, Divers, or similar) or grouted-in vibrating wire piezometers (existing and/or new) equipped with data loggers. Groundwater level measurements will be recorded, at a minimum, daily on the data loggers to provide an ongoing continuous record of measurements in these zones. Data will be downloaded at least quarterly and quarterly summaries will be included in the annual reports (Section 3.2).

The objective of the flow and water level monitoring network is to quantify potential Project-related changes in stream flow under both summer and winter flow conditions. The data will be used to further calibrate the surface and groundwater models and update the Project water balance model. However, the uncertainty in stream flow measurements will need to be considered in evaluating the monitoring results from this network. In a USGS study, Sauer and Meyer (1992) noted that standard errors for individual discharge measurements under open water conditions can range from about 2% under ideal conditions to about 20% when conditions are poor, with most measurements having standard errors ranging from about 3% to 6%.

2.4.3 Winter Habitat Freeze-down Monitoring

During a pilot winter survey, 12 sampling sites were selected to assess substrate freezing and water flow patterns in the five Crooked Creek habitat reaches shown in Figure 2-3 (OtterTail 2012). The study was designed to investigate the feasibility of using glass vial tubes (GVTs) installed within the bed of Crooked Creek along with temperature loggers to investigate the extent of intergravel freeze-down and relationships with winter flows, thalweg depth, and temperature, as well as to determine the viability of spawning sites within Crooked Creek. Two to three sampling sites were established for each of the identified habitat reaches. GVTs and temperature loggers were placed in a transect across the stream at each site within habitat reaches HR-5, HR-4, HR-3, and H-2. The study concluded that use of GVTs could be used to monitor gravel freeze depths in the creek.

Under the ARMP, Donlin Gold will continue to evaluate these and other techniques to measure winter freeze-down. As shown in Figure 2-3, the key focus for the proposed freeze-down studies is in the area of highest drawdown adjacent to and below the pit area in Crooked Creek, between Queen Gulch (upstream) and Omega Creek (downstream). The initial questions to be answered relate to what habitat functions does the stretch of Crooked Creek currently provide during the winter months. Specifically:

- Is there winter fish passage, or does it ice up down to the substrate?
- Can eggs in redds survive in this stretch of stream or do the gravels in the stream bed freeze?

Freeze-down testing will be conducted for a minimum of 2 winters prior to the initiation of pit dewatering activities. The results of this work, as well as the flow monitoring described in Section 2.4.1, will be used to determine the need for any further baseline freeze-down testing and/or if added monitoring/studies will be needed during operations to measure potential changes in habitat functions.

2.5 Physical Habitat Monitoring

Under the CMP, aquatic physical habitat will be restored in sections of Snow, Queen and Ruby gulches and Quartz Creek. To measure the success of this work, the CMP requires documentation that the work is completed as proposed and monitoring to show it is performing as predicted. The details of this monitoring are included in Appendix A of this ARMP.

In addition, an initial measurement of the physical habitat of the streams that support aquatic resources throughout the watershed will be conducted. In 2009, detailed habitat mapping was conducted in Crooked Creek from its origin at the Donlin Creek confluence with Flat Creek to the mouth at the Kuskokwim River (OtterTail 2009). Habitat mapping included channel and flow mapping to identify and quantify riffle, pool, and run habitats. Within each reach, specific habitat types were identified, and additional habitat metrics were measured at seven random locations within each habitat type. Substrate type, embeddedness, habitat features, depth, and water velocity were measured at each site and recorded. This data was used to generate maps of specific habitat mapping units (HMUs).

The transects mapped were extended to outside the bankfull width to aid in assessment of off-channel and backwater habitat connectivity. Similar measurements collected at main channel transects were made in off-channel/backwater habitats exhibiting evidence of connectivity at bankfull or lower flows. In addition to typical transect data collected at main channel locations, detailed survey measurements of connection points to the main channel were collected to assist with predictions of connectivity at various flows. The approach allowed for Rosgen channel classifications and HMU quantification along the entire reach of Crooked Creek and an assessment of available habitats during baseflow conditions as well as predictions of habitat availability at varying predicted higher and lower flows.

A detailed habitat survey was also conducted in Crooked Creek near the mouth of Anaconda Creek, because this reach is predicted to have the highest potential for flow alteration later in the Project life, approximately at year 20. The survey consisted of 13 major transects and 11 minor transects along 1,574 feet of Crooked Creek. Data collection and mapping included channel sinuosity, reach gradient, bankfull widths at each major transect, detailed pool information, residual pool depths, percent fines, substrate data, and estimation of large woody debris.

For purposes of the ARMP, implementation of watershed-level habitat mapping will consist of a stream channel bathymetric survey using emerging LiDAR technology to document conditions prior to initiation of pit dewatering and other Project activities. The survey reach would begin in Donlin Creek upstream of Dome Creek and continue downstream to the mouth of Crooked Creek. Getmuna Creek would also be surveyed to a point upstream of the MS-10 material source and road crossing in each fork of Getmuna Creek. The survey would map the bathymetry of main channels and would extend landward to cover the floodplain of each main channel. The survey is intended to provide sufficient data to be able to track changes in gross habitat types within the floodplain including, sinuosity, depth profile, and estimates of available riffle, pool and run features as well as an assessment of backwater habitat connectivity and availability.

After the initial LiDAR survey, additional surveys would be conducted on an as needed basis using an adaptive management approach. The results of annual biomonitoring would specifically be used to determine when and if additional LiDAR surveys are needed. Should declines in fish stream productivity and fish populations occur that cannot be explained through changes in water quality or physical blockages (e.g., such as those associated with beaver dams), additional LiDAR surveys could be performed to help determine if physical habitat changes are occurring at the individual stream and watershed levels. Comparison of habitat metrics determined by the follow-up LiDAR surveys with the data from the baseline LiDAR survey will provide information about physical habitat changes that could be affecting lower trophic level productivity and fish numbers.

3.0 ANALYSIS AND REPORTING

The ARMP will be implemented during pre-construction, construction, operations, closure, and post-closure of the Project. The ARMP will be updated as the monitoring procedures are further defined and then, as needed, based on regulatory changes, periodic reviews, program modifications, and monitoring results (Section 4.1).

3.1 Data Trend Analysis

3.1.1 Fish Presence and Abundance

Data collection and analysis of trends in fish populations/CPUE at each sampling site, including restoration habitat areas, will be used to evaluate drainage-wide fish distributions and overall aquatic habitat health. Comparing trends in fish numbers against aquatic macro-invertebrate and periphyton data will help identify if any potential changes are occurring and facilitate investigation of potential causes for the observed data trends. All data will be analyzed to determine what, if any, management actions need to be taken.

Analysis of the fish species monitoring data will include presence/absence of fish during sampling of a monitoring site, and changes in fish numbers and composition of the fish population (e.g., the absence/presence of a species or multiple species, shifts in the size composition of one or more species, etc.) at a site. Watershed-wide comparisons of fish sampling results from reference and potentially affected sites will be conducted to help differentiate between natural variations and potential Project impacts.

3.1.2 Aquatic Habitat

Changes in invertebrate and periphyton community composition and density can be early signs of potential impacts to fish habitat and populations. Similar to the discussion above for fish (Section 3.1.1), major changes in both invertebrate communities and periphyton standing crops that occur over the course of a single season could indicate changes to habitat health. If no obvious cause is identified, then trend analyses would be relied upon to assess whether communities are returning to baseline conditions or to within the variability observed in reference sites. If long-term trends suggest negative changes in productivity outside the ranges at reference sites, then additional analysis will be conducted to identify potential causes for the changes. Water quality data (including data gathered for APDES permit and WMP compliance) may also assist in identifying potential causes of changes in productivity of these lower trophic level communities. The data analysis will support any management actions, if needed.

3.1.3 Stream Flow Changes

The stream gage station data will be plotted against historic and predicted stream flow for each of the stations annually to determine how closely the actual flows are following the baseline conditions and modelled predictions. The modelled predictions of stream flow changes (BGC

2016) will be recalibrated and regenerated after the initial 5 years of data gathering of stream flow and groundwater level data. This process will be repeated in 5-year cycles unless the data indicates a different time interval is warranted.

3.2 Agency Reporting

An annual comprehensive monitoring report will be prepared that includes the aquatic resource, hydrologic, and water quality monitoring conducted under the ARMP. It will be consistent with the specific annual reporting requirements from the WMP and APDES permit. The report will be submitted to the ADF&G annually by March 1 of the following year.

4.0 PLAN ASSESSMENT AND ADAPTIVE MANAGEMENT

The aquatic biomonitoring results will be used to consult with appropriate agencies and for planning future monitoring and/or Project actions.

4.1 Annual Plan Assessment

Every year of aquatic monitoring will include a post field-season assessment of the program. All sites and components of the Plan would be evaluated to determine whether changes to the Plan are warranted for the following year. Changes could include any of the following:

- Addition or elimination of sites.
- Modification of site locations.
- Modification of sampling protocols (i.e., more or less intensive sampling).

Modifications would be based on analytical results but could also be based on observations of natural or Project-related changes in the area with potential to affect aquatic systems. Indications of effects to aquatic resources within the Project area could also lead to intensified sampling and/or increased sample locations. All proposed modifications would be addressed in the Plan assessment and would occur in direct coordination with and with approval by the ADF&G.

4.2 Adaptive Management

Donlin Gold's proposed aquatic monitoring program will use an adaptive management process to meet the ARMP's objectives. Under the ARMP, adaptive management is a four-step iterative process that analyzes monitoring data to modify planned actions in response to observed changes from baseline conditions. The steps are summarized below.

1. <u>Aquatic Biomonitoring</u> – Monitor aquatic resources prior to Project development to establish baseline conditions. Continue to monitor aquatic resources during construction, operations, closure, and post-closure to evaluate whether Project activities have caused changes in the aquatic ecosystem relative to the baseline conditions. Aquatic monitoring includes measures of fish use, aquatic invertebrate and periphyton productivity and community structure, water flow, and habitat availability. Section 2.0 describes planned monitoring activities.

2. <u>Analysis and Reporting</u> – Monitoring results will be analyzed for changes in the aquatic ecosystem to assess whether they are being affected by Project activities. As appropriate, the results will be also be used to assess whether mitigation measures are successful. These analytical results will be documented in the annual reports. Section 3.0 describes the proposed analysis and reporting program.

3. Planning – The site aquatic biomonitoring analyses will be used to modify or plan future monitoring or Project actions.

4. Action – Based on the results of steps 1 to 3, appropriate modifications of Project activities, mitigation measures, and/or monitoring will be implemented, as necessary. Changes may be implemented prior to Project development to offset predicted future impacts or in response to measured impacts. Once the impacts or predicted changes are quantified and the causes are fully understood, a design can be generated to address minimizing or mitigating the effect.

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APPENDIX A

Upper Crooked Creek Permittee Responsible Mitigation (PRM) Monitoring

UPPER CROOKED CREEK PERMITTEE RESPONSIBLE MITIGATION - MONITORING PLAN

Last Modified - November 2019

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1.0 INTRODUCTION

Aquatic resource monitoring is required under the U.S. Army Corps of Engineers (USACE) permit for the Donlin Gold Project (Project) for the compensatory mitigation areas of Upper Crooked Creek. This compensatory mitigation monitoring is described separately since it is directly related to measuring the performance of the proposed mitigation and the plans will not be finalized until the final mitigation designs are approved by the USACE prior to the start of Project construction. When this occurs, the approved Permittee Responsible Mitigation Monitoring Plan (PRM-MP) will be incorporated into the Aquatic Resources Monitoring Plan (ARMP) (Donlin Gold 2019). In addition to being separately reported to USACE, the results of the mitigation monitoring will be incorporated into the ARMP annual monitoring reports provided to the Alaska Department of Fish & Game (ADF&G).

1.1 Background

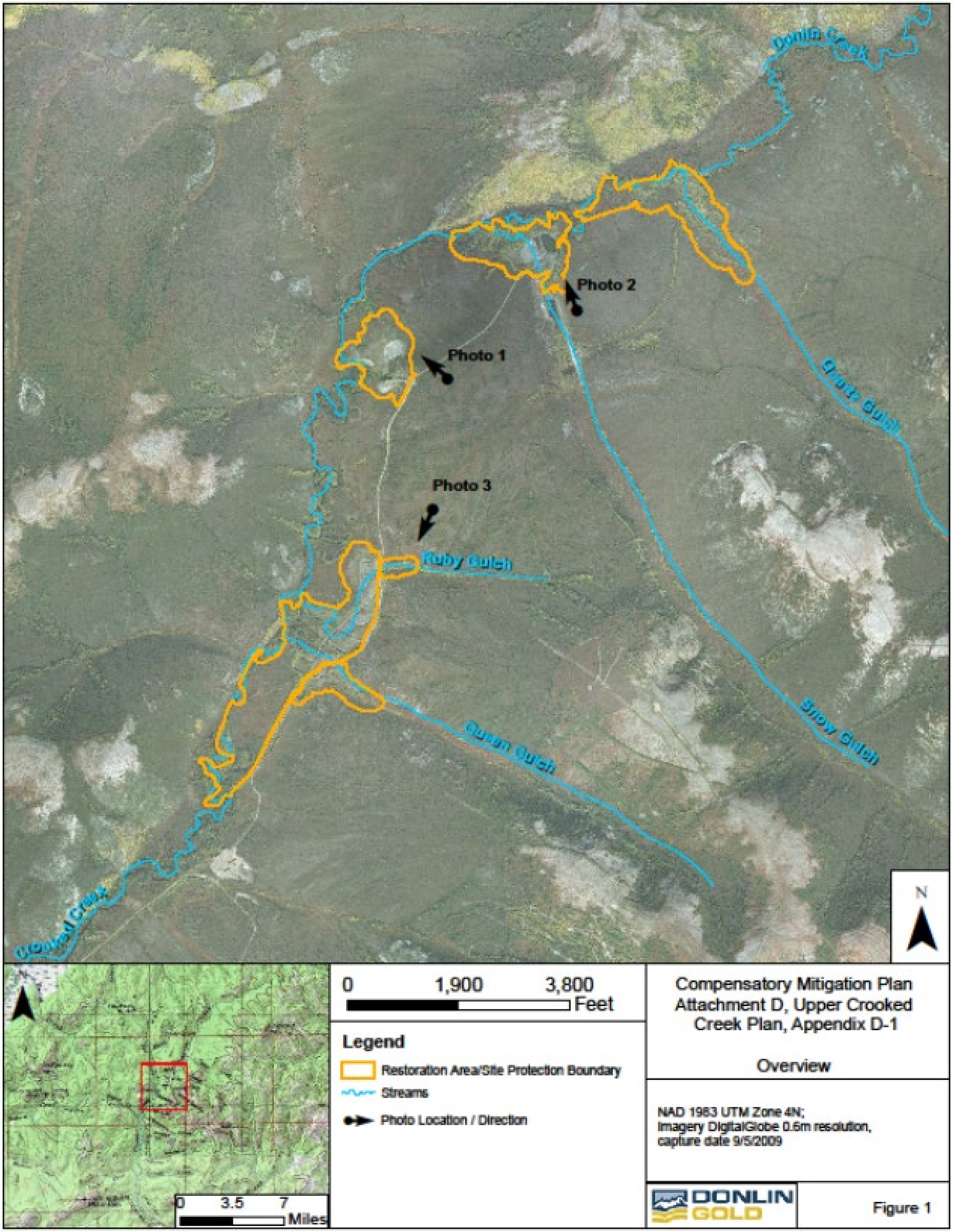
Historic placer mining impacts in the Upper Crooked Creek watershed, specifically Quartz and Snow, Ruby, and Queen gulches, have rerouted streams from their historical channels into linear excavated ditches with no floodplains. Ponds, ditches, excavations, overburden fill, and side castings have all contributed to the impacts in these drainages, which include disrupted/disconnected floodplains, lowered water tables, steep and unstable stream channels, poor water quality, steep eroding stream side slopes, loss of overlying soils, loss of vegetative cover, and narrowed hydraulic conveyances.

Based on Crooked Creek watershed fisheries habitat assessments and using the Function Based Framework for Stream Assessment and Restoration Projects (Harman et al. 2012), Donlin Gold selected the restoration of these heavily impacted drainages as part of the Compensatory Mitigation Plan (CMP) for the Project. Using a Functional Pyramid Approach (Harman et al. 2012) the Upper Crooked Creek PRM Plan (PRM Plan) (in: Donlin Gold 2018) defines how re-establishing the 15 functions critical to stream and riparian ecosystems will be achieved. The Functional Pyramid Approach builds on a hierarchy of processes starting with basic watershed hydrology, ascending through hydraulic processes dictated by channel, floodplain and stream sediment parameters which in turn drive geomorphic processes, sediment transport, large woody debris, and riparian vegetation to create bed form diversity and dynamic equilibrium. These building blocks are the focus of the restoration work and when accomplished correctly recreate the parameters for healthy physiochemical and biological habitats. Simply put, a correctly reconstructed stream with natural gradients, sinuosity, and properly sized and revegetated substrate, channel, and floodplains will reproduce healthy aquatic and fisheries habitats.

Four distinct restoration projects are described within the 221.5-acre PRM Plan boundary:

- Restoration of lower Quartz Gulch
- Restoration of lower Snow Gulch

Figure A-1 Upper Crooked Creek Mitigation Plan Area



- Restoration of the Wash Plant Area along Crooked Creek, between Snow and Ruby gulches
- Restoration of lower Ruby Gulch and Queen Gulch

Detailed figures for each drainage are provided in the PRM Plan (Donlin Gold 2018).

2.0 FINAL DESIGN, MONITORING, AND PERFORMANCE STANDARDS

This PRM-MP is intended to demonstrate to USACE that the completed mitigation projects meet specific performance standards. The final performance standards and monitoring requirements will only be established after the mitigation project designs are finalized. This is discussed further in the following sections.

2.1 Final Design

The PRM Plan includes initial designs for the restoration projects in each watershed. Establishing and implementing the final designs, which will provide the basis for the final mitigation project performance standards are expected to be a multi-step process, as follows:

Step 1. Donlin Gold will perform additional field work to assess and determine the final reference reach and design parameters. By using a reference reach, Donlin Gold will be able to compare it to other streams being sampled; “success” will ultimately be measured when the restored stream reaches fall within the natural variability of other sample sites in the monitoring program.

Step 2. At least 6 months prior to initiating Project construction, Donlin Gold will submit to USACE final restoration designs based on specific hydrologic, hydraulic, geomorphic, revegetation, and construction sequencing parameters.

Step 3. USACE will approve the final design, and the final performance standards, prior to the start of Project construction.

Step 4. Donlin Gold will construct the proposed mitigation as designed and provide as-built documentation to verify that the restorations meet the design specifications.

After completion of the constructed restoration and acceptance of the as-builts by USACE, the mitigation will enter a monitoring phase to demonstrate compliance with the performance standards.

2.2 Monitoring Program

Monitoring will be conducted to demonstrate that the mitigation is meeting its performance standards, provide a basis for USACE acceptance of the work, determine if adaptive management actions are necessary, and document the aquatic resource health of the area. Donlin Gold will monitor to measure progress against the performance standards for stream channels, wetlands, terrestrial vegetation, and fish use. Additionally, Donlin Gold will monitor stream flow. The types of monitoring to be performed are described below. A more detailed monitoring program with locations and protocols will be submitted to USACE for review and approval, along with the final designs and performance standards (see Step 2 above), at least 6 months prior to the start of the Project construction. When completed and approved, the detailed PRM-MP will be incorporated into the ARMP.

2.2.1 Stream Channel Monitoring

Monitoring of physical stream channel (hydraulic and geomorphic) parameters will be conducted annually for at least 5 years after construction or longer if performance standards are not met. Monitoring will take place during the same time period each year in early June, timed to coincide with post-spring breakup flows and before the mid-summer low water period. Obvious failures of the channel design or excessive erosion will be addressed with USACE (in coordination with ADF&G), and corrective actions will be developed by Donlin Gold and approved by USACE prior to initiation of in-stream work. If site conditions fail to meet performance standards during monitoring, the design and mitigation work plan will be reviewed and adjusted to implement solutions. After the fifth year, monitoring would only continue to be performed in those specific areas where the performance standards are not being met.

Biological monitoring of the stream channels and near pond outlets for macroinvertebrates and periphyton communities will also be conducted annually for at least five years after construction or longer if performance standards are not met. Monitoring will be conducted in mid- to late July to maintain consistency with baseline sampling and capture the period of peak abundance and species diversity.

Aquatic invertebrate sampling will be conducted using methods consistent with Section 2.1.2 and Appendix C (OtterTail 2014a) of the ARMP. Five replicate samples will be collected to reduce sampling variability within a single site and to increase statistical power. The analysis will include identifying taxa present; estimating aquatic invertebrate density and taxa richness; and calculating ratios of mayflies, stoneflies, and caddis flies versus all other aquatic invertebrate taxa. Multiple sampling sites will be established in the restored drainages and ponds (excluding the Wash Plant Area).

Lower trophic level sampling for periphyton standing crop would be conducted consistent with Section 2.1.3 and Appendix C of the ARMP and in concert with aquatic invertebrate sampling. Periphyton sampling sites will be established within newly created stream reaches, 10 rocks per site will be sampled. Samples will be processed to measure chlorophyll a, b, and c concentrations to produce an estimate of periphyton standing crop and basic community structure determination. Chlorophyll analysis will show overall productivity of the community as well as potential shifts in community structure over time by examining the relative ratios of chlorophyll a, b, and c.

Fish monitoring will be conducted annually for at least five years after construction or longer if performance standards are not met. Monitoring will occur in both pond and stream habitats within the mitigation areas (excluding the Wash Plant Area) beginning in the first open water season after construction. A combination of fyke nets in pond habitats and minnow traps in stream habitats will be employed to provide documentation of fish using the mitigation habitats. Sampling will be timed to document various important life history phases for fish anticipated to use the habitats. For example, some sampling will occur each spring to detect spawning grayling, and some sampling will occur each fall to document spawning coho salmon. Generally, most fish sampling efforts will be during mid-summer to identify peak uses by all species. Monitoring timing will be consistent from year to year for comparability of results.

2.2.2 Wetland Monitoring

Monitoring of wetland hydrology and wetland revegetation will be conducted annually for at least 5 years after construction. The wetland monitoring will occur during the same period each year before July 1. Monitoring timing may be adjusted for yearly variations in the onset of the growing season. One monitoring point will be sited for every 5 acres that are revegetated to adequately monitor trends in establishing plant communities. Point locations will be monumented with a GPS device as well as physically, using rebar stakes and flagging to facilitate revisit. At these locations, a pit will be dug (unless surface water is present) to observe hydrology, and the percent coverage of individual plant species (native and non-native), bare ground, and surface water will be recorded. Vegetation data will be compiled within a 10-square-meter (m^2) plot for shrub communities and a 1-m^2 plot for herbaceous communities. Wetland monitoring data will be compared to the performance standards to determine if additional management actions are necessary. Non-native plant recruitment data may specifically lead to active measures to remove non-native plants from restoration areas.

2.2.3 Terrestrial Habitat (Revegetation) Monitoring

Monitoring of terrestrial revegetation will be conducted on the same schedule as the monitoring of wetlands. The inspections will occur during the growing season. One monitoring point will be sited for every 5 acres that are revegetated to adequately monitor trends in establishing plant communities. Point locations will be monumented with a GPS device as well as physically, using rebar stakes and flagging to facilitate revisit. At these locations, the percent coverage of individual plant species (native and non-native) and bare ground will be recorded. Vegetation data will be compiled within a 10-m^2 plot for shrub communities and a 1-m^2 plot for herbaceous communities. Monitoring data will be compared to performance standards to determine if additional management actions are necessary. Non-native plant recruitment data may specially lead to active measures to remove non-native plants from restoration areas.

2.2.4 Additional Monitoring

In addition to the monitoring necessary to verify compliance with the performance standards, Donlin Gold will also monitor stream flows. A stream flow gage with a documented stage-flow relationship will be established on one or more of the streams as a surrogate for stream flows in all restored streams. These gages will be established upstream of the restoration work on the restored tributaries and will serve as a baseline for assessing the performance of the restoration channels across different flow regimes. The gages will be established within the stable cross-sections of natural channels. They will be monitored via recording water level sensors (i.e., pressure transducers) during the open water season beginning in the first season after construction and continuing for the duration of the stream channel monitoring program (at least five years).

2.2.5 Monitoring Reports

Mitigation-specific monitoring reports will be produced for each year of post-construction monitoring and submitted to USACE as well as ADF&G by the end of January of the following year. The results of all stream channel, wetland, terrestrial habitat, stream flow, and fish monitoring will be summarized. Each mitigation monitoring report will specifically include a description of each performance standard and identify if the standard has been achieved. If performance standards are not progressing as anticipated, adaptive management actions will be provided to USACE for approval as necessary.

At the end of all mitigation monitoring activities, a monitoring closeout report for the entire mitigation area will be completed for review and acceptance by USACE. The monitoring closeout report will briefly summarize the findings of the monitoring activities and describe how the mitigation has met the performance standards. In addition, the monitoring closeout report will formally request closure of the post-construction mitigation monitoring period.

2.3 Performance Standards

The following is a discussion of the performance standards that will be used to judge functional performance under the PRM Plan. These standards are separated into three categories targeting (i) restored stream channels, (ii) restored wetlands, and (iii) restored terrestrial habitats. By specifically using reference reaches, Donlin Gold will compare the mitigation areas to other streams. “Success” will be achieved when the new stream reaches fall within the targeted design parameters, considering the natural variability of other sample sites in the monitoring program.

2.3.1 Stream Channel Performance Standards

The primary basis of these performance standards is the U.S. Environmental Protection Agency (EPA) framework for stream function assessment (Harman et al. 2012, Appendix A-d Performance Standards Table). The referenced table lists specific performance standards that can be used to assess stream restoration projects. Each parameter is measured and assigned a score of Functioning, Functioning-At-Risk, or Not Functioning. Functioning-At-Risk can be further classified as degrading toward Not Functioning or improving toward Functioning. Not all parameters in Harman et al. 2012 are appropriate for all reconstruction projects, and a number are duplicative. Table A-1 (Upper Crooked Creek PRM Plan Stream Performance Standards) identifies the parameters and initial proposed performance standards for the Upper Crooked Creek mitigation. The final performance standard parameters and values will be approved by USACE along with the final restoration design prior

Table A-1 Upper Crooked Creek PRM Plan Stream Performance Standards[1]

Hydraulic

Parameter	Measurement Method	Performance Standard		
		Functioning	Functioning-At-Risk	Not Functioning
Floodplain Connectivity	Bank Height Ratio (BHR)	1.0 to 1.2	1.3 to 1.5	>1.5
	Entrenchment Ratio (ER)	>2.2	2.0 to 2.2	<2.0

Geomorphic

Parameter	Measurement Method	Performance Standard		
		Functioning	Functioning-At-Risk	Not Functioning
Large Woody Debris	Large Woody Debris Index (LWDI)	LWDI of project reach equals LWDI of reference reach	LWDI of project reach does not equal LWDI of reference reach, but is trending in that direction	LWDI of project reach does not equal LWDI of reference reach and is not trending in that direction
Channel Evolution	Simon Channel Evolution Model Stages	Sinuous, pre-modified, quasi-equilibrium	Aggrading	Degrading, channelization, widening
Lateral Stability	Meander Width Ratio	>3.5 based on reference reach survey	3.0 to 3.5 as long as sinuosity is >1.2	<3.0
Riparian Vegetation	Buffer Density (stems/acre) Buffer Age, Composition, Growth Canopy Density	Parameter is similar to reference reach condition, with no additional maintenance required	Parameter deviates from reference reach condition, but the potential exists for full functionality over time or with moderate additional maintenance	Significantly less functional than reference reach condition; little or no potential to improve without significant restoration effort

Table A-1 Upper Crooked Creek PRM Plan Stream Performance Standards[1] (continued)

Geomorphic (contd.)

Parameter	Measurement Method	Performance Standard		
		Functioning	Functioning-At-Risk	Not Functioning
	NRCS Rapid Visual Assessment Protocol	Natural vegetation extends at least one to two active channel widths on each side, or if less than one width, covers entire floodplain	Natural vegetation extends at least one-half to one-third active channel width on each side, or filtering function moderately compromised	Natural vegetation less than one-third active channel width on each side, or lack of revegetation, or filter function severely compromised
Bed Material Characterization	Bed Material Composition	Project reach is not statistically different than reference reach	Not applicable	Project Reach is statistically different (finer) than reference reach
Bed Form Diversity	Percent Riffle	60-70	70-80 40-60	>80 <40
	Pool-to-Pool Spacing Ratio (Slope between 3-5%)	2-4	4 to 6	>6
	Depth Variability (gravel bed streams)	>1.5	1.2 to 1.5	<1.2

Biologic[2]

Parameter	Measurement Method	Performance Standard		
		Functioning	Functioning-At-Risk	Not Functioning
Fisheries	As listed in the paragraph above	Fish presence		Fish not present
Macroinvertebrate and Periphyton Communities	As listed in the paragraph above	Exceptional to or similar to reference reach	Impaired showing improvement	Impaired no improvement

Notes:
1. Based on Harman et al. 2012 (unless otherwise noted)
2. Not based on Harman et al.

to construction. The EPA standards for stream function contain some parameters for riparian area revegetation that overlap with the wetland and terrestrial revegetation performance standards listed in other criteria.

For compliance, the performance standard scores for these parameters must show that the stream and floodplain values fall within the categories of Functioning or Functioning-At-Risk (improving) as specified by the EPA criteria. Scores within these categories must be attained for 3 consecutive years. Additionally, a Functioning score must be achieved in the final (third) year for compliance to be attained.

2.3.2 Wetland Performance Standards

All floodplain habitat areas addressed by the PRM Plan are expected to become wetlands and meet wetland vegetation and hydrology performance standards.

Wetland Vegetation Performance Standards: Vegetation performance standards have been developed to ensure that revegetated areas are on a trajectory to achieve stability and ecological functionality. Vegetation performance standards will be met at each restoration area. A restoration area will be considered to have achieved the vegetation performance standards when at least 85 percent of monitoring locations satisfy the standards.

The vegetation performance standards are outlined in Table A-2. These vegetation performance standards are based on the Draft Oregon Department of State Lands Routine Monitoring Guidance for Vegetation (ODSL 2009). It may be necessary to modify the performance standards for vegetation response to match similarities with reference vegetation communities near the Project. Any proposed modifications will be detailed in the annual mitigation monitoring report and submitted to USACE for approval.

Table A-2 Wetland Vegetation Performance Standards

Cover of native and/or revegetation hydrophytic* plant species is at least 60 percent.
Cover of invasive species is no more than 10 percent.
Cover of bare substrate is no more than 20 percent.

*Plant species with and indicator status of FAC, FACW, or OBL

Wetland Hydrology Performance Standards: Wetland floodplain habitat will additionally be required to meet wetland hydrology performance standards. The performance standard for hydrology is that the area must meet the wetland hydrology indicators as outlined in the 2007 Alaska Regional Supplement (USACE 2007). Wetland hydrology indicators as described in this Supplement will be used as evidence of sufficient hydrology to support wetland habitat formation and function. However, only a subset of the available indicators as described in the Regional Supplement will be used to gauge performance. This subset includes three of the four groups of indicators presented in the supplement (Table A-3). The fourth group, Group D – Evidence from Other Site Conditions or Data, will not be used to gauge hydrologic conditions within the PRM area because landscape variables for the group were derived for natural settings and are not applicable for use in recently constructed wetlands.

One primary indicator from any group is sufficient to conclude that wetland hydrology is present. In the absence of a primary indicator, two or more secondary indicators from any group are required to conclude that wetland hydrology is present. Monitoring for hydrologic indicators will occur within 10-m^2 plots coinciding with the vegetation monitoring. Table A-3 lists wetland hydrology indicators to be used for the Upper Crooked Creek mitigation.

Table A-3 List of Wetland Hydrology Indicators for Alaska*

Indicator	Category
Group A – Observation of Surface Water or Saturated Soils	
A1 – Surface water	Primary
A2 – High water table	Primary
A3 – Saturation	Primary
Group B – Evidence of Recent Inundation	
B1 – Water marks	Primary
B2 – Sediment deposits	Primary
B3 – Drift deposits	Primary
B4 – Algal mat or crust	Primary
B5 – Iron deposits	Primary
B6 – Surface soil cracks	Primary
B7 – Inundation visible on aerial imagery	Primary
B8 – Sparsely vegetated concave surface	Primary
B9 – Water-stained leaves	Secondary
B10 – Drainage patterns	Secondary
B15 – Marl deposits	Primary
Group C – Evidence of Current or Recent Soil Saturation	
C1 – Hydrogen sulfide odor	Primary
C2 – Dry-season water table	Primary
C3 – Oxidized rhizospheres along living roots	Secondary
C4 – Presence of reduced iron	Secondary
C5 – Salt deposits	Secondary

* Source: USACE 2007.

2.3.3 Terrestrial Habitat Performance Standards

Revegetated and regraded terrestrial habitat areas are expected to meet only terrestrial revegetation performance standards for compliance.

Terrestrial Revegetation. Vegetation performance standards have been developed to ensure that revegetated areas are on a trajectory to achieve stability and ecological functionality. Vegetation performance standards will be met at each restoration area. Achievement of vegetation performance standards will be assessed at locations established after the first full growing season (year 1). An entire restoration area will be considered to have achieved the performance standards when at least 85 percent of monitoring locations satisfy the standards.

The vegetation performance standards are outlined in Table A-4. These vegetation performance standards are based on the draft Oregon Department of State Lands Routine Monitoring Guidance for Vegetation (ODSL 2009). It may be necessary to modify the performance standards for vegetation response to match similarities with reference vegetation communities near the Project. Any proposed modifications will be detailed in the annual monitoring report and submitted to USACE for approval.

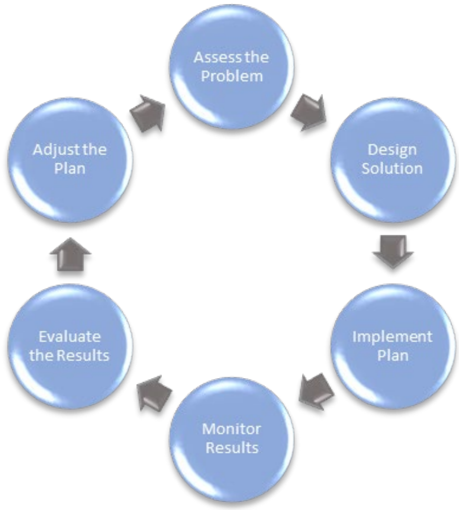
Table A-4 Terrestrial Habitat Vegetation Performance Standards

Cover of native and/or revegetation plant species is at least 60 percent.
Cover of invasive species is no more than 10 percent.
Cover of bare substrate is no more than 20 percent.

3.0 MITIGATION-SPECIFIC ADAPTIVE MANAGEMENT PLAN

The PRM Plan includes specific adaptive management requirements for the mitigation work. During restoration activities, adaptive management works toward successful restoration by adjusting and adapting to issues with implementation and onsite conditions. The adaptive management process is designed to deal with the uncertainty of the mitigation field program and allow for problem solving and adjustments during design and implementation. To have a successful Plan, Donlin Gold will follow six steps in an adaptive management process for the mitigation work (Figure A-1). Within each step, several essential elements will be completed. Adaptive management is a process of connecting and linking the information from the mitigation design, implementation, construction, monitoring, and evaluation phases to ensure that the initial design functions and meets the intended standards and objectives. If monitoring demonstrates that corrective action is needed, Donlin Gold will adjust the work plan to meet the performance standards of the Plan. Adaptive management continually evaluates the results and adjusts work elements to meet the overall objective (Ministries of Forests and Range 2008).

Figure A-1 Adaptive Management Cycle for Mitigation Work



Source: Ministries of Forests and Range 2008

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APPENDIX B
Surface Water Quality Monitoring Parameters (Long List)

Bottle Set List for Short List -1 and Long List-1*

List Type	Bottle Count	Parameters	Sample Bottle Specification
Short List-1 (Total of 6 bottles per set)	1	pH, Alkalinity, carbon trioxide (CO_3), bicarbonate (HCO_3), OH, EC, TDS	500 milliliter (ml) high-density polyethylene (HDPE), unpreserved, 0.45 membrane filtered
	1	SO_4, Cl, F	60 ml HDPE, unpreserved, 0.45 membrane filtered
	1	TSS	1 liter (L) HDPE, unpreserved, unfiltered
	1	Ca, Mg, Na, K, dissolved basis (other metals, dissolved basis: only if requested)	250 ml HDPE, nitric acid (HNO_3) preserved, 0.45 membrane filtered
	1	Metals, total basis	250 ml HDPE, HNO_3 preserved, unfiltered
	1	Mercury, total basis – EPA 1631E	500 ml HDPE, hydrochloric acid (HCl) preserved, unfiltered
	1	Methyl Mercury, total basis – EPA 1630 (Brooks Rand Laboratory)	500 ml Teflon (fluropolymer), HCL preserved, unfiltered
Long List-1 (Total of 7 bottles per set)	1	pH, Alkalinity (CO_3, HCO_3, OH), EC, TDS, SO_4, Cl, F	500 ml HDPE, unpreserved, 0.45 membrane filtered
	1	TSS	1 L HDPE, unpreserved, unfiltered
	1	Nitrate/Nitrite-N, Ammonia-N – total basis	250 ml HDPE, sulfuric acid (H_2SO_4) preserved, unfiltered
	1	total cyanide, WAD cyanide – total basis	125 ml HDPE, sodium hydroxide (NaOH) preserved, unfiltered
	1	Ca, Mg, Na, K, (dissolved basis); and dissolved metals	250 ml HDPE, HNO_3 preserved, 0.45 membrane filtered
	1	Metals, total basis	250 ml HDPE, HNO_3 preserved, unfiltered
	1	Mercury, total basis – EPA 1631E	500 ml HDPE, HCl preserved, unfiltered
	1	Methyl Mercury, total basis – EPA 1630 (Brooks Rand Laboratory)	500 ml Teflon (fluropolymer), HCL preserved, unfiltered

* Source: Donlin Gold. 2016. Quality Assurance Project Plan (QAPP) Water Quality Monitoring, Sampling and Analysis Activities. Table 7. July.

APPENDIX C

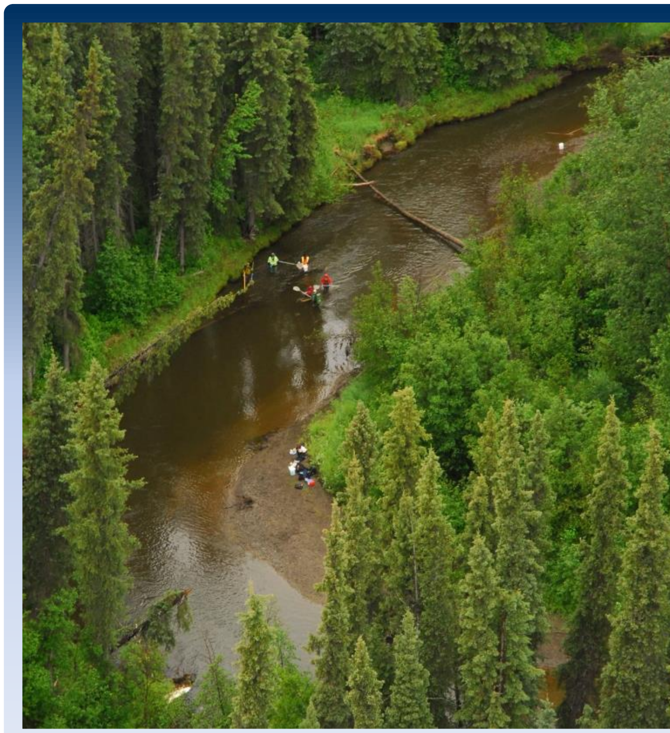
Aquatic Biomonitoring Report, Donlin Gold Project, 2004 through 2014 (OtterTail 2014a)

2014 Aquatic Biomonitoring Report
Donlin Gold Project

2004 through 2014 Data Compilation

Prepared for:

Donlin Gold, LLC
4720 Business Park Blvd., Suite G-25
Anchorage, Alaska 99503



December 2014

OtterTail Environmental Inc.
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Abstract

In 2004, OtterTail Environmental Inc. established an annual aquatic resources biomonitoring program in the Crooked Creek drainage of the Kuskokwim River, in the area of the proposed Donlin Gold Project. Components of the program include macroinvertebrate sampling, electrofishing, fish trapping, aerial salmon surveys, and fish tissue metals analysis. The main objective of this program was twofold; first to establish baseline aquatic resources data within the areas potentially influenced by the proposed mining development and second, to establish permanent monitoring sites to provide quantitative data to enable detection of changes to the aquatic community that could be caused by this development. Within the scope of this biomonitoring program, aerial salmon counts were conducted to determine the distribution of adult salmon within the Crooked Creek system. However, in order to accurately estimate the size of adult salmon populations migrating into Crooked Creek, a resistance board fish weir was added to the program in 2008.

Results from 2004-2014 data have consistently indicated that the Crooked Creek drainage supports relatively small and viable, populations of chum, Chinook, and coho salmon. Limited numbers of pink and sockeye salmon have also been documented in the fish weir. In addition, several other resident fish species typical of the Kuskokwim River drainage have been found throughout the program area, typically in relatively limited numbers.

Our surveys suggest that macroinvertebrate communities are composed of taxa typical of this region, but their relative abundance is rather low. The low abundance of macroinvertebrates, salmon, and other fish species may be due to the naturally high siltation and cobble embeddedness in this system that appears to be above average as compared to other similarly sized systems of the Kuskokwim River. Embeddedness reduces the extent of interstitial spaces in the substrate that, in turn, reduces the physical habitat and increases the likelihood of full substrate freezing and mortality.

Periphyton analysis was added to the core program in 2009, with sampling occurring in 2009, 2013, and 2014. The periphyton communities found in streams within the Crooked Creek drainage are consistent with other studies of Alaskan streams. In general, the periphyton communities are composed of taxa that are relatively good indicators of water quality, however metrics calculated such as the Shannon Diversity Index (H), evenness (e) and PTI metrics suggest that natural stressors are present in the system.

Chlorophyll a analysis was added to the core program in 2014. Chlorophyll a concentrations were found to be greater at mainstem Crooked Creek sites and larger tributaries (i.e., Bell Creek and Getmuna Creek), than at small tributaries such as American or Anaconda creeks.

Multiple years of baseline data coupled with the low sample variability observed in fish tissue metal concentrations within sites, have not only provided insight into the annual variability in background metal concentrations, but also have allowed for the assessment of differences in metal concentrations across sites. For example, a significantly higher concentration of arsenic and mercury was observed in the uppermost sampling site along the mainstem of Crooked Creek compared to downstream sites, which could be associated to natural mineralization or from the current and historic placer mining in that area. Being able to statistically test and detect these relatively small changes in metal concentrations indicates that the monitoring program would be capable of detecting potential increases in metal concentrations caused by the implementation of the Project.

In 2007, the program expanded to include aquatic biomonitoring on drainages crossed by the proposed mine access road. The methods used in these drainages were similar to the established biomonitoring protocol, but only included fish tissue metals analysis on Getmuna Creek, near a proposed material site. These surveys show aquatic communities were similar to many of the drainages of Crooked Creek. In 2009 and 2011, additional culvert and bridge crossing sites were added to the program with the expansion of the Project. In 2011 and 2012, sampling was conducted in the Kuskokwim River adjacent to a proposed Jungjuk port site facility. To further define habitat usage by fish in Crooked Creek, backwater habitat sampling was conducted in 2013 and 2014.

CONTENTS

1.0 INTRODUCTION (CORE PROGRAM)

Donlin Gold LLC. (Donlin) has proposed the development of a gold resource (the "project") within the Crooked Creek drainage of the Kuskokwim River in southwestern Alaska, near the village of Crooked Creek (**Figure 1.1-1**). For detailed information on this proposed Project, refer to the Project Description (SRK, 2012) and Environmental Evaluation Document (Arcadis, 2013).

In 2004, OtterTail Environmental, Inc. (OtterTail) was retained by Donlin to establish an aquatic resources biomonitoring program within the Crooked Creek drainage. An additional aquatic survey program area was added in 2007 to provide baseline aquatic data for drainages crossed by the proposed Mine Access Road: Donlin-Jungjuk Road (**Figure 1.1-1**). To facilitate distinction, these two program areas are described in separate sections of this report and are named core aquatic biomonitoring program (Core Program) and mine access road aquatic survey program (Mine Access Road Program). Refer to *Section 4.0* for the Mine Access Road Program.

1.1 CORE PROGRAM

In 2004, OtterTail established an aquatic resources biomonitoring program within the Crooked Creek drainage. Refer to *Section 2.0* for Core Program methods, and to *Section 3.0* for Core Program results. The Core Program consists of macroinvertebrate sampling, electrofishing, fish trapping, aerial adult salmon counts, fish weir adult salmon counts, fish tissue metals analysis, and periphyton and chlorophyll a sampling. A map of the project area can be found in **Figure 1.1-1**.

1.2 GOALS (CORE PROGRAM)

The primary goal of the Core Program was twofold; first, to establish permanent biomonitoring sites within areas that could be potentially altered by the Project, and second, to gather baseline aquatic resources data, that could be used in the future to detect and quantify changes to the health and structure of the aquatic community as a result of the mine development. It is anticipated that any effects on the aquatic biota would likely result from changes in water quality, water quantity, or aquatic habitat modification (e.g., habitat removal, stream siltation or stream channel down-cutting). Information made available by this biomonitoring is important to assist with Project design and planning of impact mitigation.

1.3 STUDY AREA (CORE PROGRAM)

The biomonitoring program area encompasses the entire Crooked Creek drainage. Crooked Creek is a tributary to the Kuskokwim River, entering the Kuskokwim from the north side near the village of Crooked Creek (**Figure 1.1-1**). The Crooked Creek drainage includes major upper tributaries such as Flat Creek and Donlin Creek, as well as a number of tributaries entering the mainstem further downstream, including Getmuna Creek and Bell Creek (**Figure 1.1-1**). The mainstem of Crooked Creek begins at the confluence of Flat Creek and Donlin Creek, flowing approximately 17.4 linear miles (33.0 river miles), or 28.0 linear km (53.1 river km), to the Kuskokwim River [approximately at river mile 258.9 (416.7 km)] (Whitmore, 2008). The Project is located near the upper mainstem section of Crooked Creek (**Figure 1.1-1**).

2.0 METHODS (CORE PROGRAM)

Primary components of the biomonitoring program included (1) site and reach selection (2) the selection of target aquatic parameters to sample, and (3) the selection of adequate methods to use for each parameter. The development of these components was based on OtterTail staff's previous experience establishing numerous mining biomonitoring programs, advice from the Alaska Department of Fish and Game (ADF&G) and biologists from other agencies, and aquatic biomonitoring efforts from other regional mining operations.

2.1 SITE AND REACH SELECTION METHODS (CORE PROGRAM)

Sampling sites were selected to evaluate existing conditions both upstream (reference reaches) and downstream (potential impact reaches) of historical and proposed mining activity, and to detect and measure potential future Project impacts on aquatic resources. Locations were also selected to correspond, when practical, to sites previously established for water quality and flow monitoring. Each biomonitoring site was selected to establish the current condition of the aquatic community for a stream segment. However, in some cases a site was selected as a representative area of an entire stream. Where possible, sites were located at the furthest downstream reach so that disturbances occurring within any portion of the watershed could be monitored in that single location. All sites were located upstream of man-made and natural obstructions (e.g., winter trails) to avoid tracking potential impacts from other non-Project related activities (e.g., snow machine use; **Figure 1.1-1; Table 2.1-1 and 2.1-2**). During the process of site selection, aerial photographs, topographical maps, historical data, and the proposed areas of disturbance were considered.

The upper Crooked Creek drainage (**Figure 1.1-1**) has the greatest potential for Project-related impacts due to its location within the mineralized zone, and its proximity to the Project. The mineralized zone extends from Ophir Creek on the north, to American Creek on the south. Several of the tributary streams in the upper Crooked Creek drainage have been or are currently being disturbed by independent placer mining; especially Quartz Creek, and Snow, Queen and Lewis gulches. In contrast, Ophir and Dome creeks are relatively undisturbed streams.

In 2004, six sites were established and sampled: two sites in Upper Crooked Creek and one site in each of Donlin, Flat, American, and Anaconda creeks. As the Project expanded, anticipated potential impacts to other areas in the drainage lead to the addition of six more sites to the program in 2006 including one site in Crevice Creek and one site in Crooked Creek downstream of Crevice Creek to capture impacts of potential groundwater and surface water reductions. A site was added near the mouth of Crooked Creek to fully encompass the drainage. A second site higher in Anaconda Creek was added to further characterize this system. The sixth additional site was located within Snow Gulch due to a proposed fresh water reservoir within this watershed.

Further, one site in Getmuna Creek was added to the program in 2007 to assess the potential impact of a proposed material site location (**Figure 1.1-1**). In 2008, the potential impact area was expanded to include Grouse and Dome creeks leading to the addition of a new site in the lower portions of those two creeks to monitor any potential effects. In 2009, sites were added in small drainages within the Project footprint, including Quartz, Lewis, and Omega Gulches. A site was also added in Eagle Creek due to new Project facilities within the drainage. In 2010, an additional site was added to the middle portion of American Creek, and sites were added to unnamed (BC), and unnamed (AC) creeks to further define fish populations within the Project area. In 2011 two additional sites were surveyed in the upper portion of the American Creek drainage, and a new site was established and surveyed in Bell Creek. In 2012, three new sites were added to upper Getmuna Creek. A complete list of sites within the Project area, their UTM coordinates, and number of years sampled is provided in **Appendix A**. The purpose of each site selected for biomonitoring is included in **Table 2.1-1**.

2.1.1 AERIAL SURVEY REACH SELECTION

Helicopter facilitated aerial surveys along the Crooked Creek drainage began at the mouth of Crooked Creek (confluence with the Kuskokwim River) and continued upstream to an unnamed but recognizable tributary located approximately 12.1 river miles (19.5 rkm) upstream of the confluence of Donlin Creek and Dome Creek (**Figure 1.1-1**). Streams were separated into reaches to document populations per segment and to document the upstream extent of migrations. Three reaches were delineated within Donlin Creek (DO-R1, DO-R2, and DO-R3) and five reaches within Crooked Creek (CR-R1, CR-R2, CR-R3, CR-R4, and CR-R5).

Tributaries that had potential to be affected by the Project were also aerially surveyed. These included Flat Creek (FL-R1), Dome Creek (DM-R1), Snow Gulch (SN-R1), American Creek (AM-R1), Grouse Creek (GR-R1), Anaconda Creek (AN-R1), Crevice Creek (CV-R1), Eagle Creek (EG-R1), five reaches in Getmuna Creek (GM-R1, GM-R2, GM-R3, GM-R4, and GM-R5), and three reaches in Bell Creek (BL-R1, BL-R2, and BL-R3; **Figure 1.1-1**).

Two main factors were considered in setting the length of aerial reaches: 1) the reach cannot be too long as to lose detail concerning salmon distribution; and 2) reach boundaries needed to be set at easily identifiable landmarks to facilitate identification of the reach boundaries from the air. The upper-most reach within a particular basin was typically ended at a tributary confluence upstream of all documented salmon. In some instances, these upper boundaries have been slightly modified across years, as additional fish observations were collected. Current boundaries are displayed in **Figure 1.1-1**.

2.1.2 Crooked Creek Weir Site Selection

Although aerial salmon counts were effective to assess the distribution and uppermost extent of salmon within the Crooked Creek system, these point-in-time surveys do not obtain the total adult salmon escapement in Crooked Creek. To address the need for total salmon escapement within the Crooked Creek drainage, OtterTail installed a resistance board fish weir in 2008 equipped with an underwater video system. This type of weir has been shown to be a highly effective method to determine total salmon escapement even under the fluctuating water levels, high turbidity, and debris loads that are common in small Alaskan streams such as Crooked Creek. Placed 1.5 river miles (2.4 rkm) upstream of the Kuskokwim River confluence and downstream of all tributaries to Crooked Creek, the location of the weir was intended to encompass the entire Crooked Creek drainage (**Figure 1.1-1**).

At the weir site, the river channel is approximately 120 feet (36.6 m) wide with an average depth of about 2.5 feet (0.76 m) during normal summer flows. Water depth is fairly consistent across the channel, with a slightly deeper section near the left bank (**Figure 2.1-1**). The weir is located along the only reach in the targeted segment of Crooked Creek that remains straight for an extended distance. This straight run produces the desired laminar flow across the channel that is critical for proper weir operation. Areas further downstream were considered unsuitable for operational success due to deeper water, non-laminar flow across the channel, asymmetrical bank profiles, and the potential for transient fish species temporarily migrating up from the Kuskokwim River. In addition, it was thought that tampering would be more likely if the weir was located further downstream and in closer proximity to the Crooked Creek Village.

2.1. 3 Biomonitoring Site Selection - Donlin and Flat Creek Mainstem (Control Sites)

Upper Donlin Creek (DO1) and Flat Creek (FL1) were selected as control sites because they are located upstream of any present or proposed mining activities (**Figure 1.1-1**). These sites will allow the assessment of differences between Project and non-Project related impacts and account for the natural variability of the system.

2.1. 4 Biomonitoring Site Selection - Donlin Creek Tributaries: Dome, Quartz and Snow Drainages

Dome Creek (DM1) and Quartz Gulch (QZ1) are located within the mineralized zone, upstream of current and proposed Project mine facilities. Snow Gulch (SN1 and SN2) is currently affected by placer mine activities. These sites were established to document the current condition of aquatic resources within the drainages (**Figure 1.1-1**).

2.1. 5 Biomonitoring Site Selection - Crooked Creek Mainstem

The uppermost mainstem site along Crooked Creek (CR2) is located 0.16 mi (0.26 km) upstream of American Creek and 0.11 mi (0.18 km) downstream of the currently active Lyman Mine diversion canal (**Figure 1.1-1**). Site CR2 was selected as a partial-reference site downstream of all known existing placer mining activities and upstream of most of the Project’s footprint. This site can be used to establish a baseline dataset and evaluate the impacts of the placer mining operations that continue to occur above this point in the watershed. In addition, the location of CR2 above the tailings impoundment was intended as a control for possible future evaluation of any impacts in Crooked Creek downstream of Anaconda Creek associated to the tailings impoundment.

Crooked Creek site (CR1) is located 0.51 mi (0.82 km) downstream of the confluence of Anaconda Creek (**Figure 1.1-1**). Sampling at CR1 will allow detection of potential effects on the Crooked Creek mainstem from mine-related activities in Anaconda Creek, Omega Gulch, and American Creek drainages.

A lower Crooked Creek site (CR0.7) was added later in the program to capture any possible effects from Crevice Creek, and will also serve to determine the extent of recovery of Crooked Creek if any effects are found upstream in site CR1 (**Figure 1.1-1**).

The lowest site on Crooked Creek (CR0.3) is located 0.84 mi (1.35 km) upstream of the mouth (**Figure 1.1-1**). This site was selected to provide a baseline dataset that encompasses the full Crooked Creek watershed and to assess the recovery of Crooked Creek if impacts are detected in upstream sites.

2.1. 6 Biomonitoring Site Selection - Crooked Creek Tributaries: Lewis, American, Grouse, Omega, Anaconda, Crevice, Eagle, Unnamed (BC), Unnamed (AC), Getmuna, and Bell Drainages

Lewis Gulch (LE1) is a small drainage within the proposed location of the ultimate pit (**Figure 1.1-1**). Site LE1 was monitored in 2009 to document the aquatic resources that would be impacted as a result of drainage removal. The site was sampled both upstream and downstream of an existing road crossing to fully capture the aquatic resources within the drainage.

American Creek (AM1) would be directly impacted by the proposed ultimate pit and waste rock facility (**Figure 1.1-1**). The study site AM1 is located just upstream of an existing road crossing. This site was established to document the aquatic resources that would be impacted as a result of Project facilities filling much of this drainage. For the same purpose, a new upstream site in this drainage (AM2) was added in 2010. Sites AM3 and AM4 were established in 2011 to assess current conditions and potential future impacts associated with the upper portions of the waste rock facility (**Figure 1.1-1**).

Grouse Creek (GR1) was added in 2008 to assess potential baseflow reductions within the drainage. Grouse Creek is near the potential cone of depression associated with proposed groundwater pumping around the ultimate pit.

Omega Gulch (OM1) is within the Project footprint. The Project would divert water from upper American Creek into Omega Gulch. Study site OM1 is located just upstream of the winter trail (**Figure 1.1-1**).

Anaconda Creek (AN1 and AN2) is the location of the proposed tailings storage facility (**Figure 1.1-1**). Site AN1 is downstream of the proposed tailings impoundment and would enable detection of any potential effects from the tailings storage facility to the stream. Site AN1 is located just upstream of the winter trail, a few hundred meters from the mouth of Anaconda Creek. Site AN2 is within the portion of the drainage proposed to be filled by tailings and was established to document aquatic resources in Anaconda Creek that would be removed as a result of the Project.

Crevice Creek (CV1) is a site selected to assess potential groundwater and surface water impacts from the adjacent Anaconda Creek drainage (**Figure 1.1-1**). During mine closure, a tunnel is proposed to divert water from the upper Anaconda Creek watershed into Crevice Creek.

Eagle Creek (EG1) was added in 2009 to address the changes in the Project footprint. The camp facilities for the Project will be relocated into this drainage, and potential effluent may enter Eagle Creek (**Figure 1.1-1**).

Sites were added to two unnamed creeks (BC1 and AC1) located south of the Project area. These sites were added to refine fish species distribution in the watershed (**Figure 1.1-1**).

A site in Getmuna Creek (GM1) was added in 2007 due to a proposed gravel borrow location near the upper reaches of the stream (**Figure 1.1-1**). This site was selected to document the aquatic biota present within the drainage and to record any changes that could occur as a result of the materials site upstream. Three additional Getmuna sites (GM2, GM3, and GM4) were added in 2012. Data from Getmuna Creek also allows for better understanding of the distribution of anadromous salmon throughout the Crooked Creek drainage given that a large portion of the Crooked Creek salmon run use Getmuna Creek for spawning and rearing.

A site in Bell Creek (BL1) near its confluence with Crooked Creek was added and surveyed in 2011 and 2012 to refine fish species distribution in the watershed (**Figure 1.1-1**).

2.1.7 OFF-CHANNEL HABITAT FISH SAMPLING SITE SELECTION

During mining operations, surface runoff from rainfall, snowmelt, and groundwater seepage in many parts of the Feasibility Study Area (FSA) would be diverted and captured (stored). This water would be entrained in the tailings, lost in the milling processes, consumed in the power plant operations, or lost to the atmosphere through evaporation. Regardless of its final use or consumption, these diverted and stored waters would reduce the runoff that would normally reach surface waters in the FSA (BGC, 2013). This reduction in stream flow could decrease the wetted surface area and frequency of the connection to the mainstem of these off-channel habitats (OtterTail, 2012). In 2013 and 2014, backwater fish sampling was added to evaluate fish use of off-channel habitats that may experience a decreased frequency of connectivity to the main channel during low flow periods due to predicted stream flow reduction associated with mining operations. Refer to *2009 Instream Habitat Analysis of Crooked Creek for the Donlin Gold Project* for information regarding the off-channel connectivity analysis (OtterTail, 2012).

Twelve off-channel sampling sites were selected along Crooked Creek, from Flat Creek to Crevice Creek. Based on a connectivity analysis conducted in 2009, six of the sites selected may experience intermittent connectivity to the main Crooked Creek channel under low stream flow conditions (BW_04, BW_05, BW_06, BW_10, BW_11, and BW_12; OtterTail, 2012). The remaining six sites selected likely do not experience intermittent connectivity with the main Crooked Creek channel during low stream flow conditions (BW_01, BW_02, BW_03, BW_07, BW_08, and BW_09; OtterTail, 2012). All habitats sampled had connectivity to the main channel during sampling in 2013.

2.2 PARAMETER SELECTION METHODS (CORE PROGRAM)

Equally important to the selection of sites and reaches for this biomonitoring program was the selection of parameters and methodologies to effectively identify short-term and long-term changes to the aquatic community. To address the goal of baseline data collection and impact assessment, the following parameters were identified: macroinvertebrates, fish populations (adult salmon aerial surveys, fish weir counts, fish traps, electrofishing, and angling), fish tissue metals analysis, periphyton, and chlorophyll a. The methodologies used are described in detail below.

Macroinvertebrate populations are effective indicators of water quality and habitat impairment due to elevated concentrations of metals, sediment, and other contaminants. The varied life histories and contaminant tolerances of indicator species can be used to identify both short- and long-term environmental changes, and to establish a relative index of water quality. Specific inventories conducted for the Project will characterize macroinvertebrate communities and provide baseline data to assess potential mining impacts.

Fish populations were selected to be assessed due to their economic and cultural importance to subsistence communities in the study area, and their important role within Alaskan aquatic ecosystems. However, adult salmon returns to spawning streams are variable and subject to a host of natural and anthropogenic factors within both freshwater and marine environments. Characterizing fish communities in reference streams and Project affected streams may help Project planners to broadly describe existing conditions, but should not be used to measure project impacts based on natural variability.

The primary purpose of the fish tissue metals analysis is to establish statistically reliable baseline data at key sites in the Crooked Creek drainage and to assess potential changes over time in metal concentrations at these sites. Most studies of fish tissue metals done in the Kuskokwim River region focus on determining concentrations of metals present in hazardous concentrations for human consumption. In contrast, the goal of this study is to assess the natural variation in metal concentrations within the system and detect changes caused by the Project.

Like macroinvertebrates, periphyton communities are also effective indicators of water quality. The varied life histories and contaminant tolerances of indicator species can be used to identify both short-term and long-term environmental changes, and to establish a relative index of water quality. Specific sampling conducted for the Project will characterize periphyton communities and provide baseline data to assess potential mining impacts.

2.3 Macroinvertebrate Methods (Core Program)

2.3.1 Macroinvertebrate Sampling Methods

Benthic macroinvertebrates were collected at 23 Core Program biomonitoring sites: DO1, FL1, DM1, QZ1, SN2, QU1, CR2, CR1, CR0.7, CR0.3, AM1, AM2, GR1, OM1, AN1, AN2, CV1, EG1, GM1, GM2, GM3, GM4 and BL1 (**Figure 1.1-1**). These sites have been sampled from one to nine years and sampling has typically occurred between July 14 and August 2. As described above, some of the sites were added in recent years due to changes to the Project. Multiple years of quantitative macroinvertebrate community monitoring were conducted in order to assess the natural variation, both among sites and years, within the Crooked Creek drainage. By controlling for the natural variation in the system, it would be possible to assess changes in the aquatic macroinvertebrate community due to Project-related impacts.

Macroinvertebrate sampling methods were standardized to minimize sampling variability. Five replicate samples were collected to reduce sampling variability within a single site and to increase statistical power. At all Crooked Creek sites, samples were collected each year from the same riffle(s) using a Surber sampler (1 ft^2, 600 µm mesh). The Surber sampler was placed on the stream bottom with its opening perpendicular to stream flow. Substrates within the 1 ft^2 (0.09 m^2) Surber base were scrubbed with a nylon brush to remove invertebrates and organic matter. Organic matter retained by the net was drained onto a 600 µm sieve, placed in plastic bags, and preserved in 70 percent isopropyl alcohol.

In the laboratory, samples were lightly rinsed with water in a 600 µm (standard #30) sieve. Macroinvertebrates were removed by hand under magnification, identified to the lowest possible taxonomic level (typically genus), and counted. Large samples (>300 individuals) were sub-sampled using a white tray subdivided into four quadrants. Samples were evenly distributed across the tray, and each quarter was picked until a minimum of 300 individuals was reached (typically ¼ or ½ of the original sample). Large samples were also viewed in their entirety before sub-sampling; large and/or rare taxa found in this search were removed and added to the sample total. A reference collection was created for future sample verification.

2.3.2 Macroinvertebrate Metals Analysis

In 2011, metals analyses were conducted on aquatic macroinvertebrates (mayflies and stoneflies) at sites DO1, CR2, CR1, and CR0.7 in support of an ecological risk assessment being developed for the proposed pit lake. Macroinvertebrates were collected with Surber samplers (*Section 2.3.1*) and kick nets (500 µm mesh size). Samples were hand sorted and picked using plastic tweezers. Samples were processed with the same field and laboratory methods described for the Core Program metals analysis (*Section 2.5*) with the exception that only enough specimens were collected to analyze one replicate at the laboratory.

2.4 Fish Population Assessment Methods (Core Program)

From 2004-2014, methods to assess fish population included aerial salmon surveys and resident fish surveys (i.e., electrofishing, trapping, and angling surveys). In 2008, a resistance board fish weir was installed near the mouth of Crooked Creek to more accurately estimate the size and timing of adult salmon populations migrating into the Crooked Creek drainage. The fish weir was operated during the 2008-2012 summer seasons.

2.4.1 ADULT SALMON - AERIAL SURVEY

Helicopter salmon counts were conducted within the Crooked Creek drainage from 2004 to 2014. Target species included Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*Oncorhynchus keta*), and coho salmon (*Oncorhynchus kisutch*). Counts were timed to sample peak numbers of adult salmon in the system and to determine how far upstream into the drainages they migrate. Therefore, the timing of aerial survey dates was intended to coincide with the end of the migration peak. These dates for Crooked Creek were determined to be late July for Chinook and chum salmon, and mid-to-late September for coho salmon. Specifically, the flight dates for Chinook and chum salmon were July 25/2004, July 23/2005, July 19-20/2006, July 24-28/2007, July 23-25/2008, July 19-22/2009, July 24-25/2010, July 21-22/2011, July 20-24/2012, July 25-28/2013, and July 26-27/2014. For the coho salmon run, the flight dates were September 23-24/2004, September 26-27/2005, September 19-20/2006, September 11-13/2007, September 18-20/2008, September 13-15/2009, September 17-18/2010, September 15-18/2011, September 19-24/2012, September 17-19/2013, and September 18-20/2014.

In addition to counting live salmon, redd counts were added to the survey in 2009. Redds were visually identified from the air by a fisheries biologist. Newly formed redds appear lighter in color than the undisturbed surrounding gravels and may remain discernible for a period of days to weeks, depending on stream flow and periphyton accumulation (Gallager et al. 2007). A redd was counted if it had a defined pit and downstream tail spill. From 2009 to 2011, no attempt was made to associate salmon species with redds. Redd counts collected from 2009 through 2011 were tallied on a per reach basis and no GPS location data was recorded. Counts were conducted in summer and fall. Refer to the aerial survey dates above for exact flight dates. Additionally, a GPS redd survey was conducted from the ground in 2009. These data are not presented in this report due to differing methodology, but can be found in the 2009 Instream Habitat Analysis of Crooked Creek for the Donlin Gold Project (OtterTail, 2012).

Starting in 2012, redd locations were GPS located, associated with a salmon species if fish were observed on a redd, and then totaled by the reach in which they occurred. For consistency, the data on redds presented in this report are not associated with a salmon species and are totaled by reach. Counts were conducted in summer and fall. Refer to the aerial survey dates above for exact flight dates.

2.4.1.1 AERIAL SURVEY- VARIABILITY REDUCTION METHODS

The eleven years of aerial salmon counts have been effective in determining the distribution of adult salmon within the Crooked Creek system. However, in order for these point-in-time surveys to provide a more informative index of the populations per stream reach, reduction of survey variability was necessary.

Annual salmon populations are inherently variable due to several natural factors affecting the return run success in a given year. The baseline data collection seeks to document this variation in the salmon run from year to year. In addition to the natural variation in the salmon run, other sources of variation in aerial surveys include decreased visibility due to tannins (organic leachate), tree canopy, daylight, and water turbidity. Some of these factors can be controlled and/or reduced as part of the aerial sampling methods but others cannot. The amount of tannins in the water cannot be reduced or avoided as tannin concentrations are related to seasonal changes in the hydrology of the catchment (e.g., flushing). Similarly, tree canopy or the amount of vegetative cover is proportionally related to sample effectiveness. On the other hand, daylight influences sampling accuracy considerably so every attempt was made to shift flight schedules to sunny or bright days, as well as during mid-day periods. Turbidity appears to be higher within the Crooked Creek system than in comparable systems of the Kuskokwim River drainage. Turbidity is primarily due to the natural geology, as silt is washed into the stream channel and suspended in the water column with any substantial rainfall. Field observations document that several watersheds in the Kuskokwim River drainage have lower levels of turbidity than Crooked Creek, with the same level of rainfall (e.g., Holukuk River, Holitna River, and even Getmuna Creek within the Crooked Creek drainage). To reduce variability, every attempt was made to fly during the best water clarity conditions, but still within the set run-timing window. This involved promptly shifting flight schedules to days where the stream water was clearest, typically after a few days without precipitation.

2.4.2.2 Aerial Accuracy Methods

In order to understand the variability of aerial survey fish counts and compare the accuracy of aerial surveys across years, the ratio of the aerial counts to the weir passage counts was employed. Aerial accuracy is determined as the fraction of aerial fish counts divided by the total weir counts, expressed as a percentage. Comparisons were made between the three most numerous species of salmon found in the Crooked Creek drainage as well as the totals of these species.

2.4.2 Adult Salmon - Crooked Creek Weir

2.4.2.1 Fish Weir Design Methods

The resistance board weir consists of floating resistance board panels, boat passage panels, a fish passage panel and chute, fixed picket near-bank weirs, bulkheads, and a video system (**Figure 2.4-1**). The weir was constructed using specifications outlined by Tobin (1994) with minor changes to some of the components. The substrate rail and floating resistance board panels covered the middle 110 foot (33.5 m) portion of the channel. Fixed pickets extended five feet (1.5 m) from the weir to each bank (**Figure 2.4-1**). Each panel was four feet (1.22 m) wide with pickets 1-1/4 inch (3.17 cm) diameter and spaced to leave a gap of 1-5/8 inches (4.13 cm) between each picket. This spacing was designed to allow smaller resident fish to pass upstream through the pickets and to restrict the crossing of targeted salmon species. Each panel was attached to a steel rail (substrate rail) anchored to the river bottom and attached to one another by connection pickets. Specialized boat passage panels were designed and installed in the deeper portion of the channel to temporarily submerge and to allow boats to pass over the weir. The weir was configured to allow fish passage near, but not at, the deepest part of the channel through a specialized panel. The video system, consisting of a sealed camera box and fish passage chute, was attached directly to the fish passage panel (Gates and Palmer, 2007). Bulkheads were installed near each bank to keep the panels taut across the channel thus preventing shifting/buckling, and protecting the banks from erosion (**Figure 2.4-1**).

A primary difference between the Crooked Creek weir and many other resistance board weir designs in Alaska is the absence of a live trap for fish collection. Fish collection was not an objective of this study. The absence of the live trap allowed fish to pass freely though the passage chute at any time of day, reduced obstruction of stream flow, and minimized stress on migrating fish. The absence of a live trap also permits uninterrupted video monitoring of fish passage events, allowing for assessment of diel (24 hour) movement patterns (Johnson et al., 2007).

2.4.2.2 Fish Weir Video Operation Methods

Setup and design of the video system was similar to that used by Gates and Palmer (2008) and Anderson et al. (2004). The weir was unmanned and outfitted with a video system to monitor upstream fish passage. This design requires no sampling or handling of fish and is a passive, non-invasive counting method. Digital video images can be reviewed numerous times without degradation, are easily archived, and can reduce possible study impacts to the species being observed (Edwards, 2005).

Attached to the upstream end of the fish passage panel, the sealed video box recorded fish passage via motion detection. The video system consisted of a video camera and a pair of 12-volt underwater pond lights. The box was filled with distilled water and separated from the river water with a glass plate, allowing the camera to easily capture images of fish passing through. An external surveillance camera was installed in a tree on the bank and was used to remotely view live footage of the weir and monitor for vandalism or debris jams.

Video footage was recorded on a digital video recorder (DVR) located in the village of Crooked Creek, Alaska. On-site power was available at this location. The DVR was equipped with motion detection to minimize the amount of blank video footage recorded and reduce review time (Gates and Palmer, 2008). The camera is designed to monitor for movement 24 hours per day, seven days a week and record the motion-detected video permanently on its hard drive.

The two video signals from the cameras were transmitted from the weir site to the DVR in Crooked Creek via two-5.8 GHz microwave frequency video repeaters. Microwave transmission of the video signal minimized the power requirements needed at the remote site and allowed staff to remotely monitor the weir operation, ensure all parts were in working order, conduct daily checks, view real-time video from both cameras, and download video footage. Video footage could be viewed onsite as well as from remote locations through a static Internet Protocol (IP) address and Intellex Network Client® software.

The electrical system at the weir was powered by eight solar panels charging a bank of eight deep-cycle batteries. Water level and flow during the operational weir periods were obtained from the Crooked Creek USGS gauge station located approximately 1.37 river miles (2.2 river km) upstream of the weir (**Figure 1.1-1**).

2.4.2.3 Fish Weir Video Data Analysis Methods

Data recorded throughout the operational period were stored on the DVR and 1TB external hard drive. The data were brought back to the office where each recorded video segment was reviewed and analyzed by experienced fish biologists. Data parameters collected for each recorded fish passage included: date and time of passage, species, sex, direction of passage, estimated total length (TL), presence and location of tags, and any other relevant notes. Sex was determined by observing external morphological features. Using measurement marks on the backdrop board of the video passage chute, length measurements were estimated using TL to the nearest inch. Although not an exact measurement, the estimated length allowed for relative comparison between each species.

2.4.2.4 Escapement Analysis Methods

Escapement is defined as the number of spawning adult salmon that passed through the weir within a season. Daily escapement numbers at the Crooked Creek weir were calculated by counting upstream passage, minus any downstream passage during a 24 hour period. This method was continued over the entire operational period.

2.4.2.4 Escapement Modeling Methods

In order to compare data on escapement of salmon from 2008 to 2012, missing daily counts as well as periods of incomplete counts were modeled using methods presented in ADF&G's Tatlawiksuk River Salmon Studies, 2010 (Clark et al., 2011). Estimates for each species of salmon were modeled in order to compare counts between species as well as overall escapement of all salmon species over time. According to the Tatlawiksuk Study, 2010, three approaches may be taken to model the different types of losses that occur in a data set: proportional, linear, and single day methods. The various methods require data from water bodies that exhibit similar characteristics and hydraulic regimes. For relevant data gaps, data from Crooked Creek in either 2009 or 2010 were used due to the facts that 1) data were for the same water body; 2) the data sets were complete for those years; and 3) the hydraulic profiles for those years were deemed similar enough to the years in question for comparison.

The following guidelines are used when deciding which model to use in estimating passage data:

1) Where either start or ending data are missing for a season, the "proportional method" is used based on complete data sets for a similar flow year of the same or similar water body.
2) The "linear method" is used to model data gaps between existing data in the same year in order to interpolate daily estimates from average observed passages two days before and two days after the inoperable period.
3) Where passage data for a single day are missing, the "single day method" is utilized. The single day method passage estimates are based on the average observed passage two days before and two days after the inoperable day.
4) On occasion when the weir is inoperative for only part of the period or the weir is over-topped; estimates of missed passage are generated using the appropriate method minus any observed passage from the compromised day.
5) In the event where the compromised day passage count is higher than the modeled data, the compromised numbers are used.

For data missing at the start of 2008 and ends of 2008 and 2012, passage counts from both 2009 and 2010 complete data sets were used together with the proportion method and Equation 1.

$$n_{d_i} = \left(\frac{(n_{2d_i} \times n_{1t_1})}{n_{2t_1}}\right) - n_{o_i} \quad (1)$$

where

n_{d_i} = passage estimate for a given day (i) of the inoperable period;
n_{2d_i} = passage for the i^{th} day in the model data set 2 ;
n_{1t_1} = known cumulative passage for the operational time period (t_I) from the estimated data set 1;
n_{2t_1} = known cumulative passage for the operational time period (t_I) from the estimated data set 2; and
n_{o_i} = observed passage (if any) from the given day (i) being estimated.

The substantial mid-season data gaps in 2011 as well as the two-day gaps and larger compromised period in 2012 were modeled using the "linear method" based on days before after the gap using Equation 2.

$$\mathbb{m}_{d_i} = \alpha + \beta \cdot i - n_{o_i} \quad (2)$$

$$\alpha = \frac{n_{d_1-1} + n_{d_1-2}}{2}$$

$$\beta = \frac{(n_{d_I+1} + n_{d_I+2}) - (n_{d_1-1} + n_{d_1-2})}{2(I+1)}$$

for ($d_1, d_2, \ldots, d_i, \ldots d_I$)

where

$\mathbb{m}_{d_i}$ = passage estimate for the i^{th} day of the period ($d_1, d_2, \ldots, d_i, \ldots d_I$) when the weir was inoperative;
n_{d_1-1} = observed passage of 1 day before the weir was inoperable or washed out;
n_{d_1-2} = observed passage of the 2nd day before the weir was inoperable or washed out;
n_{d_I+1} = observed passage the first day after the weir was reinstalled;
n_{d_I+2} = observed passage the second day after the weir was reinstalled; and
I = number of inoperable days.
n_{o_i} = observed passage (if any) from the given day (i) being estimated

The single day method passage estimates are calculated as the average observed passage two days before and two days after the inoperable day according to Equation 3.

$$\mathbb{m}_{d} = \frac{n_{d_i-1} + n_{d_1-2} + n_{d_i+1} + n_{d_i+2}}{4} \quad (3)$$

where

$\mathbb{m}_{d}$ = passage estimate for the day (i) day when the weir was inoperative;
n_{d_1-1}, n_{d_1-2} = observed passage of 1,2 days before the weir was inoperative;
n_{d_1+1}, n_{d_1+2} = observed passage of 1,2 days after the weir was inoperative;

The single day method was applied to all species counts on the single day when the weir was inoperable in 2008.

2.4.3 Resident Fish and Juvenile Salmon Surveys

Resident fish and juvenile salmon populations were evaluated at 30 Crooked Creek Core Program sites (i.e., DO1, FL1, DM1, QZ1, SN1, SN2, QU1, CR2, CR1, CR0.7, CR0.3, LEI, AM1, AM2, AM3, AM4, GR1, OM1, AN1, AN2, CV1, EG1, BC1, AC1, GM1, GM2, GM3, GM4, BL1, and Weir; **Figure 1.1-1**) between July 21-28/2004, July 23-28/2005, July 18-30/2006; July 21-31/2007;

July 24-28/2008, July 16-23/2009, July 20-24/2010, July 14-21/2011, July 20-30/2012, July 24-25/2013, and July 24-25/2014. Fish populations were monitored with backpack electrofishers, minnow traps, angling surveys, and fish weir.

2.4.3.1 Electrofishing Methods

Consistent with the Core Program goal, electrofishing is intended to provide baseline fishery data for the assessment of any future mine-related impacts. Permanent electrofishing reaches were established so the number of fish collected could be compared between years. Each reach is intended to encompass representative habitat types and to capture the majority of the species occurring in each stream segment. Electrofishing was conducted with Smith-Root, Inc. LR-24 Backpack Electrofisher® units. Sample reach boundaries were typically delineated by natural obstructions to fish movement (e.g., shallow riffle areas or pools). No block nets were used. Fish captured were identified to species, measured by grouping into pre-determined length bins, and released. Length bins were developed by OtterTail for this project based on general observations of fish life histories observed in the study area, and to allow for expedited processing of captured fish to reduce mortality. Additionally, bins provide a rough estimate of age. Bins selected were <45 mm, 45-55 mm, 55-80 mm, 80-120 mm, 120-300 mm, and >300 mm. Fish under 55 mm were generally considered young-of-the-year (YOY), whereas fish less than 120 mm were generally considered to be 1+ years in age. The bins were also developed to allow for quick sorting of slimy sculpin (*Cottus cognatus*) < 55 mm for the fish tissue metals analysis without having to physically handle each fish.

In 2004 surveys, OtterTail staff used a multiple-pass electrofishing method for fish collection. Consecutive electrofishing passes were conducted and fish were removed from the reach after each pass. Two passes were conducted if the number of fish removed in pass one accounted for more than 70 percent of the total number of fish collected in pass one and two. The reach was electrofished a third time if this criterion was not met. Due to concern for spawning salmon, Alaska Department of Fish and Game (ADF&G) requested that only a single- pass be conducted in 2005 and 2006, which precludes a true statistical fish population estimate for these years. However, OtterTail considers the single-pass method to represent minimum population of that stream reach. The multiple pass survey method was allowed after 2006.

Fish population estimates in the results section are based on the single-pass minimum given that first pass efficiency was consistently greater than 70 percent of the total catch and that single-pass data enables relative comparison with the Mine Access Road Program data, which was performed using the single-pass method. In addition, including the two restricted years of data in the population analysis increases the sample size and statistical power for future assessments of potential impacts.

2.4.3.2 Trapping Methods

Fish were also captured using minnow traps set outside of the electrofishing reaches to eliminate influence from the electrofishing survey. Minnow trap dimensions were 16.5 inch (41.9 cm) long, with a 7.5 inch (19.1 cm) diameter, and were constructed with 1/4 inch (0.64 cm) galvanized steel mesh. Three traps were set at each site and baited with preserved salmon eggs in the best habitats for trap use, which was typically pool habitat. Minnow traps were set for approximately 24 hours. Fish captured were identified, measured (same methods described for electrofishing in *Section 2.4.3.1*), and released.

2.4.3.3 Fish Weir Methods

Resident species were incidentally observed passing through the weir. Because these observations resulted in documentation of new species within the Crooked Creek drainage, these data were incorporated into the monitoring program. The methods used for observation of resident species are the same as those described in *Section 2.4.2* for adult salmon.

2.4.4 Crooked Creek Off-Channel Habitat Fish Sampling

2.4.4.1 Off-Channel Sampling Methods

Off-channel habitat fish sampling was conducted from September 14-16, 2013 and August 23-29, 2014. Off-channel sampling sites were sampled using a combination of electrofishing, minnow traps, and fyke nets. Dependent on individual off-channel habitat conditions, electrofishing was conducted when applicable depth and visibility were present. Electrofishing methods were consistent with methods from Core Program, as described in *Section 2.4.3.1.* Multiple locations in each habitat were sampled to ensure that all representative habitat types were sampled and to capture the majority of the species occurring in each habitat.

Minnow traps were set at all sites and were located outside of electrofishing reaches to eliminate influence from electrofishing. Minnow trap dimensions were 16.5 inch (41.9 cm) long, with a 7.5 inch (19.1 cm) diameter, and were constructed with 1/4 inch (0.64 cm) galvanized steel mesh. Three to twelve minnow traps were spaced broadly across each site, dependent on habitat size (e.g., more traps in larger habitats). Traps were baited with preserved salmon eggs and placed in the best habitats for trap use. Minnow traps were set for approximately 24 hours.

Fyke nets were placed where applicable based on habitat size and expected sampling efficiency. Setup and design of each fyke net varied depending upon the conditions at the site. Fyke net wings varied in length from 15 to 30 ft (4.6 – 9.1 m), with a height of 3 ft (0.9 m) and a 1/8 inch (3.18 mm) mesh size. Often, the fyke was set up with a center net (leader) and two wings facing downstream at approximately 30 degree angles to divert fish into the traps. In other situations, fyke nets were set with a single leader to divert fish into to the trap. Fyke net traps were baited with commercial salmon eggs and/or canned tuna fish. Fyke nets were set for approximately 24 hours. Fish captured were identified, measured (same methods described for electrofishing in *Section 2.4.3.1*), and released.

2.5 Fish Tissue Metal Concentrations Methods (Core Program)

In 2004, three key sites (CR1, CR2, and DO1) were selected for fish tissue metals analysis (**Figure 1.1-1**). Site DO1 was selected as a control site because of its location upstream of the Project and the currently active independent placer mining operation. Site CR2 is just downstream of all historic and active placer mining in the watershed and was selected to differentiate between these activities and any potential effects from the Project. Site CR1, located downstream of the proposed waste rock and tailings facilities, will be used to assess changes due to the Project. A fourth site (CR0.7) was added in 2006, downstream of the Crevice Creek confluence, to capture the predicted possible impacts due to a proposed water diversion from the Anaconda Creek drainage. Due to the fact that this site is further downstream than CR1, data gathered may be useful for the evaluation of recovery from any impacts that may be detected at CR1.

2.5.1 Target Age Class and Size Class Selection

To minimize variability in the dataset it was necessary to select a target age and size class, as well as a target fish species. Juvenile fish <55mm in total length (TL) were selected for three primary reasons:

1) Low Variability: fish in this size class rapidly accumulate potentially toxic metals. Ott and Morris (2007) documented accumulation of metals in juvenile Dolly Varden (*Salvelinus malma*) within five to six weeks after dispersing from their un-mineralized overwintering grounds to mineralized tributaries. Testing these juvenile fish increases the likelihood that metals present at the site will be detected in the fish tissue. In addition, testing juvenile fish from the same cohort is likely to reduce sample variability as those fish would be consistently exposed to one year of bioaccumulation.

2) Limited Mobility: Juvenile fish <55 mm TL, slimy sculpin in particular, have relatively limited mobility (Cunjak et al., 2005) and can reasonably be assumed to have resided in the stream reach being surveyed since birth. This would not be the case for adult fish of other species, especially with regards to migratory species such as Arctic grayling (*Thymallus arcticus*) and salmon.

3) Assurance of Age: Sampling fish <55 mm TL also improves the likelihood that the fish sampled are all of a similar age (< 1 year old). It is important to limit samples to one age class because bioaccumulation of metals in fish tissue increases with age (Bowman et al., 2010), and testing fish of different ages can skew results and increase variability in the dataset.

Early sampling indicated that slimy sculpin <55 mm TL were likely to be YOY. However, 2005 samples suggested that YOY and age-1+ fish were present in the <55 mm size class. Additional sampling was conducted in 2006 to determine whether there was difference between the year classes at this size (OtterTail, 2007). Results from this study indicated that there were no statistical differences in metals concentrations between YOY and age-1 sculpin <55 mm TL, therefore this target length (<55 mm) was considered a good criterion to minimize sample variation.

2.5.2 TARGET SPECIES SELECTION – SLIMY SCULPIN

Initially, the preferred target species for metals analysis was coho salmon due to its value as a human food source. However, juvenile and YOY salmon are known to move considerable distances from their natal stream and into side tributaries (Davis and Davis, 2010; Kahler and Quinn, 1998), and abundance of <55 mm coho salmon during the 2004 and 2005 field seasons was limited for this analysis. This uncertainty of residence time within a reach, and low assurance of capturing sufficient numbers of fish annually to conduct the analysis ruled out using juvenile salmon as a target species. Juvenile slimy sculpin are more abundant and were also collected at all sampling sites in all years of this analysis. For the purposes of this study, slimy sculpin are considered a better target species than salmon due to their limited mobility and high abundance in the study sites. Several mark-recapture studies of freshwater sculpin have found that the majority of recaptured fish move less than 50 meters (McLeave, 1964; Brown and Downhower, 1982; Hill and Grossman, 1987; Morgan and Ringler, 1992). Slimy sculpin are relatively abundant at all metal sampling sites, and are expected to continue to be abundant in these sites for future study. Sculpin are resident fish at these sites and spawning migration access is not a limiting factor as with salmon species. Consistent abundance is essential to the success of this monitoring program as large sample numbers are necessary for statistical analyses.

2.5.3 DETERMINING NUMBER OF SAMPLES

In the development of this monitoring program, multiple replicate samples were established at each site in order to conduct statistical tests. Establishing a robust baseline dataset is important for the future comparison of pre- and post-Project effects along Crooked Creek study sites. Five to six fish were used for each composite sample in order to have enough tissue for laboratory analysis of metals. Initially, a target of 15 composite samples of each species was collected from each site. Multiple years of sampling indicated that at least 90 individuals were needed at each site to obtain the target 15 composite samples. Therefore, only slimy sculpin were collected in later years of the study because salmon were not present in high enough abundance.

2.5.4 FISH TISSUE FIELD SAMPLING

Fish were collected primarily by electrofishing. Minnow traps were used at sites where samples were difficult to obtain by electrofishing. Specimens from minnow traps were kept separate to evaluate potential contamination from the metal trap frame. Clean hand techniques were used during sampling. Fish were collected and transferred directly from the sampling nets to Ziploc® freezer bags and double bagged. Fish were measured through the sample bag to prevent contamination. From 2004 to 2007, YOY and age-1+ coho and Chinook salmon were sampled along with slimy sculpin. Salmon were no longer sampled after 2007 for the reasons described above. Fish samples were frozen as soon as possible and sent to ALS Environmenat (formerly Columbia Analytical Laboratory [CAS]) in Kelso, Washington for analysis.

2.5.5 FISH TISSUE LABORATORY ANALYSIS

Laboratory analysis of the fish tissue samples was conducted by CAS, Inc. in Kelso, Washington. On November 1, 2011, the CAS laboratory was acquired by ALS Environmental, but maintained for laboratory analysis. Each composite sample consisted of homogenized whole-body fish specimens. Results are reported in wet weight (mg/kg); a dry weight correction calculation is provided in **Appendix I**.

In the laboratory, samples were frozen and stored at –20˚C. When possible, the same number of fish (usually 5 to 8) were used to create each composite, however due to the varying sizes of specimens, this was not always possible. Based upon the weights needed for each procedure and the number of fish available, the maximum number of composites (i.e. replicates) was created from each sampling site.

Whole-body fish tissue samples were freeze-dried, grinded, and homogenized prior to digestion for metals analysis. The digestion procedure for all elements, except mercury, consisted of an acid digestion and oxidation of organic materials under elevated temperature and pressure in a closed system.

For mercury analysis, a large aliquot of sample was digested, allowing representative sub-sampling of tissues. The digestion procedure incorporates similar ratios of digesting/oxidizing reagents as found in standard U.S. Environmental Protection Agency (EPA) procedures. Additional concentrated nitric acid was added to facilitate the digestion of the high organic content.

The digested material was analyzed using a combination of laboratory methods. Selenium were analyzed using GFAAS because of uncorrectable isobaric interferences when using ICP-MS. Mercury was analyzed in tissue using standard cold vapor techniques. All other elements were analyzed using ICP-MS or ICP-OES, depending on the required sensitivity. **Table 2.5-1** contains a summary of the parameters, analytical methods, and detection limits.

2.5.6 Fish Tissue Statistical Analysis

Analyses included the calculation of basic statistical summaries, box–and-whisker plots, analysis of variance (ANOVA), and estimates of percent detectable change. Statistical analyses were conducted with JMP software. Box–and-whisker plots and ANOVA[1] were used to assess differences over the nine year sample period at each site. The percent detectable change was estimated by using the grand mean of each component at each site plus or minus three times the standard deviation for that mean. In other words, the conservative assumption is that any change in the data greater than the mean plus three times the standard deviation falls outside the natural variance of the data set.

2.5.7 Supplementary Metals Analysis (Burbot and Northern Pike)

Additional metals analyses were conducted on non-target species that are important to local subsistence communities. In 2009, four burbot (*Lota lota*) were collected at site CR0.3 to test mercury (Hg) concentrations in resident fish species close to the village of Crooked Creek. Burbot, a resident fish often used as a food source by humans in the area, were collected via electrofishing and the same field and laboratory techniques listed above were applied. In 2010, two northern pike (*Esox lucious*) were collected from Crooked Creek and analyzed. Northern pike were specifically targeted as they are an important food fish for local communities, grow to large sizes and would be likely to bioaccumulate metals in their tissue. Northern pike were collected with hook and line sampling and the same field and laboratory techniques listed above were applied.

2.6 Aquatic Life Toxicity Test Methods (Core Program)

In 2008, an aquatic life toxicity test, or whole effluent toxicity (WET) test, was performed on Crooked Creek surface water collected at Site CR0.7, downstream of all existing placer mining activities and potential impacts from the Project. This toxicity test was intended to determine if the current/historical placer mining or any natural metal releases coming from the mineralized zone were causing any detectable level of toxicity to aquatic life downstream of the Project. The detection of toxic pollutants would also be important for future NPDES permitting requirements.

Toxicity testing measures the effects of pollutants in the water column on aquatic life. The test also estimates the “safe” or “no effect” concentrations of substances in the sampled water that would allow normal propagation of aquatic life. The chronic toxicity test was selected for the Crooked Creek biomonitoring program because it is more sensitive than acute testing. Therefore, if the water passes the chronic test, it can be assumed that it would have also passed the acute tests. Chronic toxicity tests are conducted over seven days as opposed to 48-hour and 96-hour acute tests.

All field and laboratory procedures followed EPA and State of Alaska guidelines. Two gallons of stream water were collected on September 22, 24, and 26, 2008 at site CR0.7 (**Figure 1.1-1**). Samples were chilled (0-6^{o} C) and express-delivered to the SeaCrest Group in Colorado for laboratory testing. Analyses were performed to determine concentrations of alkalinity, hardness, conductivity, dissolved oxygen, ammonia, chlorine, and pH (**Appendix B**).

Over a seven day period, the chronic test measures significant differences in lethality and reproduction (using the cladoceran - *Ceriodaphnia dubia*) and growth (using the fathead minnow - *Pimephales promelas*) between control and test organisms.

[1] ANOVA analysis excluded data prior to 2006, where no data was collected at site CR0.7

Test organisms were exposed to sample concentrations of 0, 12.5, 25, 50, 75, and 100 percent. Test concentrations were created by diluting the sampled stream water with moderately hard laboratory reconstituted water (sodium bicarbonate, calcium sulfate, magnesium sulfate, potassium chloride added to de-ionized water).

Individual *C. dubia* were placed in 30 ml plastic containers containing approximately 15 ml of exposure medium. Ten replicates of each concentration were used. The animals were fed daily with a mixture of yeast, cereal leaves, and trout chow (YCT). This was supplemented with an equal volume of green algae (*Selenastrum capricornutum*). The exposure medium was changed daily in each container and the number of young released overnight were counted and recorded. Young were removed from the containers daily and discarded. Measurements of temperature, dissolved oxygen, and pH before and after water changes were recorded daily.

Less than one-day-old fathead minnows, cultured in the laboratory, were exposed in 500 ml plastic cups with 250 ml of media that was replaced daily. Four replicates were used for each concentration. Ten fish were placed in each cup, monitored daily for survival, and fed live brine shrimp at least twice per day. After seven days, the fish were removed from the cups, euthanized, and then placed in aluminum pans and dried in an oven overnight at 100°C. The pans were then weighed on a five-place analytical balance to determine the average dry weight of the fish from each replicate.

Data from the tests were analyzed using TOXSTAT statistical package. Following EPA guidelines, test acceptability was determined using control survival and performance criteria, concentration-response relationships and percent minimum significant differences.

2.7 Periphyton Methods (Core Program)

2.7.1 Periphyton Sampling Methods

As an addition to the Core Program, periphyton samples were collected at these Core Program locations: DO1, FL1, DM1, QZ1, SN2, CR2, CR1, CR0.7, CR0.3, AM1, AM2, LE1, AN1, AN2, CV1, EG1, GM1, GM2, GM3, JJ1, and BL1. (**Figure 1.1-1**) between July 16 and July 24, 2014. Periphyton community data supplement the results of the macroinvertebrate monitoring and allow for estimates of water quality and relative stream health to be made within the Crooked Creek drainage.

Periphyton samples were collected using a standardized rock scrub method (Barbour et al., 1999, Slavik et al., 2004). Five representative cobbles were randomly chosen at the same riffles that were sampled for macroinvertebrates. Cobbles were selected only if they appeared to be stable in the stream bed (i.e., not recently turned over or disturbed). A plastic 35 mm photographic slide mount was used to partition a known area of the cobble surface (8.05 cm^2). The area inside the template was scrubbed with a wire brush. The brushed area, the slide template, and the wire brush were rinsed with stream water, and the resulting slurry was brought to a volume of 125 ml with stream water. Care was taken to avoid inclusion of bryophytes, liverworts, and plant material in samples. Field samples were stored in light-proof containers and preserved with Lugol's iodine solution within 12 hours of collection.

As with macroinvertebrate samples, steps were taken to reduce sampling variability, including: 1) taking five replicate samples per site to improve statistical power; 2) sampling only in riffles to standardize the habitat type in each stream; 3) collecting samples only from the top surface of rocks; 4) selecting rocks that appeared to have been stable in the stream bed; and 5) selecting rocks away from stream margins to guard against dewatered cobbles from fluctuating water levels.

Periphyton samples were processed at Aquatic Consulting and Testing, Inc. laboratory facilities in Tempe, Arizona. As needed, additional portions were acid treated and burn mounted to facilitate diatom identifications. Organism identifications were made using a Nikon Diaphot inverted phase/contrast microscope. If required, samples were concentrated using an Utermohl settling chamber. Organism densities were computed using the settling chamber, concentration factor, and micrometer-measured sample area or using Sedgwick-Rafter counting cells.

2.8 Chlorphyll A Methods (Core Program)

2.8.1 Chlorophyll a sampling methods

As an addition to the Core Program, Chlorophyll a was collected between July 16 and 24, 2014 at these Core Program locations: DO1, FL1, DM1, QZ1, SN2, CR2, CR1, CR0.7, CR0.3, AM1, AM2, LE1, AN1, AN2, CV1, EG1, GM1, GM2, GM3, JJ1, and BL1. (Figure 1.1-1). The concentrations of chlorophyll a were measured to provide an estimate of periphyton standing crop.

Methods are based on ADF&G protocol (Ott et al., 2010). Ten flat rocks (approximately 25 cm^2) were collected from submerged riffles at each site. There rocks were assumed to be submerged for at least one month prior to sampling. A 5cm^2 piece of high density foam was placed over the top of the rock. All exposed surfaces of the rock were scrubbed twice with a toothbrush and both the rock and the toothbrush were rinsed thoroughly with stream water. The foam square was then removed from the rock and the rock was scrubbed with the toothbrush and rinsed onto a 0.45 µm glass fiber filter in a filter receptacle attached to a hand vacuum pump. The area of rock under the foam square was scrubbed twice onto the filter. The toothbrush and foam square were also rinsed onto the filter and then cleaned before the next rock. Water was extracted from the sample by the vacuum pump. When the water was within ¼ in of the glass fiber filter, a few drops of saturated $MgCO_3$ was added to the sample to prevent acidification and prevent the further conversion of chlorophyll a to phaeophytin. Pumping of the hand pump continued until the filter appeared dry.

The glass fiber filter was removed from the receptacle, folded over, wrapped in a coffee filter, and placed in a sealable plastic bag with silica desiccant. Samples were stored in a light proof cooler with ice packs, until they were frozen upon return to the field camp.

2.8.2 Chlorophyll a laboratory methods

Laboratory methods were derived from Ott et al (2010) and described below. The chlorophyll a samples were analyzed by a Jenway 6715 spectrophotometer. Fresh spinach leaves were placed in a 90 percent spectrophotometric grade acetone solution covered in aluminum foil to ensure samples remained dark and soaked overnight in a refrigerator to provide a chlorophyll sample for instrument calibration. This concentration is used as the full strength solution for instrument linear check dilutions. The solution is diluted until meaningful absorption values are recorded.

Dilutions ranging from full strength down to a solution with a concentration factor that produces chlorophyll a concentrations below the sample concentrations were analyzed on the spectrophotometer and total chlorophyll a, -b, and -c were calculated using the tri-chromatic equation that is used to convert absorbance values to total chlorophyll a, -b, and -c.

Samples were removed from the freezer, the glass fiber filters were cut into small pieces, placed into individual 15 mL centrifuge tubes with 10 mL of 90 percent acetone, and soaked overnight in a dark refrigerator. Tubes were wrapped in aluminum foil to ensure they remained dark during the entire process. Samples were placed in a centrifuge and spun at 1600 rpm for 20 minutes. Samples were then decanted individually into cuvettes and absorption values at 750 nm, 664 nm, 647 nm, and 630 nm were recorded on a split beam spectrophotometer. Approximately 0.08 mL of 0.1 N HCl was added to each cuvette and the sample sat in the dark for 90 seconds. Absorption values at 750 and 665 nm were then recorded.

The spectrophotometer was zeroed using 90 percent acetone prior to analyzing samples and also routinely throughout the analyses. Filter blanks were also processed and run. Additionally, phaeophytin was calculated to determine if chlorophyll a conversion had occurred and to correct for it.

3.0 RESULTS (CORE PROGRAM)

3.1 MACROINVERTEBRATE RESULTS (CORE PROGRAM)

A list of macroinvertebrate taxa found within the Crooked Creek drainage is presented in **Table 3.1-1**. Macroinvertebrate bioassessment metrics for sites are presented in **Appendix C** and the eleven year averages of these metrics are provided in **Table 3.1-2**. Additional statistics on the 2004 through 2014 data set are included in **Appendix D; Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4**.

3.1.1 MACROINVERTEBRATE METRICS

A brief description of the macroinvertebrate metrics calculated is provided below.

Abundance - Number of organisms per square foot of stream bottom. Under certain types of stresses, this value may increase (by tolerant organisms) or decrease (excluding non-tolerant taxa), depending on stream conditions.

Total Taxa - The total number of taxa in all replicates combined for each site. Also called richness, this metric generally increases with improved biotic condition.

Total EPT Taxa - The total number of taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera from all replicates combined at a site. This value summarizes taxa richness within the orders considered to be most sensitive to pollution.

Percent EPT Taxa - The percent contribution of the orders Ephemeroptera, Plecoptera, and Trichoptera to total macroinvertebrate abundance in all replicates combined at each site. This value summarizes the percent contribution within the orders considered to be most sensitive to pollution.

Percent Dominant Taxa - The percent contribution of the most abundant taxa at each sample site (all replicates combined). Less disturbed environments tend to support communities with evenly distributed taxa rather than a large number of individuals within one group.

Percent Chironomidae - The percent contribution of the family Chironomidae at each sample site (all replicates combined). Disproportionate dominance of this generally tolerant group usually indicates poor biotic condition. However, in many Alaska streams, this is not always the case as Chironomidae tend to be abundant at high latitudes, regardless of biotic condition.

EPT/Chironomidae - The ratio of the more sensitive EPT taxa to the more tolerant chironomids. A larger ratio indicated healthier streams, whereas a smaller number (i.e., more Chironomidae) may indicate environmental stress. However, it should be noted that Chironomidae tend to dominate communities at high latitudes.

HBI - The modified Hilsenhoff Biotic Index (HBI) summarizes the overall tolerance of the benthic community to pollution on the following scale: 0.00-3.50 (excellent), 3.51-4.50 (very good), 4.51-5.50 (good), 5.51-6.50 (fair), 6.51-7.50 (fairly poor), 7.51-8.50 (poor), and 8.51-10.00 (very poor). Tolerance scores were assigned to taxa after Hilsenhoff (1987 and 1988). Tolerance values were multiplied by the number of individuals in each taxa and summed for the entire sample, then divided by the total number of individuals.

Shannon H - A diversity index that takes into account the relative abundance and evenness of each taxa. In general, H values range from 1 to 3.5, with higher values indicating high taxa diversity and better water quality; values approaching 0 suggest a less diverse community and poor water quality.

Evenness - The measure of how evenly individuals are distributed among species. Values ranging from 0.5 to 1 represent an evenly mixed community and are indicative of unpolluted streams (natural water quality condition). Values from 0.3 to 0.5 suggest some degradation (fair condition), and from 0 to 0.3 represent a skewed community composition (poor condition).

3.1.2 Crooked Creek Drainage Macroinvertebrate Community Overview

Aquatic macroinvertebrate communities found in streams within the Crooked Creek drainage are consistent with other studies of Alaskan streams (Milner and Piorkowski, 2004). In general, although macroinvertebrate communities in Crooked Creek and its tributaries are composed of taxa indicating relatively good water quality (**Table 3.1-1**), the Shannon diversity (H), evenness (e), and HBI indices (**Figure 3.1-4**) suggested that natural stressors are present in the system. A plausible explanation for this discrepancy is based on the drastic seasonal changes in habitat conditions often observed in streams in this area. Macroinvertebrate abundance and taxa richness in Alaskan streams are often strongly affected by freezing during winter, and flooding and associated movement of the stream bottom during summer (Miller and Stout, 1989). Within the Crooked Creek drainage, several of the smaller tributaries can freeze to the stream bottom during winter (NES, 1999). In addition, the underlying geology of the area causes siltation in the Crooked Creek drainage, which in turn leads to a highly armored (or embedded) stream bottom. Siltation and the resulting decreased amount of interstitial space can reduce both the abundance and taxa richness of the macroinvertebrate community, and exacerbate the effects of winter freezing by limiting the amount of habitat available for colonization.

3.1.2.1 Macroinvertebrate Metric Results

The observed dominant taxon at most sites from 2004 to 2014 was Chironomidae, which is a family generally thought to be tolerant to pollution (**Table 3.1-2; Appendix D**). The high prevalence of chironomids in the Crooked Creek drainage as well as in other Alaskan streams is due to their short life cycles and their tendency to be more tolerant of the drastic natural disturbances common in this geographical area.

In 2009 and 2010, Chironomidae were identified to genus which, in relation to previous surveys, increased the total taxa count in Crooked Creek sites by 5 to 10 taxa depending on the stream. However, Chironomidae were grouped as one taxon for consistency with previous data and to conduct multi-year comparisons (**Appendix C**). Individual chironomid genera continued to be the dominant taxa at most sites (**Table 3.1-2**). Overall, Eukieferiella and Orthocladius, two common and widespread Chironomidae genera, were the most common taxon in the Crooked Creek drainage. However, Pagastia, a genus with a low HBI tolerance value (i.e., an indicator of good water quality), was also abundant suggesting that although the high abundance of chironomids would suggest poor water quality, individual genera within this family can actually indicate good water quality conditions. This is especially important in Alaskan streams where chironomids often make up 50 percent or more of the macroinvertebrate abundance in a given stream.

In general, macroinvertebrate abundance in streams tends to be variable and highly dependent on the flow conditions. Across all sites sampled in the Crooked Creek drainage from 2004 to 2014, invertebrate abundance varied from year to year with lower abundances observed in 2007, 2008, 2011, and 2012 (**Figure 3.1-2**). The highest macroinvertebrate abundance across all sites was observed in 2010 (**Figure 3.1-2; Appendix C**).

As expected, the smaller tributary streams had lower average macroinvertebrate abundance than the Crooked Creek reference and mainstem sites (FL1, DO1, CR2, CR1, CR0.7, and CR0.3) from 2004 through 2014 (**Figures 3.1-1 and 3.1-2**). GM1, a tributary stream to Crooked Creek, was not grouped with the tributaries for this analysis because it shows consistently high macroinvertebrate abundance across all years, and is more similar to the reference and mainstem sites than to the other tributaries.

Contrary to the high annual variability in total macroinvertebrate abundance and other metrics, the variability in EPT taxa richness across years was relatively low (**Figure 3.1-3**). Higher EPT taxa was observed at Crooked Creek reference (FL1, DO1), mainstem sites (CR2, CR1, CR0.7, CR0.3), and at GM1. Given the low annual variability, EPT richness may be the most useful metric to compare pre- and post-Project effects on the macroinvertebrate community.

The Hilsenhoff Biotic Index (HBI) suggested that water quality in sites along the Crooked Creek drainage typically ranged from “very good” to “good” (**Figure 3.1-4**). However, HBI values indicating “excellent” water quality were observed at the Donlin Creek tributary DM1 and the Crooked Creek tributaries AM2, OM1 and EG1. It should be noted here that although the HBI tolerance values were developed for streams in Wisconsin, this metric is still widely used in other Alaskan studies and can be used in our study to compare sites and track changes across years.

3.1.1.2 Reference Sites: Macroinvertebrates in Upper Donlin Creek and Flat Creek Drainages

The reference sites DO1 and FL1 are upstream tributaries to Crooked Creek that appear to have similar macroinvertebrate community composition and abundance to the Crooked Creek mainstem (i.e., Sites CR2, CR1, CR0.7, and CR0.3; **Table 3.1-2; Figure 3.1-1; Appendix C**). An analysis of variance for macroinvertebrate abundance for these sites with data from 2004 to 2012 indicated that there are significant differences across years (ANOVA, $p<0.001$; df=8) and significant differences also occur across sites (ANOVA, $p<0.001$, df= 5) (sites CR2, CR1, CR0.7, CR0.3, DO1, and FL1). Total abundance in 2004, 2007, 2008, 2011, and 2012 was less than in 2005, 2006, 2009, and 2010 (**Figure 3.1-2**).

Macroinvertebrate abundance tended to be significantly greater in FL1 than in DO1, CR1.0 and CR2.0, likely due to the unique large and angular substrate in FL1. This substrate is less likely to be disturbed by increases in stream flow thus favoring the colonization of aquatic mosses and the creation of a more suitable habitat for aquatic macroinvertebrates. Similarities in total taxa richness was also observed at Sites DO1 and FL1 (**Table 3.1-2**).

Significant differences in EPT taxa were found between reference and mainstem sites (ANOVA, $p<0.05$, df=5). DO1 had significantly greater number of EPT taxa present than FL1 ($p<0.05$). Significant differences also exist across years (ANOVA based on 2004-2012 data; $p<0.001$, df=8). The similarity of these reference sites to the Crooked Creek mainstem sites, along with their relatively low annual variability in macroinvertebrate community composition and abundance, suggests that these two locations are good control sites to assess future Project-related impacts to the Crooked Creek mainstem.

3.1.1.3 Macroinvertebrates in Donlin Creek Tributaries: Dome Creek, Quartz, and Snow Drainages

Macroinvertebrate abundance was lower at the Upper Donlin Creek tributary Snow Gulch (SN2) and at Dome Creek (DM1) than at the reference (DO1, FL1) and mainstem sites (CR2, CR1, CR0.7, and CR0.3; **Table 3.1-2; Figure 3.1-1**). However, significant differences between these sites were not found when comparing data from 2007 and 2008, when all of these locations were sampled (ANOVA, $p>0.05$, df=3). Abundance at Quartz Gulch (QZ1) was similar to the reference and mainstem sites.

The observed total number of taxa and total EPT taxa appeared lower at DM1, QZ1 and SN2 than in mainstem and reference sites (**Table 3.1-2; Figure 3.1-3**). However, the difference between Site SN2 and the reference sites is only marginally significant (ANOVA, $p=0.059$, df=2). This comparison was based on the three years for which data was collected at all these sites (i.e., 2007-2009).

The overall higher number of EPT taxa and species diversity at Site DM1 than those observed at QZ1and SN2, is consistent with the excellent water quality conditions indicated by the HBI index at this site (**Table 3.1-2; Figures 3.1-3 and 3.1-4**). HBI metrics were also indicative of excellent water quality conditions at Site QZ1 and good quality conditions at reference and mainstem sites (**Figure 3.1-4**).

3.1.1.4 Macroinvertebrates in Crooked Creek Mainstem

The Crooked Creek mainstem sites (CR2, CR1, CR0.7, and CR0.3) are similar to each other in terms of macroinvertebrate abundance, species composition, and total taxa and EPT richness (**Table 3.1-2; Figures 3.1-1 and 3.1-3**). Significant differences in abundance (ANOVA, $p<0.05$, df=3) exist between sites CR0.3 and CR2 and between sites CR0.3 and CR1. In general, mainstem sites have substantially higher macroinvertebrate abundance than the tributaries to Crooked Creek, which is likely a result of stream and catchment size. The larger size of Crooked Creek mainstem reduces the likelihood of substrate freezing during winter, allowing colonization by a larger number of taxa and favors higher macroinvertebrate abundance. Although macroinvertebrate composition and abundance was similar across Crooked Creek mainstem sites, a substantial amount of variability from year to year has been observed (**Figure 3.1-2**). These annual differences in abundance at these sites was significant (ANOVA, $p<0.05$, df=4), but significant differences in EPT taxa were not found across years (ANOVA, $p>0.05$, df=4).

3.1.1.5 Macroinvertebrates in Crooked Creek Tributaries: American Creek, Grouse Creek, Omega Gulch, Anaconda Creek, Crevice Creek, Eagle Creek, Getmuna Creek, and Bell Creek Drainages

Macroinvertebrate abundance, taxa richness, and EPT richness was typically lower in Crooked Creek tributaries than in reference or mainstem sites (**Table 3.1-2; Figures 3.1-1 and 3.1-3**). The differences in abundance between tributary sites and reference and mainstem sites were significant (ANOVA, $p<0.001$, df=22). Macroinvertebrate abundance at Sites AM1 and GM4 were higher than other tributary sites. No significant differences in abundance were found between Sites AM1 and GM4 and reference Site DO1 (ANOVA, $F=0.65$, $p>0.05$), but the difference between Sites AM1 and GM4 and reference Site FL1 were significant (ANOVA, $F=6.48$, $p<0.05$).

Total and EPT taxa were also lower in GR1, OM1, AN1, AN2, CV1, EG1, GM2, GM3, GM4 and BL1 than in AM1. The total number of taxa at this site and at reference and mainstem sites was similar (**Table 3.1-2; Figure 3.1-3**). Significant differences between the total number of taxa at Site AM1 and reference Site FL1 were not found (ANOVA, $F=3.3$, $p>0.05$). However, the total number of taxa at Site AM1 and reference Site DO1 were significantly different (ANOVA, $F=4.93$, $p<0.05$). The overall abundance and composition of the macroinvertebrate communities at BL1 and at GM2 and GM3, which were sampled for the first time in 2012, were similar to what has been observed in other Crooked Creek tributaries. However, Chironomidae were found in substantially larger numbers at sites BL1, GM2, and GM3 (**Table 3.1-2**).

The average HBI for tributary sites ranged from 2.38 at OM1 to 5.27 at GM2, suggesting that water quality conditions are good to excellent (**Table 3.1-2; Figure 3.1-4**). These sites are located in relatively small channels and their overall lower macroinvertebrate abundance and total and EPT taxa may be related to freezing during winter. Site OM1 in particular has an unexpectedly low HBI value, likely due to the dominance of shredders (Plecoptera, Nemouridae) in the macroinvertebrate community at this site. The substrate of OM1 was dominated by woody debris and leaf litter, thus the dominance of Nemoura is not surprising at this site.

The downstream tributary Getmuna Creek site GM1 was significantly different from all other tributaries sites surveyed along the Crook Creek drainage. GM1 tended to have substantially higher macroinvertebrate abundance, number of taxa, and number of EPT taxa than all other tributaries sites. Macroinvertebrate composition at GM1 was similar to reference sites (**Table 3.1-2**), but abundance was typically higher than at DO1 and all mainstem sites (**Figures 3.1-1**). GM1 likely supports higher macroinvertebrate abundance because of its abundant riffle-pool habitats, low cobble embeddedness, and larger catchment size. Further, unlike most other tributary sites in this study, GM1 is also likely to provide unfrozen refugia for aquatic organisms during winter.

3.1.3 Determination of Natural Variability in Macroinvertebrate Metrics

In general, macroinvertebrate abundance at all Crooked Creek study sites appears to change substantially across years. A distinct pattern of increasing or decreasing abundance across years has not been observed (**Figure 3.1-2**). In general since 2004, higher abundances were observed in 2005, 2006, 2009, and 2010. Natural variability is an important factor in biological monitoring programs. One of the primary goals of the macroinvertebrate biomonitoring program is to document the natural variation at each site over the course of several years. A substantial amount of spatial and temporal variability in the composition and abundance of macroinvertebrates is typically anticipated because stream environments are known to be patchy and highly dependent on a variety of natural (physical, chemical, biological) factors, including stream flow and temperature.

Because of the potential natural variability in macroinvertebrate communities within a small spatial scale (e.g., within a site) five replicate samples were collected at each Crooked Creek site to reduce variance and increase statistical power. In general, the observed within site variance was negligible for all years of the study (**Figure 3.1-1**). The greatest variation was observed between sites (**Figure 3.1-1**) and across years (**Figure 3.1-2**). Reference and mainstem sites (larger catchment size) were substantially different than tributaries (smaller catchment size).

To determine whether five replicate samples were adequate to reduce variability within each site, OtterTail increased the number of replicates in 2007. That year, 20 replicate samples were collected at a single site with a riffle large enough to accommodate this number of replicates (CR0.7). We found that there were no significant differences between metrics calculated with 5-replicate samples and with 20-replicates (OtterTail, 2008). Therefore, it appears that there is no justification for increasing the sampling effort to more than the current 5 replicates per site.

3.1.4 Metals Concentrations in Mayflies and Stoneflies within the Crooked Creek Drainage

Mayflies (order Ephemeroptera) and stoneflies (order Plecoptera) were collected from sites DO1, CR2, CR1, and CR0.7 on July 18 and 19, 2011 (**Figure 1.1-1**). Results can be found in **Table 3.1-3**. In general, metals concentrations were highest at CR2. Overall, metal concentrations in stoneflies were slightly lower than those of mayflies. For most metals analyzed, aquatic macroinvertebrates showed low levels at site DO1 (reference site), rising to peak levels at site CR2, then decreasing downstream to sites CR1 and CR0.7. This pattern closely matches the pattern seen for arsenic and mercury in the Core Program fish tissue metals analysis (refer to *Section 3.3*). Particular metals that did not follow this upstream to downstream trend included cadmium, manganese, and selenium, where no consistent trend was observed (**Table 3.1-3**).

3.2 Fish Population Assessment Results (Core Program)

The fish assemblage in the Crooked Creek system is typical of tributaries to the Kuskokwim River. The fish species known to occur within the drainages sampled are shown in **Table 3.2-1**. **Figure 1.1-1** presents the estimated average annual adult salmon distribution and relative density observed by aerial surveys as well as the resident fish species occurrence within the Crooked Creek drainage. It should be noted that the uppermost extent of the salmon distribution is based on best professional judgment from OtterTail field observations. These distributions, and densities are based on aerial survey observations alone, which have their own inherent variability. Sampling date ranges and corresponding stream discharge from the USGS gauging station on Crooked Creek can be found in **Appendix E**.

Fish population assessments from 2010-2014 indicate that the Crooked Creek drainage continues to support relatively small, but viable, populations of Chinook, chum, and coho salmon. Since the construction of the fish weir in 2008, limited numbers of sockeye salmon (*Oncorhynchus nerka*) and pink salmon (*Oncorhynchus gorbuscha*) have also been documented. With the exception of the larger Donlin Creek, Bell Creek, and Getmuna Creek drainages, neither Chinook nor chum salmon have been documented in tributaries to Crooked Creek. However, limited numbers of coho salmon have been reported in several tributaries. Several other resident fish species typical of the Kuskokwim River drainage have also been found throughout the study area (**Table 3.2-1**).

3.2.1 Adult Salmon Populations

3.2.1.1 Adult Chinook Salmon

<u>Summer Aerial Survey</u>

The eleven-year average aerial Chinook salmon count for the Crooked Creek mainstem is 135 (range: 5-62; **Table 3.2-2; Figure 1.1-1**). Prior to 2014, the only tributary in which Chinook salmon were observed was Getmuna Creek. During 2014, Chinook salmon were observed in Bell Creek and Donlin Creek. On average, more than 60 percent of the Chinook run spawns in Getmuna Creek, indicating that Getmuna Creek is an important spawning tributary for Chinook salmon in the Crooked Creek watershed (**Table 3.2-2; Figure 1.1-1; Appendix F, Appendix Q**). Although Chinook numbers are low in relation to other regional salmon populations, they have been consistently observed each year and indicate that these are small viable populations.

Surveys indicate that the majority of Chinook salmon spawning occurs in lower Crooked Creek in reaches CR-R1, CR-R2, & GM-R1. In particular, reach GMR1 consistently has the most adult Chinook of any reach surveyed, with a seven year average of 18 (**Table 3.2-2; Figure 1.1-1**). Chinook salmon have been very sparsely found as far up as the upper Crooked Creek mainstem (CR-R5). Until 2014 neither adults nor juveniles of this species have been found in Donlin Creek or in other upper side tributaries. In 2014 several adults were recorded in the upper reach of Crook Creek and within Donlin Creek. Wide variations in water clarity and color have been documented year-to-year, and may influence survey efficiency (Appendix Q).

Chinook Salmon Weir Counts

The total Chinook salmon escapement through the Crooked Creek weir has continually decreased from 100 fish in 2009 to 29 fish in 2012 (**Table 3.2-3; Figure 3.2-1**). Of this number in 2012, 22 were observed passing through the weir and an estimated 7 passed through the weir on days when the weir was not operable between July 14 and July 22, 2012 (**Table 3.2-3**). The majority (64 percent) of Chinook salmon observed since 2008 were males and averaged 871 mm TL; the average size of females was 997 mm TL (**Appendix G**).

In 2010, peak run-timing for Chinook salmon occurred between July 10 and July 30, eight days longer than in 2009 with over 50 percent of the run passing through the weir before July 13, 2010. The last Chinook salmon passed through the weir on August 12, 2010 (**Table 3.2-3; Figure 3.2-1**). The onset of the Chinook salmon peak run in 2011 (including estimated counts) occurred on July 12 with over 50 percent of fish observed passing through the weir by July 14, and the last fish was observed on August 13. The peak run in 2012 appeared between July 15 and July 21, which was a shorter time interval than previous years. Over 50 percent of the observed and estimated Chinook had passed through the weir by July 18, which is four days later than the latest date from previous years. Other weir studies on tributaries to the Kuskokwim River, such as the George River (2006) and Tatlawiksuk River (2007), displayed similar peak Chinook salmon passage from approximately June 26 to July 20 (Whitmore, 2008). Further, similar to previous years, the observed diel variation in the run of Chinook salmon during 2011 and 2012 indicated that most fish passed through the weir during night time hours (**Figure 3.2-3**).

Chinook salmon accounted for approximately 2 percent of the total salmon run recorded between 2008 and 2012 (**Table 3.2-3**). This is consistent with aerial surveys conducted to date indicating that Chinook salmon account for 3 percent of the annual salmon totals in Crooked Creek (**Table 3.2-2 and 3.2-3**). Aerial surveys for Chinook salmon in 2010 accounted for 15 percent of the total Chinook salmon run recorded at the weir during the same period (**Table 3.2-6**). Slightly reduced water quality conditions experienced during the aerial surveys likely contributed to this lower aerial survey accuracy (**Table 3.2-2**). In 2011 and 2012, the aerial count accounted for 90 and 95 percent of estimated and actual weir passages, respectively, which corresponds to good water quality conditions and aerial counts conducted on all tributaries above the weir in those years (**Table 3.2-6**).

3.2.1.2 Adult Chum Salmon

Chum Salmon Summer Aerial Survey

The eleven-year average aerial count for chum salmon in the Crooked Creek mainstem is 295 (**Table 3.2-2**). In 2014, as in previous years, the distribution of chum salmon along the Crooked Creek drainage was similar to the distribution of Chinook salmon with their relative abundance decreasing with distance upstream from the mouth. Adult chum salmon have been very sparsely found as far upstream as Donlin Creek just above Dome Creek. Chum salmon have not been observed in the smaller upper tributaries of Crooked Creek or Donlin Creek. On average, nearly 50 percent of the total chum salmon run is observed in Getmuna Creek, primarily in aerial reach GMR1 (**Appendix Q; Figure 1.1-1**). Aerial surveys conducted in 2008 documented the lowest chum salmon numbers to date with only 47 chum salmon observed in the Crooked Creek mainstem. A total of 271 chum salmon were observed in the Crooked Creek drainage in 2010, 825 in 2011, 311 in 2012, 946 in 2013, and 162 in 2014 (Appendix Q,). Wide variations in survey conditions (i.e., water clarity and color) have been documented year-to-year, and often influenced survey efficiency.

Chum Salmon Weir Counts

Total chum salmon escapement in 2010 and 2011 through the Crooked Creek weir was 1,257 and 3,755 fish, respectively (**Table 3.2-3**). Of the 3,755 fish that passed through in 2011, 1,916 were estimated counts. This high number of modeled estimates was incorporated due to the inoperative camera during the peak run period for chum salmon between July 14 and

July 26. In 2012, total chum salmon escapement through the weir was 832 fish, including 169 estimated passages for four two-day periods between June 30 and July 22 (**Table 3.2-3**). As noted for Chinook salmon, most observed chum salmon passed the weir during night-time hours (**Figure 3.2-3**). Male chum salmon accounted for 51 percent of the runs recorded since 2008. The mean length was 684 mm for females and 756 mm for males (**Appendix G**).

Three peaks in counts were observed during the 2010 chum salmon run; July 5, July 15-16, and July 25-31. The median passage day was July 26 and the last chum salmon was observed on August 30 (**Table 3.2-3; Figure 3.2-2**). In 2011, the median passage day was July 20. The last chum salmon in 2011 was recorded on September 6. In 2012, the median passage day was July 20 with the last chum salmon recorded on August 30. Overall, weir data indicates that the chum salmon run in Crooked Creek is consistent with other weir studies along the Kuskokwim that suggest the peak run-timing on Kuskokwim River tributaries range anywhere from July 4 to July 25 (Costello et al., 2007; Hildebrand et al., 2007).

Between 2010 and 2012, chum salmon accounted for an average of 61 percent of the total weir escapement. This is consistent with results showing that this species accounts for 60 percent of the total salmon observed during aerial surveys conducted over the last nine years (**Tables 3.2-3** and **3.2-2**). Weir escapement numbers for chum salmon show that the aerial survey accuracy in 2010 was approximately 50 percent (**Tables 3.2-2** and **3.2-5**). The low percentage is likely due to a low run year and poor conditions for aerial surveys in lower Crooked Creek reaches. Aerial survey accuracies in 2011 and 2012 were 38 and 70 percent, respectively, which incorporated observed and modeled data for the fish weir counts. The low accuracy of the 2012 counts may have been due to the estimated water clarity (rated 3.0) during aerial surveys (**Table 3.2-2**).

3.2.1.3 Adult Coho Salmon

<u>Coho Salmon Fall Aerial Survey</u>

The eleven-year average aerial coho salmon count (fall) for the Crooked Creek mainstem is approximately 280 fish (**Table 3.2-2**). During the 2012 peak run period, flow conditions were significantly higher than normal, making visibility almost zero and were likely to substantially affect counts. Coho salmon have been consistently observed each year indicating the population is viable. As expected, coho salmon migrate further upstream than Chinook and chum salmon, with significant numbers occurring in the larger tributaries, including Getmuna, Creek, Bell Creek, and Donlin Creek, On average, these tributaries host 28, 35, and 25 percent of the total Crooked Creek coho salmon run, respectively (Appendix Q**; Figure 1.1-1**). Wide variations in survey conditions (i.e., water clarity and color) have been documented year-to-year, often influencing survey efficiency (Appendix Q).

Previous surveys showed that beaver dam success in a given year seems to influence whether or not coho salmon have access to spawning areas in upper Donlin Creek (OtterTail, 2009c). In 2010 and 2011, many dams along Donlin Creek were breached and allowed fish access to upper reaches of the drainage. Fish were observed nearly to the end of reach DOR3 in 2010 and 2011. Fall surveys have documented very limited numbers of adult coho salmon in the lower most segments of Flat Creek and Dome Creek (Appendix Q**; Figure 1.1-1**). Adult coho salmon have been observed in Snow Gulch in 2004, 2005, and 2008, but these salmon were all observed just upstream of the stream mouth. Snow Gulch has been rerouted by placer mine activities and has recently been connected to a settling pond, though the stream channel was most recently routed around the pond by a bypass channel. In the past, the pond may have acted as a migration barrier for salmon passage into Snow Gulch.

Small coho salmon populations have also been observed in other smaller Crooked Creek tributaries. The only official recording of adult salmon in American Creek was in 2008, when three adult coho salmon were observed during the aerial survey. In 2007, there was anecdotal information of one coho salmon observed at the existing winter trail crossing. Adult salmon were expected, as YOY coho salmon have been found in four of seven years of resident fish surveys (**Table 3.2-4**). Although juvenile coho salmon are known to aggressively migrate, the small size of the YOY coho salmon found suggest either adult coho salmon spawning in American Creek or nearby spawning in the mainstem Crooked Creek. Because of documentation of more than one adult coho salmon, this stream is a candidate to be included to the ADF&G catalog of anadromous waters. In addition, the single aerial survey conducted in 2008 over Grouse Creek indicated that a limited population of coho salmon occurs in this stream.

Coho salmon have not been found in Crevice Creek or Eagle Creek. A single coho salmon was observed in the lowermost reach of Anaconda Creek in 2004. Anaconda Creek and Eagle Creek have little suitable salmon spawning substrate.

Coho Salmon Weir Counts

The total escapement of coho salmon through the Crooked Creek weir was 1,212 fish in 2010 and 591 fish in 2011. An observed 714 fish were counted in 2012 and an estimated 154 passed between September 5 and September 28 while the weir was overtopped for a total of 868 fish (**Table 3.2-3**). In 2011, the weir was overtopped from August 3 to August 26, resulting in incomplete coho counts of 591 fish and modeled data did not estimate any additional passages. Consistent with peak run-timing from approximately July 23 to September 9 in other weirs along the Kuskokwim River tributaries (Crane et al., 2007), and similar to Crooked Creek weir records from the two previous years, peak coho salmon passage occurred between August 29 and September 7 in 2010, and between September 3 and September 16 in 2011. In 2012, peak coho salmon passage occurred between August 20 and Sept 8, with the median passage date on August 26, which is earlier than previous years but not outstanding (**Table 3.2-3**). During the last three years, the median passage dates were September 4, September 6, and August 26, respectively (**Table 3.2-3; Figure 3.2-2** and **3.2-4**). Similar to the other salmon species observed, coho salmon escapement occurred during night time hours (**Figure 3.2-2**). No correlation was observed between peak run-timing of coho salmon and river stage height in Crooked Creek in any year (**Figure 3.2-4**).

Overall, female fish averaging 680 mm TL accounted for 53 percent of the coho salmon escapement from 2008 to 2012; males averaged 714 mm TL (**Appendix G**). Larger male salmon dominated the early part of the run and larger females moved later through the weir. The difference in the timing of the run between male and female salmon has also been observed throughout the Kuskokwim River drainage (Molyneaux et al., 2006; Hildebrand et al., 2007).

Based on the number of coho salmon observed passing through the weir, the aerial survey accuracy in 2010 was 62 percent (**Table 3.2-6**). This is likely an underestimate given that the Bell Creek tributary was not surveyed in 2010 or previous years, and the 2011 aerial survey revealed that approximately one third of the coho salmon observed in the drainage occurred in this tributary stream. Similar to the survey conducted in 2009, the high degree of accuracy was likely a result of good aerial survey conditions, mostly water clarity. The aerial survey accuracy for 2011 and 2012 was 180 and 7 percent, respectively (**Table 3.2-6**). The large discrepancy in 2012 may have been due to the extremely low visibility as a result of ‘poor’ water clarity and the low accuracy in 2011 was likely due to the fact that coho salmon spawn in the lower reaches of Crooked Creek, including a stretch below the weir (CR-R1), which is included in aerial surveys, resulting in fish aerial numbers that are likely missed in weir counts.

3.2.1.4 Adult Sockeye and Pink Salmon Populations

Sockeye Salmon Aerial Survey

No sockeye salmon have been recorded in the Crook Creek mainstem during the 11 years of aerial surveys. However, four sockeye salmon were observed during aerial surveys in the lowermost reach of Getmuna Creek (GMR1) in 2009, only one was observed in 2010 and 2014, and four were again observed in 2011 (**Figure 1.1-1; Appendix Q**). No sockeye salmon were observed during aerial flights in 2012 and 2013 (Appendix Q). Since 2004, nine sockeye salmon have been observed during aerial surveys. These unexpected and isolated events, coupled with observations of adult sockeye salmon moving through the weir, and juveniles found at biomonitoring sites GM1 and CR0.7, indicated that only a few sockeye salmon use the Crooked Creek drainage.

Sockeye Salmon Weir Counts

A total of five sockeye passed through the weir between July 27 and August 13, 2010; six were observed in 2011 between July 16 and September 9 with an additional 10 that were estimated to have passed between July 19 and August 3; and one was observed on July 17, 2012 (**Table 3.2-3**). The aerial surveys and the weir observations conducted to date indicate that a very small sockeye salmon population use Crooked Creek and Getmuna Creek for spawning. Juvenile sockeye salmon have been observed at biomonitoring sites CR0.7 and GM1, further indicating that sockeye salmon use the Crooked Creek drainage.

Compared to other salmon, little is known about the distribution and abundance of Kuskokwim River sockeye (Costello et al., 2007). Although juvenile anadromous sockeye salmon typically require lake rearing areas (Burgner, 1991), some sockeye salmon populations spawn in river systems without connected lakes. The ecological contribution of these atypical “river type” sockeye salmon on the Kuskokwim drainage may be larger than previously believed (Costello et al., 2007). Gilk et al. (2011) found that tributaries with no associated lake system accounted for 81 percent and 78 percent of the total tributary sockeye salmon tag recovery distribution in the mainstem Kuskokwim River and its main tributaries in 2006 and 2007, respectively, including fish from the Holitna River, Aniak River, Oskawalik River, and George River.

Pink Salmon Aerial Survey

Because of their small size and neutral coloration, pink salmon can be mistaken for resident species during aerial surveys and therefore are not a target species. A single pink salmon was observed just upstream of the fish weir during an aerial survey in 2011. Identification was verified on the ground after the survey.

Pink Salmon Weir Counts

The 2009 peak run-timing for pink salmon occurred between July 20 and July 31. With only five pink salmon observed in 2010, four in 2011, and 17 in 2012, a clear peak passage at any time throughout these seasons was not observed (**Table 3.2-3; Figure 3.2-1**). In 2010, all pink salmon were observed before June 30th and in 2011 the first two fish were observed on July 14 and the last one on August 18, showing a long distribution for the run. In 2012, the run occurred between July 18 and August 11, with a median passage date of July 26 (**Table 3.2-3**). The eight pink salmon observed at the weir in 2008 was the first documentation of this species in the Crooked Creek drainage (OtterTail, 2009b) and suggested their population is small. However, the pink salmon totals through the Crooked Creek fish passage chute could be an underestimate as some of the smaller individuals of the pink salmon run could potentially swim between the weir pickets. It should also be noted that no weir data was recorded from July 19 to August 3, 2011, which could have affected total fish counts for this year and no additional fish counts were estimated in the model.

This species typically follows a fixed two-year life cycle that results in genetically distinct odd- and even-year runs. Alaska pink salmon runs typically follow an even-numbered year increase (ADF&G, 2004) but this may vary by river drainage and over time. The data does not allow for a clear comparison and therefore any conclusions to be drawn. Multiple years of weir data will be needed for an accurate assessment of odd- or even-year peaks within Crooked Creek.

Unlike the other four salmon species that use the Crooked Creek drainage, the pink salmon run did not follow the distinct diel run-timing pattern with most fish swimming upstream during night time hours. Often, they would pass through the weir in the middle of the day, and would rarely pass through in conjunction with other pink salmon.

Little is known about pink salmon abundance in the Kuskokwim River drainage, but they generally make less extensive spawning migrations into freshwater than other Pacific salmon species (Heard, 1991). The relatively few pink salmon that return to spawn in upper Kuskokwim River tributaries are among the farthest-known migrating pink salmon in the world. Continued monitoring is needed to better understand the population dynamics of this unique stock and their importance to the ecosystem (Hildebrand et al., 2007).

Future years of weir and aerial survey data should allow for more detailed comparisons and trend observations of salmon species using the Crooked Creek drainage. This also ought to allow for better accuracy between annual aerial and weir counts (**Table 3.2-5**).

3.2.1.5 Salmon Redd Counts

Salmon redds were enumerated in the Crooked Creek watershed from 2009 through 2014. Redd surveys were conducted concurrently with the adult salmon aerial surveys. Summer redd surveys were conducted on July 19-22, 2009; July 24-25, 2010; July 21-22, 2011; July 20-24, 2012; July 25-28, 2013; and July 26, 2014. Fall redd surveys were conducted on September 13-15, 2009; September 17-18, 2010; September 15-18, 2011; September 19-24, 2012; September 17-19, 2013; and September 18-20, 2014.

On average, 165 redds are documented each year in the Crooked Creek watershed during summer redd surveys. Summer redds tended to be more abundant in the lower watershed, with 95 percent of summer redds occurring in the mainstem Crooked Creek occurring in the lower reaches CRR1 and CRR2 (**Figure 1.1-1; Appendix F**). A similar trend was noted in Getmuna Creek, with 93 percent of redds documented in Getmuna Creek occurring in the lower reach GMR1 (**Figure 1.1-1; Appendix F**). Adult salmon aerial counts also show Chinook and chum salmon preferences toward these lower reaches (CRR1, CRR2, and GMR1; **Table 3.2-2**). Although redds were not associated with a specific salmon species, Chinook and chum salmon are the most abundant species present during summer surveys.

Fall redd surveys have documented a five year average of 288 redds in the Crooked Creek watershed. Although redds were not associated with a specific salmon species, adult salmon aerial surveys conducted concurrently show, as expected, coho salmon to be the most abundant species present during fall surveys. Fall redd surveys show the tendency of coho salmon to spawn higher in the watershed and in tributaries. On average, the Crooked Creek tributaries Donlin Creek, Getmuna Creek and Bell Creek accounted for 20 percent, 25 percent and 20 percent of all fall redds respectively. Redds have been documented as high up in the watershed as upper Donlin Creek reach DOR3, upper Getmuna Creek reaches GMR3 and GMR4, and upper Bell Creek reaches BLR2 and BLR3 (**Figure 1.1-1; Appendix F**).

Indicative of coho salmon spawning preferences, fall redds have also been documented in several small tributaries including Dome Creek (DMR1), American Creek (AMR1), and an unnamed tributary to the South Fork of Getmuna Creek (49.0 Creek, reach FNR1; **Appendix F**).

Redd counts represents a point-in-time count, and should be considered a peak count rather than a total redd count. As with adult salmon aerial surveys, wide variations in survey conditions (i.e., water clarity and color) have been documented year-to-year, and may influence survey efficiency (Appendix Q).

3.2.2 Resident Fish and Juvenile Salmon Populations

Resident species in the Crooked Creek drainage are typical of other tributaries in the Kuskokwim River drainage. We observed stable populations of slimy sculpin, Dolly Varden, burbot, and Arctic grayling. Small populations of nine-spine stickleback (*Pungittius pungittius*), longnose sucker (*Catostomus catostomus*), Alaskan brook lamprey (*Lampetra alaskensis*), Alaska blackfish (*Dallia pectoralis*), and round whitefish (*Prosopium cylindraceum*) were also present. Slimy sculpin was typically the most abundant species and were consistently found at all sample sites except Dome Creek, Quartz Creek, Snow Gulch, Lewis Gulch, Omega Gulch, upper Anaconda Creek, and two unnamed creeks (AC and BC; **Tables 3.2-4** and **3.2-7**).

As described in the methods section, the electrofishing multiple pass removal method was only approved by the ADF&G in 2004, 2007, 2008, and 2009. Although multiple-pass population estimates could not be calculated for 2005 and 2006, relative one-pass population estimates for these years provide a minimum population size estimate for each reach. To conduct year to year comparisons, all fish population estimates are based on one-pass data (**Table 3.2-4**).

As in previous years, juvenile coho salmon were present in many of the sites surveyed throughout the Crooked Creek drainage in 2010, 2011, and 2012. However, a substantial decline was observed in the juvenile coho salmon population from the 2009 peak that followed a high count of adults in the weir during the previous year. Fish population summaries are provided in **Table 3.2-4**.

3.2.2.1 Reference Sites: Upper Donlin Creek and Flat Creek

Upper Donlin Creek (DO1)

Upper Donlin Creek was not sampled in 2013 or 2014, but in previous years it supported populations of slimy sculpin, Dolly Varden, burbot, Arctic grayling, and juvenile and adult coho salmon. Juvenile Chinook salmon have not been found at this site. Coho salmon YOY have been found every year, except 2011, suggesting that this reach, or one nearby, is likely used by coho salmon for spawning and rearing. Overall, slimy sculpin and coho salmon juveniles appear to be the most abundant species at this site; Dolly Varden, Arctic grayling, and burbot were fairly common. The round whitefish, a species that had not been observed in previous surveys, was found at this site in 2010 and 2011 (**Table 3.2-6**).

From 2004 through 2012, the electrofishing reach at DO1 had an average population of 143 fish per 300 ft per year. Population size at DO1 ranged from 45 fish per 300 ft in 2007 to 313 fish per 300 ft in 2009. In 2011, 78 fish per 300 ft were collected at this site and 51 fish per 300 ft were collected in 2012 (**Table 3.2-6**). Coho salmon were not observed in this site in 2011. The annual variability in the size of the overall fish assemblage is largely driven by the variability in abundance of juvenile coho salmon. This variability is most likely attributed to changes in both adult spawner return (natural recruitment) and access to spawning grounds (successful passage past beaver dams).

The angling surveys indicated an abundance of Arctic grayling in large pool habitat (OtterTail, 2007). These surveys confirm this upper section of Donlin Creek is used by Arctic grayling for summer feeding. More recent surveys at Site DO1 also have found juvenile Arctic grayling, suggesting that at least some spawning may occur in this stream section.

Flat Creek (FL1)

Flat Creek was not sampled in 2010, 2011, 2012, 2013, or 2014 but in previous years, coho salmon, Dolly Varden, Arctic grayling, round whitefish, slimy sculpin, and burbot have been found in this site. The total number of fish observed in this reach has ranged from 65 fish per 300 ft in 2004 to 242 fish per 300 ft in 2009. The annual average number of fish captured at this site is 137 fish per 300 ft (**Table 3.2-4**).

Slimy sculpin has consistently been the most dominant species at Site FL1. Coho salmon appear to use Flat Creek for rearing of young in very limited numbers and possibly by adults for spawning. The only adult coho salmon observed at this site was reported in the 2008 aerial survey (**Table 3.2-2**), suggesting that coho salmon spawning could occur in this drainage. However, it is also possible that this single adult in could have been a stray, as it was observed near the mouth of Flat Creek. This creek is not currently on the ADF&G anadromous catalog (ADF&G, 2004), and the single adult coho salmon observed in 2008 does not provide enough evidence to change that status. Further, no Chinook or chum salmon of any life stage have been observed in this creek (**Table 3.2-4**).

Species composition at Flat Creek and Donlin Creek is very similar, but substantially more juvenile and adult coho salmon have been observed at Donlin Creek. YOY fish (TL < 55mm) have been observed consistently at both creeks, indicating that rearing occurs in these drainages.

3.2.2.2 Donlin Creek Tributaries: Dome Creek, Quartz Gulch, and Snow Gulch Drainage Results

Dome Creek (DM1)

Site DM1 was not sampled in 2010, 2011, 2012, 2013, or 2014. The 2008 and 2009 resident fish surveys found Dolly Varden as well as juvenile and adult coho salmon in Dome Creek, with a two year average of 55 fish per 300 ft (**Table 3.2-4**). Juvenile coho salmon were found in relatively abundant numbers in 2009 and adult coho salmon have been observed in both years of the aerial surveys (**Tables 3.2-5** and **3.2-2**).

Quartz Gulch (QZ1)

No fish were observed in Quartz Gulch during 2009 surveys (**Table 3.2-4; Appendix H**). There is very little suitable habitat and it is not likely that overwintering could occur in the drainage. This site was not sampled in 2010, 2011, 2012, 2013, or 2014.

Snow Gulch (SN1 & SN2)

Fish habitat in Snow Gulch is limited by the drainage's small size. As described above, previous aerial spawning surveys documented coho salmon in the lower reach. Placer mining activities have filled in the migration corridor and likely preclude coho salmon and other resident species from moving past this obstruction to upper mainstem portions of this stream. Survey site SN2 is located well above ongoing independent placer mining activities.

Qualitative fish sampling at sites SN1 and SN2 was conducted in 2006 to determine which species were present (**Figure 1.1-1**). In 2007, the objective shifted to a comprehensive biomonitoring survey within Snow Gulch; SN2 was selected as the site to permanently add to the program.

Sites SN1 and SN2 were not sampled in 2010 or 2014, but previous surveys showed that the only fish species occurring in these reaches was Dolly Varden. This species was observed in 2011, 2012 and 2013 at SN2 with an annual average approximately 3 fish per 300 ft (**Table 3.2-4**). All Dolly Varden collected were over 80 mm TL, except in 2013, where no fish captured was greater than 55 mm TL.

3.2.2.3 Crooked Creek Mainstem

Crooked Creek Mainstem at CR2

Crooked Creek was sampled just downstream of all historic and current placer mining at site CR2 (**Figure 1.1-1**). CR2 was not sampled in 2014; however, previous surveys found juvenile coho and Chinook salmon, Dolly Varden, Arctic grayling, round whitefish, slimy sculpin, burbot, and Alaska blackfish have been found (**Table 3.2-4; Figure 1.1-1**). The total number of fish captured at this reach ranged from 81 fish per 300 ft in 2008 to 314 fish per 300 ft in 2010. The annual average number of fish captured at this site was 199 fish per 300 ft. Slimy sculpin was consistently the most abundant species at CR2 (**Table 3.2-4**). Juvenile Arctic grayling and Dolly Varden were found at this site, suggesting they may overwinter this far upstream in the drainage. Burbot, round whitefish, and Alaska blackfish were also found in low abundance (**Table 3.2-4**).

From 2004 to 2012, juvenile coho and Chinook salmon have been found at Site CR2 in low numbers (**Table 3.2-6**). This is consistent with aerial surveys that have documented adults of both species in the reach. Coho salmon fry abundance was higher than Chinook salmon in this stream segment. Juvenile coho salmon abundance has remained substantially lower after 2005; neither one of these species was observed at this site in 2011 and only a few juvenile coho salmon were found in 2012. Although aerial surveys and field observations documented limited numbers of chum salmon spawning in this reach, no juveniles were found during the electrofishing surveys, likely because fry migrate downstream soon after hatching.

Crooked Creek Mainstem at CR1

Crooked Creek site CR1 was originally established to assess all potential impacts to Crooked Creek from the Project. However, given that potential impacts to Crevice Creek could influence Crooked Creek further downstream of CR1, this location will be used to assess potential impacts associated to the tailings impoundment (located within Anaconda Creek) and the mine pit and waste rock facilities (located within American Creek; **Figure 1.1-1**).

CR1 was not sampled in 2014; however, previous surveys found these species: Dolly Varden, Arctic grayling, round whitefish, slimy sculpin, burbot, nine-spine stickleback, and juvenile and adult coho and Chinook salmon. Juvenile chum salmon were not found during electrofishing surveys likely due to their downstream migration soon after emerging from the gravel. However, the aerial surveys document that chum salmon spawn in this area in limited numbers (**Table 3.2-2**). The dominant species in this site are slimy sculpin followed by coho salmon. YOY round whitefish and Arctic grayling were found in limited numbers suggesting they likely overwinter in high elevation reaches of the drainage. Excluding the 2013 backwater fish sampling, site CR1 is also the only site in the Crooked Creek drainage where nine-spine stickleback have been observed. Dolly Varden and burbot were found in limited numbers (**Table 3.2-4; Figure 1.1-1**).

Overall, fish population estimates have ranged from 146 fish per 300 ft in 2012 to 1,248 fish per 300 ft in 2009. The eight-year average was 467 fish per 300 ft (**Table 3.2-4; Figure 1.1-1**). A total of 637 fish per 300 ft were captured in 2011 and 146 fish per 300 ft were captured in 2012 a substantial decline from the 2009 total, which was largely driven by the 832 juvenile coho salmon observed that year (compared to the average of 110 coho per year) (**Table 3.2-6)**.

Crooked Creek Mainstem at CR0.7

Mainstem Site CR0.7 was added to the biomonitoring program in 2006 to assess potential impacts from Crevice Creek (**Figure 1.1-1**). Because of their proximity, the fish assemblages at Sites CR0.7 and CR1 were fairly similar. The population total over the seven years of sampling ranged from 166 fish per 300 ft in 2012 to 787 fish per 300 ft in 2010, and the annual average number of fish captured was 442 fish per 300 ft (**Tables 3.2-4**). The only additional species at CR0.7 were Alaska blackfish, longnose sucker, and juvenile sockeye salmon, which were found in limited numbers. Juvenile sockeye salmon have only been observed in this site during the surveys conducted in 2009 and 2010; these are the only records of juvenile sockeye salmon in the Crooked Creek mainstem. CR0.7 was not sampled in 2013 or 2014.

Crooked Creek Mainstem at CR0.3

Site CR0.3 was added to the biomonitoring program in 2006 near the mouth of Crooked Creek to fully encompass the watershed and to provide a site to monitor recovery in the event that effects are documented in the upper watershed (**Figure 1.1-1**). As expected, most of the species found in the drainage also occur at Site CR0.3. The Alaska brook lamprey has not been found at any other site within the Crooked Creek drainage. Both longnose sucker and Alaska brook lamprey were found during most surveys, suggesting viable populations exist in this lowermost reach of Crooked Creek (**Table 3.2-4**).

Total fish captures at Site CR0.3 have ranged from 236 fish per 300 ft in 2007 to 452 fish per 300 ft in 2010. On average, 323 fish per 300 ft have been captured at this site on an annual basis (**Table 3.2-4; Figure 1.1-1**). Site CR0.3 was not sampled in 2011, 2012, 2013, or 2014.

3.2.2.4 Crooked Creek Tributaries: Queen Gulch, Lewis Gulch; American Creek, Grouse Creek, Omega Gulch, Anaconda Creek, Crevice Creek, Eagle Creek, Unnamed Creek (BC), Unnamed Creek (AC), Getmuna Creek, and Bell Creek

Queen Gulch (QU1)

In 2010, an electrofishing survey documented no fish in site QU1 and subsequent surveys have not been carried out because aquatic habitat is very limited near the sampling site and independent placer mining operations have heavily affected the lower portions of this stream (**Table 3.2-4; Figure 1.1-1**).

Lewis Gulch (LE1)

No fish were found at Site LE1 in 2009 during the only survey that has been conducted at this site (**Table 3.2-4**). Much like the 2006 Snow Gulch surveys, the sampling at LE1 consisted of qualitative fish sampling at various sites to determine which species were present. Lewis Gulch has been re-routed by independent placer mine activities and the lowermost reach is a manmade canal that diverts water into Crooked Creek just upstream of biomonitoring site CR2 (**Figure 1.1-1**). Lewis Gulch has not been sampled since 2009.

American Creek (AM1 and AM2) – Proposed Waste Rock and Mine Pit Location

In 2010, only the site AM2 was surveyed and this effort resulted in the capture of a total of 57 fish/300 ft, all of which were Dolly Varden (**Table 3.2-6**). Previous surveys in Site AM1 have reported good numbers of resident Dolly Varden and slimy sculpin (**Table 3.2-4; Figure 1.1-1**). A limited number of Arctic grayling and burbot have also been found during resident fish surveys in deep pool habitat. Coho salmon juveniles (both YOY and age 1+) were found four out of six years, suggesting that limited spawning may occur in this drainage. Supporting this conclusion, aerial surveys documented limited adult coho salmon use in this drainage (**Table 3.2-2**). The small size of American Creek limits its potential as a significant coho salmon stream.

The annual population estimate for all fish species in American Creek at AM1 ranged from 11 fish per 300 ft in 2011 to 114 fish per 300 ft in 2005, with a mean of 56 fish per 300 ft. Only 11 fish were observed at this site in 2011 (**Table 3.2-6**). The wide range population estimates can be explained, in part, by better water clarity in 2005, 2006, and 2009 that allowed a better capture rate for slimy sculpin, which was the species driving the annual differences. The NES (1999) winter-use survey found that surface flow was discontinuous within American Creek during winter, so overwinter fish distribution may be limited to localized unfrozen areas. Due to the 2008 aerial survey documenting the presence of three adult coho salmon, this stream has been added to the ADF&G anadromous stream catalog. In 2012 no fish were collected at sites AM3, and AM4, which were established in 2011 to document fish presence in the upper portions of the watershed. American Creek was not sampled in 2014.

Grouse Creek (GR1)

Grouse Creek was only surveyed in 2008. The 2008 resident survey found only two species, Dolly Varden and slimy sculpin, with a total of 38 fish per 300 ft (**Table 3.2-4**). This species assemblage was expected for this reach based on its substrate, flow, and location within the drainage. It is possible that coho salmon use this drainage for spawning, but no juvenile coho salmon were found in 2008. However, adult coho salmon were observed in the lower drainage during the aerial survey indicating they likely use Grouse Creek in some capacity (**Figure 1.1-1**).

Omega Gulch (OM1)

Site OM1 was electrofished in 2009 to document the fish species assemblage. No fish were captured in limited aquatic habitat (**Table 3.2-4**).

Anaconda Creek (AN1 and AN2) – Proposed Tailings Impoundment Location

Surveys of Anaconda Creek have documented the presence of low numbers of burbot, slimy sculpin, and Dolly Varden at AN1. In addition, Arctic grayling, burbot, and coho salmon were observed just downstream of this site in 2011 (**Table 3.2-6; Figure 1.1-1**). AN1 is located approximately 0.25 miles (0.4 km) upstream of the mouth, immediately upstream of the winter trail. Aerial surveys documented the presence of one adult coho salmon in 2004, just upstream of its mouth and downstream of the winter trail crossing (which is also site AN1). Due to the thickness of the riparian canopy and the deep narrow channel, it is possible that other coho salmon were overlooked during the fall helicopter surveys. However, the presence of an adult salmon population in Anaconda Creek appears unlikely. Spawning habitat is very limited, as silt is the dominant substrate type. The lower portion of Anaconda Creek has been added to ADF&G's anadromous stream catalog.

Lower Anaconda Creek's (AN1) annual fish population ranged from two fish per 300 ft in 2004 to 36 fish per 300 ft in 2011, with a mean of 15 fish per 300 ft (**Table 3.2-6**). The 2008 trapping survey documented 26 slimy sculpin, but in other years, trapping abundance averaged 1 fish/trap (**Appendix H**). The difference in electrofishing survey abundance between years appeared to be a direct result of turbid water conditions in 2004 and 2008, reducing the survey effectiveness considerably compared to surveys done in the other five years. This stream is highly turbid during rainfall, and its silt-dominated substrate and correspondingly low macroinvertebrate production are likely important factors limiting fish abundance (**Appendix E**).

In 2006, an additional site was added in upper Anaconda Creek (AN2) to document the fish population in this stream segment that is proposed to be filled (**Figure 1.1-1**). Dolly Varden have been consistently found at this site, with an average abundance over four years of 3 fish per 300 ft (**Table 3.2-4**). Some sand and gravel substrate occurs in the upper Anaconda Creek reach, but the majority of this reach is heavily incised and has silt substrate similar to the lower section. The limited number of YOY fish observed during resident surveys along reaches AN1 and AN2 could indicate potential freezing during winter and/or unsuitable habitat for this life stage. Consistently, macroinvertebrate indicator species found at this site such as Perlodidae are also found in little or no abundance some years suggesting freezing or other natural disturbances occur some years (refer to *Section 3.1.1.5*). Anaconda Creek was not surveyed in 2014.

Crevice Creek (CV1)

Site CV1 was not surveyed in 2010, 2011, 2012, 2013, or 2014, but Dolly Varden and slimy sculpin have been documented at this site in previous surveys (**Table 3.2-4; Figure 1.1-1**). A large discrepancy in slimy sculpin abundance occurred over the four year period, with 134 fish per 300 ft in 2006 and an average of 11 fish per 300 ft in subsequent years (**Table 3.2-6**). Unlike the comparably sized Anaconda Creek, the predominant gravel substrate in many sections of the Crevice Creek reach provides more favorable fish habitat conditions.

Eagle Creek (EG1)

Eagle Creek (EG1) was added to the Project in 2009. A small population of Dolly Varden, slimy sculpin, and burbot were observed in this site (**Figure 1.1-1**). Similar to Anaconda Creek (AN1), the stream channel at EG1 is very incised and dominated by silt substrate. This site was not surveyed in 2010, 2011, 2012, 2013, or 2014.

Unnamed (BC1)

In 2010, Site BC1 was surveyed to document the fish species assemblage. One Dolly Varden was captured during the electrofishing survey and 3 more were captured with minnow traps. No other species were documented (**Table 3.2-4; Appendix H**). This site was not surveyed in 2014.

Unnamed (AC1)

Site AC1 was only surveyed in 2010 to document the fish species assemblage. No fish were captured in the electrofishing survey or minnow traps (**Table 3.2-4; Appendix H**).

Getmuna Creek (GM1, GM2, GM3, and GM4)

Getmuna Creek (GM1) was added to the program in 2007 to document aquatic baseline conditions. This drainage had been identified as the location for a gravel mine to supply material for the construction of the proposed Donlin-Jungjuk road. The sample reach has similar aquatic biota diversity to the lower Crooked Creek mainstem sites illustrating that it is an important tributary (**Table 3.2-4; Figure 1.1-1**). Getmuna Creek sites (GM2, GM3, and GM4) were added in 2012 to incorporate potential impacts in proximity to the proposed gravel mine.

Getmuna Creek (GM1) was not surveyed in 2010, 2011, 2012, 2013, or 2014. The number of fish captured at this site in previous surveys ranged from 199 to 802 fish per 300 ft, and averaged of 518 fish per 300 ft (**Table 3.2-4**). Six of the seven species identified in Getmuna Creek were salmonids (**Table 3.2-1; Figure 1.1-1**). The 2009 study documented the highest abundance of slimy sculpin throughout the Crooked Creek drainage with a total of 536 fish per 300ft (**Table 3.2-6**). To date, aerial surveys along Getmuna Creek have consistently found relatively high numbers of Chinook, chum and coho salmon, and low numbers of sockeye salmon (**Table 3.2-2; Figure 1.1-1**).

In 2012, Getmuna Creek sites GM2, GM3, GM4 were added to document fish populations in close proximity to the proposed gravel mine that may be affected from future impacts to the system (**Figure 1.1-1**). The two resident species found at all three sites were Dolly Varden and slimy sculpin ranging from 6 fish per 300 ft to 36 fish per 300 ft and 31 fish per 300 ft to 59 fish per 300 ft, respectively (**Tables 3.2-4** and **3.2-6**). A single Arctic grayling was captured at GM2. Juvenile coho salmon were captured at all three sites ranging in abundance from nine fish per 300 ft to 31 fish per 300 ft (**Tables 3.2-4** and **3.2-5**). Of these three sites, only GM3 was sampled in 2013 and 2014.

Bell Creek (BL1)

Bell Creek (BL1) was added to the Project in 2011. Fish species observed in this site during 2011 and 2012 surveys include Chinook and coho salmon, Dolly Varden, Arctic grayling, round whitefish, slimy sculpin, and nine-spine stickleback. The predominant species was slimy sculpin accounting for 88 percent of the 113 fish per 300 ft (**Table 3.2-4**). BL1 was not sampled during 2014.

3.2.2.5 Crooked Creek Weir - Resident Fish

The Crooked Creek weir was added to the Program in 2008 to document the entire adult salmon escapement through the Crooked Creek drainage. The weir system is designed to allow smaller resident species to pass between the weir pickets. However, some resident fish choose to pass through the video box and those species are also counted and measured via video data.

Resident species observed at the weir include Dolly Varden, Arctic grayling, round whitefish, longnose sucker, slimy sculpin, lamprey (unidentified), burbot, rainbow trout (*Oncorhynchus mykiss*), humpback whitefish (*Coregonus pidschian*), and northern pike. Of these, the latter three species had not been previously documented within the Crooked Creek drainage. Total counts of each species observed at the weir can be found in **Table 3.2-7**. Because smaller resident species can pass through the pickets of the weir, the non-salmon counts are provided only for general information and cannot be used as population estimates.

3.2.3 Crooked Creek Backwater Fish Sampling Results

Twelve backwater habitats were sampled for fish species composition in 2013 and 14 backwaters were sampled in 2014 (Figure 3.2-5). A total of 8 species were collected including: juvenile coho salmon; Dolly Varden; Arctic grayling; slimy sculpin; Northern pike; Alaska blackfish; burbot; and nine-spine stickleback (**Table 3.2-8**). Of the species collected, only nine-spine stickleback were found at each of the 14 sites and were the dominant species with 797 fish, across all sampling methods (**Table 3.2-8**). Juvenile coho salmon were collected at 11 of the 14 sites with a total of 572 fish. The highest occurrence of 167 fish was collected from BW_07 (**Table 3.2-8**). Alaska blackfish comprised 349 fish and were found at 11 of the 14 sampling sites. Burbot, slimy sculpin, Arctic grayling, Dolly Varden, and northern pike were collected in limited numbers (**Table 3.2-8**). During the survey, Crooked Creek was flowing at above average flows, making these backwater habitats velocity refugia for juvenile fish. These data suggests that off-channel habitat is important for juvenile coho salmon and resident fish species found within the Crooked Creek drainage.

3.3 Fish Tissue Metal Concentration Results (Core Program)

Extensive fish tissue sampling has been conducted as part of the aquatic biomonitoring program since 2004. A consistent pattern of increasing or decreasing metal concentrations across years or sites has not been observed. Metals concentrations were generally lower in 2009 than in previous years but an increase to levels observed in previous years was noted in 2010, 2011, and 2012 (**Figures 3.3-1 through 3.3-11**). Metal concentrations observed thus far display considerable variability from year to year but well below levels that are toxic to humans and other organisms (ADEC, 2009; **Appendix P**). All fish tissue metal concentrations presented are based on wet weight. A wet weight to dry weight conversion for the sampled fish, slimy sculpin, is available in **Appendix I**.

Since 2012, we continued to observe low variance in slimy sculpin tissue samples at each site, suggesting that 15 replicate composite samples collected at each location are adequate to accomplish the objectives of this biomonitoring program (**Table 3.3-1; Appendix J**). In addition, data continues to suggest that juvenile slimy sculpin (< 55 mm TL) is the optimal species to use for long-term monitoring of metals in fish tissue due to the sample size needed for the analyses and the observed low variability in metal concentrations among the replicates collected at each site (**Table 3.3-1; Figures 3.3-1** through **3.3-11; Appendix K**). Potential changes in metals concentrations in Crooked Creek resulting from the Project can be detected by slimy sculpin tissue analyses.

Given that increased precipitation can lead to increased surface runoff and transportation of minerals and metals into stream channels, it was hypothesized that the annual variation in metal concentrations could be caused, in part, by annual variations in precipitation and stream flow. High precipitation and stream flows were observed in 2010. Drier years, such as 2009, appear to be associated with lower metal concentrations in fish tissues. To test this hypothesis we ran a series of simple regressions between the average concentration of each metal constituent (i.e., all sites combined) and the total annual discharge from 2004 to 2012. Given that continuous flow data at Crooked Creek is not available before 2007, we used flow data from the USGS gage station on the Kuskokwim River at Crooked Creek (Station 15304000). Results show that the only metal for which there is a significant relationship between annual discharge and concentration is copper (r^2= 0.56, t=2.94, df=6, p=0.03); a marginally significant relationship between discharge and manganese concentration was also noted (r^2= 0.44, t=2.4, df=6, p=0.06). These results suggest that there are other unknown factors that influence the annual variability in metal concentrations.

Fish tissue metals analysis was conducted on Getmuna Creek at site GM3 in 2012, 2013, and 2014. Getmuna Creek is a tributary to Crooked Creek; therefore GM3 was not included in the core program metals statistical analysis (**Figures 3.3-1 through 3.3-11**). Two year average mercury concentrations were 0.059 mg/kg, a 45 percent higher concentration than the highest average concentration for mainstem Crooked Creek site CR2, which averaged 0.041 mg/kg over nine years of sampling (**Table 3.3-1**). Copper concentrations were also significantly higher than concentrations found in the mainstem of Crooked Creek (**Table 3.3-1**). Higher concentrations of mercury and copper are likely due to different underlying geology in the Getmuna watershed.

3.3.1 Variability in Metal Concentration across Years and Sites

We analyzed the annual variability in tissue metal concentrations at each site to assess natural changes in background levels. As stated previously, the underlying reasons for natural changes in metals concentrations are largely unknown.

Across all sites, mercury, selenium, and zinc tended to have the smallest coefficients of variation (CV) (**Table 3.3-1**). Therefore, future increases in the concentration of these metals above background levels may be more easily detected than other metals.

A two-way ANOVA test to assess changes in metal concentrations across sites and years indicated that significant annual differences were evident for all metals except iron, lead, and manganese. Significant differences across sites were only evident for arsenic, cadmium, manganese, and mercury (**Table 3.3-2**).

As observed in previous years, samples collected at Site CR2 during 2010 and 2011 appeared to have higher concentrations of arsenic than samples from any other site (**Figure 3.3-2**). It should be noted that a drainage ditch from an active placer mining operation flows into Crooked Creek just upstream of this site. In 2010, trapping mortalities for coho salmon were observed in the effluent of this ditch. A Tukey-Kramer HSD test indicated that the concentration of arsenic at CR2 is significantly higher than the concentrations at other sites (q=2.79, alpha=0.05). Consistently across all years, low arsenic concentrations have been observed at Site DO1 (the reference site; **Figure 3.3-2**). Arsenic appeared to decrease consistently from 2006 to 2009 at all sites but a slight increase was noted in 2010 (**Figure 3.3-2**).

Aluminum, cadmium, copper, and manganese, show similar trends with higher concentrations observed in 2005-2006 at all sites, and a declining trend each year until 2009. For these metals, concentrations observed in 2010 are very similar or higher than those observed in 2009 (**Figures 3.3-1, 3.3-3, 3.3-5,** and **3.3-8**). As noted above, it was hypothesized that the higher metal concentrations observed some years could be related to high precipitation and subsequent sediment transport from the naturally occurring mineralized zone in the area, however, results of analysis conducted did not support this hypothesis.

Similar to arsenic, the average concentration of mercury across all years was significantly higher at site CR2 than at the other three sites (**Figure 3.3-9**; Tukey-Kramer, q=2.79, p=0.05). As noted above, the higher concentration of mercury at Site CR2 could also be related to the placer mining operation located upstream of this site. Although mercury appeared to be higher in 2008 than in any other year (**Figure 3.3-9**), this concentration is only significantly different than the average concentration observed in 2009 (Tukey-Kramer, q=3.17, p=0.05), which as for other metals, is the year associated with the lowest concentrations. At this point, it is unknown what factor or factors could be associated to the higher mercury concentration observed in 2008.

3.3.2 Determination of the Percent Unnatural Change Needed to Detect Impairment

Multiple years of baseline data have provided insight into the annual variability in background metal concentrations, which will allow the detection of potential increases in metal concentrations caused by the implementation of the Project. In **Table 3.3-1**, the "Detectable change" statistic represents a conservative estimate of the percent change that would need to occur before the assumption could be made that such change exceeds the expected range of natural variability. Because metal sample collection at Site CR0.7 has been two years shorter than at other sites, the detectable change statistic for most metals at this site is much higher. Consequently, smaller changes in metal concentrations may be detectable in the future at Sites DO1, CR2, and CR1.

The estimated average percent change needed to be considered out of the range of natural variation for arsenic are 74, 72, 75, and 90 percent at Sites DO1, CR2, CR1, and CR0.7, respectively (**Table 3.3-1**). Other metals have higher annual variation and therefore potential concentration increases would need to be larger to exceed the range of natural variation. At some sites, the concentration of aluminum, chromium, iron, and lead would have to increase 100 percent or more to exceed the documented background concentrations. Based on mercury concentrations in fish tissue recorded from 2004 to 2014, a conservative estimate of future detectable change for this metal would be a difference of 56, 40, 49, and 47 percent at Sites DO1, CR2, CR1, and CR0.7, respectively (**Table 3.3-1**).

In the early stage of this biomonitoring program, it was assumed that the baseline data collection phase of this program would only be able to achieve the first of the two primary goals: to document natural annual variation in metals concentrations, and predict future changes that are outside the range of this natural variance. However, good sampling practices and relatively low variation in the data within each site suggests that significant differences can be detected for certain metals between sites or between years (**Table 3.3-2**). This indicates that data collected thus far is reliable for the future detection and assessment of potential Project impacts.

3.3.3 Juvenile Salmon Mercury Concentrations within the Crooked Creek Drainage

During the first four years of this program, juvenile and YOY salmon were collected when present at the four pre-determined metals sites. Although juvenile slimy sculpin (<55mm) were ultimately determined to be the best target species and size class for metals analyses, review of the juvenile salmon results from 2004-2007 show interesting trends in mercury concentration, especially within the context of other studies within the Kuskokwim River region (Gray et al., 1996; Mueller and Matz, 2002; Jewett and Duffy, 2007).

Since YOY salmon are less likely to migrate long distances as adults do, it can reasonably be assumed that metals found in their tissue were absorbed near the sampling location. In general, mercury concentrations were very low in YOY coho and Chinook salmon, ranging from 0.012 to 0.028 mg/kg wet weight (**Table 3.3-3**). Year 1+ juvenile coho and Chinook salmon were also sampled at some sites, and their mercury concentrations tended to be at least double that of the YOY, ranging from 0.042 to 0.056 mg/kg wet weight. But given that salmon age 1+ are more likely to migrate, we cannot assume that heavy metal absorption occurred at the sampling site. Mercury concentrations in juvenile salmon tissues in the Crooked Creek drainage were comparable to concentrations found in nearby waters, such as the Innoko National Wildlife Refuge and elsewhere in the Kuskokwim region (Gray et al., 1996; Mueller and Matz, 2002). The higher mercury concentration observed in juvenile coho and Chinook salmon suggests that bioaccumulation occurs in the Crooked Creek drainage. It should also be noted that these concentrations fall well below the State of Alaska consumption guidelines, currently set at 1 mg/kg (Jewett and Duffy, 2007).

3.3.4 Burbot Mercury Concentrations within the Crooked Creek Drainage

Burbot samples for mercury analysis were not collected in 2010, 2011, 2012, 2013, or 2014. In 2009, burbot were sampled at the study site closest to the village of Crooked Creek (Site CR0.3) in an attempt to quantify mercury concentrations in large resident fish populations. Burbot are consumed by humans in the area, and monitoring mercury concentrations in their tissues is imperative to human health. Only four individuals were captured in 2009 (**Table 3.3-4**). In comparison to other fish-tissue mercury studies conducted in the Kuskokwim and Yukon regions, mercury concentrations in Crooked Creek burbot are relatively low. This is likely due to bioaccumulation, as the burbot caught at CR0.3 were smaller than those used for testing in other studies (Alaska DEC, 2009; Duffy et al., 1999; Hinck et al., 2006; and Pulliainen et al., 1992). Bioaccumulation of mercury is common in fish tissues with older and larger fish being more likely to have higher concentrations of this metal accumulated in their tissues. Although accumulation of mercury appears to be present in burbot in Crooked Creek, concentrations fall well below the State of Alaska consumption guidelines currently set at 1 mg/kg (Jewett and Duffy, 2007).

3.3.5 Northern Pike Mercury Concentrations within the Crooked Creek Drainage

Two northern pike were collected in 2010 to analyze mercury concentrations in their tissue. The fish collected at the fish weir was 795 mm TL. This fish was captured upstream of the weir panels and it may have migrated in from another location. The second fish was 295 mm TL and was collected approximately 1.25 miles (2 km) downstream of Crevice Creek, in a backwater (AMFA7) that was disconnected from the main channel at the time of collection. Mercury concentrations in these specimens were 0.085 and 0.421 mg/kg (wet weight), respectively (**Table 3.3-5**).

3.4 Aquatic Life Toxicity Test Results (Core Program)

Toxicity tests conducted in 2008 at Site CR0.7 indicated that current water quality conditions at that site have no toxic effects on aquatic life. Chronic tests using *Ceriodaphnia dubia* show that survival was 100 percent in the 100 percent concentration and ranged from 80 to 100 percent in the remaining concentrations. Control survival was 90 percent. No statistically significant mortality was measured in any concentration. The 25 percent inhibition concentration (IC25) for survival was >100 percent (**Appendix B**). Average number of neonates (offspring) was 25.7 in the 100 percent concentration and ranged from 19.9-25.2 in the remaining concentrations. Average number of neonates in the control was 19.7. No statistically significant differences in number of neonates were found between the control and any concentration. The IC25 for reproduction was >100 percent (**Appendix B**).

Chronic tests on fathead minnow showed that survival was 95 percent in the 100 percent concentration and ranged from 90 percent-100 percent in the remaining concentrations. Control survival was 98 percent. No statistically significant differences for survival were measured in any concentration when compared to the control. The IC25 for survival was >100 percent (**Appendix B**). Average weight in the 100 percent concentration was 0.433 mg per individual, and average weight ranged from 0.400 mg to 0.455 mg in the remaining concentrations. Average weight for control minnows was 0.406 mg. No statistically significant differences were measured for growth in any concentration when compared to the control. The IC25 for growth was >100 percent (**Appendix B**).

3.5 Periphyton Results (Core Program)

Periphyton taxa identified in the Crooked Creek drainage in 2013-2014 are listed in **Table 3.5-1**. **Table 3.5-2** includes a summary of all metrics. **Figure 3.5-1** reports periphyton abundance by site. Figure **3.5-2** reports mean number of total algal and diatom taxa by site and compares results between sampling years.

3.5.1 Crooked Creek Drainage Periphyton Community – Overview

The periphyton communities found in streams within the Crooked Creek drainage are consistent with other studies of Alaskan streams (Miller et al., 1992; Slavik et al., 2004; **Table 3.5-1**). In general, the periphyton communities are composed of taxa that are relatively good indicators of water quality; however metrics calculated such as **percent *Achnanthes minutissimum*** suggest that some natural stressors are present in the system.

Although freezing is an important factor affecting macroinvertebrate communities, it is not a factor that affects periphyton, as most periphyton taxa (with the exception of some Rhodophyta) are able to survive freezing. However, flooding and associated scouring are important factors affecting the periphyton community. Scouring removes periphyton from rock surfaces, and “resets” that community to an earlier successional stage (e.g., adnate diatoms). Periphyton succession begins with adnate diatoms that dwell close to the rock surface. These are followed by taller, stalked diatoms that are elevated above the substrate in order to compete for light and nutrients in the water column. The last successional stage is colonial diatoms, which are not attached to the substrate but are loosely associated with the stalked taxa and periphyton mats on the substrata. Because they are not attached, colonial taxa are easily washed away by scouring flows.

Generally, the dominance of diatoms in a periphyton community is indicative of good water quality, whereas filamentous algae tend to proliferate with high nutrient inputs and poor water quality. Stevenson and Bahls (1999) found that the diatom species *Achnanthidium minutissimum* was associated with recent scouring or toxic pollution events, and increased abundance is often indicative of disturbance in streams, therefore, the metric **percent *Achnanthes minutissima*** was included in the analysis. Another index used is **percent motile diatoms**, which takes into account the genera *Navicula* and *Nitzschia*, both of which are motile and tend to move on top of deposited sediments. Increased abundance of these taxa suggests an increase in siltation in the stream. The pollution tolerance index (PTI) developed by Lange-Bertalot (1979) can also be used to estimate relative pollution in a stream, based on the abundance of tolerant or intolerant diatoms in a stream.

3.5.2 Periphyton Metrics

Periphyton bioassessment summary statistics for the 2014 sampled sites are presented in **Table 3.5-2** and illustrated, in part, in **Figures 3.5-1** and **3.5-2**.

3.5.2-1 Description of Periphyton Metrics

Abundance - Number of algal cells per square foot of stream bottom. Under certain types of stress, this value may increase (by tolerant organisms) or decrease (excluding non-tolerant taxa), depending on stream conditions.

Total Number of Taxa - The total number of taxa in all replicates combined for each site. Also called richness, this metric generally increases with improved biotic condition.

Total Number of Diatom Taxa - The total number of diatom taxa in all replicates combined for each site. Generally, the dominance of diatoms in a periphyton community is indicative of good water quality, whereas filamentous algae tend to proliferate with high nutrient inputs and poor water quality.

Percent *Achnanthes minutissima* - This species is a cosmopolitan diatom that has a very broad ecological amplitude. It is an attached diatom and often the first species to pioneer a recently scoured site, sometimes to the exclusion of all other algae. *A. minutissima* is also frequently dominant in streams influenced by acid mine drainage and to other chemical contributions. For use in bioassessment, the quartiles of this metric from a population of sites has been used to establish judgment criteria, e.g., 0-25% = no disturbance, 25-50% = minor disturbance, 50-75% = moderate disturbance, and 75-100% = severe disturbance.

Percent Motile Diatoms - The percent motile diatoms is a siltation index, expressed as the relative abundance of *Navicula* + *Nitzschia* + *Surirella*. The three genera are able to crawl towards the surface if they are covered by silt; their abundance is thought to reflect the amount and frequency of siltation. Relative abundances of *Gyrosigma*, *Cylindrotheca*, and other motile diatoms may also be added to this metric.

Percent Dominant Taxon - The percent contribution of the most abundant taxon at each sample site (all replicates combined). Less disturbed environments tend to support communities with evenly distributed taxa, rather than a large number of individuals within one group.

Shannon H - A diversity index that takes into account the relative abundance and evenness of each taxon. In general, higher values of H indicate high taxa diversity and better water quality, while values approaching 0 suggest a less diverse community.

Evenness - The measure of how evenly individuals are distributed among species. Values ranging from 0.5 to 1 represent an evenly mixed community, and are indicative of natural, unpolluted streams. Values of 0.3 to 0.5 suggest some degradation (fair), and 0 to 0.3 represent a skewed community composition, suggesting poor water quality.

Pollution Tolerance Index for Diatoms (PTI) – Similar to the Hilsenhoff Biotic Index (HBI) for macroinvertebrates, the PTI (Lange-Bertalot, 1979) assigns tolerance values to diatom taxa ranging from 1 (most tolerant to pollution) to 3 (least tolerant to pollution). Low PTI values may be indicators of current pollution in a stream channel.

3.5.2-2 Periphyton Metrics Results

Algal orders found in the Crooked Creek drainage in 2013-2014 included Bacillariophyta (diatoms), Chlorophyta (green algae), Cryptophyta (cryptomonads), Cyanobacteria ("blue-green" algae), Rhodophyta (red algae), and Streptophyta (flagellated green algae). Diatoms were the dominant order in the Crooked Creek drainage (**Table 3.5-2 and Figure 3.5-2**).

Periphyton **abundance** in streams tends to be highly variable and dependent upon the flow and scouring conditions leading up to the sampling period, as well as the amount of grazing by macroinvertebrates at each site. Both high flow/scouring or high grazing pressure should decrease the abundance of periphyton at study sites. Periphyton **abundance** varied from 2.07 x 10^7 cells/ft^2 at EG1 to 1.96 x 10^9 cells/ft^2 at CR0.3 (**Table 3.5-2**).

The **percent *Achnanthes minutissimum*** is a metric often used in conjunction with mining studies (Stevenson and Bahls, 1999). This diatom species is often higher in streams that have been recently disturbed by flooding and/or inputs of toxic pollutants such as those associated with acid mine drainage. *Achnanthes minutissimum* is a cosmopolitan diatom genus across North America, and its high abundance in the Crooked Creek drainage (more than 50 percent of the diatom community at sites CR1 and CR0.3) may be due to naturally-occurring mineral deposits or frequent natural disturbances (especially flooding and associated scouring) that are common in Alaska streams **(Table 3.5-2).** There was significant variability in the **percent *Achnanthes minutissimum***, with values ranging from 1.3 percent at AN2 to 56.7 percent at CR0.3.

The **percent motile diatoms** metric is another index that has shown success in assessing stream health for biomonitoring programs in the continental United States (Stevenson and Bahls, 1999). Overall, this index showed relatively low numbers across all sampling sites (**Table 3.5-2**). Sites EG1 and GM1 showed a slightly higher **percent motile diatom** index of over 4 percent (**Table 3.5-2**). This suggests that siltation may be higher at EG1 and GM1 than at other sites in the drainage.

The **PTI** metric takes into account the abundance and tolerance of each diatom species to pollution (Lange-Bertalot, 1979). Diatom communities that are less tolerant to pollution have a higher **PTI** value (closer to 3) and communities that are more tolerant to pollution have values closer to 1. PTI values ranged from 2.11 at site JJ1 to 2.94 at CV1, suggestive of relatively good water quality (**Table 3.5-2**).

3.6 Chlorophyll A Results (Core Program)

Mean chlorophyll a concentrations, along with one standard deviation from each sampling location, are presented in **Table 3.6-1**. Chlorophyll a was not collected at sites OM1, AC1, or BC1 as suitable substrate was not present in these streams near the sampling locations during the 2014 sampling period.

Chlorophyll a concentrations from the 21 sampling stations ranged from 0.3 mg/m^2 at site AN2 to 10.5 mg/m^2 at site CR.3 in 2014. Chlorophyll a concentrations were greatest in the mainstem of Crooked Creek and the larger tributaries flowing into

Crooked Creek (i.e., Getmuna and Bell creeks). Concentrations of chlorophyll a were least in the small tributaries entering into Crooked Creek, such as American and Anaconda creeks.

4.0 INTRODUCTION (MINE ACCESS ROAD PROGRAM)

In order to sustain the proposed mining activities, the Project identified a proposed transportation corridor to facilitate the transport of fuels, chemicals, reagents and other mining supplies from outside locations to the Project. The proposed transportation corridor would include two main components; the proposed Jungjuk Port Site (Port), and the proposed Donlin-Jungjuk Road (Mine Access Road) (**Figure 1.1-1**). The Mine Access Road would provide vehicle access for the transportation of commodities between the Port and the Project. The Port would be developed to receive shipments from barges operating on the Kuskokwim River and provide storage for commodities and diesel fuel bound for the Project. The Port would contain a large on-river docking facility for offloading commodities as well as a 2.8 million USgal (10.6 ML) diesel fuel temporary storage facility..

In 2007, an aquatic survey program area was added to provide baseline aquatic data in the drainages potentially affected by this proposed transportation corridor. Two additional studies were added in conjunction with the Mine Access Road Program in 2009 and later in 2011. The 2009 study was a culvert crossing study performed to fulfill the Alaska Department of Fish & Game (ADF&G) requirements for the Title 16 permit regarding culvert construction at streams crossings. The second, added in 2011, was a study performed on the Kuskokwim River near the Port. Methods and results of these studies are presented below (**Figure 1.1-1**).

4.1 GOALS (MINE ACCESS ROAD PROGRAM)

The goals of the Mine Access Road Program are similar to the goals of the Core Program. One of the main differences is that there are no planned hard rock mining operations for this area. With drainages not exposed to the effects of tailings or waste rock, the potential for increased metal concentrations downstream of the area of disturbance is much lower and fish tissue metals analysis was not warranted.

With the proposed construction and operation of the Mine Access Road, Port, and the development of materials source sites, the most significant potential impacts within this Program area are increased erosion and sedimentation at the stream crossings and spills from transportation vehicles. This area had no existing background aquatic information, so an initial reconnaissance of primary drainages was an important step to understand which aquatic resources were present, and in what locations.

4.2 STUDY AREA (MINE ACCESS ROAD PROGRAM)

The 30 mile (48 km) Mine Access Road would cross streams within the Crooked Creek and Jungjuk Creek drainages as well as a small unnamed tributary to the Kuskokwim River (**Figure 1.1-1**). The Port would be located on the Kuskokwim River, approximately 8 river miles (13km) downstream of the village of Crooked Creek (**Figure 1.1-1**).

There is considerable overlap between the Core and Mine Access Road Programs in terms of the study area. Specifically, Crooked Creek and one of its larger tributaries, Getmuna Creek are represented in both sections. Refer to *Section 1.3* for more information about the Crooked Creek Drainage study area.

The Jungjuk Creek drains an area of 17.4 mi^2 (45.1 km^2) originating on the northern flanks of the Horn Mountains. Jungjuk Creek has an average wetted width of 17.0 ft (5.2 m) and runs relatively clear as compared to Crooked Creek, likely due to a different underlying geology. Jungjuk Creek has a higher gradient, and lower sinuosity than Crooked Creek, and primarily made up of riffle habitat, with few pools. Beaver activity is heavy upstream of sampling Site JJ1, likely limiting upstream migration of anadromous fish in most years.

The Kuskokwim River is the second largest river in Alaska, draining approximately 50,193 mi^2 (129,999 km^2) or 11 percent of the total area of Alaska (Brown, 1983). Near the Port, the Kuskokwim River is a wide river with an average wetted width of 1,500 ft (457.3 m). The habitat around the Port is relatively uniform, mostly consisting of deep run habitat typical of rivers this size. Several mid-channel islands are present upstream of the Port; abandoned channels and off-channel habitats located on these islands provide some habitat for fish.

5.0 METHODS (MINE ACCESS ROAD PROGRAM)

Because the methods in this study are similar to the Core Program, only clarifications of any differences from the Core Program methods are described in this section. Refer to *Section 2.0* for a complete listing of the Core Program methods. For the purposes of this report, the term "bridge" will refer to either a traditional bridge or an oversized, stream simulation-type culvert.

5.1 SITE AND REACH SELECTION METHODS (MINE ACCESS ROAD PROGRAM)

5.1.1 MINE ACCESS ROAD BIOMONITORING SITE SELECTION

Sampling sites were generally selected to document aquatic conditions near or downstream of Mine Access Road crossings. To reduce duplicate sampling, data collected at sites or reaches sampled under the Core Program were used. Coordinates for all sampling sites within the Mine Access Road Program can be found in **Appendix A**.

A sampling site was selected at Jungjuk Creek (Site JJ1) to capture effects from all significant drainages that could be crossed by the Mine Access Road. This site was established downstream from all proposed Mine Access Road crossings within the Jungjuk Creek drainage to document any changes that may occur from future activities in that drainage (**Figure 1.1-1**).

Core Program Site CR2 was used as a surrogate site for the Mine Access Road crossing over Crooked Creek (BR3). Refer to the Core Program sections for more information about the CR2 sampling site (**Figure 1.1-1**). Bridges BR47 and BR48 will span the North and South Forks of Getmuna Creek near a proposed gravel mine. Aerial survey data from Core Program reaches GM-R2, GM-R3, GM-R4, GM-R5, and FN-R1 was used to describe fish assemblages at these crossings (**Figure 1.1-1**). Additionally, Core Program Sites GM2, GM3, and GM4 provide information about the North and South forks immediately downstream of both of these crossings as well as Getmuna Creek.

5.1.2 CULVERT CROSSING FISH PRESENCE/ABSENCE SITE SELECTION

The proposed plans for the Mine Access Road included using culverts for some of the smaller streams and wetted crossings. To conform to all ADF&G Title 16 permit requirements regarding culvert size and design, additional survey sites were added for some of the smaller drainages. Additional sites where salmon were not observed during Mine Access Road surveys were not proposed to be spanned by a bridge or oversized culvert; crossings found to contain salmon are proposed to be either bridged or constructed with an oversized culvert per ADF&G (2001) and Alaska Department of Transportation (ADOT) recommendations.

All drainages proposed to have a bridge or oversized culvert installed had an established Mine Access Road survey site downstream of the crossing. Drainages known to contain juvenile and/or adult salmon were omitted from this survey (**Figure 1.1-1**). Streams found to contain salmon were to be spanned by a bridge or designed with an oversized culvert following the ADF&G and ADOT recommendations regarding the design, permitting, and construction of culverts for fish passage (ADF&G 2001).

Prior to fish surveys conducted in 2009, the Project proposed to span unnamed (FN) creek with a culvert. Surveys documented salmon in the stream thus prompting the Project to change the span to a bridge (BR49). Survey data at unnamed (FN) creek was collected with methods described in *Section 5.4.2.2*.

5.1.3 JUNGJUK PORT SITE SELECTION

Sites were selected on the Kuskokwim River just downstream (KU13, KU14, KU15), upstream (KU9, KU10, KU11, KU12), and at the Port Site (KU8), to collect a representative sample within the vicinity of the Port. Each site contained slightly different habitat types, therefore different sampling methods were used within the Kuskokwim River. Sites were selected with the intention of maximizing the number of fish species documented during the study. In 2012, several alternative sites were sampled both upstream (KU25, KU24, KU23) and downstream (KU20) of the Port Site (KU8) on the Kuskokwim River (**Figure 1.1-1**).

5.2 Parameter Selection Methods (Mine Access Road Program)

For this study, OtterTail developed a list of parameters that would be useful to establishing baseline conditions and for future impact assessments. Parameters included aquatic macroinvertebrates, adult salmon aerial surveys, fish traps, fish seines, fyke nets, and electrofishing. The methodologies used are described in each of their respective sections below.

5.3 Macroinvertebrate Methods (Mine Access Road Program)

5.3.1 Mine Access Road and Jungjuk Port Site Macroinvertebrate Survey

Benthic macroinvertebrates were collected at a single Mine Access Road site location (Jungjuk Creek Site JJ1) and at twelve locations on the Kuskokwim River associated with the Port (Sites KU8, KU9, KU10, KU11, KU12, KU13, KU14, KU15, KU20, KU23, KU24, and KU25). Macroinvertebrates were quantitatively sampled at Site JJ1 in 2007 and 2008 by taking three replicate Surber samples as described in the Core Program (refer to *Section 2.3*). Macroinvertebrates at Jungjuk Port sites were sampled in 2011 and 2012 with a combination of Surber and Ponar® Samplers. Surber samples were collected at Sites KU8, KU10, KU11, KU12, KU14, KU20, KU23 and KU25 following the standard protocols described previously. A Ponar® Sampler was used to sample deepwater habitats with a high fine sediment load (Sites KU8, KU9, KU13, KU15 and KU24). The Ponar® samples a 9 x 9 inch (22.9 cm x 22.9 cm) area of stream bottom, approximately 3-5 inches (7.6-12.7 cm) deep. Three replicate samples were taken at each site. The sediments collected in the Ponar® Sampler were washed with river water on a 600 µm sieve in the field to remove excess fine sediments. Samples were preserved in alcohol and shipped to the laboratory for analyses.

5.4 Fish Population Assessment Methods (Mine Access Road Program)

5.4.1 Adult Salmon Aerial Survey

An aerial salmon survey was conducted along Jungjuk Creek as part of the Mine Access Road Program (**Figure 1.1-1)**. The same methods described for the Core Program were used. Surveys were conducted in the fall (September 13, 2007; September 19, 2008; September 18, 2010; and September 18, 2011), September 13-17, 2009; 2010; and 2011) to document coho salmon presence/absence. Aerial surveys were not conducted during the fall of 2012. Summer aerial surveys were conducted to document the presence/absence of Chinook and chum salmon (July 26, 2007; July 25, 2010; July 22, 2011; and July 24, 2012).

5.4.2 Resident Fish and Juvenile Salmon Survey

5.4.2.1 Mine Access Road Biomonitoring Survey

Resident fish populations were evaluated at a single location in Jungjuk Creek (i.e., Site JJ1; **Figure 1.1-1**). These surveys were conducted on September 12, 2007 and August 2, 2008. Surveys were conducted with a backpack electrofisher as described in the Core Program section for one-pass minimum population assessments. Fish trapping with minnow traps was also conducted at JJ1 with methods identical to those listed for the Core Program in *section 2.4.3.2*.

5.4.2.2 Culvert Crossing Fish Presence/Absence Survey

The objective of the culvert crossing survey was to document fish species in drainages that were to have culverts installed during the construction of the Mine Access Road. Single pass electrofishing was the sampling method for fish. No block nets were used. As a general guideline, electrofishing reach lengths were set to, but not limited to 40 times the wetted width of the stream, therefore reach lengths varied depending upon the stream size and changes in habitat types within the reach. Electrofishing surveys were conducted as described in *Section 2.4.3.1*.

The drainages were analyzed to assess the need of culverts. If a site did not contain a wetted drainage (such as a swale or wetland), that site was photo documented at the spot of the Mine Access Road crossing. Typically, if a wetted drainage was found, a one pass electrofishing survey was performed from just downstream of the Mine Access Road crossing point upstream to the crossing. No macroinvertebrate collection was performed as part of this study.

Crossing points CU43 and BR49 were sampled on July 31, 2009. Sampling for crossing point BR61 was conducted on July 17, 2011. Crossing points BR63, CU59, CU60, and CU62 were sampled on July 18, 2011.

5.4.2.3 Kuskokwim River Port Site Fish Survey

The Kuskokwim River port site study contained different sampling conditions than the Mine Access Road and culvert survey sites, and therefore the methods used for fish collection differed as well. Multiple sampling methods were used in attempt to capture the fish assemblage in the Kuskokwim River. Methods included fish seines, fyke nets, and electrofishing, depending on what the conditions warranted at each sampling site.

Fyke nets were used to sample fish assemblages in the deeper water areas along the Kuskokwim. Setup and design of each fyke net varied depending upon the conditions at the site. Fyke net wings varied in length from 15 to 30 ft (4.6 – 9.1 m), with a height of 3 ft (0.9 m) and a 1/8 inch (3.18 mm) mesh size. Often, the fyke was set up with a center net (leader) and two wings facing downstream at approximately 30 degree angles to divert fish into the traps. In other situations, fyke nets were set with a single leader to divert fish into to the trap. Fyke net traps were baited with commercial salmon eggs and/or canned tuna fish. Fyke nets were set for approximately 24 hours.

Fish seines were also used for sampling the fish assembly along the shallower margins of the Kuskokwim River. Seines were typically 4 ft (1.2 m) deep by 30 ft (9.1 m) long with 1/8 inch (3.18 mm) mesh size. Depending on site conditions, 20 ft (6.1 m) and 40 ft (12.2 m) long seines were also used. The number of seine hauls at each site ranged from three to seven to capture different habitat types within the site. The single pass electrofishing method was performed at Sites KU8 and KU9, as these sites were shallow enough to allow for effective electrofishing.

Site KU9 is located mid-channel on the Kuskokwim River near the downstream tip of an island (**Figure 1.1-1**). Habitat consists mostly of deep eddying margins with heavy silt deposition and very little physical habitat structure. The margins of the stream were sampled using three passes with a fish seine [30 ft (9.1 m) seine length]. Electrofishing was also conducted along stream margins and in some off channel habitat found upstream of the sampling site.

Sampling Site KU10 is located just downstream of Site KU9, on the north side of the Kuskokwim River (**Figure 1.1-1**). The site can be characterized as a monotonous slow riffle with gravel, sand, and silt dominating the substrate. This site was sampled with both a seine [30 ft (9.1 m) seine length], and a fyke net.

Sites KU11 and KU12 are located on the eastern side of an island, near the upstream end (**Figure 1.1-1**). Habitats at both sites are made up of a slow riffle with gravel and silt dominating the substrate. Site KU25, sampled in 2012, is located just upstream of site KU11 on the northern side of the island (**Figure 1.1-1**). The habitat at this site is similar to Site KU11, with a dominant substrate of gravel and silt within the littoral zone. Three seine tows and electrofishing were conducted at this site. Sites KU23 and KU24, sampled in 2012, are located just downstream of Site KU25 on the northern side of the island (**Figure 1.1-1**). Generally, the habitat for both sites could be classified as backwater, with substrate dominated by gravel and sand, covered in fine silt. Electrofishing and a single fyke net set were conducted at both sites, with three additional seine tows [30 ft (9.1 m) seine length] conducted at KU24.

<u>Port Site (KU8)</u>

Site KU8 is located adjacent to the Port (**Figure 1.1-1**). Habitat consists of slow, nearly slack, water with silt dominating the substrate and very little habitat complexity. A total of three fyke nets were set in 2011 as well as three seine tows and electrofishing conducted along the margins and small backwater areas. In 2012, the site was sampled via electrofishing and a single fyke net was set.

<u>Downstream Sites (KU13, KU14, KU15, KU20)</u>

Site KU14 was located on the northwest side of the river, downstream of the Port (**Figure 1.1-1**). Substrate at Site KU14 consists of a mix of gravel and larger cobbles, mixed with finer sediments. Generally, the habitat could be classified as a run.

Clear water entering the Kuskokwim River from Jungjuk Creek resulted in lower turbidity at this site. The lack of deep mud made seining considerably more effective, so a total of seven tows were conducted. No electrofishing was conducted at any downstream sites in 2011. The site was sampled in 2012, with collection methods consisting of six seine tows [30 ft (9.1 m) seine length] and a single fyke net.

Site KU20 was the only alternative site in 2012 sampled downstream of the Port, located on the northwest side of the river (**Figure 1.1-1**). The habitat features for this site are similar to Sites KU13 and KU15, consisting of substrate dominated by sand and gravel covered with a layer of silt. Electrofishing and a single fyke net were conducted.

6.0 RESULTS (MINE ACCESS ROAD PROGRAM)

6.1 MACROINVERTEBRATE RESULTS (MINE ACCESS ROAD PROGRAM)

A list of macroinvertebrate taxa found within the Mine Access Road drainages and near the Port is shown in **Table 6.1-1** and **Table 6.1-2**. A summary of macroinvertebrate metrics for sites sampled from 2007 to 2012 are included in **Appendix L** and **M**. Average macroinvertebrate metrics for 2007-2012 are shown in **Table 6.1-3**.

6.1.1 JUNGJUK CREEK – MINE ACCESS ROAD (SITE JJ1)

Jungjuk Creek Site (Site JJ1) was sampled in 2007 and 2008. Macroinvertebrate abundance was consistent both years (**Figures 6.1-1** and **6.1-2**) but a higher number of total and EPT taxa were collected in 2007 (**Appendix M**). Consistently, the Shannon Diversity Index (H) and Evenness (e) suggest that water quality conditions were slightly better in 2007. These differences could also result from natural variability in stressors occurring in the system. Freezing, flooding, and high natural siltation rates are likely the most significant factors affecting stream community structure in drainages near the Kuskokwim River. Siltation limits macroinvertebrate colonization by filling the interstitial spaces in the gravel-cobble stream bottom, reducing the amount of area in the stream bottom that could be colonized. Furthermore, these interstitial spaces are used by macroinvertebrates as refugia from freezing during winter, so fewer interstitial spaces would also decrease the ability of macroinvertebrates to overwinter. Overall, the HBI index suggested that water quality conditions are very good at Site JJ1 (**Figure 6.1-3**).

In relation to core program sampling sites, the observed macroinvertebrate abundance and community composition at Site JJ1 was similar to the sites sampled within the Crooked Creek drainage (**Tables 6.1-3** and **3.1.2**). On average, abundance at this site was 211 invertebrates / ft^2; 22 taxa were found of which 12 were EPT taxa. As in core Crooked Creek drainage sites, Chironomidae was the predominant taxa at Site JJ1.

6.1.2 JUNGJUK PORT SITE SURVEY (SITES KU8, KU9, KU10, KU11, KU12, KU13, KU14, KU15, KU20, KU23, KU24, KU25)

The Jungjuk Port sites (KU8, KU9, KU10, KU11, KU12, KU13, KU14, and KU15), located in the Kuskokwim River were surveyed for the first time in 2011. In 2012, several alternative sites were selected (KU20, KU23, KU24, KU25) along with sites KU8, KU9, and KU14 in an attempt to increase the number of different aquatic habitat types sampled for the study. These sites present different habitat types than the shallow riffles typically sampled for macroinvertebrates at other biomonitoring sites. Generally, Jungjuk Port sampling sites consist of deep, slow moving water with fine sediments and gravels on the river bottom. Therefore, it is not surprising that the macroinvertebrate community identified at these sites was substantially different present at other sites sampled in this study.

Overall, macroinvertebrate abundance at Jungjuk Port sites was low, similar to the abundance levels observed in some of the Crooked Creek tributaries (e.g., Anaconda Creek - Sites AN1 and AN2; **Tables 6.1-3** and **3.1-2**). Similarly, both total and EPT taxa found at these sites was substantially lower than at other sites surveyed in this study (**Table 6.1-3; Figure 6.1-4**). The macroinvertebrate community was composed primarily of Chironomidae and Oligochaeta taxa (**Table 6.1-3**). Based on macroinvertebrate samples collected using surbers, the dominance of Chironomidae taxa ranged from 70 percent at Site KU8 to 99 percent at Site KU12 (**Table 6.1-3; Appendices L** and **M**). The Shannon diversity and evenness indices reflect the dominance of a single taxa and low diversity at these sites. The HBI index suggested fair water quality conditions at most of the Jungjuk Port sites sampled; this index indicated good water quality conditions at Sites KU8 and KU15 (**Figure 6.1-3; Appendices L** and **M**). However, given the proximity between these sites, the observed differences in HBI may reflect slight differences in the habitats sampled and not necessarily differences in water quality.

6.2 Fish Population Assessment Results (Mine Access Road Program)

Fish surveys associated with the Mine Access Road are limited to electrofishing in Jungjuk Creek in 2007 and 2008, and aerial surveys in the same creek from 2007 to 2012. The fish assemblage found during these surveys is typical of tributaries of the Kuskokwim River. A list of fish species found during Mine Access Road surveys is included in **Table 6.2-1**.

6.2.1 Adult Salmon Aerial Survey

Coho salmon is the only species that has been observed during aerial surveys along Jungjuk Creek. Annual coho salmon counts have ranged from two fish in 2008 to eight fish in 2011 (**Table 6.2-2**). **Figure 1.1-1** includes the estimated adult salmon density and distribution observed by aerial surveys as well as the resident fish species occurrence within the Mine Access Road drainages. It should be noted that the uppermost extent of the salmon distribution is a best guess estimate based strictly on observations from OtterTail, and that these distributions and densities are based on aerial survey observations alone. A large beaver dam complex appears to be limiting the upstream extent of coho salmon in this drainage.

Chinook, chum and coho salmon have been documented in the North and South Forks of Getmuna Creek (**Table 3.2-2**). Refer to *Section 3.2.1* of the Core Program for more information about salmon runs on Getmuna Creek.

6.2.2 Resident Fish and Juvenile Salmon Survey

Resident populations in Jungjuk Creek were surveyed in October, 2007 and in August, 2008. Surveys found adult and juvenile coho salmon, Dolly Varden, Arctic grayling, round whitefish, and slimy sculpin. The electrofishing surveys showed a two year average population of 98 fish per 300 ft (**Table 6.2-3; Appendix N**).

Fish species collected at GM1 include Chinook and coho salmon, sockeye salmon, Dolly Varden, Arctic grayling, round whitefish, slimy sculpin, and nine-spine stickleback (**Table 3.2-4**). Refer to *Section 3.2.2.4* of the Core Program for more information on electrofishing results from site GM1.

6.2.2.1 Bridge and Culvert Stream Crossing Fish Presence/Absence Surveys

Presence/absence surveys were conducted in summer 2009, and 2011 to assess fish species assemblages at streams to be crossed by the Mine Access Road. Information gathered from other sampling sites or reaches was used to further refine the documented species at each location.

<u>Culvert Crossings (CU43, CU59, CU60, and CU62)</u>

Culvert crossing location CU43 is in the headwaters of North Fork Getmuna Creek. Culverts CU59, CU60, and CU62 are all tributaries to Jungjuk Creek. No fish were found at any of the culvert crossings (**Figure 1.1-1; Appendix O**).

<u>Bridge Crossings (BR3, BR47, BR48, BR49, BR61, and BR63)</u>

The Mine Access Road crosses Crooked Creek (BR3) downstream of Core Program site CR2 (**Figure 1.1-1**). Fish species present at this location include Chinook, chum and coho salmon adults, which were documented during aerial surveys of reach CRR4 (**Table 3.2-2**). Chinook and coho salmon juveniles, Dolly Varden, Arctic grayling, round whitefish, slimy sculpin, burbot, and Alaska blackfish were collected at site CR2 (**Tables 3.2-2** and **3.2-4**).

The North Fork of Getmuna Creek is crossed by the Mine Access Road at BR47 (**Figure 1.1-1**). Aerial surveys have documented Chinook, chum and coho salmon adults in this reach (GM-R2) (**Table 3.2-2**). Electrofishing surveys at site GM2, conducted in 2012 as part of the Core program show that Dolly Varden, Arctic grayling, and slimy sculpin are present downstream of the bridge in this reach (**Table 3.2-5** and *Section 3.2.2.1*). To the south, the Mine Access Road crosses the South Fork of Getmuna Creek at BR48 (**Figure 1.1-1**). During aerial surveys conducted in reach GM-R3, and GM-R4, adult Chinook, chum and coho salmon have been documented (**Table 3.2-2**). Additionally, species collected during the 2012 survey at GM4 show that Dolly Varden and slimy sculpin reside in the reach below BR48 (**Table 3.2-5** and *Section 3.2.2.1*).

Crossing point BR49 spans the small unnamed (FN) creek, a tributary to the South Fork of Getmuna Creek. This crossing point is located just to the south of BR48. Electrofishing surveys conducted in 2009 sampled juvenile coho salmon, Dolly Varden, Arctic grayling, and slimy sculpin (**Appendix O**). The results of this survey prompted the Project to upgrade the crossing structure from a culvert to a bridge.

West of the Port, the Mine Access Road follows Jungjuk Creek, crossing the mainstem in two locations (BR61, and BR63). Electrofishing surveys conducted in 2011 documented a population of Dolly Varden at each location (**Appendix O**). Surveys conducted downstream of these bridge crossings in 2007 and 2008 at Site JJ1 documented Arctic grayling, round whitefish and slimy sculpin. Additionally, aerial surveys conducted in reach JJR1 during fall in 2007, 2008, 2010, and 2011 documented limited numbers of adult coho salmon. Aerial surveys conducted during 2012 found no Chinook, chum or sockeye salmon in the system (**Table 6.2-2**).

6.2.2.2 Port Site Fish Survey Results

In 2011, eight sites were sampled, four upstream, three downstream and one adjacent to the Port. The sampling effort resulted in the collection of over 1,100 fish measured and identified. Though a variety of sampling methods were deployed, including seines, fyke nets and electrofishing, a majority of fish were collected with seines (88 percent). In general the most abundant species captured along Kuskokwim River sites by all methods was the longnose sucker (25 percent total relative abundance) and Arctic grayling (22 percent total relative abundance) (**Table 6.2-4**). In 2012, seven sites were sampled that included three sites from 2011 (KU8, KU9, KU14) along with three alternative sites upstream (KU23, KU24, KU25) and one alternative site downstream (KU20) of the Port. A total of 1,221 fish were identified and measured with the majority being collected by electrofishing (74 percent). The longnose sucker was the most abundant species collected across all sampling methods (seine, fyke, electrofishing) with a 52, 44, and 63 percent total relative abundance, respectively (**Table 6.2-4**). Juvenile sockeye salmon were the second most abundant species collected across all sites (267 fish) constituting 22 percent of the total fish collected in 2012 (**Table 6.2-4**).

<u>Upstream Sites (KU9, KU10, KU11, KU12, KU23, KU24, KU25)</u>

Site KU9 is located mid-channel on the Kuskokwim River near the downstream tip of an island (**Figure 1.1-1**). Results of electrofishing revealed a high abundance of round whitefish (46 percent), as well as the presence of sockeye salmon, Arctic grayling, longnose sucker, Alaskan brook lamprey, burbot, and slimy sculpin. Only 81 total fish were collected at this site, the fewest of any port sampling site in 2011 (**Table 6.2-4**). In 2012, four species of fish were collected electrofishing. A total of 116 fish were collected with a high abundance of longnose sucker (61 percent) and juvenile sockeye salmon (35 percent), in addition to three undifferentiated juvenile whitefish and a single slimy sculpin (**Table 6.2-4**).

Site KU10 is located just downstream of Site KU9, on the north side of the Kuskokwim River (**Figure 1.1-1**). Species assemblage in 2011 for Site KU10 included Chinook, chum, pink, and sockeye salmon juveniles, Arctic grayling, round whitefish, longnose sucker, and slimy sculpin. The fyke net deployed at this location became fouled with debris during the set, and caught only a single sockeye salmon fry (**Table 6.2-4**).

Sites KU11 and KU12 are located on the eastern side of an island, near the upstream end (**Figure 1.1-1**). In 2011, longnose sucker was the most abundant species at both sites with 28 and 25 percent relative abundance respectively. Other fish documented at these locations include sockeye salmon fry, Arctic grayling, round whitefish, broad whitefish (*Coregonus nasus)*, humpback whitefish, least cisco, and slimy sculpin (**Table 6.2-4**).

Site KU25, sampled in 2012, is located just upstream of site KU11 on the northern side of the island (**Figure 1.1-1**). The most abundant species collected at this site were longnose sucker (79 percent total relative abundance electrofishing and 47 percent total relative abundance in seine nets) and juvenile sockeye salmon (17 percent total relative abundance electrofishing and 33 percent total relative abundance in seine nets (**Table 6.2-4**). Other species collected at this site included Arctic grayling, slimy sculpin, and undifferentiated juvenile whitefish.

Sites KU23 and KU24, sampled in 2012, are located just downstream of Site KU25 on the northern side of the island (**Figure 1.1-1**). Fish species included juvenile Chinook, coho, and sockeye salmon, Arctic grayling, round whitefish, undifferentiated juvenile whitefish, and slimy sculpin. Longnose sucker was the most abundant specie collected at both sites (**Table 6.2-4**).

Port Site (KU8)

Site KU8 is located adjacent to the Port (**Figure 1.1-1**). The most abundant fish documented at this site was Arctic grayling juveniles (77 percent in seines and 15 percent in fyke nets). Other species collected include Chinook, coho, sockeye, and pink salmon juveniles, Dolly Varden, round whitefish, humpback whitefish, least cisco, sheefish, longnose sucker, slimy sculpin, burbot, and lamprey (undifferentiated). In 2012, Longnose sucker and juvenile sockeye salmon were the most abundant, consisting of 38 and 30 percent of the total fish collected, respectively (**Table 6.2-4**).

Downstream Sites (KU13, KU14, KU15, KU20)

Site KU14 is located on the northwest side of the river, downstream of the Port (**Figure 1.1-1**). Longnose sucker and juvenile Arctic grayling were the dominant fish species in samples with 36 and 42 percent relative abundance, respectively (**Table 6.2-4**). In 2012, longnose sucker was the most abundant fish species at this site, accounting for 33 percent of total fish collected (**Table 6.2-4**). Only 39 fish were collected at this site, the fewest of any port sampling site in 2012.

Sites KU13 and KU15 are located on the northwest side of the river, downstream of the Port (**Figure 1.1-1**). Both sites displayed habitat features similar to Site KU8, but with a bit higher water velocity. Fish species found included coho and sockeye salmon juveniles, Arctic grayling, round whitefish, humpback whitefish, sheefish, least cisco, longnose sucker, slimy sculpin, northern pike, and burbot. Round whitefish was the most abundant fish sampled (**Table 6.2-4**).

Site KU20 was the only alternative site in 2012 sampled downstream of the Port and is located on the northwest side of the river (**Figure 1.1-1**). A total of 52 fish were identified and measured at this site collected via electrofishing and a single fyke net set. The most abundant fish species at this site were slimy sculpin and juvenile coho salmon, accounting for 33 and 27 percent of total fish caught (**Table 6.2-4**). Other species collected included juvenile sockeye salmon, Dolly Varden, Arctic grayling, round whitefish, and whitefish (undifferentiated).

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8.0 TABLES

Table 2.1-1

Stream Characteristics and Purpose for Sites Selected for the Donlin Gold Mine Project Aquatic Biomonitoring Program

Stream	Drainage Area mi^2	Drainage Area km^2	Current Status	Sampling Site	Location[1]	Purpose
Control Sites						
Donlin Creek	48.8	126.4	No historical or proposed mining	**DO1**	Approx. 0.16 mi. (0.26 km) downstream of confluence with Ophir Creek and 0.62 mi. (1.0 km) upstream of confluence with Dome Creek.	Control site above mineralized zone in major tributary creating Crooked Creek
Flat Creek	19.5	50.5	No proposed mining	**FL1**	Approx. 0.14 mi. (0.23 km) upstream of Crooked Creek confluence	Control site above mineralized zone in major tributary creating Crooked Creek
Potentially Affected Sites						
Crooked Creek	335.0	867.6	Historical mining; possible small portion of proposed mining affects (above most activities)	**CR2**	upstream of American Creek confluence and approx. 0.11 mi. (0.18 km) downstream of currently active placer mine diversion canal	Mainstem site downstream of all historical mining activities; therefore, site used to assess if any detected changes are from placer mining operations or proposed Donlin project
			Historical/current placer mining upstream	**CR1**	Approx. 0.51 mi. (0.82 km) downstream of Anaconda Creek confluence	Mainstem site downstream of most currently known possible proposed mine affects
				CR0.7	Approx. 0.35 mi. (0.56) downstream of Crevice Creek confluence	Mainstem site downstream of all historical mining activities and downstream of all currently known possible proposed mine affects
				CR0.3	Approx. 0.84 mi. (1.35 km) upstream of confluence with Kuskokwim River	Mainstem site at the mouth of Crooked Creek; assess amount of recovery if possible potential affects are observed at upstream sites
				Weir	1.5 mi. (2.4 km) upstream of the Kuskokwim River Confluence and 0.67 mi. (1.08 km) upstream of CR0.3	Count adult salmon migrating into Crooked Creek drainage
Snow Gulch	3.3	8.5	No historical/current placer mining upstream of this location in watershed	**SN2**	Approx. 1.5 mi. (2.4 km) upstream of Crooked Creek confluence and upstream of current placer mining operation	Potentially affected by possible mine disturbance that may enter into upper watershed, location of proposed reservoir
Queen Gulch	0.9	2.3	Historical Mining	**QU1**	Approx. 0.3 mi. (0.48 km) upstream of historic confluence with Crooked Creek, and upstream of placer mining influence	Potentially affected by proposed pit, upstream of placer mine disturbances
Lewis Gulch	0.8	2.1	Historical and proposed mining	**LE1**	Sites both upstream and downstream of current road approx. 0.3 mi. (0.48 km) upstream of historic confluence with Crooked Creek	Document aquatic resources potentially affected by proposed pit and wasterock filling
American Creek	6.5	16.8	Proposed mining Pit and Waste Rock Facility	**AM1**	Above historic winter access road and approx. 0.5 mi. (0.8 km) upstream of confluence with Crooked Creek	Document aquatic resources potentially affected by proposed pit and wasterock filling
				AM2	Approx. 2.3 mi. (3.7 km) upstream of confluence with Crooked Creek	Document aquatic resources potentially affected by proposed pit and wasterock filling
			Proposed mining Waste Rock Facility and Natural Gas Pipeline Shoofly Access Road.	**AM3**	Upper extent of American Creek watershed	Potentially affected by waste rock facility
				AM4	Upper extent of American Creek watershed	Potentially affected by waste rock facility
Omega Gulch	1.0	2.6	Proposed mining	**OM1**	Approx. 0.4 mi. (0.64 km) upstream of Crooked Creek confluence	Document aquatic resources potentially affected by proposed activities within the drainage
Anaconda Creek	7.6	19.7	Proposed tailings impoundment	**AN1**	Approx. 0.25 mi. (0.40 km) upstream of confluence with Crooked Creek and immediately upstream of the historic winter road	Document aquatic resources in Anaconda Creek potentially affected by proposed tailings impoundment upstream
				AN2	Approx. 2.6 mi. (4.2 km) upstream of Crooked Creek confluence	Document aquatic resources in upper Anaconda Creek potentially affected by proposed tailings impoundment
Crevice Creek	6.8	17.6	No historical mining: proposed possible impacts	**CV1**	Approx. 930 ft. (283 m) upstream of Crooked Creek confluence	Potentially affected by proposed surface water diversion from Anaconda Creek
Potentially Indirectly Affected						
Dome Creek	6.8	17.6	No historical or proposed mining	**DM1**	Approx. 0.53 mi. (0.85 km) upstream of Crooked Creek confluence	Potentially affected by possible mine disturbance that may enter into upper watershed
Quartz Gulch	1.2	3.1	No historical or proposed mining	**QZ1**	Approx 0.47 mi. (0.76 km) upstream of Crooked Creek confluence	Potentially affected by possible mine disturbance that may enter into upper watershed
Grouse Creek	12.1	31.3	No historical or proposed mining	**GR1**	Approx. 0.5 mi. (0.8 km) upstream of Crooked Creek confluence	Potential groundwater affects within watershed from pit dewatering activities
Eagle Creek	8.5	22.0	no historical or proposed mining	**EG1**	Approx. 0.83 mi. (1.34 km) upstream of Crooked Creek confluence	Road and material sites in upper watershed
Getmuna Creek	98.6	255.4	No historical disturbance	**GM1**	Approx. 2.5 mi. (4.0 km) upstream of Crooked Creek confluence	Document aquatic resources potentially affected by proposed Gravel Mine and road crossings
				GM2	Approx. 0.47 mi. (0.76 km) downstream of proposed Gravel Mine	Document aquatic resources potentially affected by proposed Gravel Mine and road crossings
				GM3	Approx. 1.5 mi. (2.4 km) downstream of proposed Gravel Mine	Document aquatic resources potentially affected by proposed Gravel Mine and road crossings
				GM4	Approx. 0.55 mi. (0.88 km) downstream of proposed Gravel Mine	Document aquatic resources potentially affected by proposed Gravel Mine and road crossings
Unnamed (FN)	5.6	14.5	No historical disturbance	**FN1**	Approx. 0.34 mi. (0.55 km) upstream of confluence with South Fork Getmuna Creek	Document aquatic resources potentially affected by proposed road corridor
Unaffected Streams						
Unnamed (BC)	0.4	1.0	No historical mining; proposed possible impacts	**BC1**	Approx. 0.22 mi. (0.35 km) upstream of confluence with Crooked Creek	Further refine fish distribution data for the Crooked Creek Watershed
Unnamed (AC)	0.3	0.8	No historical mining; proposed possible impacts	**AC1**	Approx. 0.25 mi. (0.40 km) upstream of confluence with Crooked Creek	Further refine fish distribution data for the Crooked Creek Watershed
Bell Creek	71.3	184.5	No historical disturbance	**BL1**	Just upstream of historic winter trail	Further refine fish distribution data for the Crooked Creek Watershed

Notes:

A map displaying site locations can be found in Figure 1.1-1. A list of coordinates (latitude and longitude) can be found in Appendix A.

1) Lengths listed in location descriptions are estimated stream lengths

Table 2.1-2
Crooked Creek Stream Characteristics

Stream Name	Percent of Crooked Creek Watershed[1]	Drainage Area (mi²)	Drainage Area (km²)	Aerial Reach	Site within Reach	Slope	Sinuosity	Rosgen Type[2]	Dominant Substrate in Riffles[3]	AVG Wetted Width[4] (ft)	AVG Wetted Width[4] (m)
Donlin Creek	9.09	30.5	79.0	DOR1	na	0.30%	1.47	na	na	na	na
				DOR2	DO1	0.40%	1.82	B5c	gravel	19.9	6.1
				DOR3	na	0.70%	1.48	na	na	na	na
Dome Creek	2.03	6.8	17.6	DMR1	DM1	2.60%	1.06	G4	gravel/cobble	8.6	2.6
Quartz Gulch	0.35	1.2	3.1	na	QZ1	3.20%	1.03	G3g	gravel/cobble	8	2.4
Snow Gulch	1.01	3.4	8.8	SNR1	SN2	1.90%	1.04	G6	sand	4.4	1.3
Queen Gulch	0.21	0.7	1.8	na	QU1	2.60%	1.01	G3g	sand/gravel	6.6	2
Flat Creek	5.8	19.5	50.5	FLR1	FL1	0.60%	1.12	B3c	cobble	12.1	3.7
Lewis Gulch	0.23	0.8	2.1	na	LE1	4.40%	1.01	G3g	gravel/cobble	2.5	0.8
American Creek	2.04	6.9	17.9	AMR1	AM1	2.20%	1.4	B5	gravel/cobble	10.5	3.2
				AMR1	AM2	2.20%	1.4	B5	gravel/cobble	13.1	4
Grouse Creek	3.56	12	31.1	GRR1	GR1	0.90%	1.07	B5c	gravel	13.2	4
Omega Gulch	0.3	1	2.6	na	OM1	4.50%	1.06	G6da	silt/sand	3.3	1
Anaconda Creek	2.34	7.9	20.5	ANR1	AN1	1.40%	1.4	G6c	silt/sand	7.3	2.2
				ANR1	AN2	1.40%	1.4	G6c	silt/sand	7.4	2.3
Crevice Creek	2.01	6.8	17.6	CVR1	CV1	0.70%	1.14	B5c	gravel	5.3	1.6
Eagle Creek	2.53	8.7	22.5	EGR1	EG1	1.00%	1.05	G6c	silt/sand	5	1.5
Unnamed (BC)	0.1	0.4	1.0	na	BC1	2.80%	1.03	G6da	sand	5	1.5
Unnamed (AC)	0.08	0.3	0.8	na	AC1	2.30%	1.04	G6da	sand	3	0.9
Bell Creek	21.23	71.3	184.7	BLR1	BL1	0.40%	1.68	C4	gravel/cobble	29.5	9.0
				BLR2	na	1.20%	1.21	na	na	na	na
				BLR3	na	1.00%	1.26	na	na	na	na
Getmuna Creek	29.39	98.6	255.4	GMR1	GM1	0.40%	1.65	C4	gravel/cobble	51.6	15.7
					GM3	0.43%	1.72	C4	gravel/cobble	32	9.8
				GMR2	GM2	0.50%	1.39	C4	gravel/cobble	20.6	6.3
				GMR3	GM4	1.00%	1.2	C4	gravel/cobble	26	7.9
				GMR4	na	2.3 %	1.03	na	na	na	na
				GMR5	na	2.10%	1.01	na	na	na	na
Unnamed (FN)	1.67	5.6	14.5	FNR1	na	1.10%	1.02	na	na	na	na
Crooked Creek	100	335.5	868.9	CRR1	CR0.3	0.20%	1.62	C4	gravel/cobble	[5]23.4	[5]7.1
				CRR2	na	0.20%	1.97	na	na	na	na
				CRR3	CR1	0.10%	2.06	C4	gravel/cobble	54.2	16.5
				CRR3	CR0.7	0.10%	2.06	C4	gravel/cobble	49.3	15
				CRR4	na	0.10%	2.7	na	na	na	na
				CRR5	CR2	0.30%	1.65	C4	gravel/cobble	36	11

Notes:

Refer to **Figure 1.1-1** for aerial reach and sampling site locations.

1) Percent of Crooked Creek Watershed and Drainage area are estimates.

2) Data on entrenchment, or flood prone width has not been collected. Therefore, definitive classifications cannot be made and should be used only as a relative estimate of stream type (Rosgen et al. 1996).

3) This classification was not quantified and was determined by field notes, photographs, and general knowledge of the streams.

4) Average wetted width measured at biomonitoring site.

5) Wetted width at CR0.3 represents only the side channel in which the survey is conducted; Total wetted width for the entire mainstem at this location is ~60 ft. (18 m).

Table 2.5-1
Fish Tissue Analytes, Analytical Methods, and Method Detection Limits (2004-2014)

			Ranges for Method Detection Limits[1] (mg/kg)												
Component	**Symbol**	**EPA Analytical Method**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Average Range**	**Maximum Range**
Aluminum	Al	6010B-ICP/MS	0.9-1.3	0.8-1.1	0.8-2.1	0.7-1.6	0.1-0.1	0.05-0.07	0.05-0.1	0.004-0.07	0.04-0.05	0.04-0.05	0.04-0.04	0.3484-0.654	0.04-0.04
Arsenic	As	6020-ICP/MS	0.01-0.01	0.01-0.01	0.01-0.03	0.005-0.013	0.013-0.016	0.009-0.013	0.007-0.013	0.0003-0.005	0.004-0.005	0.004-0.004	0.004-0.004	0.00723-0.0119	0.004-0.004
Cadmium	Cd	6020-ICP/MS	0.001-0.001	0.001-0.001	0.004-0.011	0.001-0.003	0.0008-0.001	0.0008-0.0011	0.001-0.002	0.00003-0.0005	0.0004-0.0005	0.0004-0.0004	0.0004-0.0004	0.001043-0.00215	0.0004-0.0004
Chromium	Cr	6010B-ICP/MS	0.05-0.08	0.06-0.08	0.08-0.21	0.05-0.13	0.011-0.014	0.013-0.018	0.01-0.03	0.001-0.02	0.0038-0.0048	0.004-0.004	0.004-0.004	0.02828-0.05908	0.004-0.004
Copper	Cu	6020-ICP/MS	0.01-0.02	0.004-0.006	0.004-0.011	0.003-0.008	0.008-0.01	0.005-0.007	0.005-0.01	0.0003-0.005	0.004-0.005	0.004-0.004	0.004-0.004	0.00473-0.0086	0.004-0.004
Iron	Fe	6010B-ICP	0.1-0.1	0.1-0.14	0.2-0.5	0.4-1.1	0.1-0.1	0.1-0.1	0.07-0.13	0.005-0.09	0.04-0.05	0.04-0.05	0.04-0.04	0.1155-0.236	0.04-0.04
Lead	Pb	6020-ICP/MS	0.001-0.002	0.002-0.003	0.001-0.003	0.0005-0.0013	0.0006-0.0008	0.0003-0.0004	0.001-0.002	0.00001-0.0001	0.0001-0.0001	0.0001-0.00011	0.00011-0.00011	0.000661-0.001281	0.00011-0.00011
Manganese	Mn	6010B-ICP/MS	0.001-0.001	0.08-0.11	0.02-0.04	0.002-0.005	0.003-0.004	0.002-0.01	0.003-0.006	0.0004-0.007	0.004-0.005	0.004-0.004	0.004-0.004	0.01194-0.0192	0.004-0.004
Mercury[2]	Hg	1631E-AFS	0.3-0.3	-	0.05-0.25	0.05-0.2	0.1-0.1	0.1-0.2	0.3-1.1	0.01-0.3	0.3-0.6	0.08-0.09	0.1-0.3	0.1433-0.3489	0.1-0.3
Selenium	Se	7740-GFAA	0.07-0.1	0.06-0.08	0.1-0.3	0.08-0.13	0.05-0.06	0.05-0.07	0.06-0.1	0.004-0.07	0.04-0.05	0.04-0.05	0.04-0.04	0.0554-0.101	0.04-0.04
Zinc	Zn	6020-ICP/MS	0.01-0.02	0.1-0.14	0.02-0.11	0.007-0.02	0.01-0.01	0.009-0.013	0.01-0.03	0.001-0.011	0.011-0.014	0.013-0.013	0.013-0.013	0.0191-0.0381	0.013-0.013

Notes:
1) The Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
2) No MDL available for mercury in 2005.

Table 3.1-1
Macroinvertebrate Taxa Collected within the Crooked Creek Drainage (2004-2014)

Order	Family	Genus	Total count[1]
Ephemeroptera	Ameletidae	*Ameletus*	202
	Baetidae	*Acentrella*	6157
		Baetis	4169
	Ephemerellidae	*Drunella*	471
		Ephemerella	1746
		Serratella	14
	Heptageniidae	*Cinygmula*	4336
		Epeorus	514
		Rhithrogena	21
Plecoptera	Capniidae	*Capnia*	1191
	Chloroperlidae	*Paraperla*	29
		Plumiperla	105
		Suwallia	2303
	Nemouridae	*Nemoura*	312
		Podmosta	187
		Zapada	3979
	Perlodidae	*Arcynopteryx*	54
		Isoperla	661
Trichoptera	Apataniidae	*Apatania*	1476
	Brachycentridae	*Brachycentrus*	269
	Glossosomatidae	*Glossosoma*	13
	Hydroptilidae	*Hydroptila*	26
		Stactobiella	2
	Limnephilidae	*Dicosmoecus*	46
		Ecclisiomyia	326
		Hydatophylax	54
		Psychoglypha	43
	Rhyacophilidae	*Rhyacophila*	34
Diptera	Ceratopogonidae		82
	Chironomidae		23514
	Chironomidae[2]	*Corynoneura*	9
		Diamesa	425
		Diplocladius	5
		Eukiefferiella	8255
		Limnophyes	3
		Micropsectra	1052
		Orthocladius	6562
		Pagastia	5898
		Paraphaenocladius	24
		Parorthocladius	437
		Pseudodiamesa	15
		Pseudokieferiella	14
Diptera	Chironomidae[2]	*Rheocricotopus*	200
		Rheotanytarsus	474
		Thienameniella	63
		Trichotanypus	2
		Trissopelopia	9
		Tvetenia	135
		Stempellina	6
	Dixidae	*Dixa*	1
		Dixella	6
	Empididae	*Chelifera*	775
		Oreogeton	2
	Limoniidae	*Limnophila*	17
		Rhabdomastix	13
	Psychodidae	*Pericoma*	207
	Simuliidae	*Gymnopais*	408
		Metacnephia	970
		Prosimulium	6164
		Simulium	5572
		Stegopterna	9
	Tipulidae	*Dicranota*	168
		Tipula	22
	Dolichopodidae		16
Acariformes	Hydrachnidae		2016
Amphipoda			3
Cladocera			3
Coleoptera	Dytiscidae	*Colymbytes*	3
			20
		Laccophilus	1
		Oreodytes	9
Collembola			106
Copepoda			5
Gastropoda	Physidae	*Physa*	2
	Valvatidae	*Valvata*	1
Oligochaeta			3086
Ostracoda			14
Turbellaria			74
Grand Total			**95620**

1) Total abundance is shown for all sites and years of study.
2) Chironomidae were identifed to genus in 2009 and 2010 only.

Table 3.1-2

Macroinvertebrate Bioassessment Summary Statistics within the Crooked Creek Drainage (2004-2014)

Site	DO1	FL1	DM1	QZ1	SN2	QU1	CR2	CR1	CR0.7	CR0.3	AM1	AM2	GR1	OM1	AN1	AN2	CV1	EG1	GM1	GM2	GM3	GM4	BL1
n years	9	6	2	1	6	1	9	9	7	5	6	1	1	1	4	4	4	1	3	1	3	1	2
n reps	*45*	*28*	*10*	*5*	*30*	*3*	*45*	*45*	*35*	*25*	*30*	*3*	*5*	*5*	*20*	*20*	*20*	*5*	*13*	*5*	*15*	*5*	*10*
	Mean SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD	**Mean** SD
General Metrics[1]																							
Abundance(# / ft^2)	244.3 181.3	498.8 290.9	155.8 116.0	259.2 --	90.2 34.1	435.3 --	212.4 190.1	229.9 169.6	262.7 196.1	377.9 272.2	175.5 110.1	587.0 --	66.6 --	79.8 --	61.7 40.5	34.1 31.8	124.8 57.5	59.0 --	460.5 298.2	75.8 --	170.2 41.7	179.0 --	35.3 19.1
# Taxa	20.2 4.1	20.0 1.7	16.5 2.1	15.0 --	14.3 4.0	13.0 --	19.8 4.2	19.4 3.6	20.1 3.7	19.8 2.9	17.7 2.7	21.0 --	12.0 --	11.0 --	12.5 2.6	12.8 4.8	15.5 1.3	14.0 --	22.7 3.1	12.0 --	13.7 1.5	13.0 --	10.5 0.7
# EPT Taxa	11.8 2.0	11.5 1.2	8.5 2.1	6.0 --	7.7 1.4	4.0 --	11.3 1.9	10.7 2.9	11.1 1.6	11.2 2.5	9.2 1.6	7.0 --	6.0 --	4.0 --	6.3 2.5	5.8 3.0	7.8 1.0	6.0 --	13.7 1.2	9.0 --	8.7 0.6	8.0 --	7.0 --
% EPT Taxa	30.7 12.4	20.6 7.0	57.6 15.2	51.7 --	25.7 9.1	59.0 --	34.8 12.9	35.6 8.3	28.6 8.2	27.2 7.4	35.8 14.7	14.8 --	18.9 --	64.7 --	51.6 18.7	36.0 20.7	21.2 12.7	68.8 --	40.9 16.3	15.8 --	29.0 14.6	74.2 --	41.6 28.1
% Dominant Taxon	54.7 19.1	56.4 18.0	30.7 13.9	45.4 --	57.2 10.7	25.1 --	39.1 10.4	41.7 12.3	58.0 14.7	52.7 9.5	43.1 16.3	69.0 --	51.7 --	41.4 --	28.3 6.2	31.5 8.1	50.0 11.9	29.8 --	50.9 16.1	79.7 --	59.7 17.0	29.4 --	49.7 28.8
% Chironomidae	54.7 19.1	54.1 21.6	14.5 1.7	42.3 --	53.0 16.2	14.2 --	32.3 13.9	38.8 15.3	58.0 14.7	52.7 9.5	35.5 20.8	8.1 --	6.0 --	10.0 --	17.9 8.3	31.0 8.8	16.9 14.8	18.3 --	50.3 17.3	79.7 --	59.7 17.0	8.4 --	49.3 29.4
EPT/Chironomidae Ratio	0.7 0.6	0.5 0.4	3.9 0.6	1.2 --	0.5 0.2	4.1 --	1.7 1.7	1.1 0.6	0.6 0.3	0.5 0.2	1.4 0.9	1.8 --	3.2 --	6.5 --	3.4 2.2	1.3 0.9	8.1 14.6	3.8 --	1.0 0.8	0.2 --	0.5 0.3	8.9 --	1.2 1.3
Diversity Indices																							
Shannon (H)	1.68 0.5	1.50 0.4	2.02 0.2	1.21 --	1.46 0.2	1.75 --	1.95 0.2	1.82 0.3	1.56 0.4	1.75 0.2	1.69 0.3	1.30 --	1.59 --	1.60 --	1.90 0.1	1.90 0.2	1.52 0.3	1.92 --	1.66 0.2	0.95 --	1.43 0.4	2.08 --	1.49 0.4
Evenness (e)	0.57 0.2	0.50 0.1	0.72 0.0	0.45 --	0.56 0.1	0.68 --	0.66 0.1	0.62 0.1	0.52 0.1	0.59 0.1	0.59 0.1	0.43 --	0.64 --	0.67 --	0.76 0.1	0.78 0.1	0.56 0.1	0.73 --	0.53 0.1	0.38 --	0.55 0.2	0.81 --	0.64 0.2
Biotic Indices																							
HBI	4.83 0.4	5.03 0.4	3.28 0.5	3.41 --	4.20 1.0	3.93 --	4.59 0.4	4.73 0.3	4.95 0.3	4.88 0.4	4.28 0.6	3.34 --	3.71 --	2.38 --	4.01 0.5	4.36 0.4	3.84 0.5	3.35 --	4.68 0.3	5.27 --	4.90 0.4	3.51 --	4.04 1.6
% Composition Per Order																							
Ephemeroptera	20.5 10.1	10.1 6.5	28.3 3.7	0.8 --	12.0 3.6	24.0 --	22.6 9.5	25.6 8.6	17.5 8.8	14.8 5.9	27.7 14.0	8.2 --	16.2 --	0.3 --	30.1 10.5	18.0 16.8	18.1 12.1	15.6 --	22.9 3.9	6.3 --	19.24 10.02	63.69 --	17.66 8.75
Plecoptera	8.5 3.5	9.2 5.0	29.1 18.9	50.8 --	13.0 5.7	35.0 --	10.5 7.4	7.5 6.0	7.5 3.4	8.9 6.6	7.4 3.0	6.0 --	2.4 --	64.4 --	11.2 7.1	14.8 7.5	3.0 1.0	30.8 --	6.4 3.0	5.0 --	5.18 3.20	10.50 --	21.18 15.46
Trichoptera	1.7 1.9	1.3 1.0	0.3 0.0	-- --	0.8 0.6	-- --	1.6 1.9	2.5 3.1	3.3 3.0	3.6 3.0	0.7 1.0	0.5 --	0.3 --	-- --	10.3 19.9	3.2 4.7	0.1 0.2	22.4 --	11.6 18.8	4.5 --	4.63 7.15	-- --	2.75 3.89
Diptera	62.7 16.1	74.6 8.4	32.1 11.0	43.2 --	60.1 15.5	39.5 --	57.6 13.1	59.9 7.4	67.5 7.9	63.8 11.4	48.0 25.4	80.9 --	64.9 --	16.5 --	31.7 12.8	46.6 15.3	66.8 12.3	23.7 --	55.4 18.4	80.2 --	62.68 19.18	14.19 --	50.79 29.02
Oligochaeta	3.1 6.1	1.2 0.9	9.1 5.6	3.5 --	14.0 19.8	1.2 --	3.5 3.6	1.6 1.1	1.8 1.7	6.7 7.0	15.7 15.6	3.1 --	16.2 --	17.3 --	15.2 9.8	15.3 9.0	11.4 6.6	4.7 --	1.6 1.6	4.0 --	5.94 9.02	11.62 --	4.74 4.97
Acariformes	3.5 4.2	3.6 2.9	0.0 0.1	-- --	0.1 0.1	0.1 --	3.2 3.5	2.0 3.4	2.2 2.2	2.3 1.8	0.4 0.3	0.2 --	-- --	-- --	1.0 1.2	1.6 2.0	0.4 0.4	0.7 --	2.0 2.5	-- --	2.28 3.08	-- --	2.87 4.06
Amphipoda	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.2 --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Cladocera	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.0 0.0	0.0 0.0	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.0 0.1	-- --	-- --	-- --	-- --
Coleoptera	0.0 0.0	-- --	-- --	-- --	-- --	-- --	0.4 1.1	0.4 1.1	0.1 0.1	-- --	0.0 0.1	-- --	-- --	-- --	-- --	-- --	-- --	0.3 --	-- --	-- --	-- --	-- --	-- --
Collembola	0.0 0.0	0.0 0.0	0.1 0.1	0.2 --	0.1 0.1	-- --	0.5 1.3	0.4 0.7	0.1 0.2	-- --	0.0 0.1	0.1 --	-- --	1.3 --	0.5 0.7	-- --	0.1 0.1	-- --	-- --	-- --	0.05 0.09	-- --	-- --
Copepoda	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.1 0.4	0.0 0.0	-- --	-- --	0.1 --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Gastropoda	-- --	-- --	-- --	-- --	-- --	-- --	0.0 0.0	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.0 0.1	-- --	-- --	-- --	-- --	-- --	-- --
Ostracoda	0.0 0.0	-- --	-- --	-- --	-- --	-- --	0.1 0.3	-- --	0.0 0.0	0.0 0.0	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.0 0.1	-- --	-- --	-- --	-- --
Turbellaria	-- --	-- --	1.1 1.2	1.3 --	0.0 0.1	0.2 --	-- --	-- --	-- --	-- --	0.0 0.1	0.7 --	-- --	0.3 --	-- --	0.5 0.7	-- --	1.7 --	0.0 0.0	-- --	-- --	-- --	-- --

Notes:

For sample site locations, refer to Figure 1.1-1. Chironomidae genera grouped as one taxon for multi-year comparisons.

1) Refer to the text for definitions of metrics.

n years = Number of years site has been sampled

n reps = Total number of replicates sampled

Mean = Average of all samples for all years

SD = Standard deviation of the mean. SD not calculated for sites with only one year of data.

Table 3.1-3
Metal Concentrations in Mayflies and Stoneflies for Sites within the Crooked Creek Drainage (2011)

			Metal Concentrations per Site (mg/kg Wet Weight)				
Order	**Component**	**Detection Limit AVG (Range)**	**DO1**	**CR2**	**CR1**	**CR0.7**	**Average**
Mayflies	**Solids, Total**		**1.32**	**18.6**	**18.6**	**2.4**	**10.23**
	Aluminum	0.0305 (0.004 - 0.056)	82.2	566	550	95.4	323.4
	Antimony	0.000205 (0.00003 - 0.00037)	0.00067	0.0144	0.0081	0.0016	0.006193
	Arsenic	0.00205 (0.0003 - 0.0037)	0.0541	1.54	0.97	0.126	0.672525
	Cadmium	0.000205 (0.00003 - 0.00037)	0.016	0.238	0.244	0.0228	0.1302
	Chromium	0.00825 (0.001 - 0.015)	0.12	0.777	0.679	0.145	0.43025
	Copper	0.00205 (0.0003 - 0.0037)	0.198	2.91	2.59	0.484	1.5455
	Iron	0.04075 (0.005 - 0.074)	93.6	727	546	105	367.9
	Lead	0.00005 (0.00001 - 0.00009)	0.02311	0.17558	0.15158	0.03817	0.09711
	Manganese	0.00305 (0.0004 - 0.0056)	11.4	91.7	109	11.5	55.9
	Mercury	0.00006 (0.00001 - 0.00011)	0.00084	0.0157	0.00715	0.00105	0.006185
	Selenium	0.0305 (0.004 - 0.056)	0.041	0.979	0.721	0.085	0.4565
	Zinc	0.006 (0.001 - 0.011)	1.39	22.3	14.8	2.36	10.2125
Average Mayflies			***14.6***	***110.2***	***95.7***	***16.7***	***59.3***
Stoneflies	**Solids, Total**		**1.62**	**13.7**	**13.5**	**0.77**	**7.3975**
	Aluminum	0.0235 (0.005 - 0.041)	206	528	288	21.6	260.9
	Antimony	0.000155 (0.00003 - 0.00027)	0.0035	0.016	0.0097	0.00064	0.00746
	Arsenic	0.00155 (0.0003 - 0.0027)	0.242	1.22	0.583	0.036	0.52025
	Cadmium	0.000155 (0.00003 - 0.00027)	0.0055	0.0378	0.0237	0.0026	0.0174
	Chromium	0.00625 (0.001 - 0.011)	0.325	0.755	0.453	0.035	0.392
	Copper	0.00155 (0.0003 - 0.0027)	0.308	2.58	2.63	0.18	1.4245
	Iron	0.0315 (0.006 - 0.055)	366	593	425	25	352.25
	Lead	0.00004 (0.00001 - 0.00007)	0.08481	0.18678	0.10175	0.0294	0.100685
	Manganese	0.00235 (0.0005 - 0.0041)	48.7	38.7	17	2.07	26.6175
	Mercury	0.0000475 (0.00001 - 0.00008)	0.00147	0.0162	0.00867	0.00043	0.006693
	Selenium	0.0235 (0.005 - 0.041)	0.017	0.393	0.285	0.02	0.17875
	Zinc	0.00475 (0.001 - 0.008)	1.38	17.2	17	0.758	9.0845
Average Stoneflies			***48.1***	***92.0***	***58.8***	***3.9***	***50.7***
Average Total			**31.3**	**101.1**	**77.2**	**10.3**	**55.0**

Notes:
Samples collected on July 18, 2011. Refer to Figure 1.1-1 for sampling site locations.
Samples were collected with a variety of methods including kick nets and surber samplers.
Method detection limits are shown as an average for all sites followed by a range for all sites.
Wet weight to dry weight conversion for Mayflies is 0.239.
Wet weight to dry weight conversion for Stoneflies is 0.198.

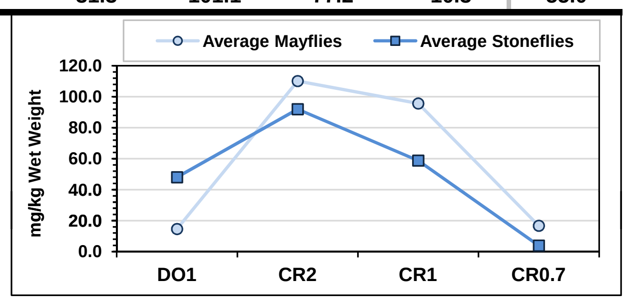


Table 3.2-1
Fish Species Identified within the Crooked Creek Drainage (2004-2013)

Fish Species			**Drainage**																		
Family	**Species**	**Common Name**	**Donlin Creek[2]**	**Flat Creek**	**Dome Creek**	**Quartz Gulch**	**Snow Gulch[3]**	**Queen Gulch**	**Crooked Creek[4]**	**Lewis Gulch**	**American Creek**	**Grouse Creek**	**Omega Gulch**	**Anaconda Creek**	**Crevice Creek**	**Eagle Creek**	**B Creek**	**A Creek**	**Getmuna Creek**	**Bell Creek**	**Grand Total**
Salmonidae	*Oncorhynchus tshawytscha*	Chinook salmon							X										X	X	X
	Oncorhynchus keta	Chum salmon	X						X										X	X	X
	Oncorhynchus kisutch	Coho salmon	X	X	X		X		X		X	X		X					X	X	X
	Oncorhynchus gorbuscha	Pink Salmon							X[1]												X
	Oncorhynchus nerka	Sockeye salmon							X										X		X
	Oncorhynchus mykiss	Rainbow trout							X[1]												X
	Salvelinus malma	Dolly Varden	X	X	X		X		X		X	X		X	X	X	X		X	X	X
	Thymallus arcticus	Arctic grayling	X	X					X		X			X					X	X	X
	Prosopium cylindraceum	Round whitefish	X	X					X										X	X	X
	Coregonus pidschian	Humpback whitefish							X[1]												X
Catostomidae	*Catostomus catostomus*	Longnose sucker							X												X
Cottidae	*Cottus cognatus*	Slimy sculpin	X	X					X		X	X		X	X	X			X	X	X
Esocidae	*Esox lucius*	Northern pike							X												X
Umbridae	*Dallia pectoralis*	Alaska blackfish							X												X
Petromyzontidae	*Lampetra alaskensis*	Alaskan brook lamprey							X												X
Gadidae	*Lota lota*	Burbot	X	X					X		X	X		X		X					X
Gasterosteidae	*Pungittius pungittius*	Nine-spine stickleback							X											X	X
		Total Species Count	**7**	**6**	**2**	**0**	**2**	**0**	**17**	**0**	**5**	**4**	**0**	**5**	**2**	**3**	**1**	**0**	**8**	**8**	**17**

Notes:

Includes data from trapping, all electrofishing passes, aerial surveys, and weir counts.

1) Observed at weir site only

2) Mouth to endpoint of survey approximately 4.8 km (3 mi) upstream from confluence with Ophir Creek

3) Coho salmon adults have been found only in the lower reach of Snow Gulch.

4) Mouth to terminus at confluence of Flat and Donlin Creeks

Table 3.2-2
Adult Salmon Aerial Couts for the Crooked Creek Mainstem (2004-2014)

Season	Species	REACH # Years[1] Year	DOR3 (9,10)	DOR2 (11,11)	DOR1 (11,11)	CRR5 (11,11)	CRR4 (11,10)	CRR3 (11,10)	CRR2 (11,10)	CRR1 (11,10)	Crooked Creek Mainstem Total
			Crooked Creek Mainstem								
Summer	Chinook salmon	2004	0	0	0	0	2	4	20	29	55
		2005	ns	0	0	6	2	0	6	1	15
		2006	0	0	0	0	1	1	5	5	12
		2007	0	0	0	0	1	1	2	0	4
		2008	0	0	0	0	0	0	2	1	3
		2009	0	0	0	0	3	3	6	10	22
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	1	5	6
		2012	0	0	0	0	0	2	1	5	8
		2013	0	0	0	0	0	4	3	0	7
		2014	ns	0	5	1	5	0	0	0	11
		Mean[2]	0.0	0.0	0.5	0.6	1.3	1.4	4.2	5.1	13.0
		Min	0	0	0	0	0	0	0	0	0
		Max	0	0	5	6	5	4	20	29	55
	Chum salmon	2004	0	1	0	0	1	3	134	52	191
		2005	ns	4	7	7	15	24	178	291	526
		2006	0	0	0	0	0	1	146	280	427
		2007	0	0	2	8	17	21	89	264	401
		2008	0	0	0	0	0	1	30	16	47
		2009	0	1	0	2	10	4	72	77	166
		2010	0	0	0	0	2	3	37	66	108
		2011	0	0	0	0	0	4	177	212	393
		2012	0	0	0	0	0	1	124	109	234
		2013	0	0	0	2	12	4	333	243	594
		2014	ns	0	0	1	2	0	150	9	162
		Mean[2]	0.0	0.5	0.8	1.8	5.4	6.0	133.6	147.2	295.4
		Min	0	0	0	0	0	1	30	9	47
		Max	0	4	7	8	17	24	333	291	594
	Coho salmon	2004	0	0	0	0	0	0	0	0	0
		2005	ns	0	0	0	0	0	0	0	0
		2006	0	0	0	0	0	0	0	0	0
		2007	0	0	0	0	0	0	0	0	0
		2008	0	0	0	0	0	0	0	0	0
		2009	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	0	0	0
		2012	0	0	0	0	0	0	0	0	0
		2013	0	0	0	0	0	0	0	0	0
		2014	ns	0	0	0	0	0	0	0	0
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Min	0	0	0	0	0	0	0	0	0
		Max	0	0	0	0	0	0	0	0	0
	Sockeye salmon	2004	0	0	0	0	0	0	0	0	0
		2005	ns	0	0	0	0	0	0	0	0
		2006	0	0	0	0	0	0	0	0	0
		2007	0	0	0	0	0	0	0	0	0
		2008	0	0	0	0	0	0	0	0	0
		2009	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	0	3	3
		2012	0	0	0	0	0	0	0	0	0
		2013	0	0	0	0	0	0	0	0	0
		2014	ns	0	0	0	0	0	0	1	1
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4
		Min	0	0	0	0	0	0	0	0	0
		Max	0	0	0	0	0	0	0	3	3
	Pink salmon	2004	0	0	0	0	0	0	0	0	0
		2005	ns	0	0	0	0	0	0	0	0
		2006	0	0	0	0	0	0	0	0	0
		2007	0	0	0	0	0	0	0	0	0
		2008	0	0	0	0	0	0	0	0	0
		2009	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	0	0	0
		2012	0	0	0	0	0	0	0	0	0
		2013	0	0	0	0	0	0	1	0	1
		2014	ns	0	0	0	0	0	0	0	0
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
		Min	0	0	0	0	0	0	0	0	
		Max	0	0	0	0	0	0	1	0	

Table 3.2-2
Adult Salmon Aerial Couts for the Crooked Creek Mainstem (2004-2014)

Season	Species	REACH # Years[1] Year	Crooked Creek Mainstem DOR3 (9,10)	DOR2 (11,11)	DOR1 (11,11)	CRR5 (11,11)	CRR4 (11,10)	CRR3 (11,10)	CRR2 (11,10)	CRR1 (11,10)	Crooked Creek Mainstem Total
Fall	Chinook salmon	2004	0	0	0	0	0	0	0	0	0
		2005	0	0	0	0	0	0	0	0	0
		2006	0	0	0	0	0	0	0	0	0
		2007	0	0	0	0	0	0	0	0	0
		2008	0	0	0	0	0	0	0	0	0
		2009	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	0	0	0
		2012	0	0	0	0	ns	ns	ns	ns	0
		2013	0	0	0	0	0	0	0	0	0
		2014	ns	0	0	0	0	0	0	0	0
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Min	0	0	0	0	0	0	0	0	0
		Max	0	0	0	0	0	0	0	0	0
	Chum salmon	2004	0	0	0	0	0	0	0	0	0
		2005	0	0	0	0	0	0	0	0	0
		2006	0	0	0	0	0	0	0	0	0
		2007	0	0	0	0	0	0	0	0	0
		2008	0	0	0	0	0	0	0	0	0
		2009	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	0	0	0
		2012	0	0	1	0	ns	ns	ns	ns	1
		2013	0	0	0	0	0	0	0	0	0
		2014	ns	0	0	0	0	0	0	0	0
		Mean[2]	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
		Min	0	0	0	0	0	0	0	0	0
		Max	0	0	1	0	0	0	0	0	1
	Coho salmon	2004	0	190	56	27	23	9	3	2	311
		2005	0	1	0	1	0	0	0	0	3
		2006	40	37	3	0	0	0	0	0	83
		2007	39	15	2	0	7	8	0	0	132
		2008	6	62	34	24	38	25	18	14	427
		2009	0	45	58	8	3	15	40	7	434
		2010	90	18	31	35	5	4	22	8	415
		2011	208	58	31	39	36	19	26	3	1064
		2012	8	7	0	1	ns	ns	ns	ns	56
		2013	30	3	0	2	0	0	0	0	82
		2014	ns	44	0	7	6	2	0	10	69
		Mean[2]	42.1	43.6	19.5	13.1	11.8	8.2	10.9	4.4	279.6
		Min	0	1	0	0	0	0	0	0	3
		Max	208	190	58	39	38	25	40	14	1064
	Sockeye salmon	2004	0	0	0	0	0	0	0	0	0
		2005	0	0	0	0	0	0	0	0	0
		2006	0	0	0	0	0	0	0	0	0
		2007	0	0	0	0	0	0	0	0	0
		2008	0	0	0	0	0	0	0	0	0
		2009	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	0	0	0
		2012	0	0	0	0	ns	ns	ns	ns	0
		2013	0	0	0	0	0	0	0	0	0
		2014	ns	0	0	0	0	0	0	0	0
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Min	0	0	0	0	0	0	0	0	0
		Max	0	0	0	0	0	0	0	0	0
	Pink salmon	2004	0	0	0	0	0	0	0	0	0
		2005	0	0	0	0	0	0	0	0	0
		2006	0	0	0	0	0	0	0	0	0
		2007	0	0	0	0	0	0	0	0	0
		2008	0	0	0	0	0	0	0	0	0
		2009	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0
		2011	0	0	0	0	0	0	0	1	1
		2012	0	0	0	0	ns	ns	ns	ns	0
		2013	0	0	0	0	0	0	0	0	0
		2014	ns	0	0	0	0	0	0	0	0
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
		Min	0	0	0	0	0	0	0	0	0
		Max	0	0	0	0	0	0	0	1	1

Table 3.2-2
Adult Salmon Aerial Couts for the Crooked Creek Mainstem (2004-2014)

Season Species	REACH # Years[1] Year	DOR3 (9,10)	DOR2 (11,11)	DOR1 (11,11)	CRR5 (11,11)	CRR4 (11,10)	CRR3 (11,10)	CRR2 (11,10)	CRR1 (11,10)	Crooked Creek Mainstem Total
		Crooked Creek Mainstem								
Total Summer Count	Mean[2]	0.0	0.5	1.3	2.5	6.6	7.4	137.9	152.6	308.8
Total Fall Count	Mean[2]	42.1	43.6	19.6	13.1	11.8	8.2	10.9	4.5	279.8
Total Salmon	Mean[2]	42.1	44.2	20.9	15.5	18.4	15.6	148.8	157.1	588.6
Chinook Salmon	Mean[2]	0.0	0.0	0.5	0.6	1.3	1.4	4.2	5.1	13.0
Chum Salmon	Mean[2]	0.0	0.5	0.9	1.8	5.4	6.0	133.6	147.2	295.5
Coho Salmon	Mean[2]	42.1	43.6	19.5	13.1	11.8	8.2	10.9	4.4	279.6
Sockeye Salmon	Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4
Pink Salmon	Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2

Notes:
ns = not surveyed
1) # Years sampled = (# Summer Surveys,# Fall Surveys)
2) Mean = (total # fish seen)/(# years surveyed)
Refer to Figure 1.1-1 for aerial reach locations and adult salmon distributions within the Crooked Creek drainage.
Summer aerial flight dates for Chinook, chum, sockeye, and pink salmon: July 25, 2004; July 23, 2005; July 19-20, 2006; July 24-28, 2007; July 23-25, 2008; July 19-22, 2009; July 24-25, 2010; July 21-22, 2011; July 20-24, 2012; July 25-28, 2013; July 26, 2014. Fall aerial flight dates for coho salmon: September 23-24, 2004;

Table 3.2-3

Daily Salmon Escapement at the Crooked Creek Weir (2008-2012)

Chinook Salmon

Date	2008 Daily	2008 %	2009 Daily	2009 %	2010 Daily	2010 %	2011 Daily	2011 %	2012 Daily	2012 %
6/28	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6/29	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6/30	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/2	1	1.2	1	1.0	0	0.0	0	0.0	0	0.0
7/3	0	1.2	0	1.0	0	0.0	0	0.0	0	0.0
7/4	0	1.2	0	1.0	0	0.0	0	0.0	0	0.0
7/5	0	1.2	0	1.0	0	0.0	0	0.0	0	0.0
7/6	1	2.3	1	2.0	0	0.0	0	0.0	0	0.0
7/7	0	2.3	0	2.0	1	2.0	0	0.0	0	0.0
7/8	2	4.7	2	4.0	0	2.0	0	0.0	1	3.4
7/9	0	4.7	0	4.0	8	18.4	2	6.3	2	10.3
7/10	6	11.6	7	11.0	8	34.7	0	6.3	0	10.3
7/11	10	23.3	12	23.0	1	36.7	0	6.3	1	13.8
7/12	17	43.0	20	43.0	5	46.9	8	31.3	0	13.8
7/13	6	50.0	7	50.0	2	51.0	3	40.6	2	20.7
7/14	1	51.2	1	51.0	1	53.1	3	50.0	1	24.1
7/15	0	51.2	0	51.0	1	55.1	0	50.0	2	31.0
7/16	0	51.2	0	51.0	1	57.1	2	56.3	4	44.8
7/17	6	58.1	7	58.0	2	61.2	0	56.3	0	44.8
7/18	1	59.3	1	59.0	0	61.2	0	56.3	4	58.6
7/19	2	61.6	2	61.0	0	61.2	0	56.3	2	65.5
7/20	3	65.1	4	65.0	0	61.2	0	56.3	2	72.4
7/21	3	68.6	4	69.0	2	65.3	0	56.3	2	79.3
7/22	0	68.6	0	69.0	1	67.3	0	56.3	1	82.8
7/23	3	72.1	3	72.0	0	67.3	0	56.3	1	86.2
7/24	3	75.6	3	75.0	0	67.3	0	56.3	0	86.2
7/25	4	80.2	5	80.0	0	67.3	0	56.3	0	86.2
7/26	3	83.7	4	84.0	0	67.3	0	56.3	1	89.7
7/27	1	84.9	1	85.0	0	67.3	0	56.3	0	89.7
7/28	4	89.5	3	88.0	2	71.4	1	59.4	0	89.7
7/29	1	90.7	1	89.0	0	71.4	1	62.5	0	89.7
7/30	0	90.7	0	89.0	2	75.5	1	65.6	0	89.7
7/31	0	90.7	4	93.0	3	81.6	1	68.8	1	93.1
8/1	0	90.7	1	94.0	2	85.7	1	71.9	1	96.6
8/2	2	93.0	1	95.0	0	85.7	1	75.0	0	96.6
8/3	0	93.0	2	97.0	0	85.7	1	78.1	0	96.6
8/4	2	95.3	0	97.0	2	89.8	1	81.3	0	96.6
8/5	1	96.5	0	97.0	2	93.9	1	84.4	0	96.6
8/6	2	98.8	0	97.0	1	95.9	1	87.5	0	96.6
8/7	0	98.8	1	98.0	0	95.9	1	90.6	0	96.6
8/8	0	98.8	0	98.0	1	98.0	0	90.6	0	96.6
8/9	0	98.8	0	98.0	0	98.0	0	90.6	0	96.6
8/10	0	98.8	0	98.0	0	98.0	1	93.8	0	96.6
8/11	0	98.8	0	98.0	0	98.0	1	96.9	0	96.6
8/12	1	100.0	1	99.0	1	100.0	0	96.9	0	96.6
8/13	-1	98.8	0	99.0	0	100.0	1	100.0	0	96.6
8/14	0	98.8	0	99.0	0	100.0	0	100.0	0	96.6
8/15	0	98.8	0	99.0	0	100.0	0	100.0	1	100.0
8/16	0	98.8	0	99.0	0	100.0	0	100.0	0	100.0
8/17	0	98.8	0	99.0	0	100.0	0	100.0	0	100.0
8/18	0	98.8	0	99.0	0	100.0	0	100.0	0	100.0
8/19	1	100.0	1	100.0	0	100.0	0	100.0	0	100.0
8/20	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/21	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/22	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/23	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/24	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/25	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/26	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/27	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/28	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/29	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/30	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
8/31	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/1	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/2	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/3	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/4	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/5	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/6	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/7	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/8	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/9	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/10	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/11	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/12	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/13	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/14	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/15	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/16	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/17	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/18	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/19	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/20	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/21	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/22	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/23	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/24	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/25	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/26	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/27	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/28	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Total	**86**		**100**		**49**		**32**		**29**	

Chum Salmon

Date	2008 Daily	2008 %	2009 Daily	2009 %	2010 Daily	2010 %	2011 Daily	2011 %	2012 Daily	2012 %
6/28	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0
6/29	0	0.1	0	0.1	0	0.0	0	0.0	1	0.1
6/30	0	0.1	0	0.1	0	0.0	1	0.0	1	0.2
7/1	1	0.1	1	0.1	0	0.0	0	0.0	1	0.4
7/2	2	0.2	2	0.2	0	0.0	0	0.0	0	0.4
7/3	0	0.2	0	0.2	0	0.0	7	0.2	1	0.5
7/4	1	0.3	1	0.3	0	0.0	8	0.4	2	0.7
7/5	1	0.4	1	0.3	63	5.0	18	0.9	4	1.2
7/6	5	0.6	6	0.6	11	5.9	22	1.5	6	1.9
7/7	2	0.8	2	0.7	10	6.7	11	1.8	13	3.5
7/8	8	1.2	9	1.2	31	9.1	112	4.8	21	6.0
7/9	18	2.3	21	2.2	27	11.3	129	8.2	34	10.1
7/10	46	5.0	54	4.9	8	11.9	67	10.0	25	13.1
7/11	86	10.1	101	10.0	18	13.4	184	14.9	23	15.9
7/12	132	17.8	155	17.8	19	14.9	197	20.1	75	24.9
7/13	67	21.8	79	21.7	31	17.3	126	23.5	29	28.4
7/14	3	22.0	4	21.9	9	18.1	109	26.4	41	33.3
7/15	9	22.5	11	22.5	58	22.7	99	29.0	29	36.8
7/16	15	23.4	18	23.4	67	28.0	228	35.1	24	39.7
7/17	9	23.9	11	24.0	24	29.9	180	39.9	12	41.1
7/18	15	24.8	18	24.9	25	31.9	176	44.6	26	44.2
7/19	43	27.3	50	27.4	50	35.9	170	49.1	40	49.0
7/20	84	32.3	99	32.3	27	38.0	163	53.4	40	53.8
7/21	87	37.4	102	37.5	23	39.9	155	57.6	34	57.9
7/22	89	42.6	104	42.7	12	40.8	148	61.5	29	61.4
7/23	101	48.6	118	48.6	18	42.2	140	65.2	25	64.4
7/24	26	50.1	31	50.2	21	43.9	133	68.8	21	66.9
7/25	70	54.2	82	54.3	59	48.6	125	72.1	14	68.6
7/26	55	57.4	65	57.6	65	53.8	118	75.3	23	71.4
7/27	57	60.8	67	60.9	84	60.5	110	78.2	19	73.7
7/28	24	62.2	75	64.7	57	65.0	103	80.9	32	77.5
7/29	28	63.9	81	68.8	42	68.3	95	83.5	25	80.5
7/30	21	65.1	68	72.2	52	72.5	88	85.8	25	83.5
7/31	42	67.6	81	76.2	66	77.7	80	87.9	16	85.5
8/1	81	72.3	72	79.9	41	81.0	73	89.9	9	86.5
8/2	50	75.3	38	81.8	23	82.8	65	91.6	19	88.8
8/3	50	78.2	42	83.9	30	85.2	58	93.2	22	91.5
8/4	54	81.4	65	87.1	18	86.6	50	94.5	10	92.7
8/5	31	83.2	28	88.5	16	87.9	43	95.6	14	94.4
8/6	50	86.2	26	89.9	23	89.7	26	96.3	6	95.1
8/7	37	88.3	36	91.7	15	90.9	29	97.1	11	96.4
8/8	32	90.2	28	93.1	16	92.2	19	97.6	4	96.9
8/9	25	91.7	26	94.4	31	94.7	23	98.2	1	97.0
8/10	15	92.6	16	95.2	17	96.0	8	98.4	2	97.2
8/11	23	93.9	17	96.0	17	97.4	16	98.9	4	97.7
8/12	21	95.2	12	96.6	11	98.2	4	99.0	1	97.8
8/13	7	95.6	4	96.8	2	98.4	3	99.0	4	98.3
8/14	10	96.2	6	97.1	9	99.1	2	99.1	2	98.6
8/15	8	96.6	5	97.4	3	99.4	8	99.3	1	98.7
8/16	5	96.9	9	97.8	1	99.4	9	99.5	2	98.9
8/17	9	97.5	9	98.3	3	99.7	7	99.7	4	99.4
8/18	6	97.8	14	99.0	1	99.8	2	99.8	2	99.6
8/19	8	98.3	1	99.0	1	99.8	3	99.9	0	99.6
8/20	2	98.4	1	99.1	0	99.8	4	100.0	0	99.6
8/21	0	98.4	0	99.1	0	99.8	0	100.0	0	99.6
8/22	3	98.6	2	99.2	0	99.8	0	100.0	1	99.8
8/23	2	98.7	3	99.3	0	99.8	0	100.0	1	99.9
8/24	5	99.0	0	99.3	0	99.8	0	100.0	0	99.9
8/25	2	99.1	0	99.3	0	99.8	0	100.0	0	99.9
8/26	1	99.2	0	99.3	0	99.8	0	100.0	0	99.9
8/27	3	99.4	0	99.3	0	99.8	0	100.0	0	99.9
8/28	1	99.4	10	99.8	0	99.8	0	100.0	0	99.9
8/29	5	99.7	0	99.8	1	99.9	0	100.0	0	99.9
8/30	1	99.8	0	99.8	1	100.0	0	100.0	1	100.0
8/31	1	99.8	0	99.8	0	100.0	0	100.0	0	100.0
9/1	0	99.8	0	99.8	0	100.0	0	100.0	0	100.0
9/2	0	99.8	0	99.8	0	100.0	0	100.0	0	100.0
9/3	0	99.8	0	99.8	0	100.0	0	100.0	0	100.0
9/4	0	99.8	0	99.8	0	100.0	0	100.0	0	100.0
9/5	0	99.8	1	99.9	0	100.0	0	100.0	0	100.0
9/6	0	99.8	0	99.9	0	100.0	1	100.0	0	100.0
9/7	0	99.8	1	99.9	0	100.0	0	100.0	0	100.0
9/8	1	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/9	1	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/10	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/11	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/12	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/13	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/14	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/15	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/16	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/17	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/18	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/19	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/20	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/21	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/22	0	99.9	0	99.9	0	100.0	0	100.0	0	100.0
9/23	1	100.0	1	100.0	0	100.0	0	100.0	0	100.0
9/24	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/25	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/26	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/27	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/28	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Total	**1699**		**1991**		**1257**		**3755**		**832**	

Coho Salmon

Date	2008 Daily	2008 %	2009 Daily	2009 %	2010 Daily	2010 %	2011 Daily	2011 %	2012 Daily	2012 %
6/28	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6/29	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6/30	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/10	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/11	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/12	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/13	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/14	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/15	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/16	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/17	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/18	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/19	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/20	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/21	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/22	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/23	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/24	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/25	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/26	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/27	3	0.1	1	0.1	0	0.0	0	0.0	0	0.0
7/28	1	0.1	0	0.1	0	0.0	0	0.0	1	0.1
7/29	1	0.1	0	0.1	0	0.0	0	0.0	0	0.1
7/30	0	0.1	2	0.2	0	0.0	0	0.0	0	0.1
7/31	0	0.1	0	0.2	1	0.1	0	0.0	0	0.1
8/1	1	0.1	0	0.2	3	0.3	0	0.0	0	0.1
8/2	2	0.2	0	0.2	1	0.4	0	0.0	1	0.2
8/3	1	0.2	0	0.2	0	0.4	0	0.0	1	0.3
8/4	5	0.3	1	0.3	2	0.6	0	0.0	0	0.3
8/5	1	0.4	5	0.7	1	0.7	0	0.0	0	0.3
8/6	7	0.5	2	0.8	3	0.9	0	0.0	1	0.5
8/7	2	0.6	3	1.1	0	0.9	0	0.0	5	1.0
8/8	13	0.9	3	1.3	5	1.3	0	0.0	0	1.0
8/9	10	1.1	2	1.5	10	2.1	1	0.2	2	1.3
8/10	8	1.3	5	1.9	7	2.7	0	0.2	1	1.4
8/11	19	1.8	11	2.7	4	3.1	0	0.2	3	1.7
8/12	28	2.4	0	2.7	13	4.1	1	0.3	7	2.5
8/13	27	3.1	4	3.0	10	5.0	0	0.3	11	3.8
8/14	62	4.5	5	3.4	17	6.4	0	0.3	4	4.3
8/15	35	5.4	11	4.2	25	8.4	0	0.3	12	5.6
8/16	21	5.9	51	8.2	14	9.6	1	0.5	2	5.9
8/17	18	6.3	27	10.3	15	10.8	3	1.0	3	6.2
8/18	40	7.3	14	11.4	0	10.8	2	1.4	10	7.4
8/19	40	8.2	7	11.9	1	10.9	1	1.5	108	19.8
8/20	27	8.8	19	13.4	0	10.9	3	2.0	58	26.5
8/21	36	9.7	6	13.8	5	11.3	0	2.0	12	27.9
8/22	81	11.6	11	14.7	3	11.6	0	2.0	3	28.2
8/23	74	13.4	6	15.1	4	11.9	1	2.2	14	29.8
8/24	96	15.7	43	18.5	24	13.9	14	4.6	73	38.2
8/25	91	17.8	6	18.9	22	15.7	2	4.9	89	48.5
8/26	60	19.3	5	19.3	6	16.2	0	4.9	16	50.3
8/27	77	21.1	7	19.8	35	19.1	0	4.9	11	51.6
8/28	76	22.9	4	20.2	47	22.9	0	4.9	15	53.3
8/29	54	24.2	40	23.2	49	27.0	0	4.9	54	59.6
8/30	58	25.6	47	26.9	62	32.1	2	5.2	23	62.2
8/31	258	31.7	51	30.8	74	38.2	0	5.2	7	63.0
9/1	285	38.5	38	33.7	56	42.8	53	14.2	9	64.1
9/2	303	45.7	218	50.6	32	45.5	63	24.9	8	65.0
9/3	183	50.0	116	59.5	47	49.3	77	37.9	10	66.1
9/4	409	59.8	47	63.2	93	57.0	24	42.0	13	67.6
9/5	289	66.7	58	67.6	63	62.2	26	46.4	22	70.2
9/6	117	69.4	25	69.6	50	66.3	39	53.0	14	71.8
9/7	104	71.9	19	71.0	114	75.7	23	56.9	15	73.5
9/8	177	76.1	40	74.1	51	80.0	17	59.7	16	75.3
9/9	185	80.5	113	82.9	36	82.9	26	64.1	17	77.3
9/10	172	84.6	36	85.6	23	84.8	11	66.0	19	79.5
9/11	140	87.9	23	87.4	27	87.0	0	66.0	20	81.8
9/12	53	89.2	17	88.7	9	87.8	0	66.0	21	84.2
9/13	127	92.2	41	91.9	13	88.9	8	67.3	20	86.5
9/14	53	93.5	17	93.2	16	90.2	6	68.4	24	89.3
9/15	50	94.7	16	94.4	14	91.3	12	70.4	17	91.2
9/16	12	95.0	4	94.7	8	92.0	32	75.8	11	92.5
9/17	34	95.8	11	95.6	14	93.2	14	78.2	10	93.7
9/18	31	96.5	10	96.4	10	94.0	15	80.7	8	94.6
9/19	12	96.8	4	96.7	19	95.5	12	82.7	12	96.0
9/20	37	97.7	12	97.6	16	96.9	33	88.3	11	97.2
9/21	20	98.1	7	98.1	15	98.1	16	91.0	10	98.4
9/22	19	98.6	6	98.6	13	99.2	15	93.6	7	99.2
9/23	19	99.0	6	99.1	6	99.7	5	94.4	4	99.7
9/24	9	99.3	3	99.3	2	99.8	14	96.8	1	99.8
9/25	3	99.3	1	99.4	0	99.8	11	98.6	0	99.8
9/26	16	99.7	5	99.8	2	100.0	8	100.0	1	99.9
9/27	9	99.9	3	100.0	0	100.0	0	100.0	0	99.9
9/28	3	100.0	0	100.0	0	100.0	0	100.0	1	100.0
Total	**4204**		**1295**		**1212**		**591**		**868**	

Pink Salmon

Date	2008 Daily	2008 %	2009 Daily	2009 %	2010 Daily	2010 %	2011 Daily	2011 %	2012 Daily	2012 %
6/28	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6/29	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6/30	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7/5	0	0.0	0	0.0	1	20.0	0	0.0	0	0.0
7/6	0	0.0	0	0.0	0	20.0	0	0.0	0	0.0
7/7	0	0.0	0	0.0	0	20.0	0	0.0	0	0.0
7/8	0	0.0	0	0.0	0	20.0	0	0.0	0	0.0
7/9	0	0.0	0	0.0	0	20.0	0	0.0	0	0.0
7/10	1	9.1	3	5.1	0	20.0	0	0.0	0	0.0
7/11	0	9.1	0	5.1	0	20.0	0	0.0	0	0.0
7/12	0	9.1	0	5.1	0	20.0	0	0.0	0	0.0
7/13	0	9.1	0	5.1	1	40.0	0	0.0	0	0.0
7/14	0	9.1	2	8.5	0	40.0	2	50.0	0	0.0
7/15	0	9.1	0	8.5	0	40.0	0	50.0	0	0.0
7/16	0	9.1	0	8.5	0	40.0	0	50.0	0	0.0
7/17	0	9.1	0	8.5	0	40.0	0	50.0	0	0.0
7/18	0	9.1	0	8.5	0	40.0	0	50.0	2	10.5
7/19	0	9.1	0	8.5	1	60.0	0	50.0	1	15.8
7/20	0	9.1	0	8.5	0	60.0	0	50.0	2	26.3
7/21	0	9.1	1	10.2	0	60.0	0	50.0	1	31.6
7/22	0	9.1	0	10.2	0	60.0	0	50.0	1	36.8
7/23	1	18.2	6	20.3	0	60.0	0	50.0	0	36.8
7/24	0	18.2	2	23.7	0	60.0	0	50.0	1	42.1
7/25	0	18.2	2	27.1	0	60.0	0	50.0	1	47.4
7/26	0	18.2	2	30.5	0	60.0	0	50.0	1	52.6
7/27	0	18.2	2	33.9	0	60.0	0	50.0	0	52.6
7/28	0	18.2	2	37.3	0	60.0	0	50.0	4	73.7
7/29	1	27.3	6	47.5	0	60.0	0	50.0	2	84.2
7/30	0	27.3	9	62.7	1	80.0	0	50.0	0	84.2
7/31	1	36.4	3	67.8	0	80.0	0	50.0	0	84.2
8/1	0	36.4	4	74.6	0	80.0	0	50.0	0	84.2
8/2	0	36.4	0	74.6	0	80.0	0	50.0	0	84.2
8/3	0	36.4	0	74.6	0	80.0	0	50.0	0	84.2
8/4	1	45.5	2	78.0	0	80.0	0	50.0	1	89.5
8/5	0	45.5	2	81.4	0	80.0	0	50.0	1	94.7
8/6	1	54.5	1	83.1	0	80.0	0	50.0	0	94.7
8/7	0	54.5	0	83.1	0	80.0	0	50.0	0	94.7
8/8	1	63.6	2	86.4	0	80.0	0	50.0	0	94.7
8/9	0	63.6	1	88.1	1	100.0	0	50.0	0	94.7
8/10	0	63.6	1	89.8	0	100.0	0	50.0	0	94.7
8/11	0	63.6	0	89.8	0	100.0	1	75.0	0	94.7
8/12	0	63.6	0	89.8	0	100.0	0	75.0	1	100.0
8/13	0	63.6	0	89.8	0	100.0	0	75.0	0	100.0
8/14	0	63.6	1	91.5	0	100.0	0	75.0	0	100.0
8/15	0	63.6	0	91.5	0	100.0	0	75.0	0	100.0
8/16	0	63.6	0	91.5	0	100.0	0	75.0	0	100.0
8/17	0	63.6	1	93.2	0	100.0	0	75.0	0	100.0
8/18	1	72.7	1	94.9	0	100.0	1	100.0	0	100.0
8/19	0	72.7	1	96.6	0	100.0	0	100.0	0	100.0
8/20	0	72.7	0	96.6	0	100.0	0	100.0	0	100.0
8/21	1	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/22	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/23	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/24	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/25	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/26	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/27	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/28	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/29	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/30	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
8/31	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
9/1	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
9/2	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
9/3	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
9/4	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
9/5	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
9/6	0	81.8	0	96.6	0	100.0	0	100.0	0	100.0
9/7	1	90.9	0	96.6	0	100.0	0	100.0	0	100.0
9/8	1	100.0	0	96.6	0	100.0	0	100.0	0	100.0
9/9	0	100.0	0	96.6	0	100.0	0	100.0	0	100.0
9/10	0	100.0	0	96.6	0	100.0	0	100.0	0	100.0
9/11	0	100.0	1	98.3	0	100.0	0	100.0	0	100.0
9/12	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/13	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/14	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/15	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/16	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/17	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/18	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/19	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/20	0	100.0	0	98.3	0	100.0	0	100.0	0	100.0
9/21	0	100.0	1	100.0	0	100.0	0	100.0	0	100.0
9/22	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/23	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/24	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/25	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/26	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/27	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
9/28	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Total	**11**		**59**		**5**		**4**		**19**	

Sockeye Salmon and **Total**

Date	2008 Daily	2008 %	2009 Daily	2009 %	2010 Daily	2010 %	2011 Daily	2011 %	2012 Daily	2012 %	Total All Years Daily	Total All Years %
6/28	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.0
6/29	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
6/30	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.0
7/1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0.0
7/2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	0.1
7/3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	8	0.1
7/4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	12	0.2
7/5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	88	0.7
7/6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	52	1.0
7/7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	39	1.2
7/8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	186	2.2
7/9	6	10.0	1	10.0	0	0.0	0	0.0	0	0.0	248	3.6
7/10	0	10.0	0	10.0	0	0.0	0	0.0	0	0.0	225	4.8
7/11	0	10.0	0	10.0	0	0.0	0	0.0	0	0.0	436	7.2
7/12	0	10.0	0	10.0	0	0.0	0	0.0	0	0.0	628	10.6
7/13	0	10.0	0	10.0	0	0.0	0	0.0	0	0.0	353	12.6
7/14	0	10.0	0	10.0	0	0.0	0	0.0	0	0.0	177	13.6
7/15	0	10.0	0	10.0	0	0.0	0	0.0	0	0.0	209	14.7
7/16	0	10.0	0	10.0	0	0.0	3	18.8	0	0.0	362	16.7
7/17	0	10.0	0	10.0	0	0.0	1	25.0	1	100.0	253	18.1
7/18	0	10.0	0	10.0	0	0.0	1	31.3	0	100.0	269	19.6
7/19	6	20.0	1	20.0	0	0.0	1	37.5	0	100.0	369	21.6
7/20	6	30.0	1	30.0	0	0.0	1	43.8	0	100.0	432	24.0
7/21	0	30.0	0	30.0	0	0.0	1	50.0	0	100.0	415	26.3
7/22	0	30.0	0	30.0	0	0.0	1	56.3	0	100.0	386	28.4
7/23	12	50.0	2	50.0	0	0.0	1	62.5	0	100.0	431	30.7
7/24	0	50.0	0	50.0	0	0.0	1	68.8	0	100.0	242	32.1
7/25	0	50.0	0	50.0	0	0.0	1	75.0	0	100.0	363	34.1
7/26	6	60.0	1	60.0	0	0.0	1	81.3	0	100.0	345	36.0
7/27	6	70.0	1	70.0	1	20.0	1	87.5	0	100.0	354	37.9
7/28	0	70.0	0	70.0	0	20.0	1	93.8	0	100.0	310	39.6
7/29	1	71.7	0	70.0	0	20.0	0	93.8	0	100.0	285	41.2
7/30	0	71.7	0	70.0	0	20.0	0	93.8	0	100.0	269	42.7
7/31	1	73.3	1	80.0	0	20.0	0	93.8	0	100.0	301	44.3
8/1	0	73.3	0	80.0	1	40.0	0	93.8	0	100.0	290	45.9
8/2	1	75.0	0	80.0	1	60.0	0	93.8	0	100.0	205	47.0
8/3	0	75.0	0	80.0	0	60.0	0	93.8	0	100.0	207	48.2
8/4	1	76.7	0	80.0	2	100.0	0	93.8	0	100.0	217	49.4
8/5	1	78.3	1	90.0	0	100.0	0	93.8	0	100.0	148	50.2
8/6	3	83.3	0	90.0	0	100.0	0	93.8	0	100.0	153	51.0
8/7	0	83.3	0	90.0	0	100.0	0	93.8	0	100.0	140	51.8
8/8	0	83.3	0	90.0	0	100.0	0	93.8	0	100.0	124	52.5
8/9	2	86.7	0	90.0	0	100.0	0	93.8	0	100.0	135	53.2
8/10	2	90.0	0	90.0	0	100.0	0	93.8	0	100.0	83	53.7
8/11	0	90.0	0	90.0	0	100.0	0	93.8	0	100.0	116	54.3
8/12	2	93.3	0	90.0	0	100.0	0	93.8	0	100.0	104	54.9
8/13	0	93.3	0	90.0	1	120.0	0	93.8	0	100.0	73	55.3
8/14	0	93.3	0	90.0	0	120.0	0	93.8	0	100.0	118	55.9
8/15	0	93.3	0	90.0	0	120.0	0	93.8	0	100.0	109	56.5
8/16	0	93.3	0	90.0	-1	100.0	0	93.8	0	100.0	114	57.2
8/17	1	95.0	1	100.0	0	100.0	0	93.8	0	100.0	101	57.7
8/18	0	95.0	0	100.0	0	100.0	0	93.8	0	100.0	94	58.2
8/19	1	96.7	0	100.0	0	100.0	0	93.8	0	100.0	174	59.2
8/20	1	98.3	0	100.0	0	100.0	0	93.8	0	100.0	115	59.8
8/21	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	60	60.1
8/22	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	104	60.7
8/23	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	105	61.3
8/24	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	255	62.7
8/25	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	212	63.9
8/26	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	88	64.3
8/27	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	133	65.1
8/28	0	98.3	0	100.0	0	100.0	0	93.8	0	100.0	153	65.9
8/29	1	100.0	0	100.0	0	100.0	0	93.8	0	100.0	204	67.0
8/30	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	195	68.1
8/31	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	391	70.3
9/1	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	441	72.7
9/2	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	624	76.1
9/3	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	433	78.5
9/4	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	586	81.7
9/5	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	459	84.2
9/6	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	246	85.6
9/7	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	277	87.1
9/8	0	100.0	0	100.0	0	100.0	0	93.8	0	100.0	303	88.8
9/9	0	100.0	0	100.0	0	100.0	1	100.0	0	100.0	379	90.9
9/10	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	261	92.3
9/11	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	211	93.5
9/12	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	100	94.0
9/13	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	209	95.2
9/14	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	116	95.8
9/15	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	109	96.4
9/16	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	67	96.8
9/17	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	83	97.2
9/18	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	74	97.6
9/19	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	59	98.0
9/20	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	109	98.6
9/21	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	69	98.9
9/22	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	60	99.3
9/23	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	42	99.5
9/24	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	29	99.7
9/25	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	15	99.7
9/26	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	32	99.9
9/27	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	12	100.0
9/28	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	4	100.0
Total	**60**		**10**		**5**		**16**		**1**		**18190**	

Notes:

Weir operational period was from 7/28/2008 to 9/29/2008, 6/3/2009 to 9/28/2009, 6/17/2010 to 9/27/2010, 6/27/2011 to 9/27/2011, and 6/27/2012 to 9/28/2012.

Boxed area = the second and third quartile passage dates.

\# Boxed area = median passage day.

Shaded area denotes a period when the weir was inoperable or partially operable and fish passage was estimated using the Proportion Method from ADF&G report, Tatlawiksuk River Salmon Studies, 2010 (Fishery Data Series no. 07-56).

Shaded area denotes a period when the weir was inoperable or partially operable and fish passage was estimated using the Single Day Method from ADF&G report, Tatlawiksuk River Salmon Studies, 2010 (Fishery Data Series no. 07-56).

Shaded area denotes a period when the weir was inoperable or partially operable andfish passage was estimated using the Linear Method from ADF&G report, Tatlawiksuk River Salmon Studies, 2010 (Fishery Data Series no. 07-56).

% =Cumulative Proportion of the total run

Table 3.2-4
Summary of Electrofishing Results by Site within the Crooked Creek Drainage (2004-2014)

Average # Fish Captured[1] (#/300 ft)

				Chinook salmon (Juvenile)		Coho salmon (Juvenile)		Sockeye salmon (Juvenile)		Dolly Varden		Arctic grayling		Round whitefish		Longnose sucker		Slimy sculpin		Alaska blackfish		Alaskan brook lamprey		Burbot		Nine-spine stickleback		
Streams	**Site**	**n (years)**	**# Species**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Total**
Donlin Creek	DO1	9	6		--	**36.3**	(2-182)		--	**3.6**	(0-6.9)	**2.3**	(0-6.9)	**0.2**	(0-1)		--	**99.1**	(34.4-167.1)		--		--	**1.7**	(0-3)		--	**143.2**
Flat Creek	FL1	6	6		--	**1.6**	(0-3.1)		--	**2.1**	(0-10.9)	**1.0**	(0-3.1)	**0.3**	(0-1.5)		--	**129.0**	(55.8-225.4)		--		--	**2.8**	(0-6.2)		--	**136.7**
Dome Creek	DM1	2	2		--	**28.0**	(0-56.1)		--	**26.8**	(22-31.7)		--		--		--		--		--		--		--		--	**54.9**
Quartz Creek	QZ1	1	0		--		--		--		--		--		--		--		--		--		--		--		--	**0.0**
Snow Gulch	SN1	1	1		--		--		--	**10.8**	NA		--		--		--		--		--		--		--		--	**10.8**
	SN2	7	1		--		--		--	**3.3**	(1.2-9.4)		--		--		--		--		--		--		--		--	**3.3**
Queen Gulch	QU1	1	0		--		--		--		--		--		--		--		--		--		--		--		--	**0.0**
Crooked Creek	CR2	9	8	**2.0**	(0-7.6)	**18.3**	(3-70.1)		--	**4.6**	(1.5-11.8)	**6.1**	(0-27.6)	**1.3**	(0-7.9)		--	**165.1**	(56.4-274.3)	**0.2**	(0-2)		--	**1.1**	(0-3.9)		--	**198.7**
	CR1	9	8	**2.1**	(0-10.9)	**110.0**	(1.6-831.6)		--	**0.3**	(0-1.6)	**5.2**	(0-29.5)	**1.9**	(0-10.7)		--	**345.1**	(65.5-632.6)		--		--	**1.2**	(0-4.7)	**1.4**	(0-3.1)	**467.2**
	CR0.7	7	10	**2.1**	(0-8.5)	**35.9**	(6.4-195.7)	3.6	(0-23.4)	**4.9**	(0-8.5)	**12.5**	(0-36.2)	**2.1**	(0-6.4)	**0.3**	(0-2.1)	**375.4**	(142.6-704.3)	**0.3**	(0-2.1)		--	**4.6**	(2.1-12.8)		--	**441.6**
	CR0.3	5	10	**5.5**	(0-22.7)	**11.8**	(1.5-45.5)		--	**3.0**	(0-12.1)	**40.3**	(10.6-71.2)	**5.8**	(0-12.1)	**7.0**	(1.5-15.2)	**242.1**	(121.2-319.7)	**0.3**	(0-1.5)	**2.7**	(1.5-6.1)	**4.2**	(1.5-7.6)		--	**322.7**
Lewis Gulch	LE1	1	0		--		--		--		--		--		--		--		--		--		--		--		--	**0.0**
American Creek	AM1	7	5		--	**6.0**	(0-18.3)		--	**8.2**	(2.7-15.5)	**0.4**	(0-1.8)		--		--	**41.0**	(3.7-99.7)		--		--	**0.3**	(0-0.9)		--	**55.9**
	AM2	1	1		--		--		--	**57.0**	NA		--		--		--		--		--		--		--		--	**57.0**
	AM3	1	0		--		--		--		--		--		--		--		--		--		--		--		--	**0.0**
	AM4	2	0		--		--		--		--		--		--		--		--		--		--		--		--	**0.0**
Grouse Creek	GR1	1	2		--		--		--	**1.4**	NA		--		--		--	**36.2**	NA		--		--		--		--	**37.7**
Omega Gulch	OM1	1	0		--		--		--		--		--		--		--		--		--		--		--		--	**0.0**
Anaconda Creek	AN1	7	5		--	**0.1**	(0-1)		--	**0.8**	(0-3)	**0.9**	(0-6)		--		--	**12.4**	(0.9-27)		--		--	**1.1**	(0-2.7)		--	**15.3**
	AN2	4	1		--		--		--	**3.4**	(2-3.9)		--		--		--		(0-0)		--		--		--		--	**3.4**
Crevice Creek	CV1	4	2		--		--		--	**0.6**	(0-2.2)		--		--		--	**42.0**	(2.2-134.3)		--		--		--		--	**42.5**
Eagle Creek	EG1	1	3		--		--		--	**0.9**	NA		--		--		--	**11.8**	NA		--		--	**0.9**	NA		--	**13.6**
BC Creek	BC1	1	1		--		--		--	**1.0**	NA		--		--		--		--		--		--		--		--	**1.0**
AC Creek	AC1	1	0		--		--		--		--		--		--		--		--		--		--		--		--	**0.0**
Getmuna Creek	GM1	3	7	**12.0**	(6-21.6)	**90.8**	(15.6-231.6)	0.8	(0-2.4)	**2.4**	(0-7.2)	**1.2**	(0-2.4)	**0.4**	(0-1.2)		--	**410.8**	(175.2-536.4)		--		--		--		--	**518.4**
	GM2	1	5		--	**16.0**	NA		--	**36.0**	NA	**1.0**	NA		--		--	**59.0**	NA		--		--		--		--	**112.0**
	GM3	2	4		--	**35.3**	(10-65)		--	**15.7**	(6-32)	**0.3**	(0-1)		--		--	**86.0**	(48-154)		--		--		--		--	**137.3**
	GM4	1	3		--	**9.0**	NA		--	**17.0**	NA		--		--		--	**31.0**	NA		--		--		--		--	**57.0**
Bell Creek	BL1	2	7	**0.5**	(1-1)	**6.0**	(4-8)		--	**1.5**	(3-3)	**3.0**	(1-5)	**1.5**	(3-3)		--	**99.0**	(44-154)		--		--		--	**1.0**	(2-2)	**112.5**
	Totals		12	**24.2**		**405.1**		**4.4**		**205.4**		**74.2**		**13.4**		**7.3**		**2185.0**		**0.8**		**2.7**		**18.0**		**2.4**		**2942.8**

Notes:
Refer to Figure 1.1-1 for site locations.
Any adult salmon observed in electrofishing reaches were not shocked and were allowed to pass or avoided; Adult salmon are not included in the above counts.
1) #/300 ft = number of fish per 300 feet. Only one pass was allowed in 2005 & 2006; therefore, one pass minimum population was used in each year in this table to enable comparison between years.
2) A total of 17 species have been found in Crooked Creek: northern pike, chum salmon, pink salmon, humpback whitefish and rainbow trout were documented with other methods including aerial surveys and weir video.
Range = minimum to maximum number of fish captured across all years that the site was sampled
NA = no range available for 1 year of sampling

Table 3.2-5

The Accuracy of Aerial Surveys for Crooked Creek (2008-2012)

a. The Accuracy of Aerial Surveys Compared to Observed Fish Weir Counts

	2004			2005			2006			2007			2008			2009			2010			2011			2012		
Species	**Weir[1]**	**Aerial[4]**	**% Accuracy**	**Weir[1]**	**Aerial[4]**	**% Accuracy**	**Weir[1]**	**Aerial[4]**	**% Accuracy**	**Weir[1]**	**Aerial[4]**	**% Accuracy**	**Weir[2]**	**Aerial[4]**	**% Accuracy**	**Weir**	**Aerial[5]**	**% Accuracy**	**Weir**	**Aerial[4]**	**% Accuracy**	**Weir[3]**	**Aerial**	**% Accuracy**	**Weir[6]**	**Aerial**	**% Accuracy**
Chinook salmon	na	55	na	na	15	na	na	12	na	na	53	na	0	21	0.0%	61	60	98.4%	33	5	15.2%	18	16	88.9%	17	20	117.6%
Chum salmon	na	191	na	na	526	na	na	427	na	na	1223	na	0	82	0.0%	544	372	68.4%	552	271	49.1%	1673	825	49.3%	341	312	91.5%
Coho salmon	na	311	na	na	3	na	na	83	na	na	132	na	2430	427	17.6%	791	434	54.9%	666	415	62.3%	385	1064	276.4%	165	56	33.9%
TOTALS	**0**	**557**	**0**	**0**	**544**	**0**	**0**	**522**	**0**	**0**	**1408**	**0**	**2430**	**530**	**21.8%**	**1396**	**866**	**62.0%**	**1251**	**691**	**55.2%**	**2076**	**1905**	**91.8%**	**523**	**388**	**74.2%**

b. The Accuracy of Aerial Surveys Compared to Observed *and Modeled* Fish Weir Counts[7]

	2004			2005			2006			2007			2008			2009			2010			2011			2012		
Chinook salmon	na	55	na	na	15	na	na	12	na	na	53	na	62	21	33.9%	61	60	98.4%	33	5	15.2%	18	16	88.9%	21	20	95.2%
Chum salmon	na	191	na	na	526	na	na	427	na	na	1223	na	821	82	10.0%	544	372	68.4%	552	271	49.1%	2161	825	38.2%	446	312	70.0%
Coho salmon	na	311	na	na	3	na	na	83	na	na	132	na	4204	427	10.2%	1295	434	33.5%	1212	415	34.2%	591	1064	180.0%	868	56	6.5%
TOTALS	**0**	**557**	**0**	**0**	**544**	**0**	**0**	**522**	**0**	**0**	**1408**	**0**	**5087**	**530**	**10.4%**	**1900**	**866**	**45.6%**	**1797**	**691**	**38.5%**	**2770**	**1905**	**68.8%**	**1335**	**388**	**29.1%**

c. Differences Between Accuracies Based on Modeled and Actual Fish Weir Counts

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Chinook salmon	na	na	na	na	-33.9%	0.0%	0.0%	0.0%	22.4%
Chum salmon	na	na	na	na	-10.0%	0.0%	0.0%	11.1%	21.5%
Coho salmon	na	na	na	na	7.4%	21.4%	28.1%	96.3%	27.5%
TOTALS					**11.4%**	**16.5%**	**16.8%**	**23.0%**	**45.1%**

Notes:

The operational periods of the Crooked Creek weir were from 7/28/2008 to 9/29/2008, 6/3/2009 to 9/28/2009, 6/17/2010 to 9/27/2010, 6/27/2011 to 9/27/2011 and 6/27/2012 to 9/28/2012.
Aerial surveys in Crooked Creek began on 7/25/2004, 7/23/2005, 7/19/2006, 7/26/2007, 7/23/2008, 7/19/2009, 7/24/2010, 7/21/2011, and 7/20/2012 for the chinook and chum salmon runs and on 9/23/2004, 9/26/2005, 9/20/2006, 9/11/2007, 919/2008, 9/13/2009, 9/17/2010, 9/15/2011, and 9/19/2012 for the coho salmon run.
To allow for comparison, weir counts shown in this table reflect only those salmon that passed the weir on a date equal to or prior to the date of the aerial survey for a given year. Shaded areas denote (a) incomplete weir counts that were (b) estimated using modeled data based on ADFG methods.

Weir = weir count; **Aerial** = aerial survey count; **% Accuracy**= (aerial count)/(weir count) x 100

1) Crooked Creek weir counts not available for 2004-2007.

2) Crooked Creek weir not operational until after the chinook and chum salmon aerial flights had been conducted. Weir was partially operational during the coho salmon run on 9/8/2008 and from 9/10/2008 to 9/20/2008, 9/22/2008 to 9/28/2008.

3) The Crooked Creek weir was not operational from 7/18/2011 to 8/6/2011. Weir was overtopped by high flows from 8/3/2011 to 8/26/2011.

4) Prior to 2011, aerial counts for Crooked Creek did not include Bell Creek.

5) Two chinook salmon were documented downstream of weir during the aerial survey, and therefore were removed from the aerial count for comparison purposes.

6) Crooked Creek weir not operational from 6/30 - 7/1, 7/7 - 7/8, 7/14 - 7/15 and 7/21 - 7/22, 2012. Weir was overtopped by high flows from 9/5 - 9/12 and 9/16 - 9/28, 2012.

7) Weir counts in 2008, 2011, and 2012 incoporate modeled fish passage data during fully and partially inoperable weir dates.

Table 3.2-6
Summary of Electrofishing Results by Site and Year within the Crooked Creek Drainage (2004-2014)

		Fish Captured [1] (#/300 ft)												
Site	Year	Chinook salmon (juvenile)	Coho salmon (juvenile)	Sockeye salmon (juvenile)	Dolly Varden	Arctic grayling	Round whitefish	Longnose sucker	Slimy sculpin	Alaska blackfish	Alaskan brook lamprey	Burbot	Nine-spine stickleback	Grand Total
DO1	2004	- -	85.6	- -	- -	1.0	- -	- -	69.8	- -	- -	3.0	- -	159.3
	2005	- -	15.7	- -	- -	- -	- -	- -	144.5	- -	- -	2.9	- -	163.2
	2006	- -	13.8	- -	5.9	- -	- -	- -	100.3	- -	- -	2.0	- -	121.9
	2007	- -	2.0	- -	3.9	2.0	- -	- -	34.4	- -	- -	2.9	- -	45.2
	2008	- -	16.7	- -	3.9	4.9	- -	- -	167.1	- -	- -	1.0	- -	193.7
	2009	- -	182.0	- -	6.9	3.0	- -	- -	121.0	- -	- -	- -	- -	312.8
	2010	- -	5.9	- -	3.9	6.9	1.0	- -	144.6	- -	- -	- -	- -	162.3
	2011	- -	0.0	- -	5.9	3.0	1.0	- -	66.9	- -	- -	1.0	- -	77.7
	2012	- -	4.9	- -	2.0	- -	- -	- -	43.3	- -	- -	1.0	- -	51.1
	Mean	**- -**	**36.3**	**- -**	**3.6**	**2.3**	**0.2**	**- -**	**99.1**	**- -**	**- -**	**1.5**	**- -**	**143.0**
	SD	**- -**	*60.6*	- -	*2.5*	*2.4*	*0.5*	- -	*56.4*	- -	- -	*1.1*	- -	
FL1	2004	- -	3.1	- -	- -	- -	- -	- -	55.8	- -	- -	6.2	- -	65.1
	2005	- -	1.5	- -	- -	1.5	1.5	- -	114.7	- -	- -	4.6	- -	124.0
	2006	- -	- -	- -	- -	- -	- -	- -	136.4	- -	- -	- -	- -	136.4
	2007	- -	1.5	- -	- -	- -	- -	- -	106.9	- -	- -	1.5	- -	110.0
	2008	- -	1.5	- -	1.5	3.1	- -	- -	134.5	- -	- -	1.5	- -	142.3
	2009	- -	1.6	- -	10.9	1.6	- -	- -	225.4	- -	- -	3.1	- -	242.5
	Mean	**- -**	**1.6**	**- -**	**2.1**	**1.0**	**0.3**	**- -**	**129.0**	**- -**	**- -**	**2.8**	**- -**	**136.7**
	SD	**- -**	*1.0*	- -	*4.4*	*1.3*	*0.6*	- -	*55.5*	- -	- -	*2.3*	- -	
DM1	2008	- -	- -	- -	22.0	- -	- -	- -	- -	- -	- -	- -	- -	22.0
	2009	- -	56.1	- -	31.7	- -	- -	- -	- -	- -	- -	- -	- -	87.8
	Mean	**- -**	**28.0**	**- -**	**26.8**	**- -**	**- -**	**- -**	**- -**	**- -**	**- -**	**- -**	**- -**	**54.9**
	SD	**- -**	*39.7*	- -	*6.9*	- -	- -	- -	- -	- -	- -	- -	- -	
QZ1	2009	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	--
SN1	2006	- -	- -	- -	10.8	- -	- -	- -	- -	- -	- -	- -	- -	10.8
SN2	2006	- -	- -	- -	9.4	- -	- -	- -	- -	- -	- -	- -	- -	9.4
	2007	- -	- -	- -	2.7	- -	- -	- -	- -	- -	- -	- -	- -	2.7
	2008	- -	- -	- -	1.2	- -	- -	- -	- -	- -	- -	- -	- -	1.2
	2009	- -	- -	- -	2.4	- -	- -	- -	- -	- -	- -	- -	- -	2.4
	2011	- -	- -	- -	1.2	- -	- -	- -	- -	- -	- -	- -	- -	1.2
	2012	- -	- -	- -	2.4	- -	- -	- -	- -	- -	- -	- -	- -	2.4
	2013	- -	- -	- -	3.7	- -	- -	- -	- -	- -	- -	- -	- -	3.7
	Mean	**- -**	**- -**	**- -**	**3.3**	**- -**	**- -**	**- -**	**- -**	**- -**	**- -**	**- -**	**- -**	**3.3**
	SD	- -	- -	- -	*2.8*	- -	- -	- -	- -	- -	- -	- -	- -	
QU1	2010	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	--
CR2	2004	3.0	70.1	- -	1.5	3.0	1.5	- -	187.5	- -	- -	1.5	- -	268.2
	2005	- -	62.5	- -	7.6	- -	- -	- -	117.3	- -	- -	- -	- -	187.5
	2006	7.6	3.0	- -	7.6	- -	- -	- -	99.1	- -	- -	- -	- -	117.3
	2007	- -	3.0	- -	3.0	- -	- -	- -	173.7	- -	- -	- -	- -	179.8
	2008	1.5	9.1	- -	1.5	10.7	- -	- -	56.4	- -	- -	1.5	- -	80.8
	2009	5.9	5.9	- -	11.8	5.9	2.0	- -	232.9	- -	- -	- -	- -	264.5
	2010	- -	5.9	- -	5.9	27.6	- -	- -	274.3	- -	- -	- -	- -	313.8
	2011	- -	0.0	- -	2.0	7.9	7.9	- -	254.6	2.0	- -	3.9	- -	278.3
	2012	- -	4.7	- -	- -	- -	- -	- -	90.2	- -	- -	3.1	- -	97.9
	Mean	**2.0**	**18.3**	**- -**	**4.6**	**6.1**	**1.3**	**- -**	**165.1**	**0.2**	**- -**	**1.1**	**- -**	**198.7**
	SD	*3.2*	*28.4*	- -	*3.7*	*8.8*	*2.9*	- -	*93.3*	*0.7*	- -	*1.6*	- -	
CR1	2004	- -	43.5	- -	- -	- -	- -	- -	228.5	- -	- -	- -	1.6	273.6
	2005	- -	12.4	- -	- -	- -	- -	- -	248.7	- -	- -	- -	3.1	264.2
	2006	4.7	6.2	- -	- -	29.5	- -	- -	399.5	- -	- -	3.1	3.1	446.1
	2007	- -	4.7	- -	- -	1.6	- -	- -	267.4	- -	- -	3.1	3.1	279.8
	2008	3.1	10.9	- -	1.6	3.1	1.6	- -	416.6	- -	- -	4.7	1.6	443.0
	2009	- -	831.6	- -	- -	- -	- -	- -	416.6	- -	- -	- -	- -	1248.2
	2010	10.9	9.3	- -	- -	12.4	3.1	- -	430.6	- -	- -	- -	- -	466.3
	2011	- -	1.6	- -	1.6	- -	1.6	- -	632.6	- -	- -	- -	- -	637.3
	2012	- -	70.1	- -	- -	- -	10.7	- -	65.5	- -	- -	- -	- -	146.2
	Mean	**2.1**	**110.0**	**- -**	**0.3**	**5.2**	**1.9**	**- -**	**345.1**	**- -**	**- -**	**1.2**	**1.4**	**467.2**
	SD	*4.1*	*258.3*	- -	*0.8*	*11.0*	*2.8*	- -	*147.1*	- -	- -	*2.1*	*1.3*	
CR0.7	2006	4.3	6.4	- -	4.3	2.1	- -	2.1	391.5	- -	- -	8.5	- -	419.1
	2007	- -	8.5	- -	4.3	- -	2.1	- -	208.5	- -	- -	12.8	- -	236.2
	2008	2.1	12.8	- -	4.3	4.3	- -	- -	221.3	- -	- -	4.3	- -	248.9
	2009	8.5	195.7	2.1	- -	12.8	2.1	- -	325.5	- -	- -	4.3	- -	551.1
	2010	- -	14.9	23.4	8.5	27.7	6.4	- -	704.3	2.1	- -	- -	- -	787.2
	2011	- -	- -	- -	8.5	36.2	2.1	- -	634.0	- -	- -	2.1	- -	683.0
	2012	- -	12.8	- -	4.3	4.3	2.1	- -	142.6	- -	- -	- -	- -	166.0
	Mean	**2.1**	**35.9**	**3.6**	**4.9**	**12.5**	**2.1**	**0.3**	**375.4**	**0.3**	**- -**	**4.6**	**- -**	**441.6**
	SD	*3.6*	*75.5*	*9.4*	*2.9*	*14.1*	*2.1*	*1.1*	*191.5*	*1.0*	- -	*4.3*	- -	
CR0.3	2006	3.0	3.0	- -	1.5	10.6	- -	10.6	284.8	- -	1.5	1.5	- -	316.7
	2007	22.7	7.6	- -	- -	63.6	6.1	4.5	121.2	- -	4.5	6.1	- -	236.4
	2008	1.5	1.5	- -	- -	37.9	9.1	15.2	257.6	- -	1.5	7.6	- -	331.8
	2009	- -	1.5	- -	1.5	18.2	12.1	3.0	227.3	1.5	6.1	6.1	- -	277.3
	2010	- -	45.5	- -	12.1	71.2	1.5	1.5	319.7	- -	- -	- -	- -	451.5
	Mean	**5.5**	**11.8**	**- -**	**3.0**	**40.3**	**5.8**	**7.0**	**242.1**	**0.3**	**2.7**	**4.2**	**- -**	**322.7**
	SD	*10.7*	*19.0*	- -	*5.1*	*26.8*	*5.1*	*5.7*	*75.7*	*0.8*	*2.3*	*2.6*	- -	
LE1	2009	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	--
AM1	2004	- -	- -	- -	2.7	- -	- -	- -	11.0	- -	- -	0.9	- -	14.6
	2005	- -	3.7	- -	11.0	- -	- -	- -	99.7	- -	- -	- -	- -	114.3
	2006	- -	18.3	- -	6.4	- -	- -	- -	75.9	- -	- -	- -	- -	100.6
	2007	- -	- -	- -	7.3	0.9	- -	- -	3.7	- -	- -	- -	- -	11.9
	2008	- -	2.7	- -	15.5	1.8	- -	- -	6.4	- -	- -	- -	- -	26.5
	2009	- -	17.4	- -	11.9	- -	- -	- -	82.3	- -	- -	0.9	- -	112.5
	2011	- -	- -	- -	2.7	- -	- -	- -	8.2	- -	- -	- -	- -	11.0
	Mean	**- -**	**6.0**	**- -**	**8.2**	**0.4**	**- -**	**- -**	**41.0**	**- -**	**- -**	**0.3**	**- -**	**55.9**
	SD	- -	*8.5*	- -	*4.8*	*0.8*	- -	- -	*42.7*	- -	- -	*0.5*	- -	
AM2	2010	- -	- -	- -	57.0	- -	- -	- -	- -	- -	- -	- -	- -	57.0
AM3[2]	2011	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	
AM4	2011	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	
AM4[3]	2011	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	
GR1	2008	- -	- -	- -	1.4	- -	- -	- -	36.2	- -	- -	- -	- -	37.7
OM1	2009	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	
AN1	2004	- -	- -	- -	0.9	- -	- -	- -	0.9	- -	- -	- -	- -	1.8
	2005	- -	- -	- -	1.8	- -	- -	- -	8.2	- -	- -	0.9	- -	11.0
	2004	- -	- -	- -	0.9	- -	- -	- -	0.9	- -	- -	- -	- -	1.8
	2005	- -	- -	- -	1.8	- -	- -	- -	8.2	- -	- -	0.9	- -	11.0
	2006	- -	- -	- -	- -	- -	- -	- -	16.5	- -	- -	2.7	- -	19.2
	2007	- -	- -	- -	- -	- -	- -	- -	13.0	- -	- -	1.0	- -	14.0
	2008	- -	- -	- -	3.0	- -	- -	- -	3.0	- -	- -	- -	- -	6.0
	2009	- -	- -	- -	- -	- -	- -	- -	18.0	- -	- -	1.0	- -	19.0

Table 3.2-6
Summary of Electrofishing Results by Site and Year within the Crooked Creek Drainage (2004-2014)

		Fish Captured [1] (#/300 ft)												
Site	Year	Chinook salmon (juvenile)	Coho salmon (juvenile)	Sockeye salmon (juvenile)	Dolly Varden	Arctic grayling	Round whitefish	Longnose sucker	Slimy sculpin	Alaska blackfish	Alaskan brook lamprey	Burbot	Nine-spine stickleback	Grand Total
	2011	- -	1.0	- -	- -	6.0	- -	- -	27.0	- -	- -	2.0	- -	36.0
	Mean	- -	0.1	- -	0.8	0.9	- -	- -	12.4	- -	- -	1.1	- -	15.3
	SD	- -	0.4	- -	1.2	2.3	- -	- -	6.6	- -	- -	0.8	- -	
AN2	2006	- -	- -	- -	3.9	- -	- -	- -	- -	- -	- -	- -	- -	3.9
	2007	- -	- -	- -	2.0	- -	- -	- -	- -	- -	- -	- -	- -	2.0
	2008	- -	- -	- -	3.9	- -	- -	- -	- -	- -	- -	- -	- -	3.9
	2009	- -	- -	- -	3.9	- -	- -	- -	- -	- -	- -	- -	- -	3.9
	Mean	- -	- -	- -	3.4	- -	- -	- -	- -	- -	- -	- -	- -	3.4
	SD	- -	- -	- -	1.0	- -	- -	- -	- -	- -	- -	- -	- -	
CV1	2006	- -	- -	- -	- -	- -	- -	- -	134.3	- -	- -	- -	- -	134.3
	2007	- -	- -	- -	- -	- -	- -	- -	4.5	- -	- -	- -	- -	4.5
	2008	- -	- -	- -	- -	- -	- -	- -	2.2	- -	- -	- -	- -	2.2
	2009	- -	- -	- -	2.2	- -	- -	- -	26.9	- -	- -	- -	- -	29.1
	Mean	- -	- -	- -	0.6	- -	- -	- -	42.0	- -	- -	- -	- -	42.5
	SD	- -	- -	- -	1.1	- -	- -	- -	62.6	- -	- -	- -	- -	
EG1	2009	- -	- -	- -	0.9	- -	- -	- -	11.8	- -	- -	- -	- -	13.6
BC1	2010	- -	- -	- -	1.0	- -	- -	- -	- -	- -	- -	- -	- -	1.0
AC1	2010	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
GM1	2007	8.4	15.6	- -	- -	- -	- -	- -	175.2	- -	- -	- -	- -	199.2
	2008	6.0	25.2	- -	- -	1.2	1.2	- -	520.8	- -	- -	- -	- -	554.4
	2009	21.6	231.6	2.4	7.2	2.4	- -	- -	536.4	- -	- -	- -	- -	801.6
	Mean	12.0	90.8	0.8	2.4	1.2	0.4	- -	410.8	- -	- -	- -	- -	518.4
	SD	8.4	122.0	1.2	4.2	1.2	0.7	- -	204.2	- -	- -	- -	- -	
GM2[3]	2012	- -	16.0	- -	36.0	1.0	- -	- -	59.0	- -	- -	- -	- -	112.0
GM3[3]	2012	- -	31.0	--	9.0	--	- -	- -	48.0	- -	- -	- -	- -	88.0
	2013	- -	10.0	--	6.0	1.0	- -	- -	56.0	- -	- -	- -	- -	73.0
	2014	- -	65.0	6.0	32.0	--	- -	- -	154.0	- -	- -	- -	- -	257.0
	Mean	- -	35.3	2.0	15.7	0.3	- -	- -	86.0	- -	- -	- -	- -	139.3
	SD	- -	27.8	3.5	15.7	0.6	- -	- -	5.7	- -	- -	- -	- -	
GM4[3]	0	- -	9.0		17.0				31.0					
BL1[2]	2011	1.0	4.0	- -	3.0	5.0	3.0	- -	154.0	- -	- -	- -	2.0	172.0
	2012	--	8.0	- -	--	1.0	--	- -	44.0	- -	- -	- -	0.0	53.0
	Mean	0.5	6.0	- -	1.5	3.0	1.5	- -	99.0	- -	- -	- -	1.0	112.5
	SD	0.7	2.8	- -	2.1	2.8	2.1	- -	77.8	- -	- -	- -	1.4	

Notes:
Refer to Figure 1.1-1 for site locations
DO=Donlin Creek; FL=Flat Creek; DM=Dome Creek; QZ=Quartz Creek; SN=Snow Gulch; CR=Crooked Creek; LE=Lewis Gulch; AM=American Creek; GR=Grouse Creek; OM=Omega Gulch; AN=Anaconda Creek; CV=Crevice Creek; EG=Eagle Creek; AC=A Creek; BC= B Creek; GM=Getmuna Creek; BL=Bell Creek
Any adult salmon observed in electrofishing reaches were not shocked and were allowed to pass or avoided; Adult salmon are not included in the above counts
1) #/300 ft = number of fish per 300 feet. Only one pass was allowed in 2005 and 2006. Therefore, to enable comparison between years, one pass minimum population was used in each year in this table
2) Added site in 2011
3) Newly added site in 2012
SD = standard deviation over n (years)
-- = species not found at biomonitoring site that year

Table 3.2-7
Average Weekly Counts of Non-Salmon Species at the Crooked Creek Weir (2008-2012)

Date	Rainbow Trout	Dolly Varden	Arctic Grayling	Round Whitefish	Humpback Whitefish	Longnose Sucker	Slimy Sculpin	Northern Pike	Alaskan Brook Lamprey	Burbot	Grand Total
5/30 - 6/5						1.2					1.2
6/6 - 6/12			0.4	1.4		1.0					2.8
6/13 - 6/19		0.2	0.6	0.8		24.4					26.0
6/20 - 6/26		0.2	1.0	0.2		7.2	0.4				9.0
6/27 - 7/3		0.6	1.0	0.8	0.2	14.4	0.4				17.4
7/4 - 7/10		1.6	0.2	0.6	0.2	50.0	1.0		0.4		54.0
7/11 - 7/17		0.8	0.6	0.8		55.6	0.8				58.6
7/18 - 7/24	0.2	2.2	0.4	0.4		17.0	1.6				21.8
7/25 - 7/31	0.2	2.6		0.4		6.6	1.0				10.8
8/1 - 8/7		3.8	0.2	0.8		10.6	0.4				15.8
8/8 - 8/14	0.2	5.8		0.2		13.2	0.6				20.0
8/15 - 8/21	0.2	5.8	0.2	0.2		6.8					13.2
8/22 - 8/28		2.2	0.4	0.8		5.8	0.2				9.4
8/29 - 9/4	0.2	1.2	0.4	2.6	0.2	3.8	0.2		0.2		8.8
9/5 - 9/11	0.2	1.6	0.2	3.2		6.4					11.6
9/12 - 9/18	0.2	1.4	0.2	2.4		0.8	0.4				5.4
9/19 - 9/25		1.6	0.8	5.2	0.2	1.2		0.2	0.2	0.4	9.8
9/26 - 10/2			0.6	0.4		1.0					2.0
Annual Avg Count	**1.4**	**31.6**	**7.2**	**21.2**	**0.8**	**227.0**	**7.0**	**0.2**	**0.8**	**0.4**	**297.6**
Min Length[1] (mm)	432	102	152	127	330	51	51	483	152	432	51
Max Length[1] (mm)	610	686	483	559	483	584	152	483	203	559	686
Avg Length[1] (mm)	457	408	295	319	364	359	69	483	178	546	345
Length Range (mm)	**(432-610)**	**(102-686)**	**(152-483)**	**(127-559)**	**(330-483)**	**(51-584)**	**(51-152)**	**(483-483)**	**(152-203)**	**(533-559)**	**(51-686)**

Notes:

See Table 3.2-3 for weir operational periods.

Weekly counts include all observations regardless of direction of travel. Totals should not be considered an escapement. Individuals of all species may be small enough to move between the weir pickets.

1) Length measurements were estimated as described in the methods.

Table 3.2-8
Summary of Off-Channel Habitat Fish Sampling within the Crooked Creek Drainage (2013 - 2014)

		# of Fish Captured at Crooked Creek Drainage Off-Channel Sampling Sites																												
	Site	BW_01		BW_02		BW_03		BW_04		BW_05		BW_06		BW_07		BW_08		BW_09		BW_10		BW_11		BW_12		BW_9B		BW_13		
	Connectivity Status[2]	*C*		*C*		*C*		*I*		*I*		*I*		*C*		*C*		*C*		*I*		*I*		*I*		*C*		*I*		
		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		# Fish		Total Fish
Survey Method	Species	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	
Fyke	Coho salmon	--	36	--	--	--	--	--	59	--	--	--	--	--	--	--	--	--	--	--	--	16	16	--	7	--	--	--	20	154
	Arctic grayling	--	52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	53
	Northern pike	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1
	Alaska blackfish	--	--	--	--	--	--	--	63	--	--	--	--	--	--	--	--	--	--	--	--	5	53	--	32	--	--	--	29	182
	Nine-spine stickleback	--	5	--	--	--	--	1	22	--	--	--	--	--	--	--	--	--	--	--	--	19	65	--	--	--	--	--	17	129
	Burbot	--	13	--	--	--	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	16	--	4	--	--	--	3	42
	Slimy Sculpin	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	47	--	--	--	3	51
	Total # Fish Captured	NS	107	NS	NS	NS	NS	1	150	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	42	150	NS	90	NS	NS	NS	72	612
	# Fyke Nets Set[1]	--	1	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	1	2	--	1	--	--	--	1	8
	# Fish/24hr Set	--	107.0	--	--	--	--	1.0	150.0	--	--	--	--	--	--	--	--	--	--	--	--	42.0	75.0	--	90.0	--	--	--	72.0	76.5
	# Species (All samples)	--	5	--	--	--	--	1	4	--	--	--	--	--	--	--	--	--	--	--	--	5	4	--	4	--	--	--	5	7
Minnow Traps	Coho salmon	17	4	55	10	14	7	--	2	--	--	25	--	116	4	6	--	1	--	--	--	--	1	1	1	--	--	--	21	285
	Dolly Varden	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
	Slimy sculpin	--	--	1	--	--	2	--	3	--	--	3	--	--	--	--	1	--	1	--	--	1	--	--	--	--	1	--	--	13
	Alaska blackfish	--	--	3	--	2	1	21	12	--	2	--	--	2	4	--	--	7	3	11	1	13	4	7	19	--	--	--	35	147
	Burbot	4	--	3	1	--	--	--	--	1	--	6	--	--	--	--	--	--	--	--	--	4	4	--	--	--	--	--	--	23
	Nine-spine stickleback	24	3	39	19	25	23	6	15	8	--	56	1	91	3	3	2	6	6	19	100	3	1	10	21	--	2	--	81	567
	Total # Fish Captured	45	7	101	30	41	33	27	32	9	2	91	1	209	11	9	3	14	10	30	101	21	10	18	41	NS	3	NS	137	1036
	# Minnow Traps Set[1]	10	10	10	10	6	6	9	10	4	4	11	11	10	10	3	4	10	7	9	5	10	8	7	15	--	4	--	18	221
	Average # Fish/Minnow Trap	4.5	0.7	10.1	3.0	6.8	5.5	3.0	3.2	2.3	0.5	8.3	0.1	20.9	1.1	3.0	0.8	1.4	1.4	3.3	20.2	2.1	1.3	2.6	2.7	--	0.8	--	7.6	4.7
	# Species (All samples)	3	2	5	3	3	4	2	4	2	1	5	1	3	3	2	2	3	3	2		4	4	3	3	--	2	--	3	6
Electrofishing	Coho salmon	--	--	23	--	37	2	--	--	--	--	7	13	25	22	--	--	--	--	--	--	--	--	--	--	--	4	--	--	133.0
	Arctic grayling	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
	Slimy sculpin	--	--	4	--	1	--	--	--	--	--	--	4	2	4	--	--	--	--	--	--	--	--	--	--	--	17	--	--	32.0
	Alaska blackfish	--	--	--	--	4	1	--	--	--	--	--	--	--	10	--	--	--	--	4	--	--	--	--	--	--	1	--	--	20.0
	Nine-spine stickleback	--	--	13	--	19	1	--	--	--	--	2	6	6	30	--	--	--	--	6	--	--	--	--	--	--	18	--	--	101.0
	Bubot	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1		--	--	--		--	--	--	--	--	2.0
	Dolly Varden	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1.0
	No Fish Caught	--	--	--	--	--	--	--	--	X	--	--	--	--		--	--	--	--	--	--	--	--	X	--	--	--	--	--	0.0
	Total # Fish Captured	NS	NS	41	NS	61	4	NS	NS	0	NS	9	24	33	66	NS	NS	NS	NS	10	NS	NS	NS	0	NS	NS	40	NS	NS	288.0
	# Electrofishing Passes[1]	--	--	1	--	1	1	--	--	1	--	1	1	1	1	--	--	--	--	--	--	--	--	--	--	--	1	--	--	9.0
	# Fish/100ft	--	--	41.0	--	61.0	4.0	--	--	0.0	--	9.0	24.0	33.0	66.0	--	--	--	--	--	--	--	--	--	--	--	40.0	--	--	32.0
	# Species (All Samples)	--	--	4	--	4	3	--	--	0	--	2	4	3	4	--	--	--	--	--	--	--	--	--	--	--	5	--	--	7

Notes:
Refer to Figure 1.1-1 for site locations.
Sampling methods were determined based on existing habitat conditions
1) Samples are defined as: Fyke Net Set = One 24 hour fyke net set (4' x 3' opening, 3/8" mesh,15' wings, 30' leader); Minnow Trap Set = One 24 hour minnow trap set (1" opening, 1/4" mesh);
Electrofishing Pass = One electrofisher with two netters for a distance of ~100ft along river bank
2) Connectivity Status to the main channel are defined as: C = Connected; I = Intermittent
NS: Sampling method not performed at this site

Table 3.3-1

Average Metal Concentrations in Slimy Sculpin <55mm Long within the Crooked Creek Drainage (2004-2014)

			(mg/kg Wet Weight)										
Site ID	**Year**	**n**	**Al**	**As**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Se**	**Zn**
DO1	2004	6	131.47	0.18	0.02	0.30	0.73	184.60	0.05	23.58	0.02	1.00	21.83
	2005	6	114.62	0.18	0.02	0.47	0.88	130.83	0.03	23.15	0.03	0.84	19.33
	2006	9	93.53	0.25	0.02	0.12	0.84	108.10	0.02	14.90	0.04	0.72	26.94
	2007	15	67.52	0.17	0.02	0.12	0.69	88.65	0.02	14.90	0.03	0.93	21.05
	2008	15	82.95	0.17	0.02	0.20	0.62	103.87	0.03	14.55	0.04	0.68	20.48
	2009	15	45.72	0.12	0.01	0.06	0.49	58.08	0.01	23.03	0.03	0.62	15.43
	2010	15	85.87	0.14	0.01	0.21	0.67	81.41	0.04	11.79	0.03	0.88	20.88
	2011	15	69.59	0.13	0.01	0.16	0.52	84.61	0.03	12.19	0.03	0.72	17.51
	2012	15	34.37	0.12	0.02	0.97	0.84	62.69	0.04	11.76	0.03	1.22	19.87
	Grand Mean		**80.63**	**0.16**	**0.02**	**0.29**	**0.70**	**100.32**	**0.03**	**16.65**	**0.03**	**0.85**	**20.37**
	SD		**30.80**	**0.04**	**0.00**	**0.28**	**0.14**	**38.81**	**0.01**	**5.11**	**0.01**	**0.19**	**3.16**
	CV		**0.38**	**0.25**	**0.22**	**0.97**	**0.20**	**0.39**	**0.37**	**0.31**	**0.19**	**0.22**	**0.16**
	Detectable change		**1.15**	**0.74**	**0.67**	**2.90**	**0.60**	**1.16**	**1.12**	**0.92**	**0.56**	**0.66**	**0.47**
CR2	2004	6	63.93	0.48	0.01	0.24	0.65	82.02	0.02	10.98	0.03	1.08	20.52
	2005	6	91.62	0.61	0.02	0.35	0.87	120.18	0.03	19.98	0.04	0.87	18.23
	2006	3	116.03	0.56	0.02	0.10	0.90	127.33	0.03	12.10	0.04	0.90	27.53
	2007	15	79.62	0.45	0.02	0.21	0.74	101.63	0.03	10.69	0.04	1.27	21.71
	2008	15	43.69	0.45	0.01	0.17	0.63	77.01	0.01	7.16	0.05	0.95	22.01
	2009	15	35.97	0.31	0.01	0.04	0.61	58.73	0.01	8.80	0.03	1.12	17.97
	2010	15	103.33	0.46	0.01	0.58	0.62	127.79	0.04	11.03	0.04	0.87	17.05
	2011	15	143.00	0.66	0.02	0.52	0.65	257.82	0.05	13.21	0.04	0.65	17.87
	2012	15	39.89	0.34	0.01	0.76	0.98	83.91	0.02	9.77	0.04	1.10	21.27
	Grand Mean		**79.68**	**0.48**	**0.02**	**0.33**	**0.74**	**115.16**	**0.03**	**11.52**	**0.04**	**0.98**	**20.46**
	SD		**37.20**	**0.12**	**0.00**	**0.24**	**0.14**	**58.72**	**0.01**	**3.63**	**0.01**	**0.18**	**3.24**
	CV		**0.47**	**0.24**	**0.23**	**0.74**	**0.19**	**0.51**	**0.47**	**0.32**	**0.13**	**0.19**	**0.16**
	Detectable change		**1.40**	**0.72**	**0.69**	**2.21**	**0.58**	**1.53**	**1.42**	**0.95**	**0.40**	**0.57**	**0.48**
CR1	2004	15	54.20	0.29	0.02	0.15	0.62	65.67	0.02	11.96	0.03	1.05	18.29
	2005	15	81.72	0.31	0.02	0.36	1.16	99.99	0.02	15.65	0.03	1.10	19.46
	2006	25	104.32	0.45	0.03	0.13	0.83	113.32	0.03	14.95	0.03	0.84	21.37
	2007	15	85.81	0.31	0.02	0.15	0.65	87.19	0.03	11.42	0.03	0.86	19.37
	2008	15	50.48	0.29	0.02	0.16	0.58	68.97	0.02	9.78	0.04	0.85	21.55
	2009	15	79.19	0.23	0.01	0.09	0.52	75.54	0.02	10.66	0.03	0.71	15.49
	2010	15	60.57	0.23	0.01	0.18	0.53	56.77	0.02	12.55	0.03	0.62	19.23
	2011	15	96.52	0.23	0.02	0.17	0.54	89.17	0.03	10.51	0.03	0.65	18.63
	2012	15	55.62	0.23	0.02	1.13	1.14	72.78	0.15	11.98	0.03	0.86	21.17
	Grand Mean		**74.27**	**0.29**	**0.02**	**0.28**	**0.73**	**81.04**	**0.04**	**12.16**	**0.03**	**0.84**	**19.40**
	SD		**19.73**	**0.07**	**0.01**	**0.33**	**0.26**	**17.94**	**0.04**	**1.98**	**0.01**	**0.16**	**1.90**
	CV		**0.27**	**0.25**	**0.28**	**1.16**	**0.35**	**0.22**	**1.10**	**0.16**	**0.16**	**0.19**	**0.10**
	Detectable change		**0.80**	**0.75**	**0.84**	**3.49**	**1.06**	**0.66**	**3.31**	**0.49**	**0.49**	**0.58**	**0.29**
CR0.7	2006	29	109.17	0.43	0.03	0.17	0.98	122.86	0.03	16.74	0.03	1.01	23.20
	2007	15	93.99	0.30	0.02	0.19	0.70	98.11	0.03	12.02	0.03	1.03	19.55
	2008	15	42.47	0.27	0.02	0.14	0.53	52.48	0.02	10.25	0.04	0.90	19.89
	2009	15	45.59	0.22	0.01	0.05	0.58	46.52	0.01	9.07	0.02	0.97	15.55
	2010	15	60.77	0.21	0.01	0.33	0.56	56.83	0.03	13.00	0.03	0.67	17.97
	2011	15	70.20	0.22	0.02	0.11	0.53	74.78	0.02	9.88	0.03	0.64	17.02
	2012	15	47.36	0.23	0.02	0.39	0.93	73.71	0.03	14.22	0.03	1.19	21.14
	Grand Mean		**67.08**	**0.27**	**0.02**	**0.20**	**0.69**	**75.04**	**0.02**	**12.17**	**0.03**	**0.92**	**19.19**
	SD		**25.83**	**0.08**	**0.01**	**0.12**	**0.20**	**27.31**	**0.01**	**2.72**	**0.00**	**0.20**	**2.58**
	CV		**0.38**	**0.30**	**0.33**	**0.62**	**0.28**	**0.36**	**0.28**	**0.22**	**0.16**	**0.22**	**0.13**
	Detectable change		**1.15**	**0.90**	**0.98**	**1.87**	**0.85**	**1.09**	**0.84**	**0.67**	**0.47**	**0.65**	**0.40**
GM3.0	2012	14	28.93	0.22	0.01	0.44	1.30	56.51	0.06	7.77	0.05	1.32	20.64
	2013	16	57.68	0.24	0.02	0.14	0.57	80.50	0.02	8.89	0.07	1.31	22.52
	2014	15	61.23	0.47	0.01	0.26	0.63	192.20	0.03	18.57	0.03	1.12	18.93
	Grand Mean		**49.28**	**0.31**	**0.01**	**0.28**	**0.83**	**109.74**	**0.03**	**11.74**	**0.05**	**1.25**	**20.70**
	SD		**20.33**	**0.01**	**0.00**	**0.21**	**0.52**	**16.96**	**0.03**	**0.79**	**0.01**	**0.01**	**1.33**
	CV		**0.33**	**0.03**	**0.21**	**0.82**	**0.82**	**0.09**	**1.21**	**0.04**	**0.34**	**0.00**	**0.07**
	Detectable change		**1.00**	**0.08**	**0.63**	**2.45**	**2.46**	**0.26**	**3.62**	**0.13**	**1.02**	**0.01**	**0.21**

Notes:

Al=Aluminum, As=Arsenic, Cd=Cadmium, Cr=Chromium, Cu=Copper, Fe=Iron, Pb=Lead, Mn=Manganese, Hg=Mercury, Se=Selenium, Zn=Zinc

Antimony was not detected at the MDL, therefore is not presented here

n=the number of composite samples analyzed per year

Grand Mean = Average of all years sampled; SD=Standard Deviation of the means per year; CV=Coefficient of Variation (SD/Mean); Detectable change=3*SD/Grand Mean

A wet weight to dry weight conversion chart is available in Appendix I. Method detection limits (MDL) for each analyte can be found in Table 2.5-1.

Table 3.3-2
Comparison of Slimy Sculpin <55mm Metals Concentration within the Crooked Creek Drainage Between Sites and Years Sampled (2006-2012)

Metal	Symbol	Statistical Differences
Aluminum	Al	Y
Arsenic	As	Y/S
Cadmium	Cd	Y/S
Chromium	Cr	Y
Copper	Cu	Y
Iron	Fe	--
Lead	Pb	--
Manganese	Mn	S
Mercury	Hg	Y/S
Selenium	Se	Y
Zinc	Zn	Y

Notes:
Statistical comparison based on the results of a two-way ANOVA test.
Y: significant statistical differences between years sampled
S: significant statistical differences between sites
Y/S: significant statistical differences between both years and sites
$p < 0.05$
Getmuna Creek metals site GM3 was not included in this analysis

Table 3.3-3
Mean Mercury (Hg) Concentrations in Young-of-Year (YOY) and Age 1+ Coho and Chinook Salmon within the Crooked Creek Drainage (2004-2007)

		Mean Hg (n, *SD*) (mg/Kg)				
Site	**Year**	**Coho YOY**	**Coho 1+**	**Chinook YOY**	**Chinook 1+**	**Reference**
DO1	2004	0.013 (**4**, *0.001*)				present study
	2005	0.021 (**3**, *0.002*)	0.042 (**6**, *0.004*)			present study
	2006	0.006 (**1**, *n/a*)	0.047 (**4**, *0.009*)			present study
	2007	0.012 (**2**, *0.003*)				present study
CR2	2004	0.017 (**5**, *0.001*)				present study
	2005	0.026 (**4**, *0.002*)	0.056 (**2**, *0.013*)			present study
	2006		0.045 (**2**, *0.001*)	0.016 (**1**, *n/a*)		present study
CR1	2004	0.019 (**10**, *0.003*)				present study
	2005	0.018 (**1**, *n/a*)		0.028 (**6**, *0.005*)		present study
	2006	0.017 (**2**, *0.001*)		0.021 (**2**, *0.003*)		present study
	2007	0.025 (**1**, *n/a*)				present study
CR0.7	2006	0.016 (**2**, *0.004*)		0.018 (**2**, *0.001*)		present study
Innoko NWR	1996		0.04 (**5**, *0.006*)		0.04 (**19**, *0.004*)	Mueller & Matz (2002)
Kuskokwim R. region	unknown		0.07 (**10**, *0.032*)			Gray et al. (1996)

Notes:

SD = Standard deviation of mean for each year. SD not available (n/a) for years with a single sample.

Table 3.3-4
Mean Mercury (Hg) Concentrations in Burbot at Crooked Creek Site CR0.3 (2009)

Site	Year	Habitat	Mean Hg (n, *SD*) mg/Kg	Total Length (mm)	Reference
CR0.3	2009	river	0.013 (**4**, *0.04*)	121-300	present study
Alaska statewide	2009	river, lake	0.319 (**21**, *0.28*)	N/A	Alaska DEC 2009
Yukon River, AK	2002	river	0.130 (**13**, *0.26*)	565-700	Hinck et al. 2006
Bethel, AK	1997	river	0.100 (**3**, *0.01*)	N/A	Duffy et al. 1999
Sweden & Norway	1987-1990	river	0.308 (**25**, *0.18*)	>400	Pulliainen et al. 1992

Notes:

SD = Standard deviation of mean for each year.

Table 3.3-5
Mercury Concentrations in Northern Pike Collected in the Crooked Creek Drainage (2010)

Site ID	Total Length (mm)	Weight[1] (g)	Species	Mercury (mg/Kg wet weight)	Solids Total (g)	Notes
AFMA7.0	295	46.65	Northern pike	0.085	17.8	Collected at 61.966872°, -158.266335° (1.25 miles straight line downstream of Crevice Creek, in backwater that was disconnected to the main channel at the time of collection)
WE1.0	795	698.24	Northern pike	0.421	21	Collected at 61.877497°, -158.139881° (fish weir, may have migrated in, but was captured upstream of the panels)

Notes:
1) Weight of sample after homogenization.

Table 3.5-1 (Page 1 of 3)
Periphyton Taxa Collected within the Crooked Creek Drainage (2013-2014)

Order	Division	Genus	Species
Bacillariophyta	Achnanthales	*Achnanthes*	*biasolettiana*
			bioretii
			clevei
			holstii
			laevis
			lanceolata
			laterostrata
			minutissima
			oestrupii
			pseudoswazi
			rosenstockii
			sp.
		Cocconeis	*placentula*
		Planothidium	*haynaldii*
	Bacillariales	*Nitzschia*	*adakensis*
			alpina
			angustata
			dissipata
			intermedia
			perminuta
			pseudofonticola
			pura
			sp.
	Cymbellales	*Anomoeneis*	*serians*
		Cymbella	*affinis*
			amphicephala
			caespitosa
			cistula
			cymbiformis
			gaeumanii
			hebridica
			mexicana
			minuta
			proxima
			silesiaca
			sinuata
			sp.
		Didymosphenia	*geminata*
			sp.
		Gomphonema	*affine*
			affinis
			angustatum
			clavatum
			lapponicum
			olivaceoides
			olivaceum
			parvulum
			pumilum
			sarcophagus
			sp.
			subclavatum
		Rhoicosphenia	*curvata*
	Eunotiales	*Eunotia*	*praerupta*
	Fragilariales	*Diatoma*	*mesodon*

Table 3.5-1 (Page 2 of 3)
Periphyton Taxa Collected within the Crooked Creek Drainage (2013-2014)

Order	Division	Genus	Species
Bacillariophyta cont.	Fragilariales cont.	*Diatoma cont.*	*sp.*
			tenue
			tenuis
			vulgare
		Fragilaria	*capucina*
			construens
			crotonensis
			famelica
			leptostauron
			pseudoconstruens
			vaucheriae
		Hannaea	*arcus*
		Meridion	*circulare*
		Synedra	*acus*
			sp.
			ulna
	Melosirales	*Melosira*	*distans*
			sp.
			varians
	Naviculales	*Caloneis*	*bacillum*
			schumanniana
			silicula
			sp.
		Frustulia	*rhomboides*
		Gyrosigma	*spenceri*
		Navicula	*cinctaeformis*
			circulare
			crucicula
			cryptocephala
			erifuga
			explanata
			gregaria
			laevissima
			lanceolata
			libonensis
			modica
			petersenii
			pseudolanceolata
			pupula
			radiosa
			rhynchocephala
			schmassmanii
			soehrensis
			sp.
			tenue
			trivialis
			tuscula
			veneta
		Pinnularia	*divergens*
			hemiptera
			interrupta
			legumen
			sp.
			subcapitata

Table 3.5-1 (Page 3 of 3)
Periphyton Taxa Collected within the Crooked Creek Drainage (2013-2014)

Order	Division	Genus	Species
Bacillariophyta cont.	Naviculales cont.	*Pinnularia cont.*	*viridis*
		Stauroneis	*anceps*
			fluminea
			phoenicenteron
			sp.
	Tabellariales	*Tabellaria*	*flocculosa*
	Thalassiophysales	*Amphora*	*pediculus*
			sp.
	Surirellales	*Surirella*	*brebissonii*
			linearis
			ovalis
			robusta
			sp.
			tenuis
	Thalassiosirales	*Cyclotella*	*sp.*
Chlorophyta	Chaetophorales	*Chaetophora*	*sp.*
		Stigeoclonium	*sp.*
	Chlamydomonadales	*Carteria*	*sp.*
		Chlamydomonas	*sp.*
	Chlorellales	*Actinastrum*	*sp.*
		Eremosphaera	*sp.*
	Cladophorales	*Pithophora*	*sp.*
	Sphaeropleales	*Golenkinia*	*sp.*
		Microspora	*sp.*
	Ulotrichales	*Ulothrix*	*sp.*
	Sphaeropleales	*Palmodictyon*	*sp.*
		Scenedesmus	*aculeolatus*
		Spirulina	*sp.*
		Tetraedron	*sp.*
	Cladophorales	*Rhizoclonium*	*sp.*
Cyanobacteria	Chroococcales	*Chamaesiphon*	*sp.*
	Nostocales	*Anabaena*	*cincinalis*
			sp.
		Rivularia	*sp.*
	Oscillatoriales	*Lyngbya*	*lagerheimii*
			sp.
		Oscillatoria	*sp.*
		Phormidium	*sp.*
Cryptophyta	Cryptomonadales	*Cryptomonas*	*sp.*
Rhodophyta	Acrochaetiales	*Audouinella*	*sp.*
	Batrachospermales	*Batrachospermum*	*sp.*
Streptophyta	Desmidiales	*Closterium*	*sp.*
Charophyta	Zygnematales	*Mougeotia*	*sp.*
Ochrophyta	Tribonematales	*Tribonema*	*sp.*

Table 3.5-2

Periphyton Bioassessment Summary Statistics within the Crooked Creek Drainage (2013 - 2014)

		DO1	FL1	DM1	QZ1	SN2	CR2	CR1	CR0.7	CR0.3	AM1	AM2	LE1	AN1	AN2	CV1	EG1	GM1	GM2	GM3	GM4	JJ1	BL1
Biomonitoring Site[1]		**DO1**	**FL1**	**DM1**	**QZ1**	**SN2**	**CR2**	**CR1**	**CR0.7**	**CR0.3**	**AM1**	**AM2**	**LE1**	**AN1**	**AN2**	**CV1**	**EG1**	**GM1**	**GM2**	**GM3**	**GM4**	**JJ1**	**BL1**
n years[2]		2	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1	2	2	1	1	1
n reps[3]		*10*	*5*	*5*	*5*	*5*	*10*	*10*	*10*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*10*	*10*	*5*	*5*	*5*
General Metrics[4]																							
Abundance (# algal cells/ft^2)	mean	5.61E+08	1.19E+09	2.40E+08	6.97E+08	5.56E+07	1.15E+09	9.06E+08	6.57E+08	1.96E+09	1.06E+09	1.43E+09	1.29E+08	1.21E+09	9.36E+08	3.46E+08	2.07E+07	9.51E+08	7.98E+08	9.78E+08	8.24E+07	9.46E+07	7.11E+08
	SD	2.51E+08	1.45E+08	2.00E+08	1.38E+08	1.38E+07	3.58E+08	2.27E+08	5.90E+08	5.97E+08	2.09E+08	5.57E+08	2.95E+07	5.97E+08	5.84E+08	3.95E+08	1.04E+07	5.12E+08	3.35E+08	4.22E+08	2.32E+07	1.08E+08	4.20E+08
Total # Taxa[3]		40	27	26	25	30	34	44	36	30	36	29	26	33	28	31	26	39	38	34	40	25	42
Total # Diatom Taxa		33	23	22	23	27	29	37	30	23	31	26	24	28	27	26	23	34	34	28	33	19	32
% *Achnanthidium minutissimum*		32.6	4.7	16.2	29.3	24.1	47.5	53.4	49.4	56.7	3.4	6.7	10.3	17.3	1.3	33.1	14.4	28.3	30.1	41.5	28.3	23.9	26.2
% Motile Diatoms5		2.4	3.2	1.1	0.9	1.7	1.1	2.6	3.4	1.3	3.0	1.2	2.8	1.7	0.8	2.9	4.9	4.3	2.4	2.3	0.5	0.2	0.7
% Dominant Taxon		44.7	35.3	38.3	29.2	49.7	42.6	50.9	47.3	56.6	42.3	25.7	51.6	53.1	40.6	43.3	35.7	27.8	30.4	40.3	21.4	31.3	25.8
Diversity Indices																							
Shannon (H)		2.01	2.02	2.00	1.81	1.82	1.87	1.81	1.86	1.60	2.29	2.20	1.85	1.74	1.47	1.68	1.95	2.44	2.29	1.93	2.47	2.19	2.22
Evenness (e)		0.55	0.61	0.62	0.56	0.54	0.53	0.48	0.52	0.47	0.64	0.65	0.57	0.50	0.44	0.49	0.60	0.67	0.63	0.55	0.67	0.68	0.59
Biotic Index																							
PTI		2.43	2.55	2.60	2.79	2.81	2.55	2.56	2.61	2.55	2.43	2.58	2.79	2.52	2.55	2.94	2.41	2.40	2.34	2.45	2.75	2.11	2.42
% Composition Per Order																							
Bacillariophyta		99.90%	98.58%	95.10%	99.71%	97.15%	99.96%	99.08%	99.64%	99.82%	90.94%	99.31%	99.26%	88.53%	99.69%	99.48%	94.02%	98.31%	98.02%	99.88%	99.74%	76.26%	92.42%
Charophyta		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Chlorophyta		0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.04%	0.01%	0.02%	0.63%	0.05%
Cryptophyta		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.002%	0.00%	0.00%	0.00%	0.00%	0.00%
Cyanobacteria		0.07%	1.20%	4.32%	0.29%	2.55%	0.03%	0.82%	0.32%	0.16%	8.74%	0.39%	0.55%	11.46%	0.31%	0.42%	1.61%	1.69%	1.93%	0.08%	0.06%	22.05%	7.51%
Ochrophyta		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Rhodophyta		0.01%	0.22%	0.58%	0.00%	0.30%	0.00%	0.09%	0.03%	0.00%	0.31%	0.30%	0.19%	0.01%	0.00%	0.00%	4.37%	0.00%	0.00%	0.03%	0.18%	1.06%	0.02%
Streptophyta		0.00%	0.00%	0.00%	0.00%	0.00%	0.004%	0.001%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.001%

Notes:

1) For sample site locations, refer to Figure 1.1-1.

2) n years = Number of years site has been sampled

3) n reps = Total number of replicates sampled

4) Refer to the text for definitions of metrics

5) Consists of the genera *Navicula* and *Nitzschia*

SD = Standard deviation of the mean.

Table 3.6-1

Mean Concentration and One Standard Deviation of Chlorophyll a at Each Sampling Site (2014)

Site[1]	Concentration (mg/m^2)	SD[2]
DO1	10.1	7.4
FL1	3.5	2.1
DM1	1.8	1.8
QZ1	0.3	0.1
SN2	0.3	0.1
CR2	6.2	2.9
CR1	8.5	1.9
CR0.7	5.5	3.2
CR0.3	10.5	4.2
AM1	2.6	2.6
AM2	3.2	3.3
LE1	3.5	4.8
AN1	0.6	0.3
AN2	0.3	0.2
CV1	1.4	1.2
EG1	1.0	0.5
GM1	4.9	6.4
GM2	4.0	3.1
GM3	2.1	1.5
JJ1	3.7	3.7
BL1	10.2	8.5

Notes:

1) For sample site locations, refer to Figure 1.1-1.

2) SD = Standard Deviation

Table 6.1-1
Macroinvertebrate Taxa Collected within the Mine Access Road Drainages (2007-2008)

Order	Family	Genus	Total count[1]
Ephemeroptera	Ameletidae	*Ameletus*	1
	Baetidae	*Acentrella*	9
		Baetis	53
	Ephemerellidae	*Drunella*	177
	Heptageniidae	*Cinygmula*	95
		Epeorus	67
Plecoptera	Chloroperlidae	*Paraperla*	27
		Plumiperla	3
		Suwallia	9
	Nemouridae	*Zapada*	127
	Perlodidae	*Isoperla*	24
	Taeniopterygidae	*Taenionema*	127
Trichoptera	Apataniidae	*Apatania*	8
	Limnephilidae	*Dicosmoecus*	1
		Ecclisiomyia	1
		Psychoglypha	2
	Rhyacophilidae	*Rhyacophila*	19
Diptera	Ceratopogonidae		6
	Chironomidae		623
	Empididae	*Chelifera*	27
		Oreogeton	15
	Psychodidae	*Pericoma*	6
	Simuliidae	*Prosimulium*	45
		Simulium	2
	Tipulidae	*Dicranota*	10
Acariformes	Hydrachnidae		42
Amphipoda			1
Gastropoda	Physidae	*Physa*	1
Oligochaeta			147
Ostracoda			2
Grand Total			1677

1) Total abundance for all sites and all years of study

Table 6.1-2
Macroinvertebrate Taxa Collected in the Kuskokwim River near Jungjuk Port Site (2011-2012)

Order	Family	*Genus*	Total count
Ephemeroptera	Ameletidae	*Ameletus*	2
	Baetidae	*Acentrella*	9
		Baetis	60
	Ephemerellidae	*Ephemerella*	1
	Heptageniidae	*Cinygmula*	44
Plecoptera	Chloroperlidae	*Suwallia*	26
	Nemouridae	*Zapada*	6
	Perlodidae	*Isoperla*	1
Trichoptera	Hydropsychidae	*Arctopsyche*	1
	Hydroptilidae	*Hydroptila*	1
	Limnephilidae	*Ecclisiomyia*	2
		Hydatophylax	1
Diptera	Ceratopogonidae		5
	Chironomidae		2135
	Empididae	*Chelifera*	16
		Oreogeton	1
	Simuliidae	*Gymnopais*	1
		Prosimulium	5
		Simulium	2
	Tipulidae	*Dicranota*	1
Acariformes	Hydrachnidae		48
Oligochaeta			223
Grand Total			2591

1) Total abundance for all sites and all years of study

Table 6.1-3

Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

Location[1]	Jungjuk Creek	Kuskokwim River - Jungjuk Port Site Sampling Sites												
Site ID	JJ1	KU8	KU8	KU9	KU10	KU11	KU12	KU13	KU14	KU15	KU20	KU23	KU24	KU25
year	2007-08	2011	2012	2011	2011	2011	2011	2011	2012	2011	2012	2012	2012	2012
n reps	*8*	*3*	*4*	*3*	*3*	*3*	*3*	*3*	*5*	*3*	*5*	*5*	*5*	*5*
Sample Method	Surber	Surber	Ponar®	Ponar®	Surber	Surber	Surber	Ponar®	Surber	Ponar®	Surber	Surber	Ponar®	Surber
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
General Metrics[2]														
Abundance (# / ft²)	210.8 6.5	245.7 --	53.2 --	32.3 --	32.7 --	5.3 --	76.0 --	51.7 --	22.4 --	15.3 --	134.4 --	7.4 --	19.8 --	5.6 --
# Taxa	21.5 7.8	10.0 --	2.0 --	2.0 --	4.0 --	4.0 --	2.0 --	3.0 --	6.0 --	5.0 --	11.0 --	6.0 --	2.0 --	7.0 --
# EPT Taxa	11.5 3.5	5.0 --	NA --	NA --	1.0 --	1.0 --	NA --	NA --	3.0 --	2.0 --	6.0 --	3.0 --	NA --	2.0 --
% EPT Taxa	44.3 2.5	14.5 --	NA --	NA --	2.0 --	6.3 --	NA --	NA --	10.7 --	13.0 --	3.1 --	8.11 --	NA --	7.1 --
% Dominant Taxon	38.1 6.1	70.4 --	93.2 --	76.3 --	92.9 --	81.3 --	99.1 --	56.1 --	82.1 --	60.9 --	91.7 --	86.5 --	87.9 --	78.6 --
% Chironomidae	38.1 6.1	70.4 --	93.2 --	76.3 --	92.9 --	81.3 --	99.1 --	56.1 --	82.1 --	60.9 --	91.7 --	86.5 --	87.9 --	78.6 --
EPT/Chironomidae Ratio	1.2 0.3	0.2 --	NA --	NA --	0.0 --	0.1 --	NA --	NA --	0.1 --	0.2 --	0.0 --	0.1 --	NA --	0.1 --
Diversity Indices														
Shannon (H)	2.1 0.23	1.1 --	0.2 --	0.5 --	0.3 --	0.7 --	0.1 --	0.7 --	0.7 --	1.1 --	0.4 --	0.61 --	0.4 --	0.9 --
Evenness (e)	0.69 0.01	0.49 --	0.36 --	0.79 --	0.24 --	0.50 --	0.07 --	0.65 --	0.40 --	0.65 --	0.18 --	0.34 --	0.53 --	0.46 --
Biotic Indices														
HBI	3.9 0.29	5.5 --	5.9 --	5.8 --	5.9 --	5.8 --	6.0 --	5.6 --	5.5 --	5.0 --	5.9 --	5.68 --	5.9 --	5.7 --
% Composition Per Order														
Ephemeroptera	25.77 11.06	12.35 --	-- --	-- --	-- --	6.25 --	-- --	-- --	4.46 --	-- --	2.38 --	5.41 --	-- --	3.57 --
Plecoptera	16.99 11.77	2.17 --	-- --	-- --	2.04 --	-- --	-- --	-- --	5.36 --	13.04 --	0.45 --	-- --	-- --	-- --
Trichoptera	1.56 1.77	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.89 --	-- --	0.30 --	2.70 --	-- --	3.57 --
Diptera	44.30 3.25	71.23 --	93.23 --	76.29 --	92.86 --	87.50 --	99.12 --	56.13 --	83.04 --	60.87 --	94.35 --	91.89 --	87.88 --	89.29 --
Oligochaeta	8.60 1.00	8.55 --	6.77 --	23.71 --	2.04 --	-- --	0.88 --	43.23 --	6.25 --	23.91 --	2.53 --	-- --	12.12 --	3.57 --
Acariformes	2.59 0.50	5.70 --	-- --	-- --	3.06 --	6.25 --	-- --	0.65 --	-- --	2.17 --	-- --	-- --	-- --	-- --
Amphipoda	0.05 0.07	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Gastropoda	0.05 0.07	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Ostracoda	0.10 0.14	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Turbellaria	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --

Notes:

1) For sample site locations, refer to Figure 1.1-1. *Chironomidae* genera grouped as a single taxon for multi-year comparisons.

2) Refer to the text for definitions of metrics.

year = Year site was sampled

n reps = Total number of replicates sampled

Mean = Average of all samples for all years

SD = Standard deviation of the mean

NA = Not Applicable (no EPT taxa collected)

Table 6.2-1
Fish Species Identified within the Mine Access Road Drainages (2007-2012)

			Jungjuk Creek	Kuskokwim River								
				Upstream of Port				Port	Downstream of Port			
Family	*Species*	**Common Name**	**JJ1**	**KU11**	**KU12**	**KU9**	**kU10**	**KU8**	**KU14**	**KU13**	**KU15**	**Total**
Salmonidae	*Oncorhynchus tshawytscha*	**Chinook salmon**					X	X				X
	Oncorhynchus keta	**Chum salmon**					X		X			X
	Oncorhynchus kisutch	**Coho salmon**	X					X	X	X		X
	Oncorhynchus gorbuscha	**Pink salmon**					X	X				X
	Oncorhynchus nerka	**Sockeye salmon**		X	X	X	X	X	X	X		X
	Salvelinus malma	**Dolly Varden**	X					X	X			X
	Thymallus arcticus	**Arctic grayling**	X	X	X	X	X	X	X	X	X	X
	Prosopium cylindraceum	**Round whitefish**	X	X	X	X	X	X	X	X	X	X
	Coregonus nasus	**Broad whitefish**		X								X
	Coregonus pidschian	**Humpback whitefish**		X	X			X	X	X	X	X
	Coregonus spp	**Whitefishes undifferentiated**				X	X					X
	Coregonus sardinella	**Least cisco**		X	X			X			X	X
	Stenodus leucichthys	**Sheefish**						X		X		X
Catostomidae	*Catostomus catostomus*	**Longnose sucker**		X	X	X	X	X	X	X	X	X
Cottidae	*Cottus cognatus*	**Slimy sculpin**	X	X	X	X	X	X	X	X	X	X
Esocidae	*Esox lucius*	**Northern pike**							X	X	X	X
Petromyzontidae	*Lampetra alaskensis*	**Alaskan brook lamprey**				X						X
	Lampetra spp	**Lamprey undifferentiated**						X				X
Gadidae	*Lota lota*	**Burbot**				X		X		X	X	X
		Total Species Count	5	8	7	8	9	14	10	10	8	19

Notes:

Refer to Figure 1.1-1 for biomonitoring site and aerial reach locations.

Includes data from trapping, fyke nets, seines, electrofishing, and aerial surveys.

Table 6.2-2

Adult Salmon Aerial Counts for the Mine Access Road Drainages (2007-2012)

Species	Year	JJR1	*Est. Water Clarity* [2]
Chinook salmon	2007	ns	*F*
	2008	ns	*G*
	2009	ns	*E*
	2010	ns	*P/F*
	2011	0	*G*
	2012	0	*G*
	Mean[1]	**0.0**	
	Max	*0*	
	Min	*0*	
Chum salmon	2007	ns	*F/G*
	2008	ns	*G*
	2009	ns	*E*
	2010	ns	*G*
	2011	0	*G*
	2012	0	*G*
	Mean[1]	**0.0**	
	Max	*0*	
	Min	*0*	
Coho salmon	2007	3	*F*
	2008	2	*G*
	2009	ns	*E*
	2010	6	*P/F*
	2011	8	*E*
	2012	ns	*P*
	Mean[1]	**4.8**	
	Max	*8*	
	Min	*2*	
Sockeye salmon	2007	ns	*F*
	2008	ns	*G*
	2009	ns	*E*
	2010	ns	*P/F*
	2011	0	*G*
	2012	0	*G*
	Mean[1]	**0.0**	
Mean Total Salmon		**1.9**	

Notes:

Refer to Figure 1.1-1 for aerial reach locations.

ns = not surveyed

1) Mean = (total # fish seen)/(# years surveyed)

2) Estimated water clarity based on field observations during sampling: E = excellent; G = good; F = fair; P = poor

Table 6.2-3
Summary of Electrofishing Results within the Mine Access Road Drainages (2007-2008)

Drainage Basin	River System	Site		Coho salmon (juvenile)	Chinook salmon (juvenile)	Chum salmon (juvenile)	Dolly Varden	Arctic grayling	Round whitefish	Slimy sculpin	Alaska blackfish	Alaskan brook lamprey	Burbot	Grand Total
				Fish (#/300 ft)[1]										
Kuskokwim	***Jungjuk Creek***	**JJ1**												
			2007	21	--	--	34	6	--	19	--	--	--	79
			2008	34	--	--	37	10	1	34	--	--	--	116
			Mean	**27.2**	**--**	**--**	**35.3**	**8.1**	**0.7**	**26.5**	**--**	**--**	**--**	**97.8**
			SD	*9.4*	*--*	*--*	*2.1*	*3.1*	*1.0*	*10.4*	*--*	*--*	*--*	*26.0*

Notes:
Refer to Figure 3.2-1 for site locations
Any adult salmon observed in electrofishing reaches were not shocked and were allowed to pass or avoided; Adult salmon are not included in the above counts
1) #/300 ft = number of fish per 300 feet of stream length
-- = species not found

Table 6.2-4

Summary of Fish Sampling in the Kuskokwim River Near the Proposed Jungjuk Port Site (2011-2012)

% Relative Fish Abundance at Kuskokwim River Sampling Sites

		Upstream of Port														Port		Downstream of Port										
		KU25		KU24		KU23		KU11		KU12		KU9		KU10		KU8		KU20		KU14		KU13		KU15		Total Fish	Total % RA[2]	Total % RA[2]
Survey Method	**Species Year**	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012		2011	2012
Seine	Chinook salmon	--	-	--	0.7	--	--	-	--	-	--	-	--	0.8	--	2.0	--	--	--	-	-	-	--	-	--	4	0.3	0.4
	Chum salmon	--	-	--	-	--	--	-	--	-	--	-	--	1.6	--	-	--	--	--	0.8	-	-	--	-	--	3	0.3	-
	Coho salmon	--	-	--	0.7	--	--	-	--	-	--	-	--	-	--	1.0	--	--	--	0.8	-	0.9	--	-	--	4	0.3	0.4
	Pink salmon	--	-	--	-	--	--	-	--	-	--	-	--	2.4	--	-	--	--	--	-	-	-	--	-	--	3	0.3	-
	Sockeye salmon	--	32.7	--	15.6	--	--	2.0	--	2.5	--	-	--	7.2	--	-	--	--	--	0.8	25.7	2.8	--	-	--	68	2.2	20.9
	Dolly Varden	--	-	--	-	--	--	-	--	-	--	-	--	-	--	-	--	--	--	1.6	-	-	--	-	--	2	0.2	-
	Arctic grayling	--	4.1	--	0.7	--	--	20.1	--	10.6	--	4.5	--	3.2	--	76.5	--	--	--	41.9	5.7	23.4	--	7.1	--	230	23.1	2.2
	Round whitefish	--	-	--	4.3	--	--	19.1	--	30.4	--	45.5	--	17.6	--	5.1	--	--	--	4.7	17.1	31.8	--	35.3	--	227	22.1	5.3
	Broad whitefish	--	-	--	-	--	--	0.5	--	-	--	-	--	-	--	-	--	--	--	-	-	-	--	-	--	1	0.1	-
	Humpback whitefish	--	-	--	-	--	--	13.2	--	17.4	--	-	--	-	--	1.0	--	--	--	1.6	-	3.7	--	10.6	--	71	7.3	-
	Whitefishes undifferentiated	--	12.2	--	16.3	--	--	-	--	-	--	19.7	--	0.8	--	-	--	--	--	-	-	-	--	-	--	43	1.4	12.9
	Least cisco	--	-	--	-	--	--	15.7	--	7.5	--	-	--	-	--	1.0	--	--	--	-	-	-	--	-	--	45	4.6	-
	Longnose sucker	--	46.9	--	56.7	--	--	27.5	--	24.8	--	22.7	--	50.4	--	6.1	--	--	--	35.7	37.1	12.1	--	17.6	--	370	26.1	51.6
	Slimy sculpin	--	4.1	--	5.0	--	--	2.0	--	6.8	--	4.5	--	16.0	--	7.1	--	--	--	10.9	14.3	24.3	--	25.9	--	121	11.0	6.2
	Northern pike	--	-	--	-	--	--	-	--	-	--	-	--	-	--	-	--	--	--	1.6	-	0.9	--	3.5	--	6	0.6	-
	Alaskan brook lamprey	--	-	--	-	--	--	-	--	-	--	3.0	--	-	--	-	--	--	--	-	-	-	--	-	--	2	0.2	-
	Total # Fish Captured	--	49	--	141	--	--	204	--	161	--	66	--	125	--	98	--	--	--	129	35	107	--	85	--	1200		
	# Seine Tows[1]	--	3	--	4	--	--	3	--	3	--	3	--	3	--	3	--	--	--	7	6	3	--	3	--	41		
	# Fish/Tow	--	**16.3**	--	**35.3**	--	--	**68.0**	--	**53.7**	--	**22.0**	--	**41.7**	--	**32.7**	--	--	--	**18.4**	**5.8**	**35.7**	--	**28.3**	--	**29.3**		
	# Species (All Samples)	--	5	--	8	--	--	8	--	7	--	6	--	9	--	8	--	--	--	10	5	8	--	6	--	16		
Fyke	Coho salmon	--	--	--	-	--	--	-	--	--	--	--	--	-	--	-	7.7	--	11.1	--	-	-	--	-	--	3	-	3.2
	Sockeye salmon	--	--	--	-	--	--	-	--	--	--	--	--	100.0	--	-	-	--	-	--	-	7.7	--	-	--	2	6.5	-
	Dolly Varden	--	--	--	-	--	--	-	--	--	--	--	--	-	--	-	-	--	11.1	--	25.0	-	--	-	--	3	-	3.2
	Arctic grayling	--	--	--	-	--	2.9	-	--	--	--	--	--	-	--	15.4	7.7	--	-	--	50.0	-	--	-	--	6	6.5	4.3
	Round whitefish	--	--	--	-	--	--	-	--	--	--	--	--	-	--	-	-	--	5.6	--	-	15.4	--	-	--	3	6.5	1.1
	Least cisco	--	--	--	-	--	--	-	--	--	--	--	--	-	--	-	-	--	-	--	-	-	--	25.0	--	1	3.2	-
	Sheefish	--	--	--	-	--	--	-	--	--	--	--	--	-	--	7.7	-	--	-	--	-	7.7	--	-	--	2	6.5	-
	Longnose sucker	--	--	--	70.8	--	41.2	-	--	--	--	--	--	-	--	46.2	69.2	--	5.6	--	-	46.2	--	50.0	--	55	45.2	44.1
	Slimy sculpin	--	--	--	12.5	--	55.9	-	--	--	--	--	--	-	--	15.4	7.7	--	66.7	--	25.0	-	--	-	--	38	6.5	38.7
	Burbot	--	--	--	16.7	--	--	-	--	--	--	--	--	-	--	15.4	-	--	-	--	-	23.1	--	25.0	--	10	19.4	4.3
	Northern pike	--	--	--	-	--	--	-	--	--	--	--	--	-	--	-	7.7	--	-	--	-	-	--	-	--	1	-	1.1
	Total # Fish Captured	--		--	24	--	34	0	--	--	--	--	--	1	--	13	13	--	18	--	4	13	--	4	--	124		
	# Fyke Net Sets[1]	--		--	1	--	1	1	--	--	--	--	--	1	--	3	1	--	1	--	1	1	--	1	--	12		
	# Fish/24hr Set	--		--	**24.0**	--	**34.0**	**0.0**	--	--	--	--	--	**1.0**	--	**4.3**	**13.0**	--	**18.0**	--	**4.0**	**13.0**	--	**4.0**	--	**10.3**		
	# Species (All Samples)	--		--	3	--	3	0	--	--	--	--	--	1	--	5	5	--	5	--	3	5	--	3	--	11		
Electrofishing	Coho salmon	--	-	--	-	--	--	--	--	--	--	-	-	--	--	2.4	2.5	--	35.3	--	--	--	--	--	--	18	2.1	1.8
	Pink salmon	--	-	--	-	--	--	--	--	--	--	-	-	--	--	1.2	-	--	-	--	--	--	--	--	--	1	1.0	-
	Sockeye salmon	--	16.9	--	30.4	--	26.7	--	--	--	--	20.0	35.3	--	--	1.2	32.7	--	20.6	--	--	--	--	--	--	224	4.1	24.4
	Dolly Varden	--	-	--	-	--	--	--	--	--	--	-	-	--	--	7.3	4.9	--	23.5	--	--	--	--	--	--	22	6.2	1.8
	Arctic grayling	--	0.5	--	-	--	--	--	--	--	--	-	-	--	--	22.0	7.4	--	-	--	--	--	--	--	--	32	18.6	1.6
	Round whitefish	--	-	--	8.7	--	1.5	--	--	--	--	-	-	--	--	6.1	-	--	-	--	--	--	--	--	--	11	5.2	0.7
	Lake whitefish	--	-	--	-	--	--	--	--	--	--	-	-	--	--	-	-	--	5.9	--	--	--	--	--	--	2	-	0.2
	Whitefishes undifferentiated	--	1.4	--	2.2	--	7.6	--	--	--	--	-	2.6	--	--	-	-	--	-	--	--	--	--	--	--	20	-	2.2
	Longnose sucker	--	79.2	--	56.5	--	63.4	--	--	--	--	6.7	61.2	--	--	9.8	35.8	--	-	--	--	--	--	--	--	575	9.3	62.7
	Slimy sculpin	--	1.9	--	2.2	--	0.8	--	--	--	--	66.7	0.9	--	--	48.8	15.4	--	14.7	--	--	--	--	--	--	91	51.6	4.5
	Burbot	--	-	--	-	--	--	--	--	--	--	6.7	-	--	--	-	-	--	-	--	--	--	--	--	--	1	1.0	-
	Northern pike	--	-	--	-	--	--	--	--	--	--	-	-	--	--	-	1.2	--	-	--	--	--	--	--	--	2	-	0.2
	Lamprey undifferentiated	--	-	--	-	--	--	--	--	--	--	-	-	--	--	1.2	-	--	-	--	--	--	--	--	--	1	1.0	-
	Total # Fish Captured	--	414	--	46	--	131	--	--	--	--	15	116	--	--	82	162	--	34	--	--	--	--	--	--	1000		
	# Electrofishing Passes[1]	--	1	--	1	--	1	--	--	--	--	1	1	--	--	1	1	--	1	--	--	--	--	--	--	8		
	# Fish/100ft	--	**414.0**	--	**46.0**	--	**131.0**	--	--	--	--	**15.0**	**116.0**	--	--	**82.0**	**162.0**	--	**34.0**	--	--	--	--	--	--	**125.0**		
	# Species (All Samples)	--	5	--	5	--	5	--	--	--	--	4	4	--	--	9	7	--	5	--	--	--	--	--	--	13		

Notes:

Refer to **Figure 1.1-1** for site locations.

Sampling methods were determined based on existing habitat conditions

1) Samples are defined as: Seine Tow = One seine tow (~30ft Length, 4ft depth, 1/8" mesh); Fyke Net Set= One 24 hour fyke net set (4' x 3' opening, 3/8" mesh,15' wings, 30' leader); Electrofishing Pass = One electrofisher with two netters for a distance of ~100ft along river bank

2) Total % RA = Total percent relative abundance for each fish species across all sites per sampling method

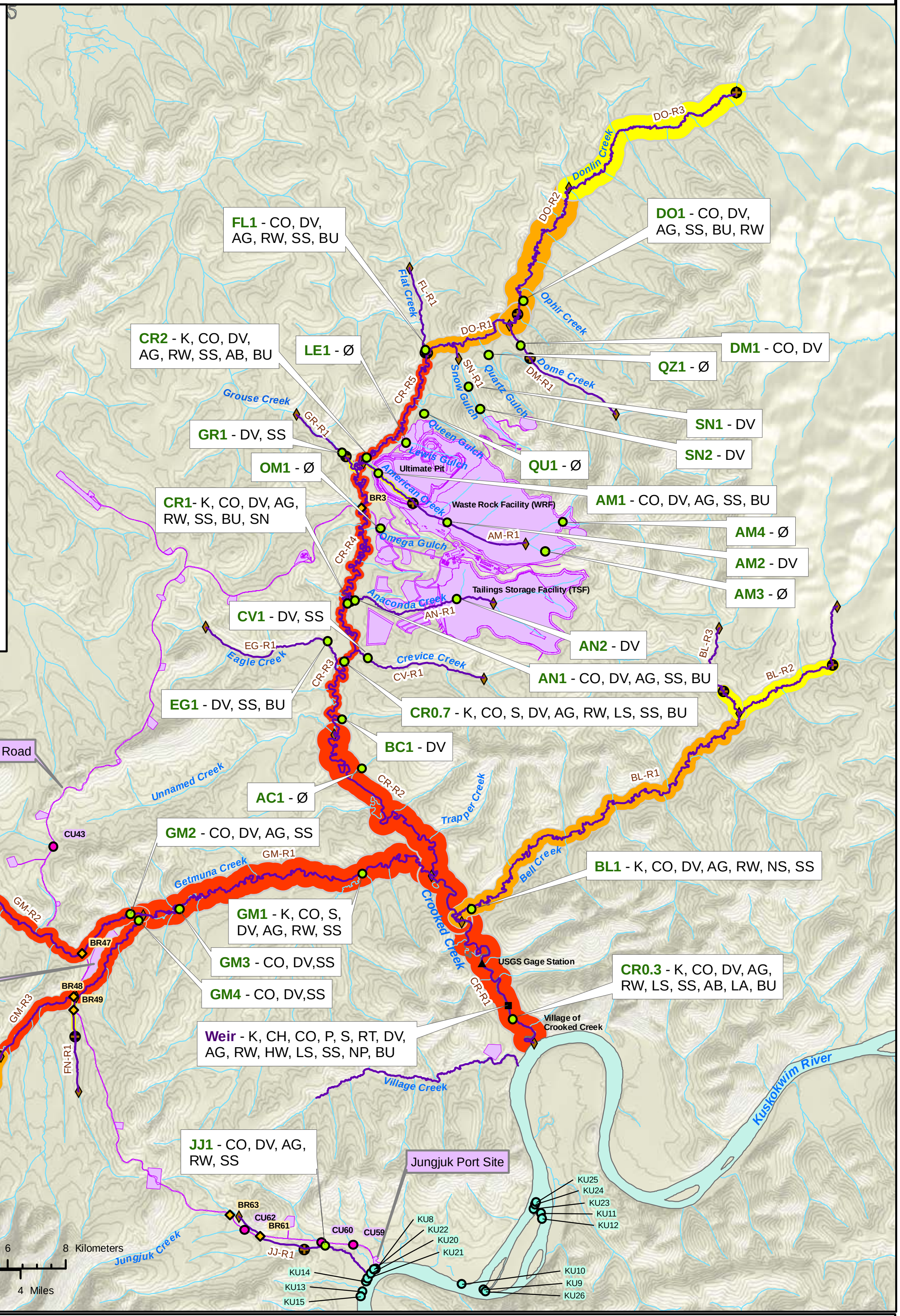
-- Sampling method not performed at this site

9.0 FIGURES

Figure 1.1-1
Resident Species Occurrence and Estimated Adult Salmon Density and Distribution within the Project Study Area

Species

Chinook salmon	--> K
Chum salmon	--> CH
Coho salmon	--> CO
Pink salmon	--> P
Sockeye salmon	--> S
Rainbow trout	--> RT
Dolly Varden	--> DV
Arctic grayling	--> AG
Round whitefish	--> RW
Humpback whitefish	--> HW
Least Cisco	--> LC
Sheefish	--> SF
Longnose sucker	--> LS
Slimy sculpin	--> SS
Northern pike	--> NP
Alaska blackfish	--> AB
Alaskan brook lamprey	--> LA
Burbot	--> BU
Nine-spine stickleback	--> SN
No fish found	--> Ø



Proposed Infrastructure	**Aquatics Sites**	**Adult Salmon in Reach**	**Maximum Adult Salmon Density (#/mile)**	**Features**
Infrastructure	Biomonitoring Site	Coho+Chum+Chinook	>30	Stream
Road	Port Sampling Site	Coho+Chum	10-30	Contours_100ft
Bridge/Oversized Culvert	Adult Salmon Extent	Coho	3-10	
Culvert	Aerial Reach Break	Aerial Reach	<3	
	Fish Weir			

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Figure 2.1-1
Aerial Photograph of the Crooked Creek Weir (2008)

Figure 2.4-1

Cross Section Photograph of the Crooked Creek Weir (2008)

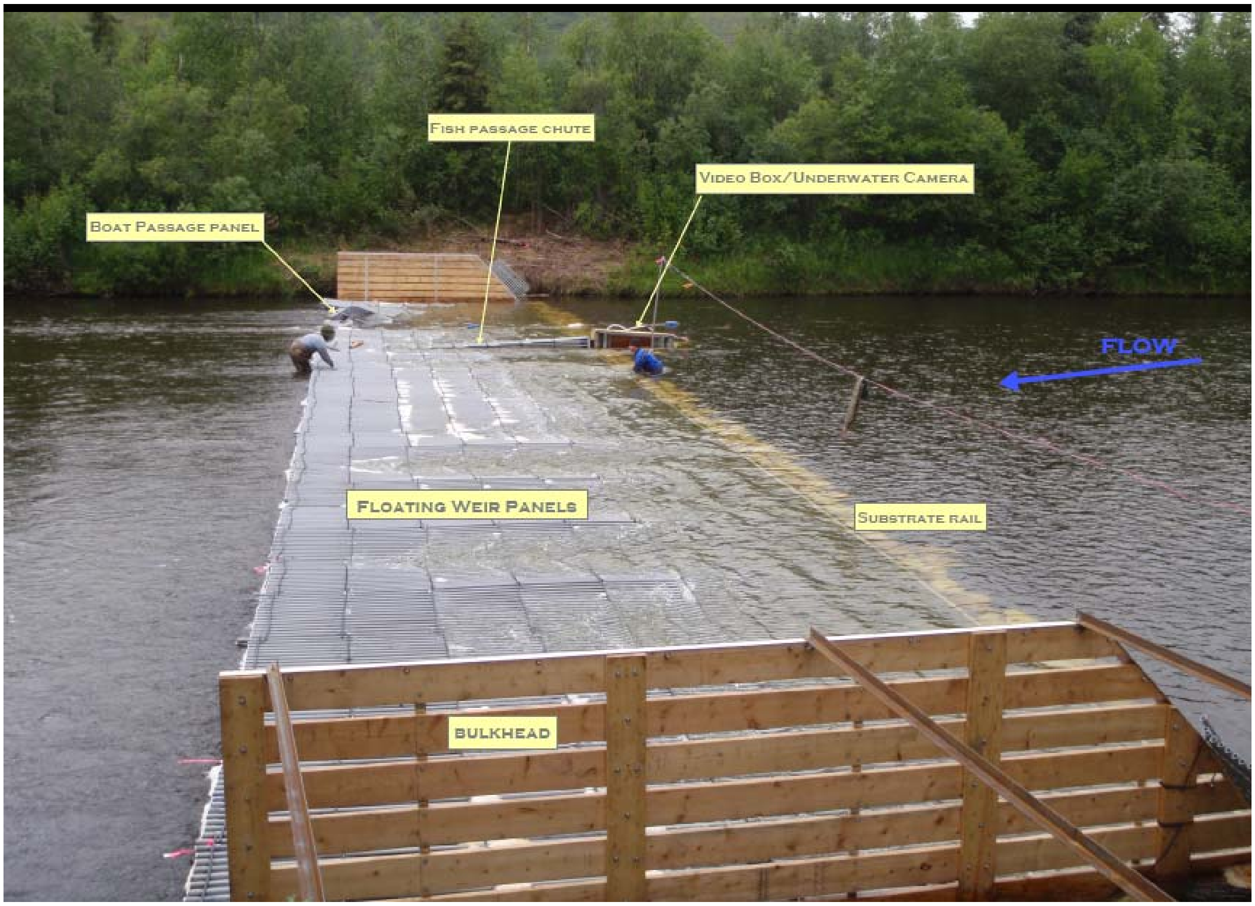
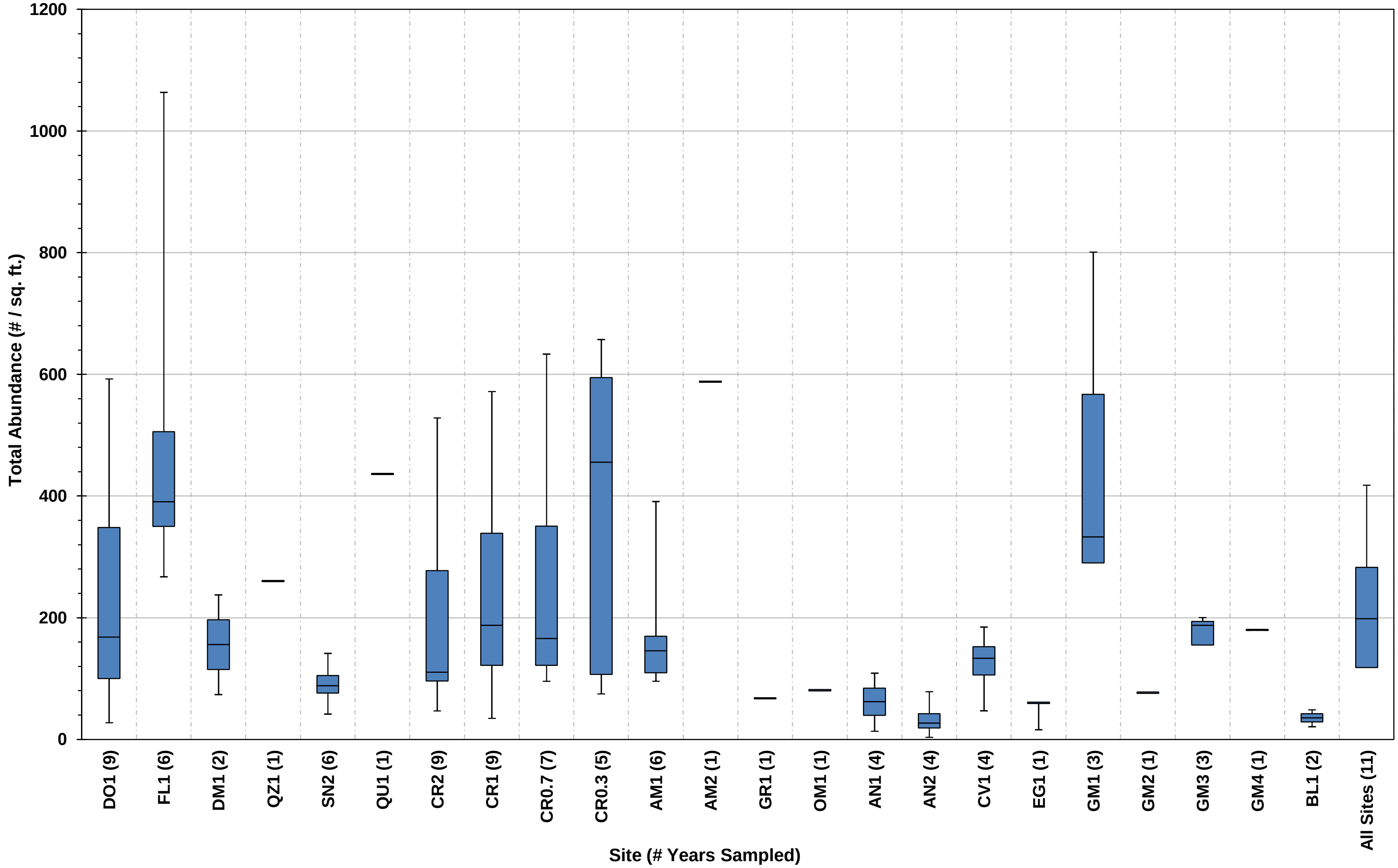


Figure 3.1-1

Macroinvertebrate Abundance for Sites within the Crooked Creek Drainage, Grouped by Site (2004-2014)

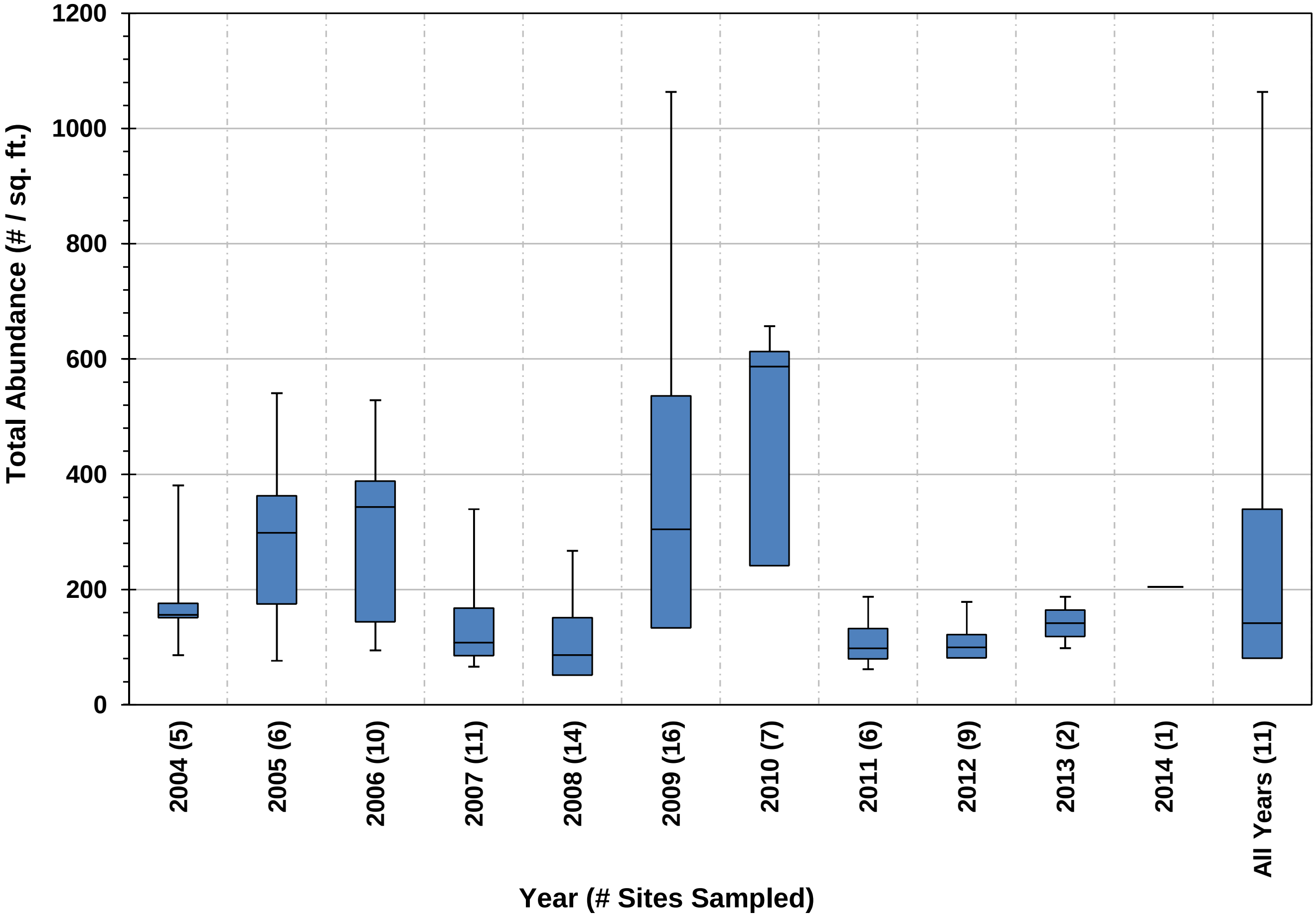


Notes:

For sample site locations, refer to Figure 1.1-1.

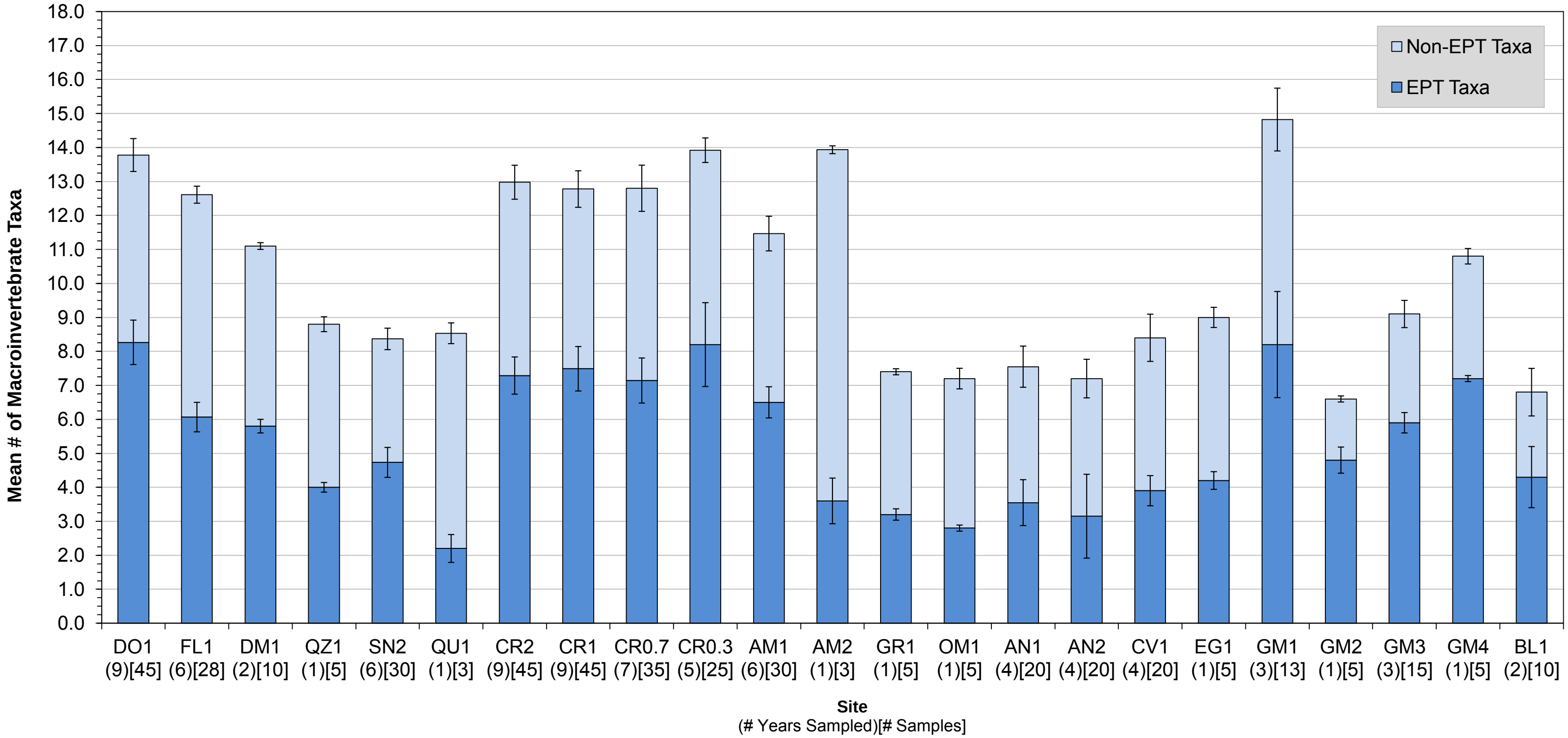
Samples were collected each year using the Surber sampling method

Figure 3.1-2
Macroinvertebrate Abundance for Sites within the Crooked Creek Drainage, Grouped by Year (2004-2014)



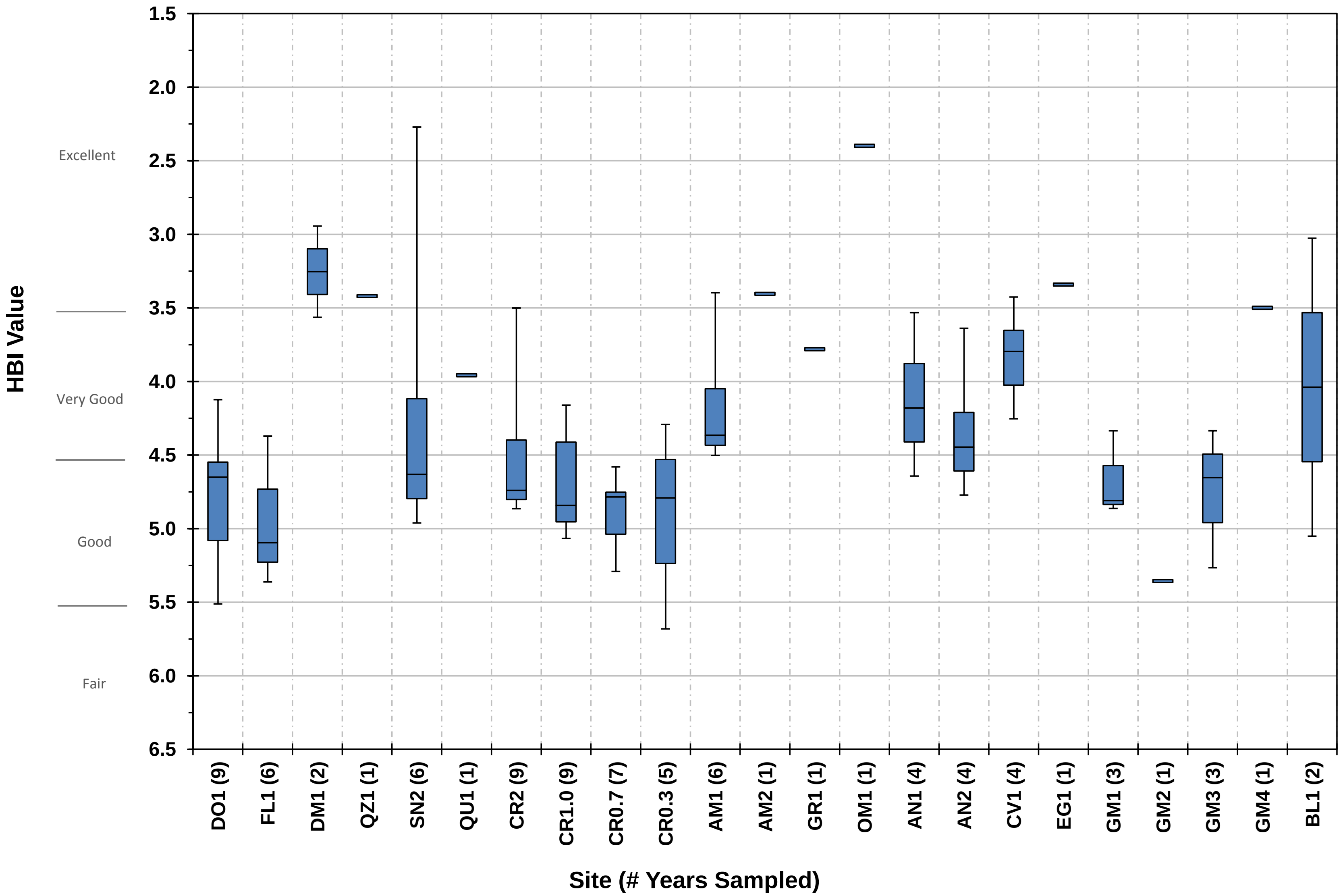
Notes:
For sample site locations, refer to Figure 1.1-1.
Samples were collected each year using the surber sampling method

Figure 3.1-3
Mean Number of EPT and Non-EPT Macroinvertebrate Taxa (Combined for Total Mean Number of Taxa) Found at Sites within the Crooked Creek Drainage (2004-2014)



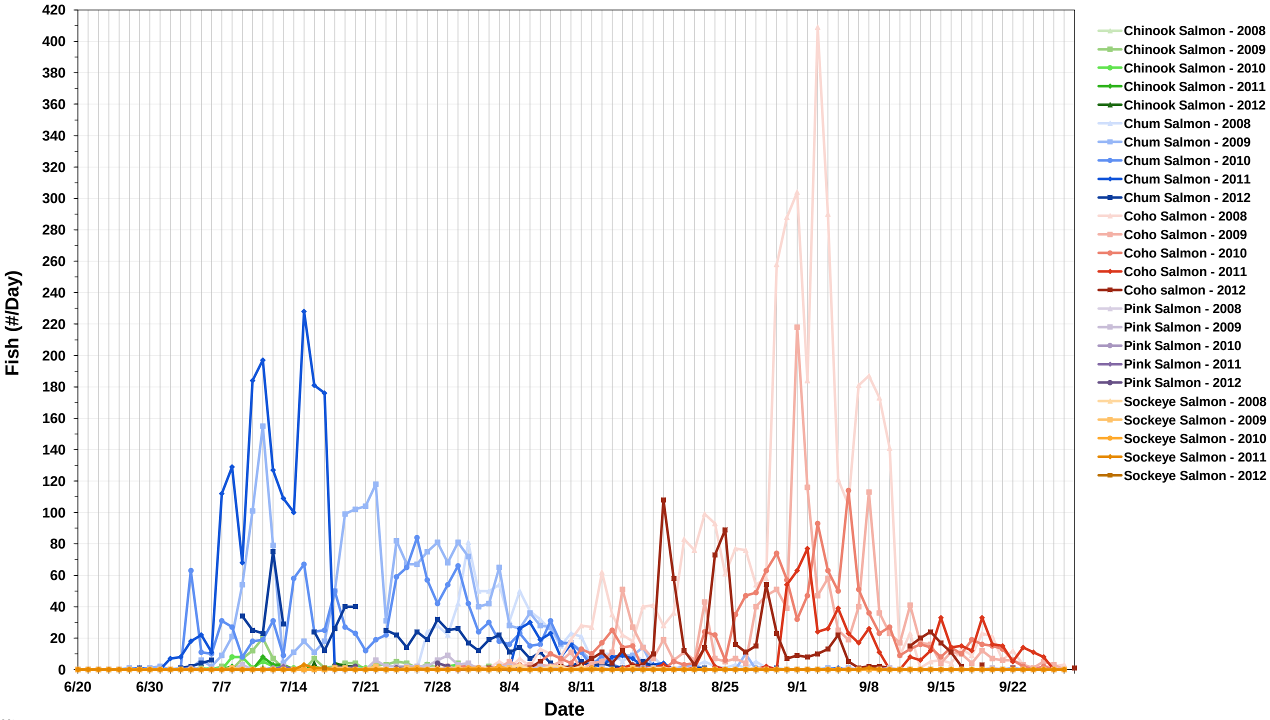
Notes:
For sample site locations, refer to **Figure 1.1-1**.
Error bars represent one standard error.

Figure 3.1-4
Hilsenhoff Biotic Index (HBI)[1] for Aquatic Macroinvertebrates within the Crooked Creek Drainage (2004-2014)



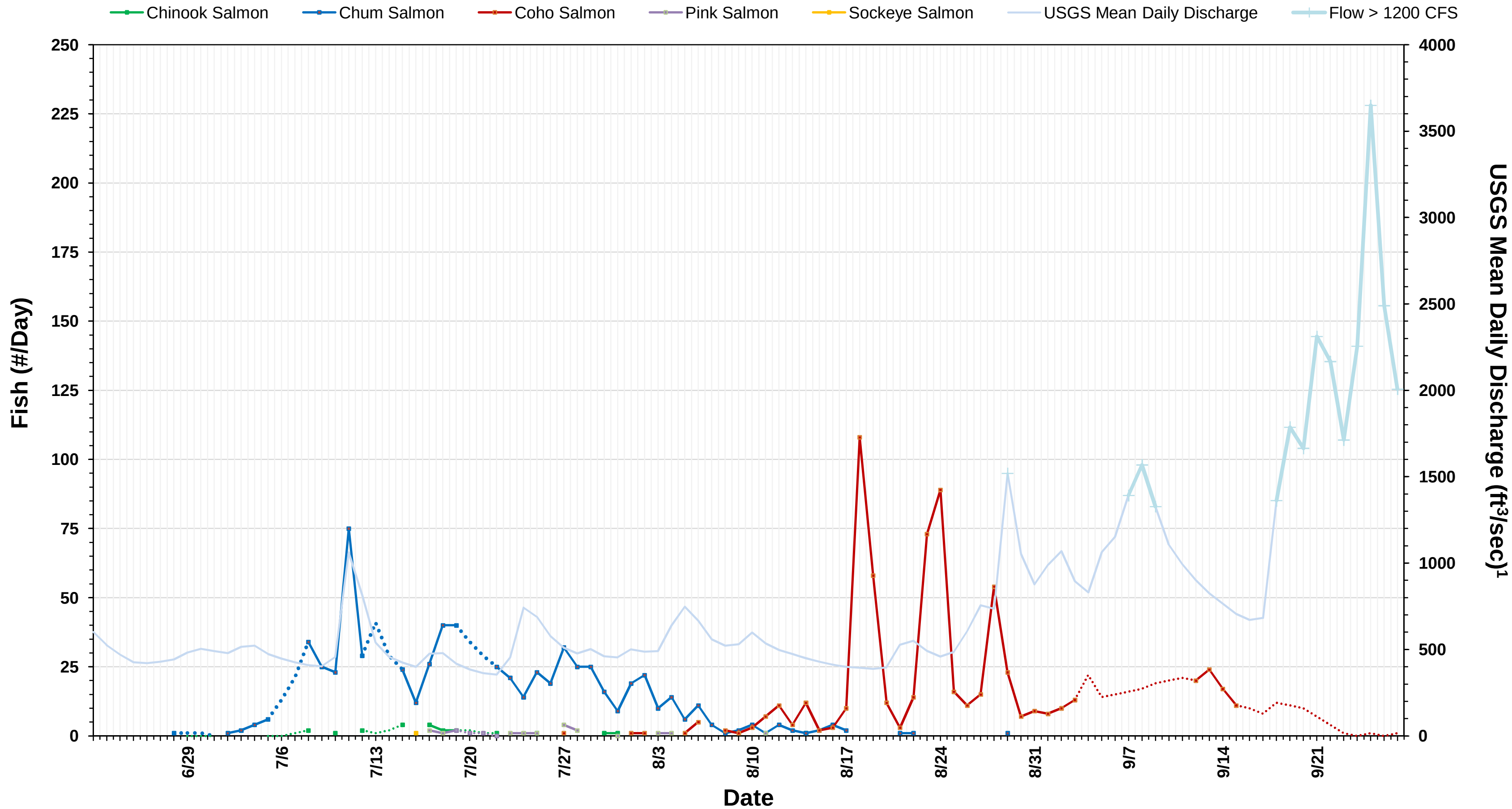
Notes:
For sample site locations, refer to Figure 1.1-1.
1) The Hilsenhoff Biotic Index (HBI) was developed using tolerance values for macroinvertebrates in Wisconsin streams (Hilsenhoff 1987, 1988). HBI takes into account the tolerance value and number of individuals of each taxon in the sample and rates streams on a scale of 0 (excellent water quality) to 10 (polluted). Values are as follows: 0.00-3.50 (excellent), 3.51-4.50 (very good), 4.51-5.50 (good), 5.51-6.50 (fair), 6.51-7.50 (fairly poor), 7.51-8.50 (poor), and 8.51-10.00 (very poor).

Figure 3.2-1
Salmon Escapement at the Crooked Creek Weir (2008-2012)



Notes:
1)- Weir operational from 7/28/2008 to 9/29/2008, from 6/3/2009 to 9/29/2009, from 6/17/2010 to 9/27/2010, from 6/17/2011 to 9/27/2011, and from 6/27/2012 to 9/2 8/2012. See **Table 3.2-3** for complete operational periods.

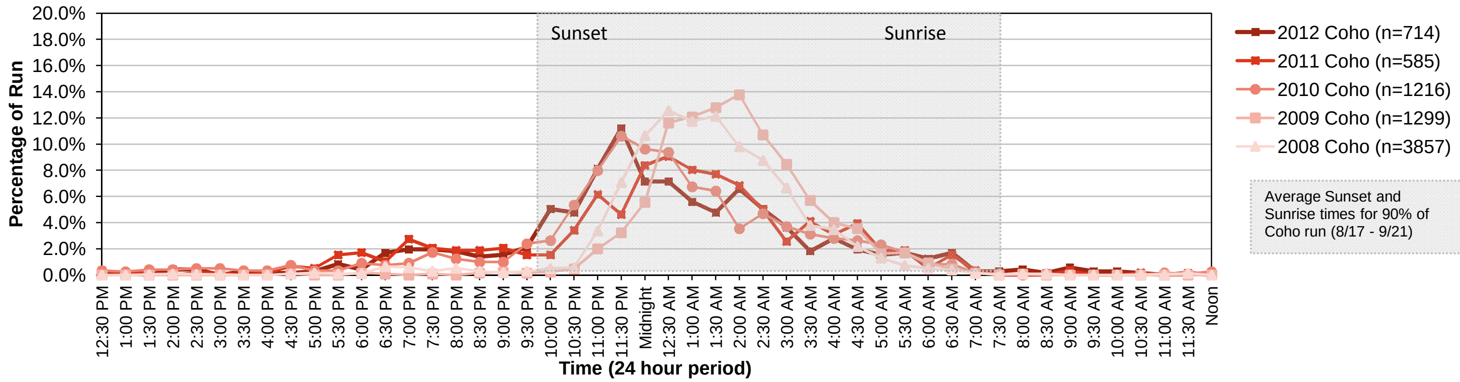
Figure 3.2-2
Daily Salmon Escapement at the Crooked Creek Weir (2012)



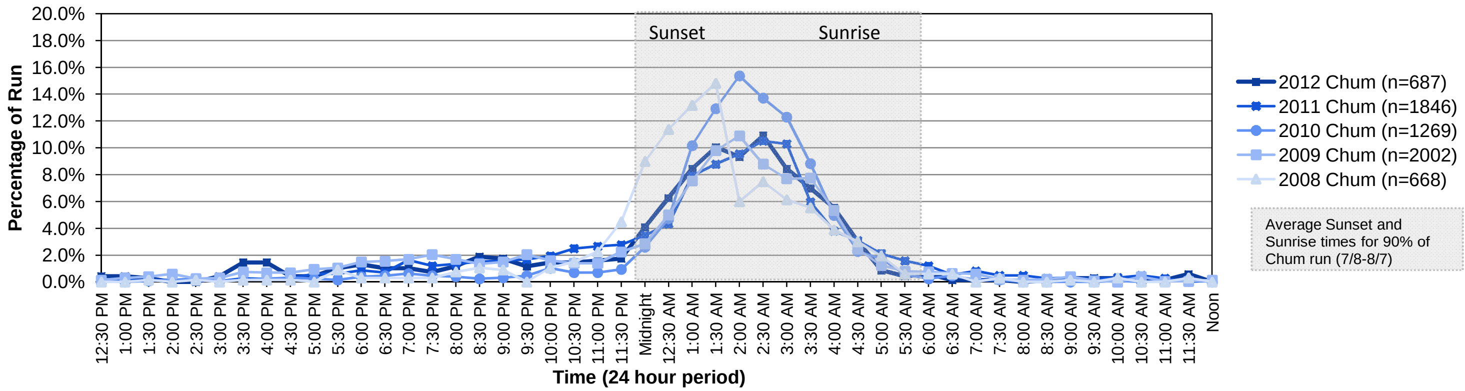
Notes:
1) Discharge measurements taken from USGS gauge station on Crooked Creek (USGS 15304010). Weir video not recorded between 6/30 - 7/1, 7/7 - 7/8, 7/14 - 7/15 and 7/21 - 7/22. Weir was overtopped between 9/5 - 9/12 and 9/16 - 9/28.
2) Dashed lines denote an estimate of fish passage calculated with methods found in ADF&G report, Tatlawiksuk River Salmon Studies, 2010 (Fishery Data Series no. 07-56).

Figure 3.2-3
Diel Run Timing for Observed Salmon at the Crooked Creek Weir (2008-2012)

COHO



CHUM



CHINOOK

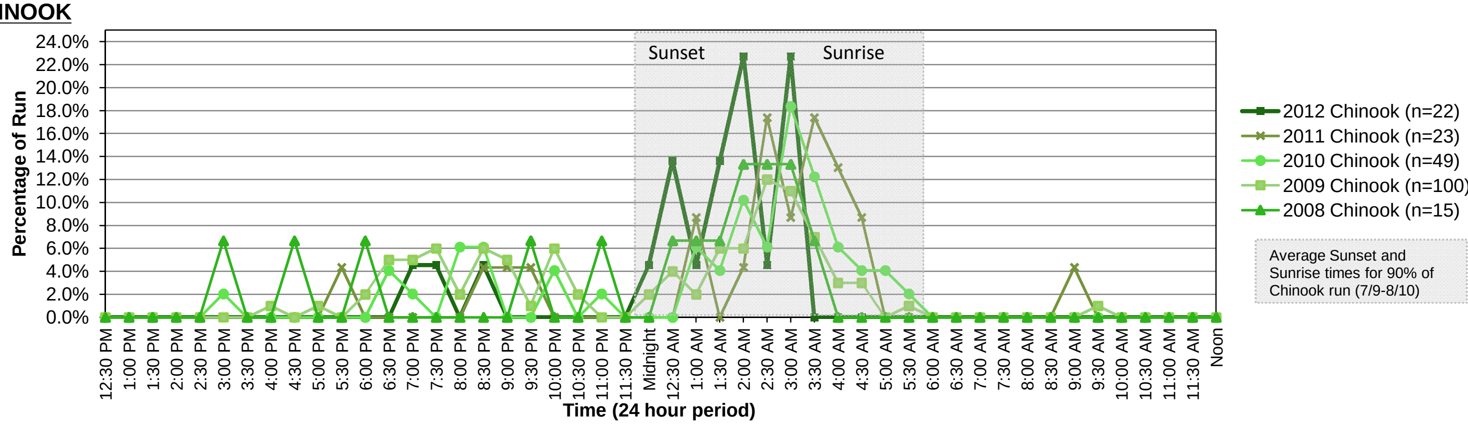
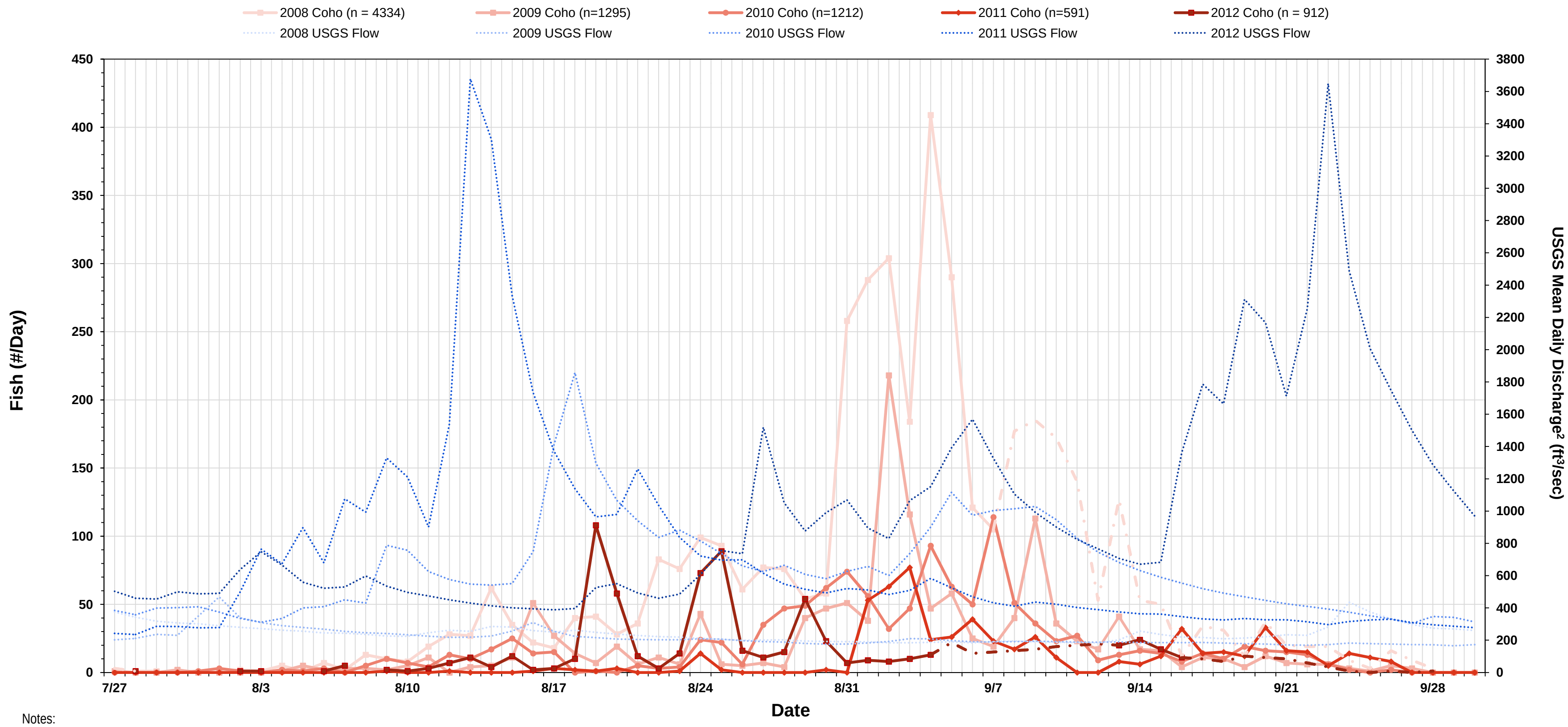
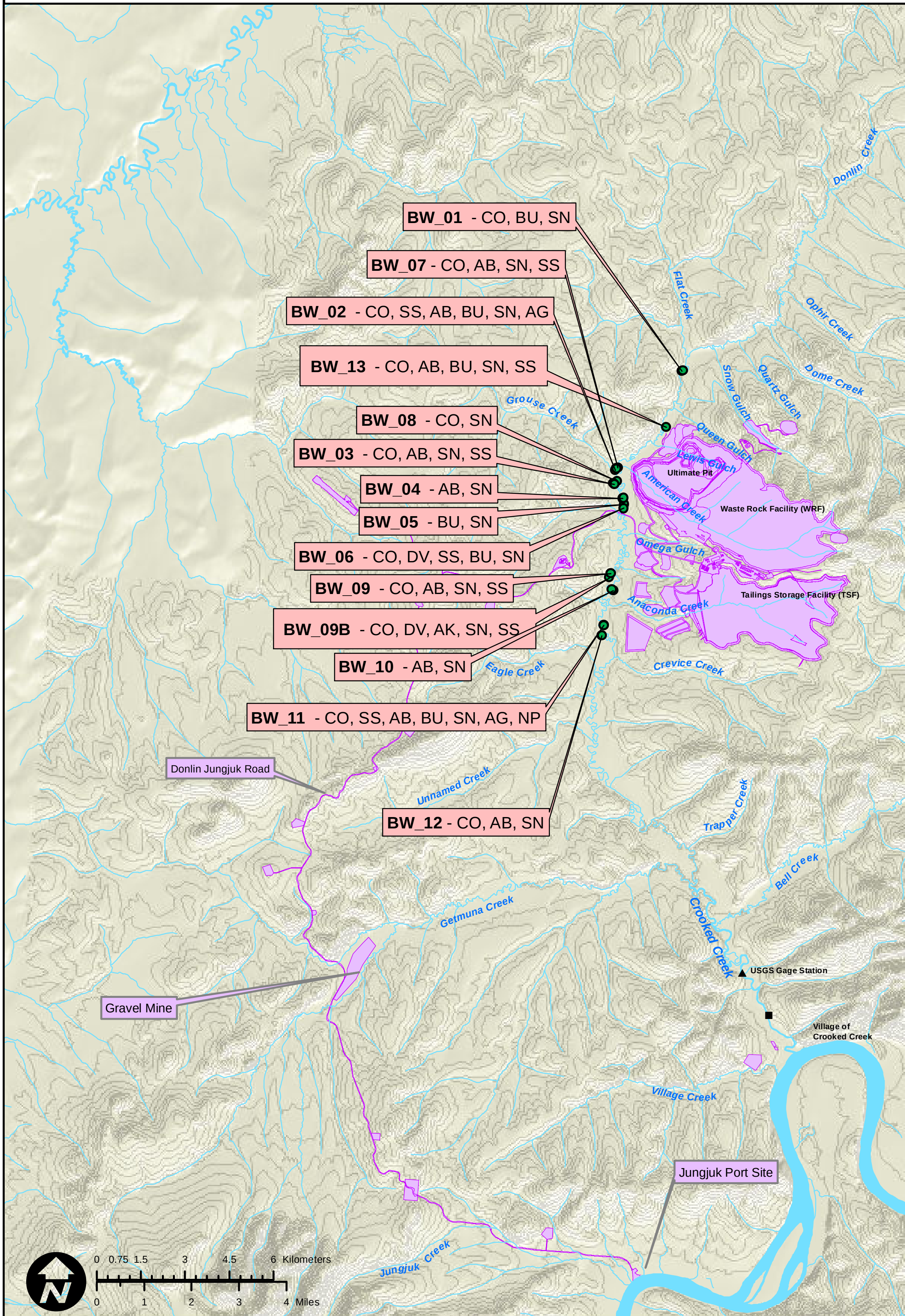


Figure 3.2-4
Daily Coho Salmon Escapement at the Crooked Creek Weir (2008-2012)[1]



Notes:
1) Weir operational from 7/28/2008 to 9/29/2008, 6/3/2009 to 9/29/2009, 6/17/2010 to 9/27/2010, 6/17/2011 to 9/27/2011, and 6/27/2012 to 9/28/2012. See Table 3.2-3 for complete operational periods.
2) Discharge measurements were taken from the USGS gauge station on Crooked Creek (USGS 15304010).
3) Dashed lines denote an estimate of fish passage calculated with methods found in ADF&G report, Tatlawiksuk River Salmon Studies, 2010 (Fishery Data Series no. 07-56).

Figure 3.2-5
Off-Channel Sampling Locations within the Crooked Creek Drainage



Species

Chinook salmon	--> K
Chum salmon	--> CH
Coho salmon	--> CO
Pink salmon	--> P
Sockeye salmon	--> S
Rainbow trout	--> RT
Dolly Varden	--> DV
Arctic grayling	--> AG
Round whitefish	--> RW
Humpback whitefish	--> HW
Least Cisco	--> LC
Sheefish	--> SF
Longnose sucker	--> LS
Slimy sculpin	--> SS
Northern pike	--> NP
Alaska blackfish	--> AB
Alaskan brook lamprey	--> LA
Burbot	--> BU
Nine-spine stickleback	--> SN
No fish found	*--> Ø*

Proposed Infrastructure
- Infrastructure
- Road

Aquatics Sites
- Off-Channel Sampling Site
- Site Name & Species List

Features
- Stream
- Contours_100ft

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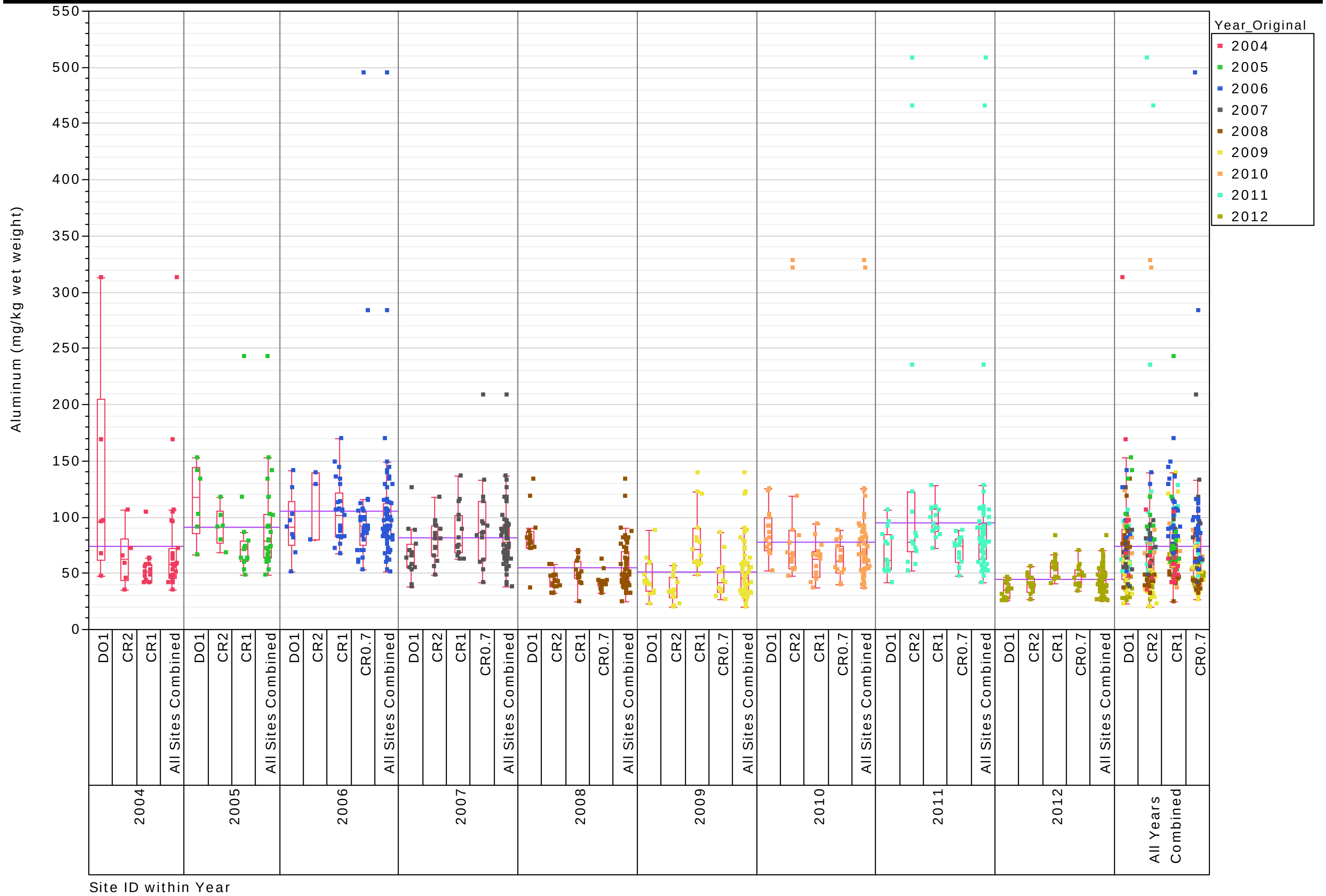
Figure 3.3-1 (Page 1 of 2)

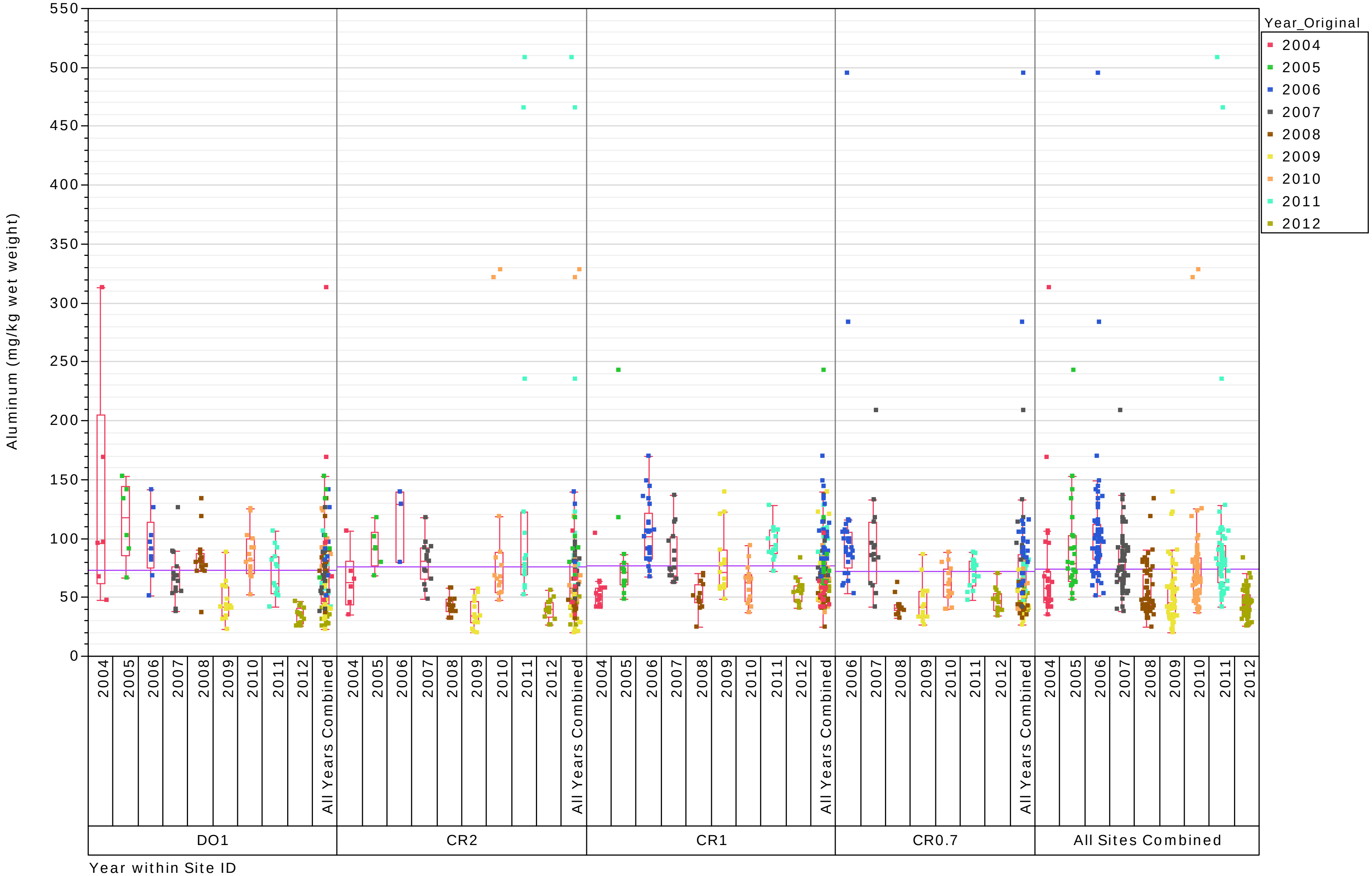
Aluminum Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)



Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

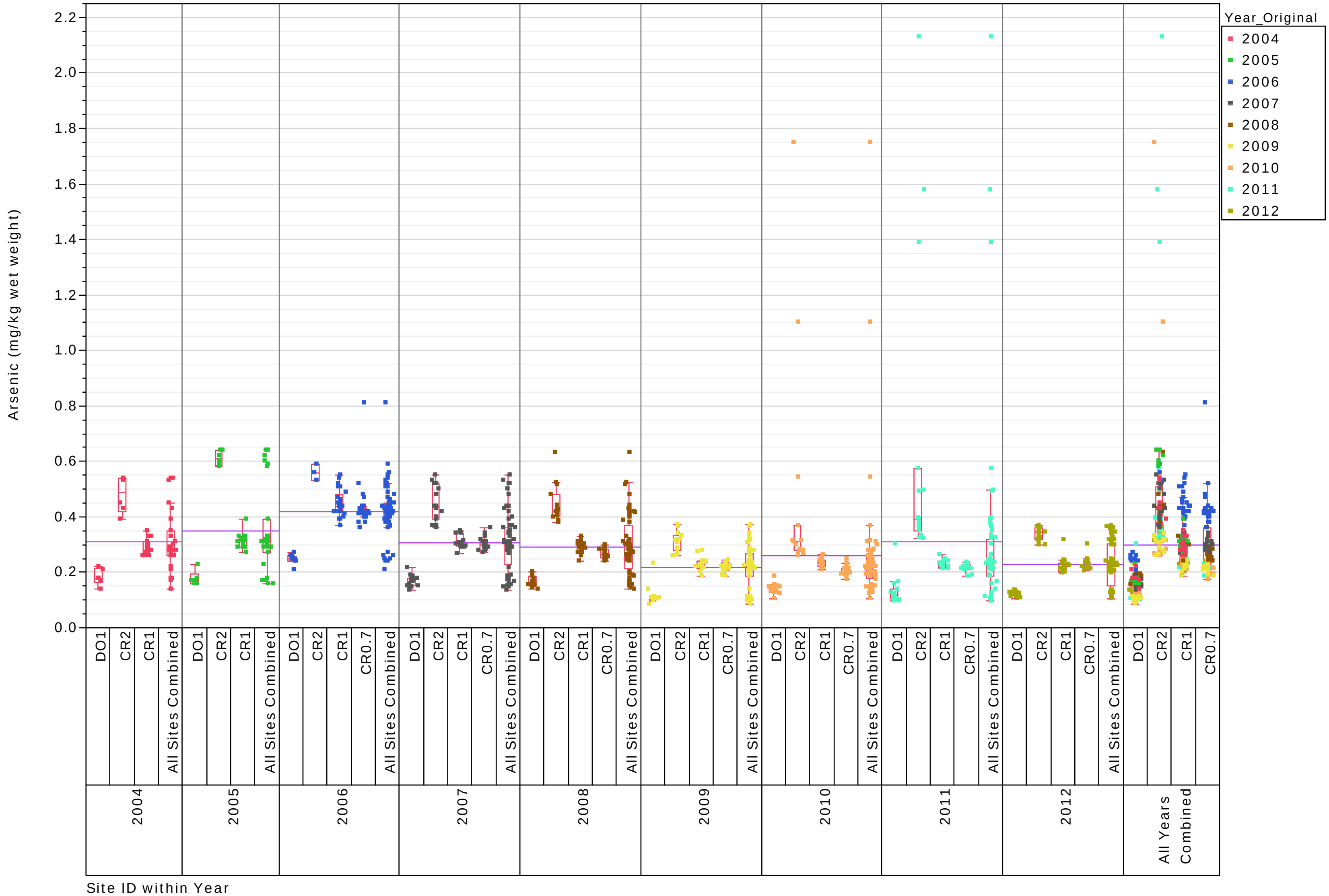
Figure 3.3-1 (Page 2 of 2)
Aluminum Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)



Notes:
Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-2 (Page 1 of 2)

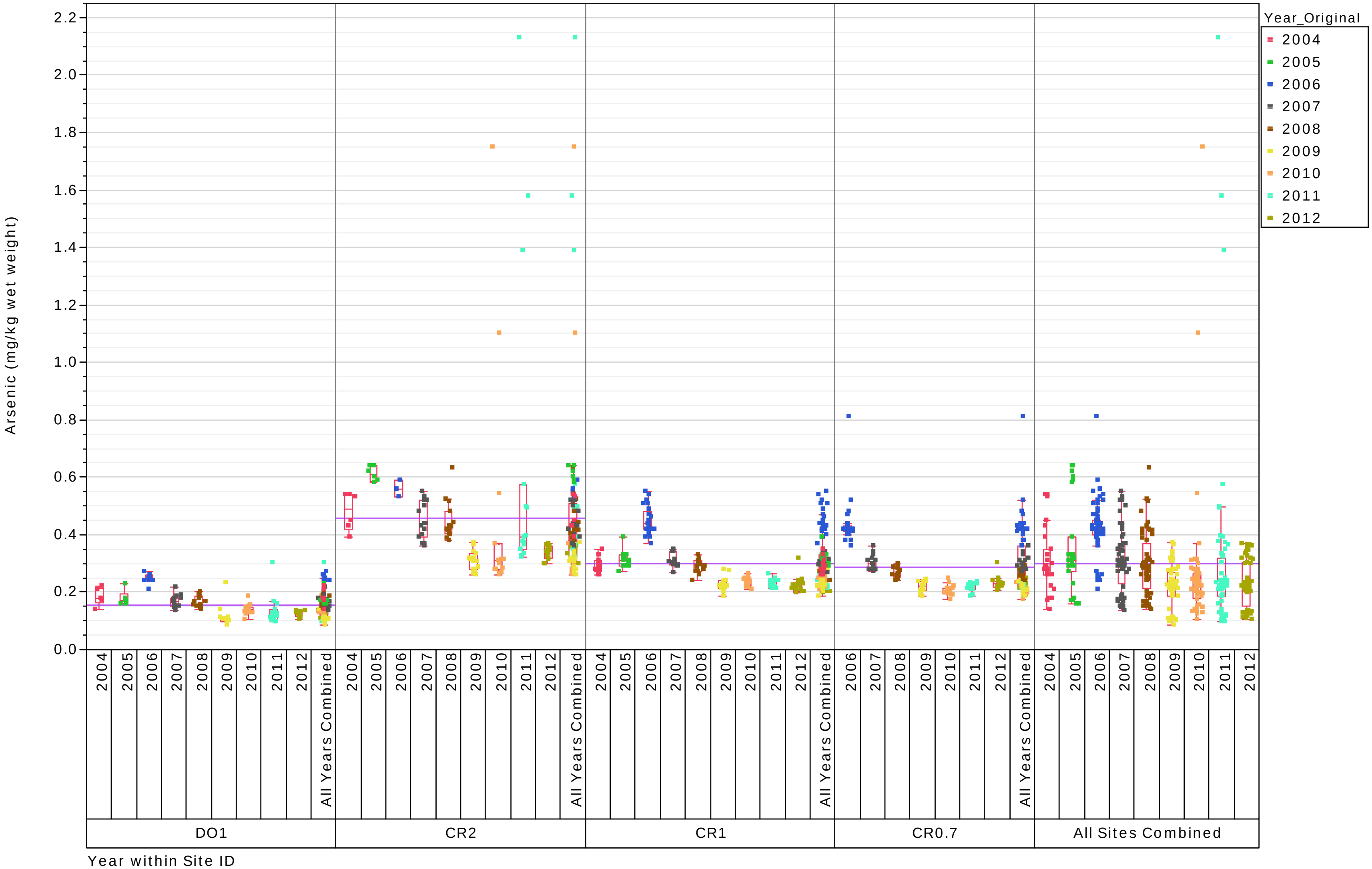
Arsenic Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)



Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

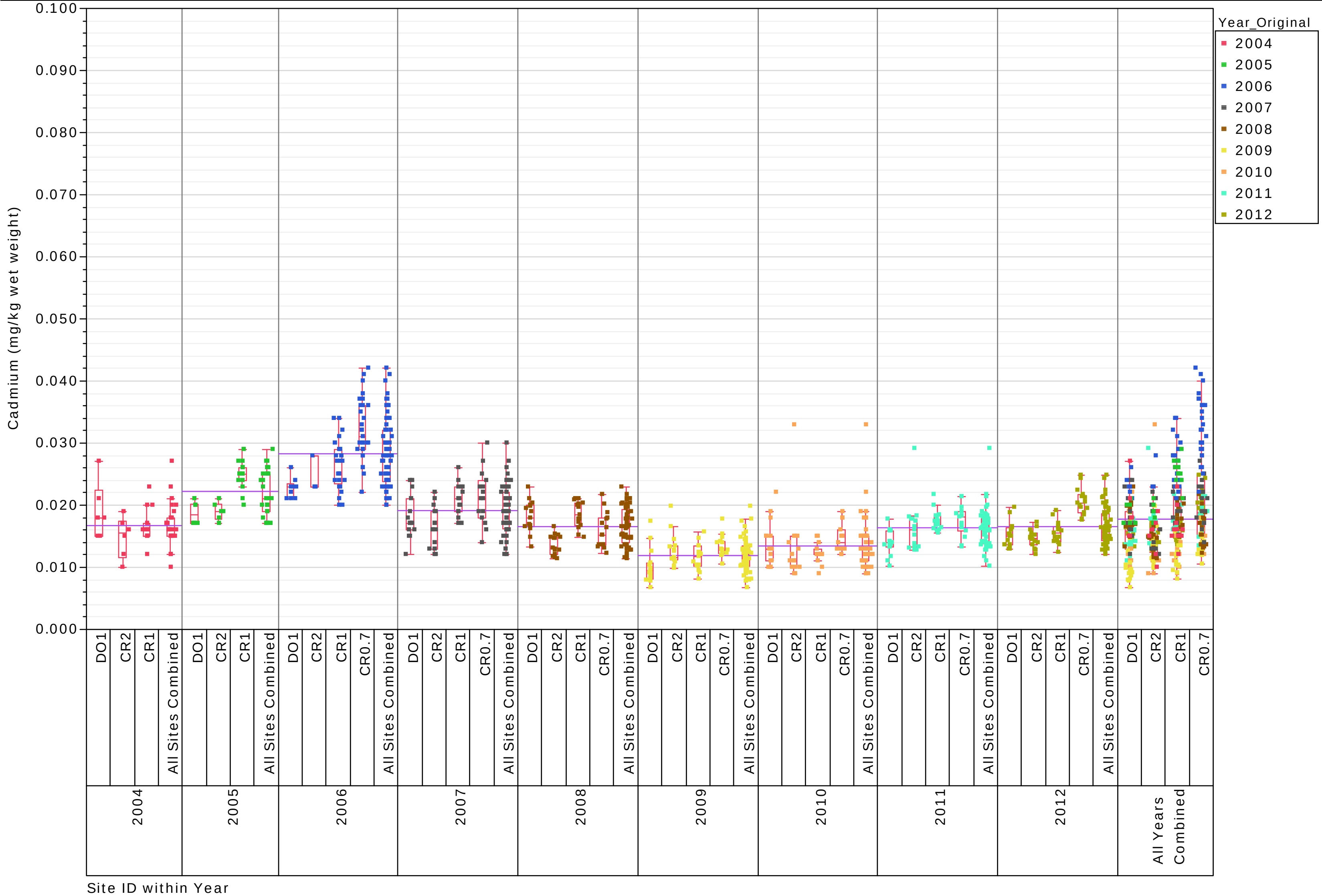
Figure 3.3-2 (Page 2 of 2)
Arsenic Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)



Notes:
Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-3 (Page 1 of 2)

Cadmium Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

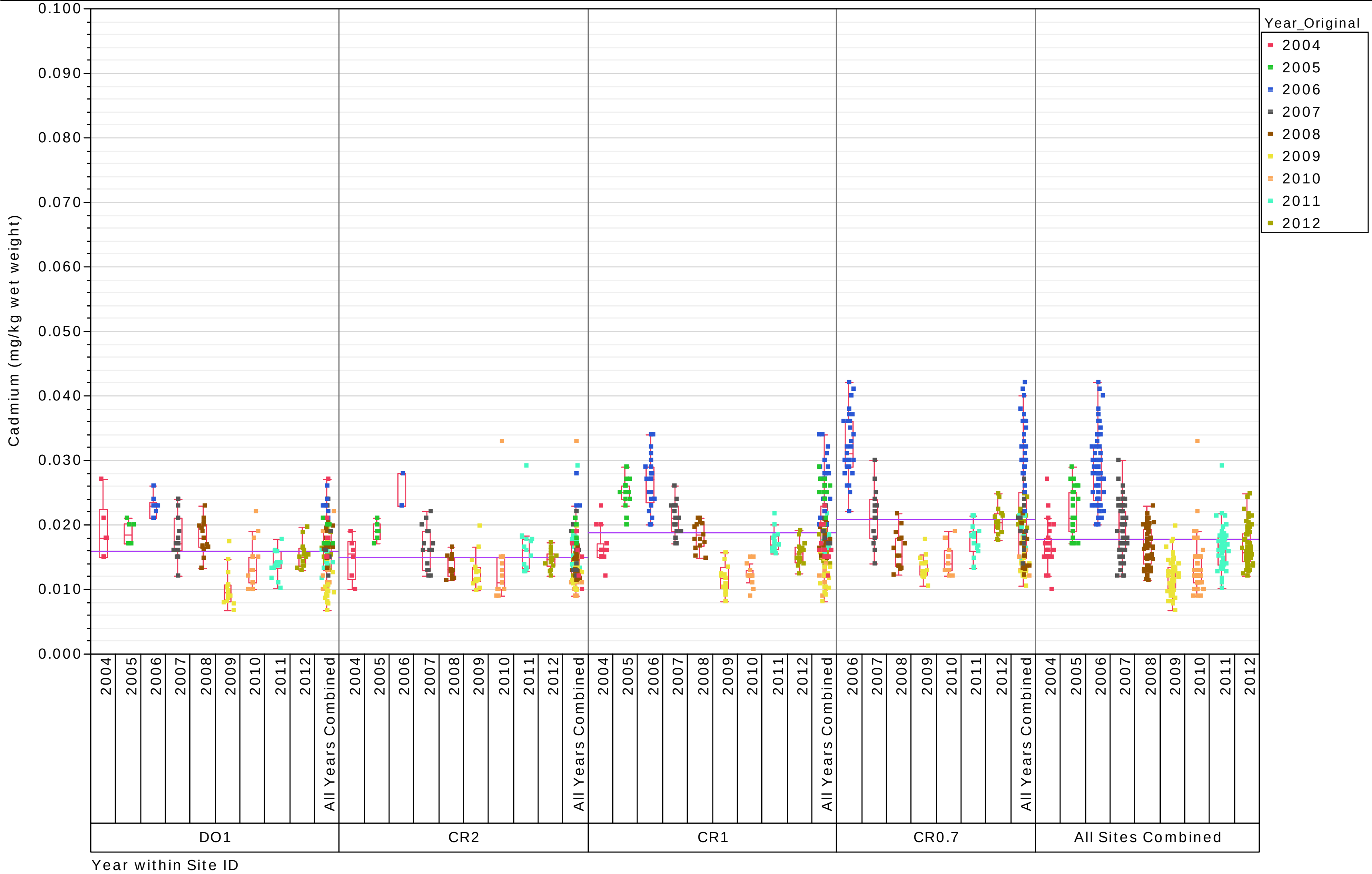


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-3 (Page 2 of 2)

Cadmium Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)

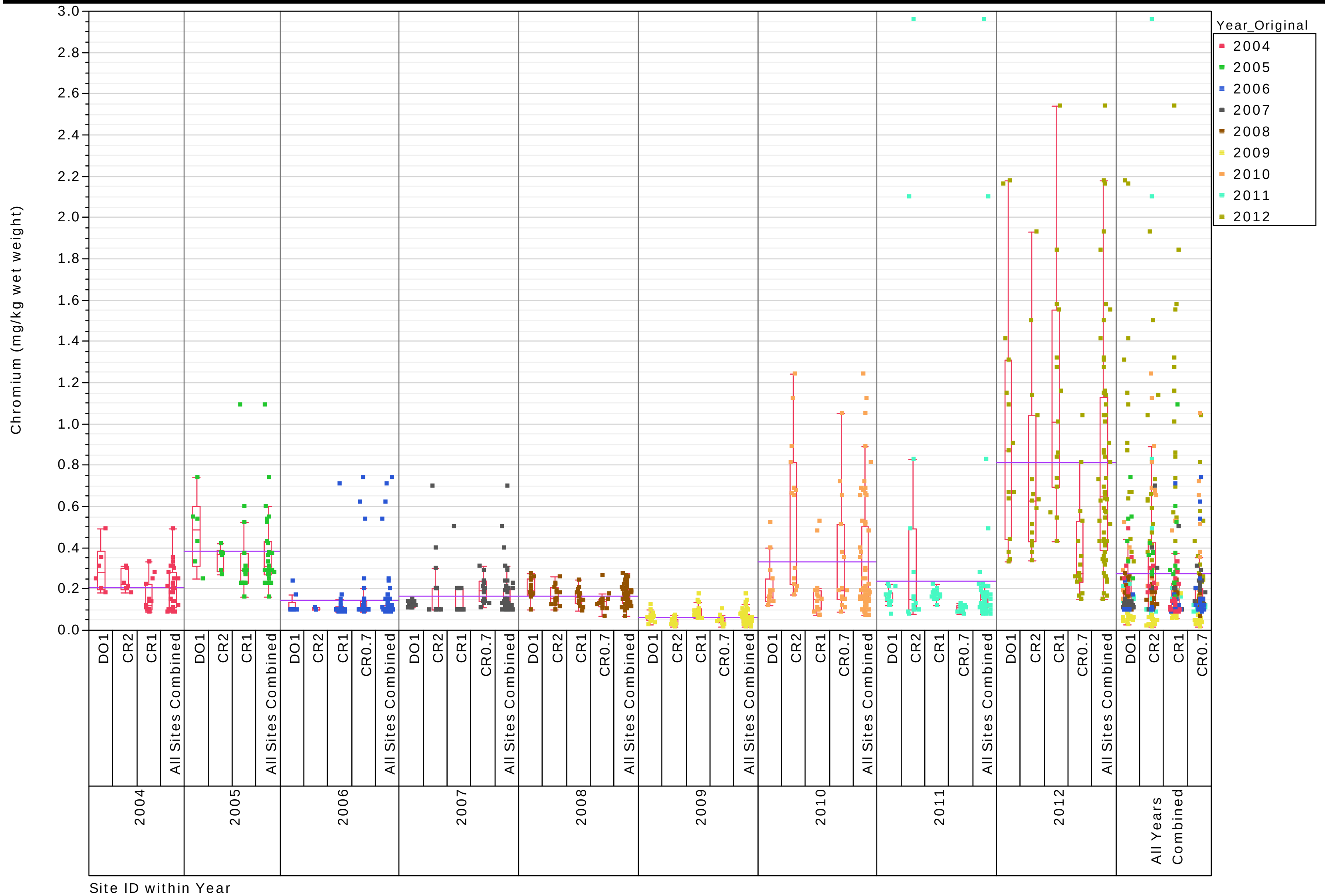


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-4 (Page 1 of 2)

Chromium Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

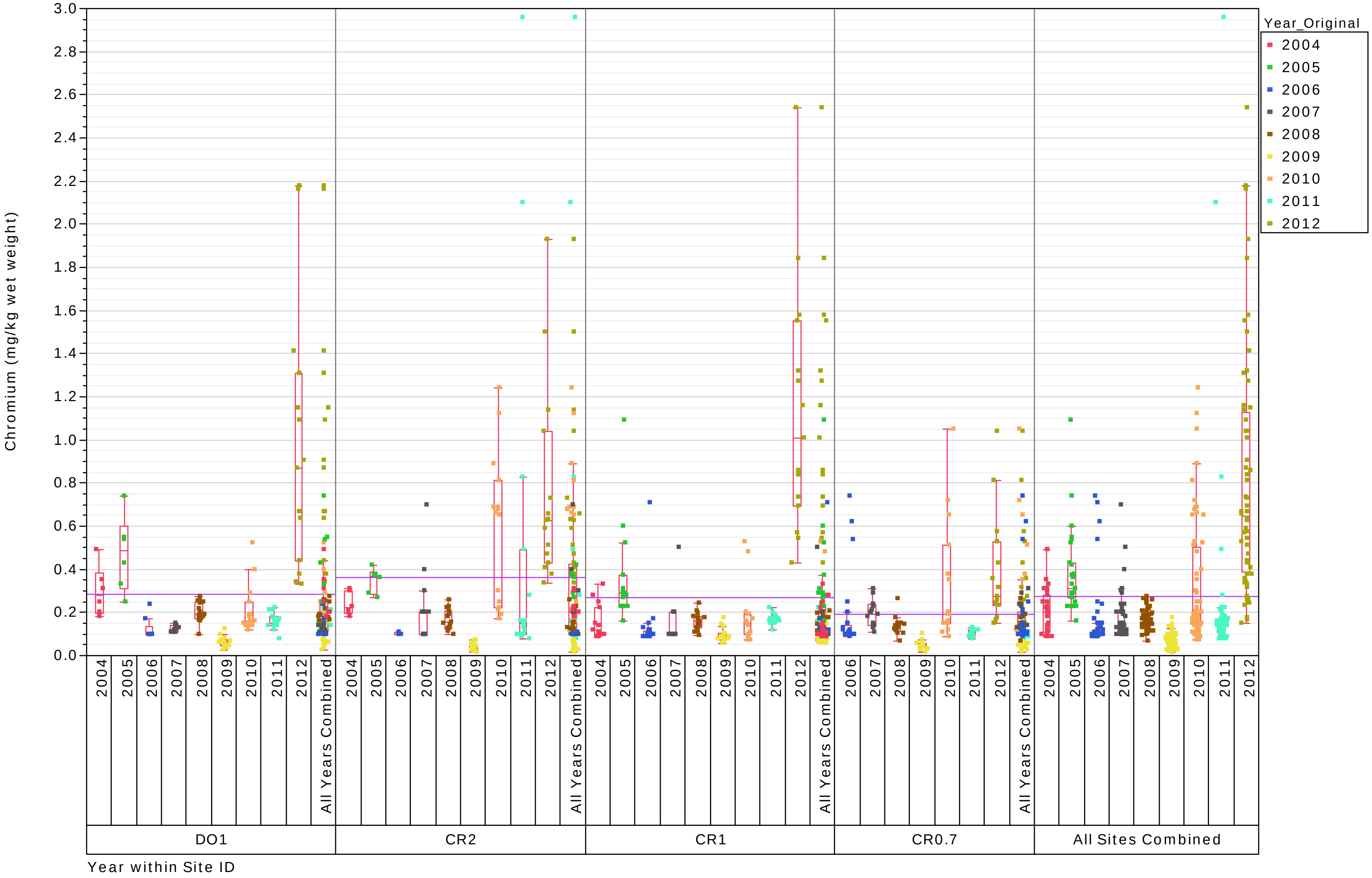


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-4 (Page 2 of 2)

Chromium Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)

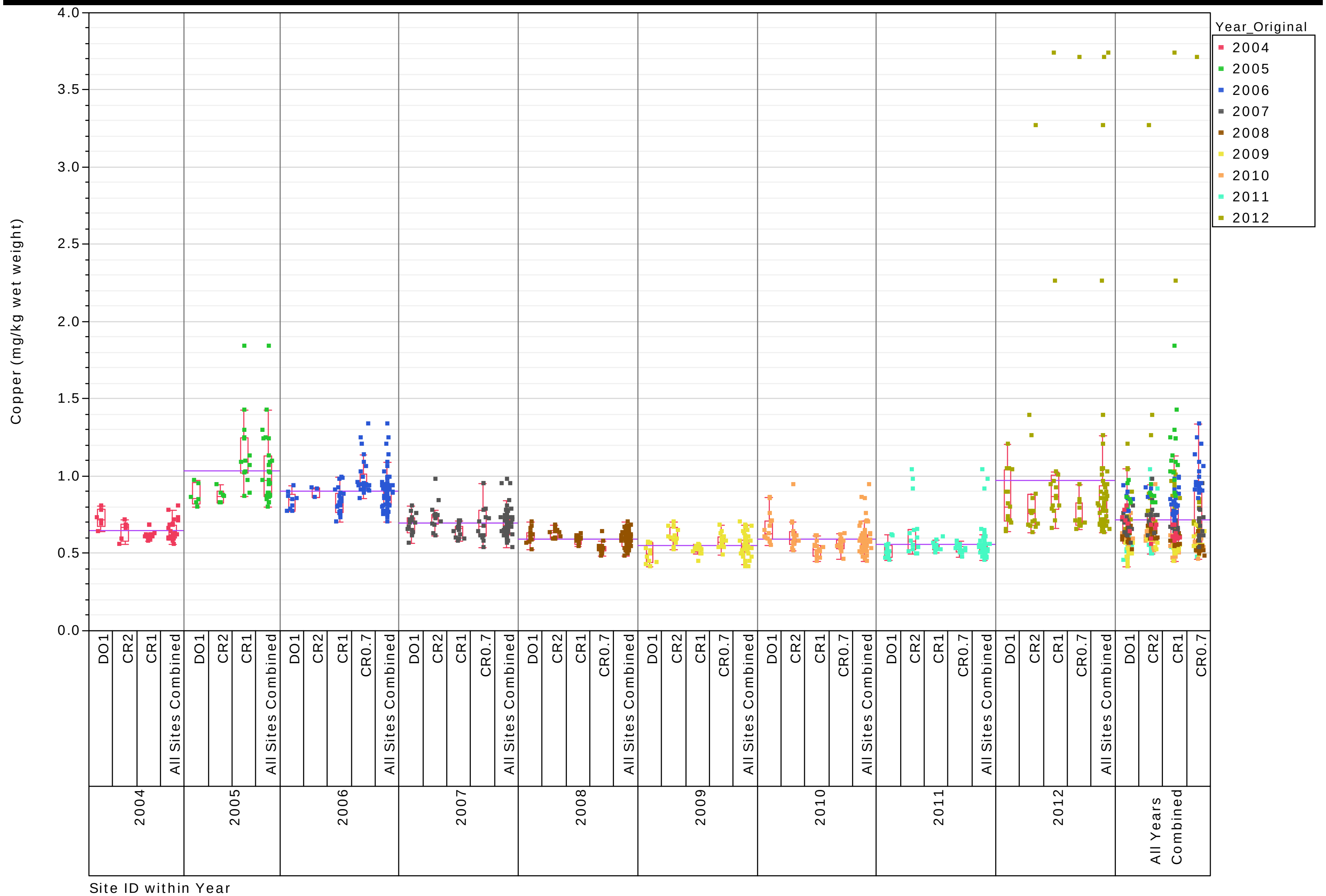


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-5 (Page 1 of 2)

Copper Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

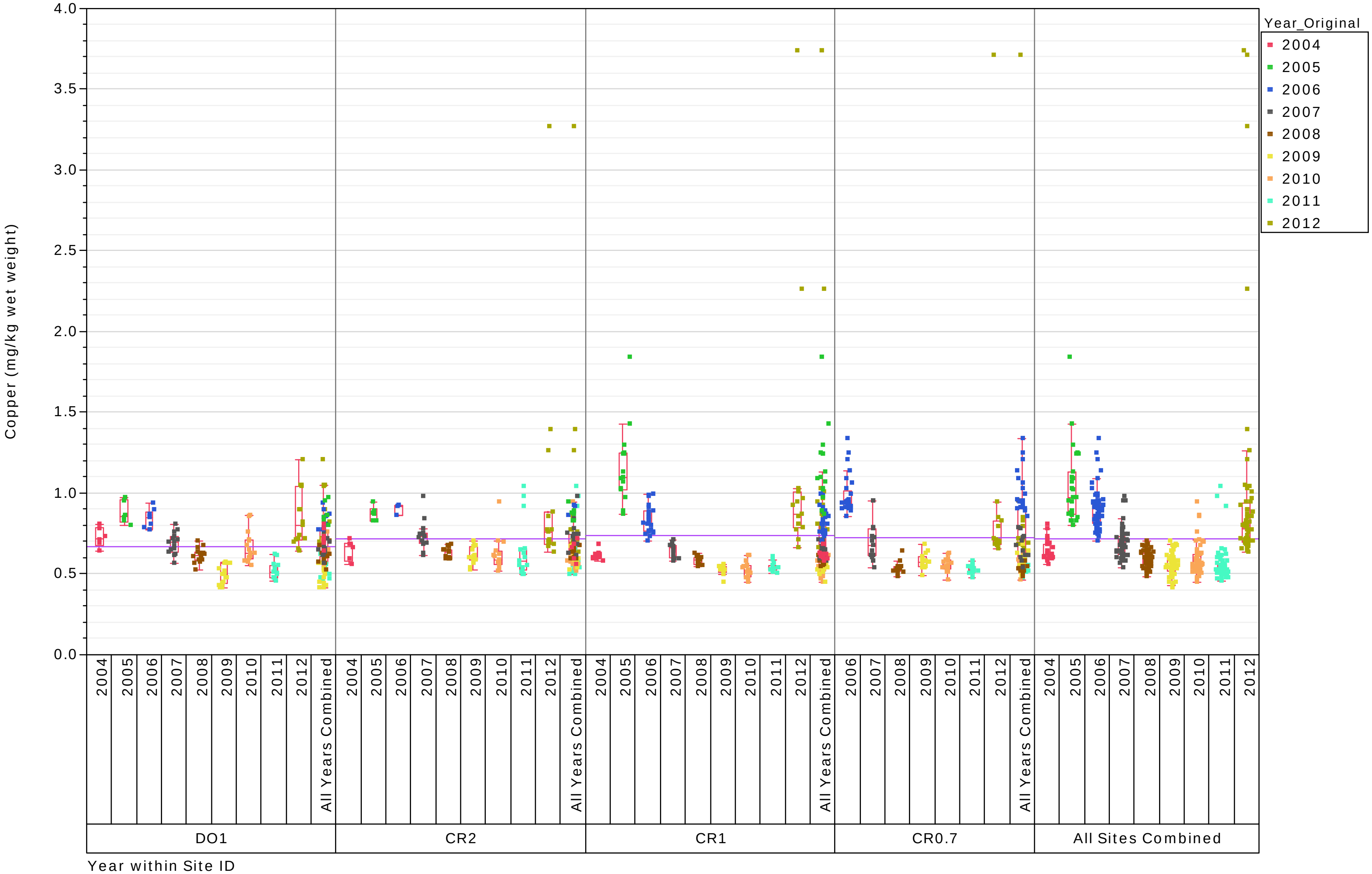


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-5 (Page 2 of 2)

Copper Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)

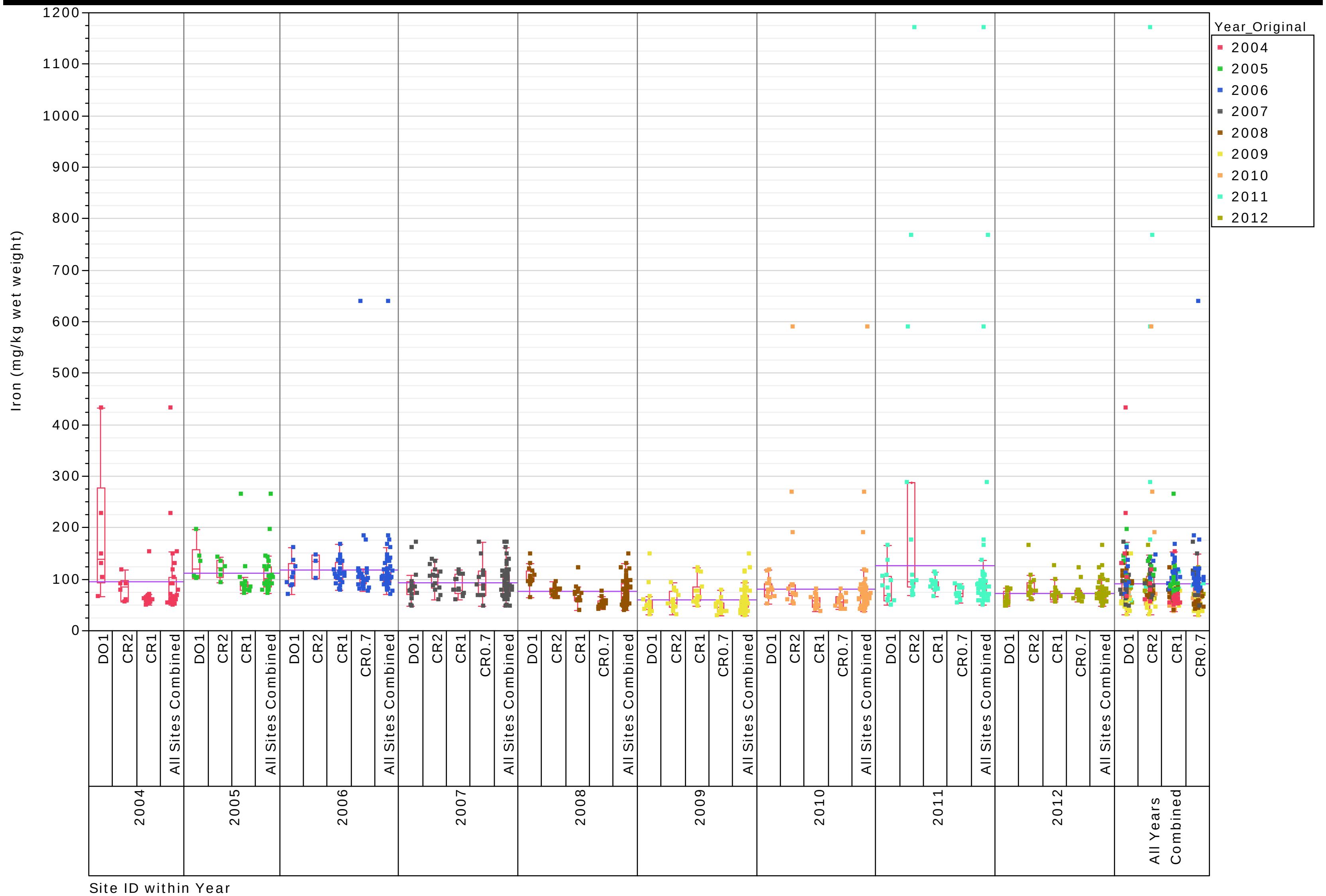


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-6 (Page 1 of 2)

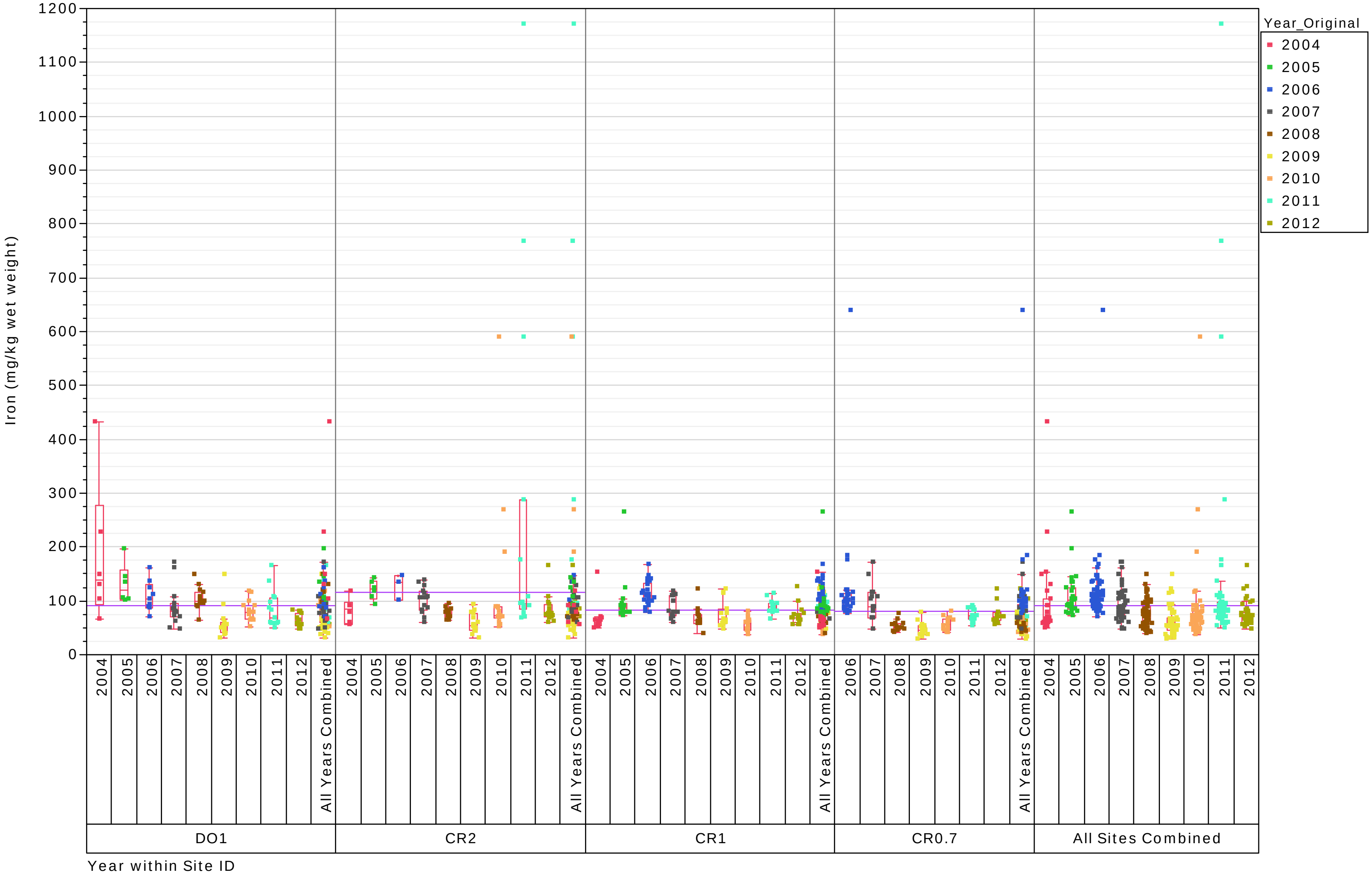
Iron Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)



Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

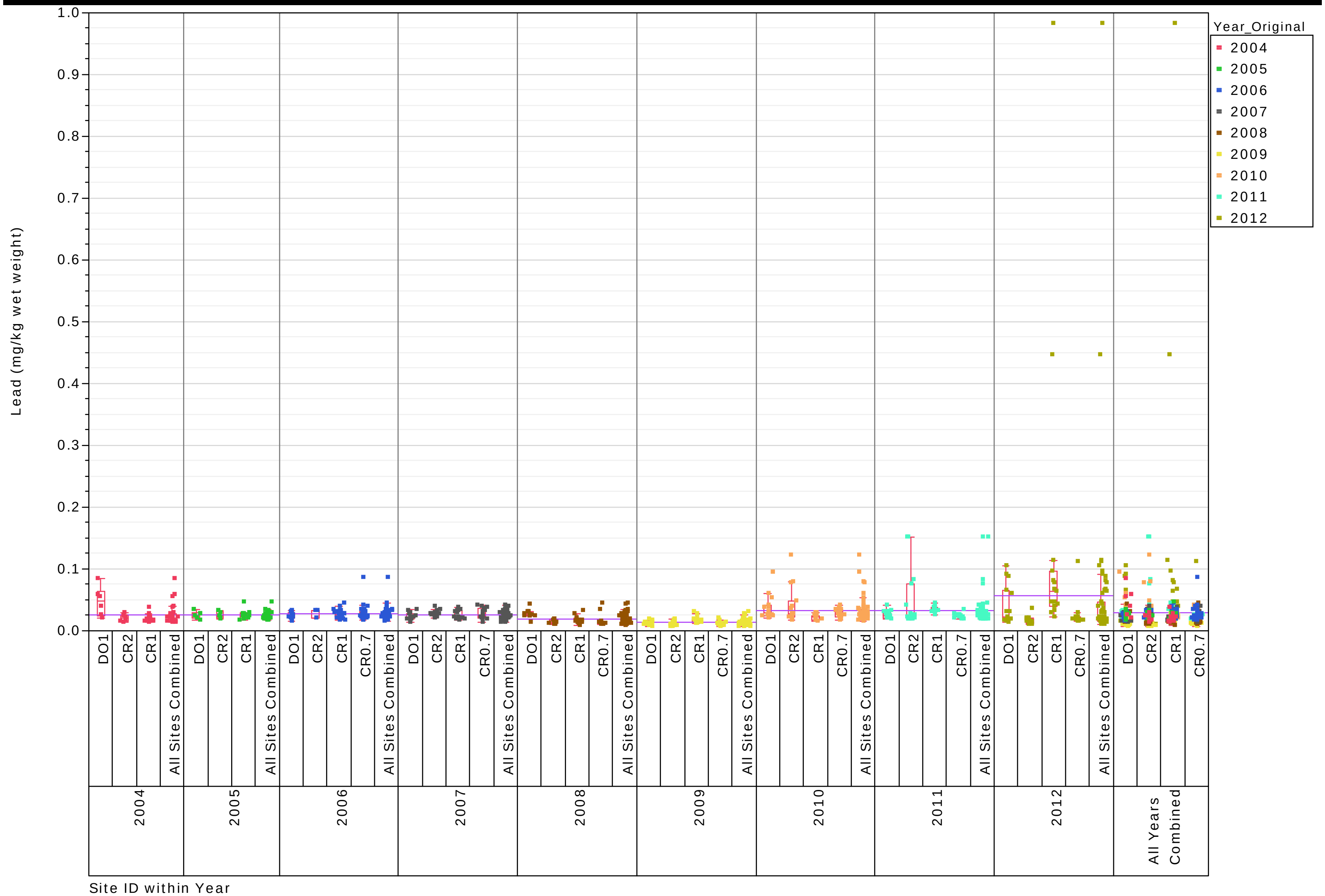
Figure 3.3-6 (Page 2 of 2)
Iron Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)



Notes:
Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-7 (Page 1 of 2)

Lead Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

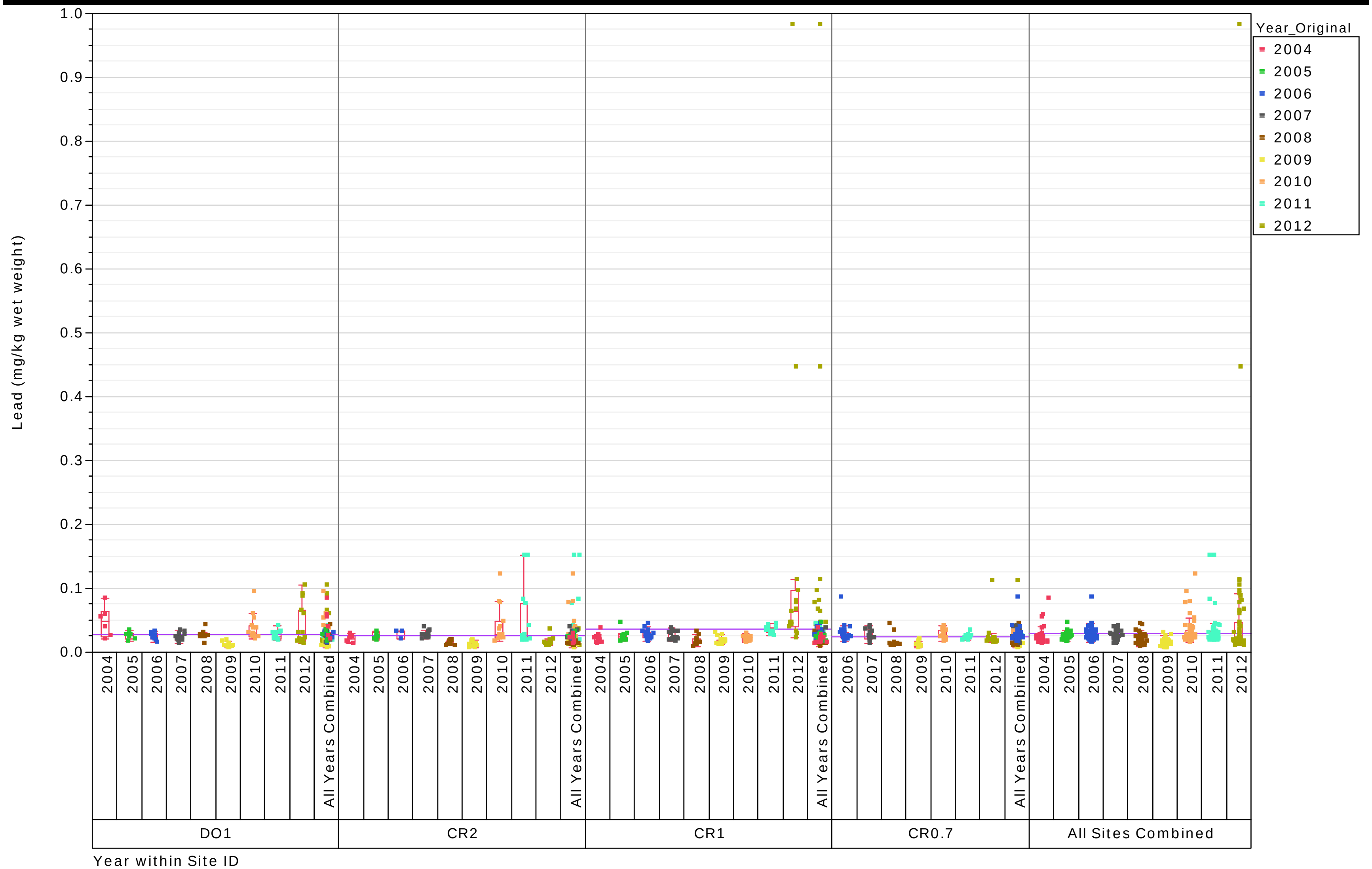


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-7 (Page 2 of 2)

Lead Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)

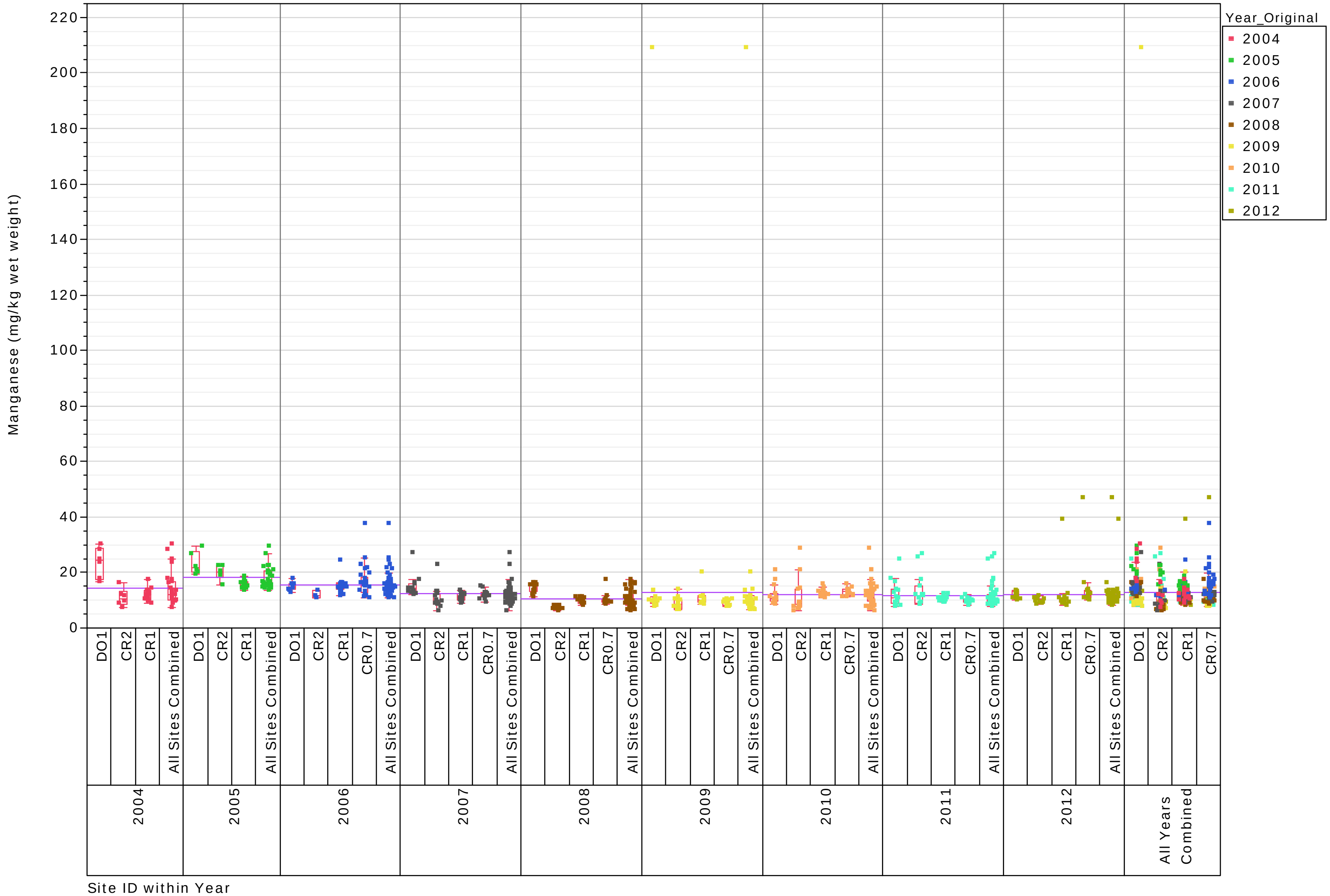


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-8 (Page 1 of 2)

Manganese Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

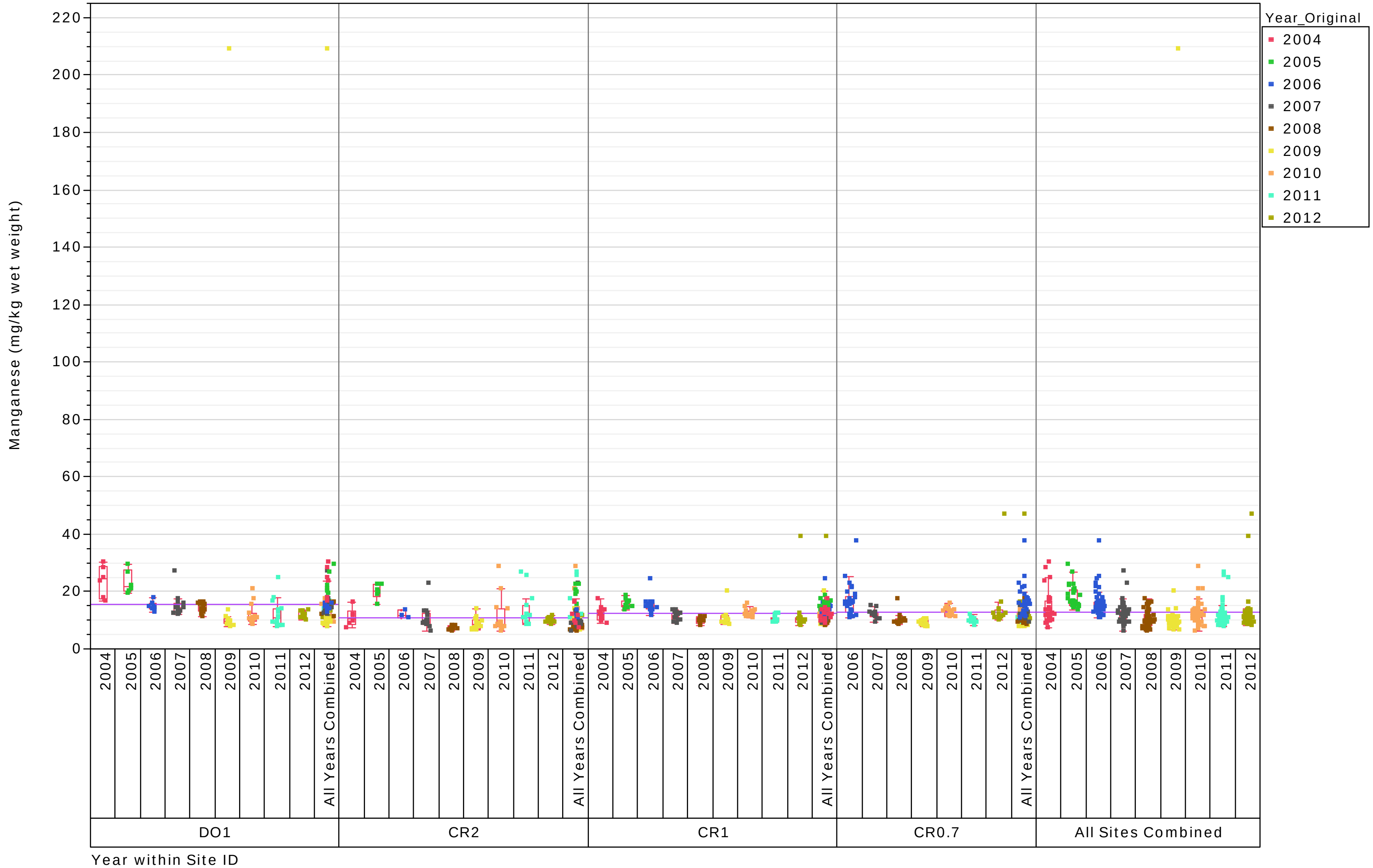


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-8 (Page 2 of 2)

Manganese Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)

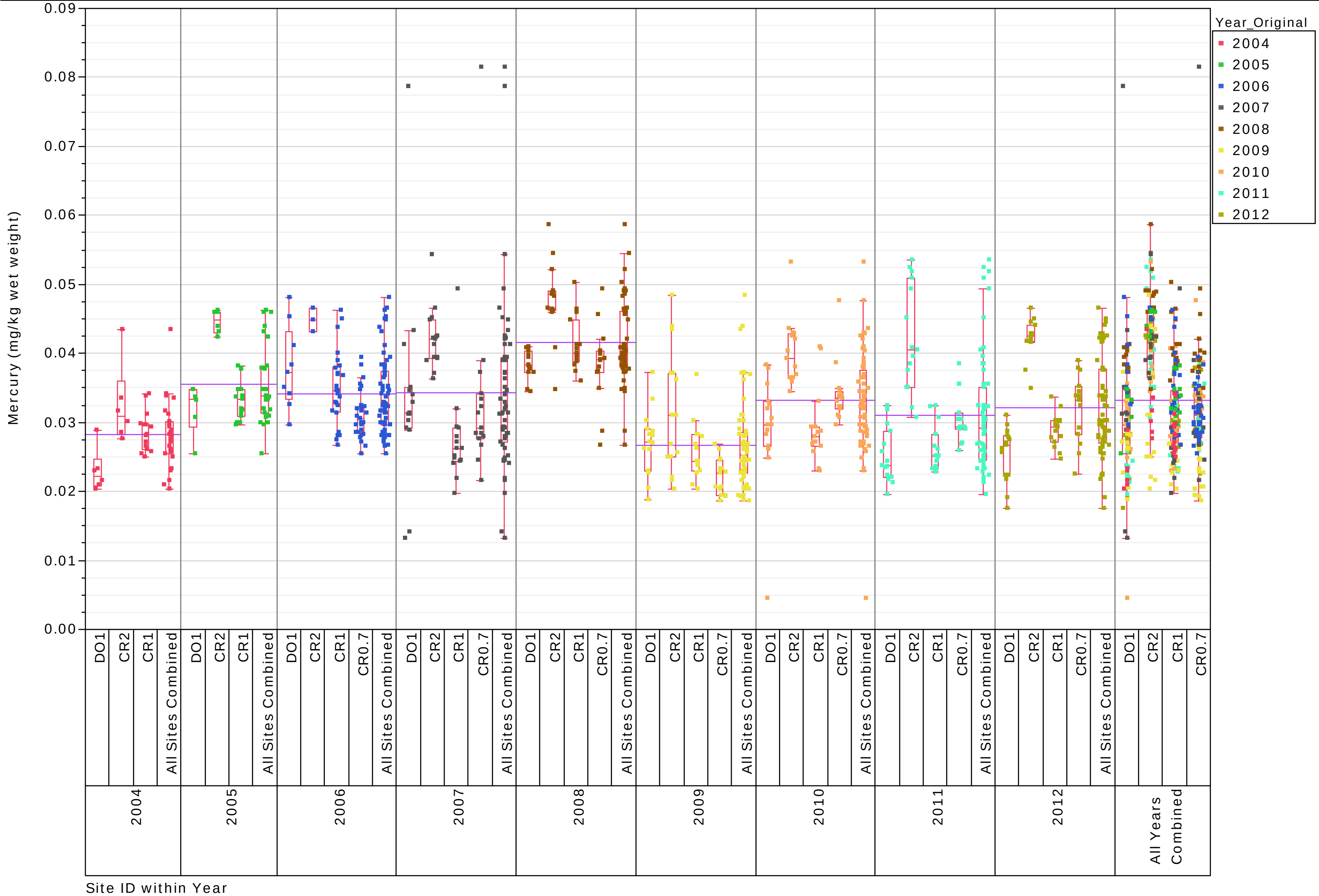


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-9 (Page 1 of 2)

Mercury Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

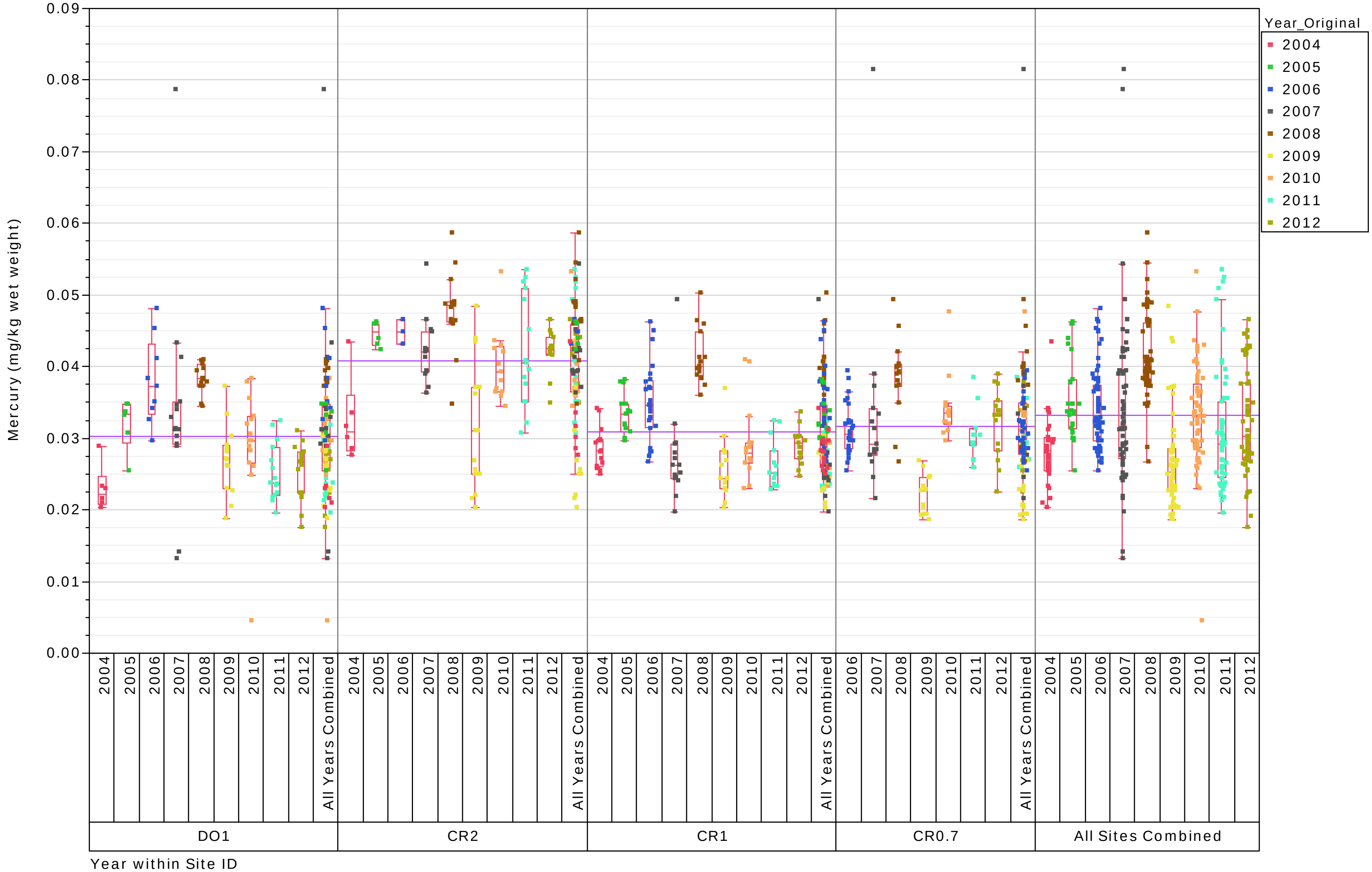


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-9 (Page 2 of 2)

Mercury Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)

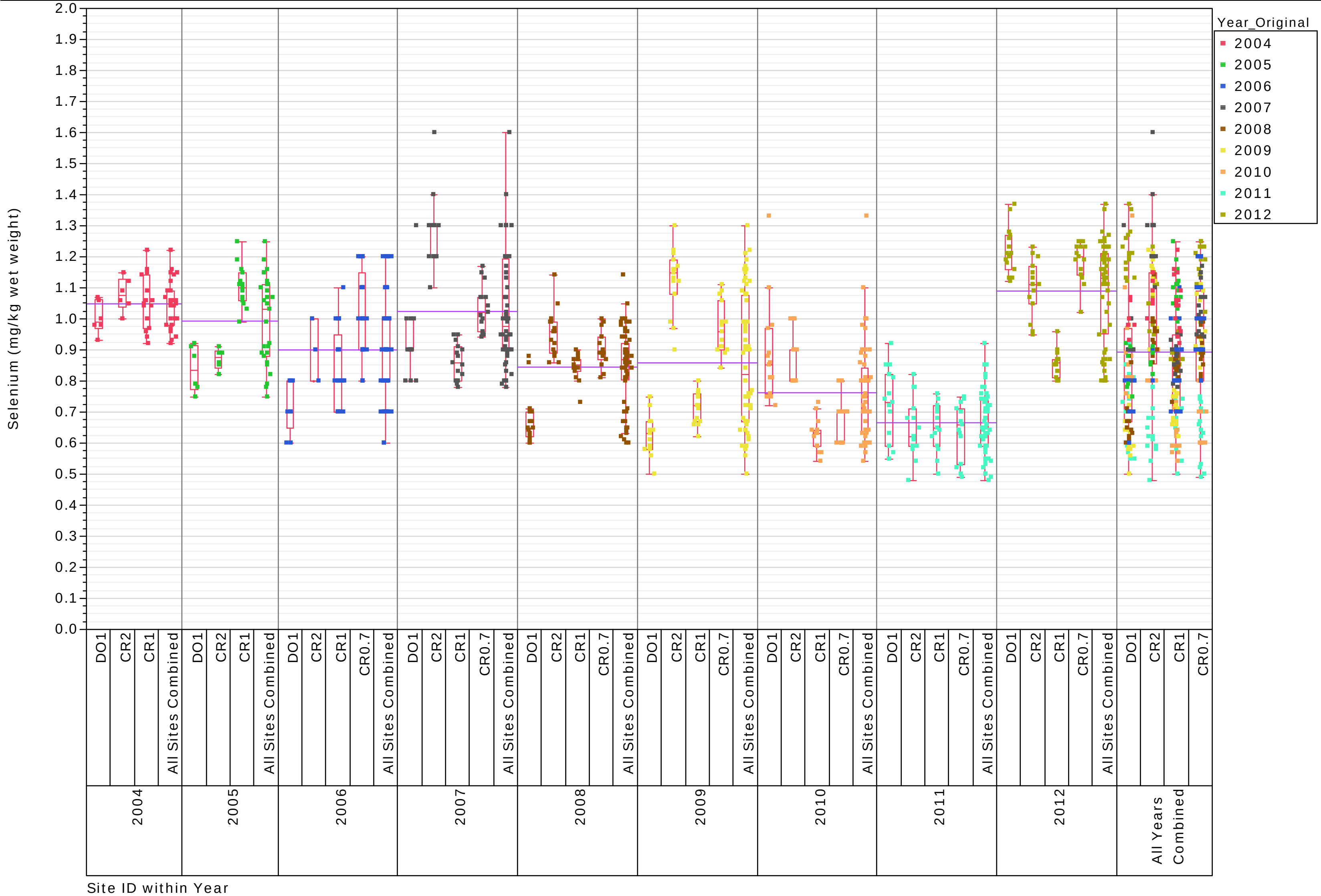


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-10 (Page 1 of 2)

Selenium Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

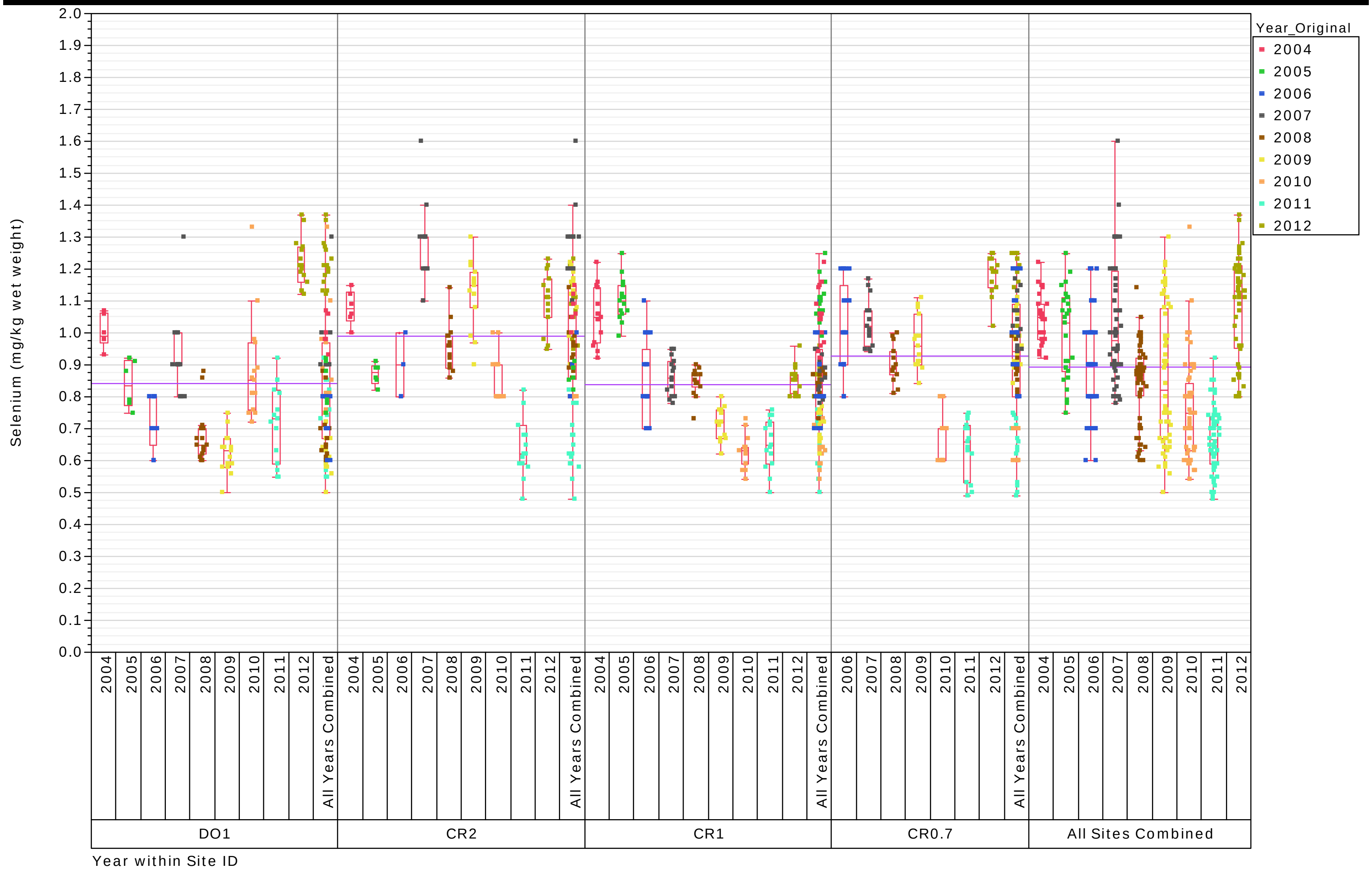


Notes:

Refer to Table 2.5-1 for method detection limits. ——— = Mean for grouping.

Figure 3.3-10 (Page 2 of 2)

Selenium Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)

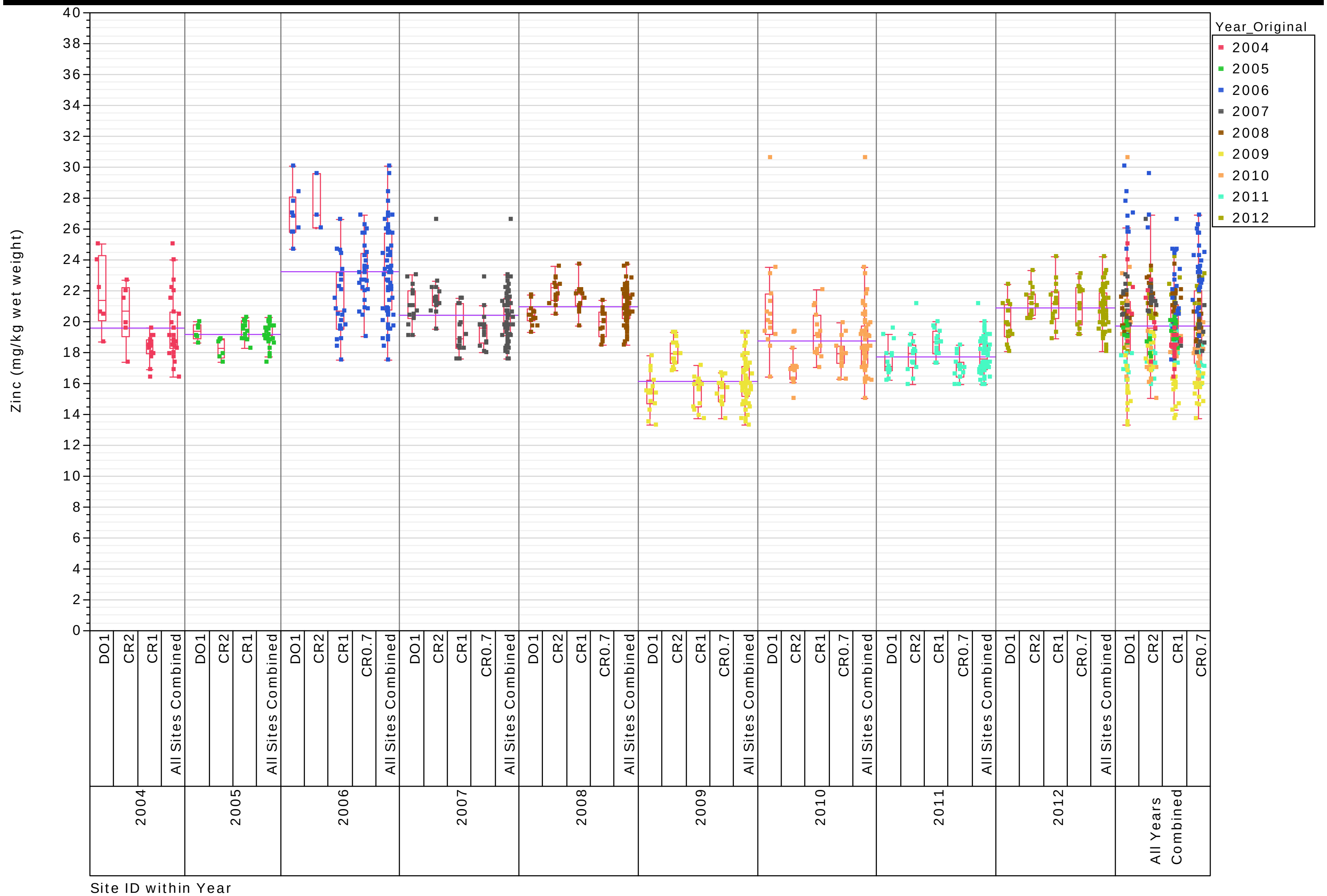


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-11 (Page 1 of 2)

Zinc Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Year (2004-2012)

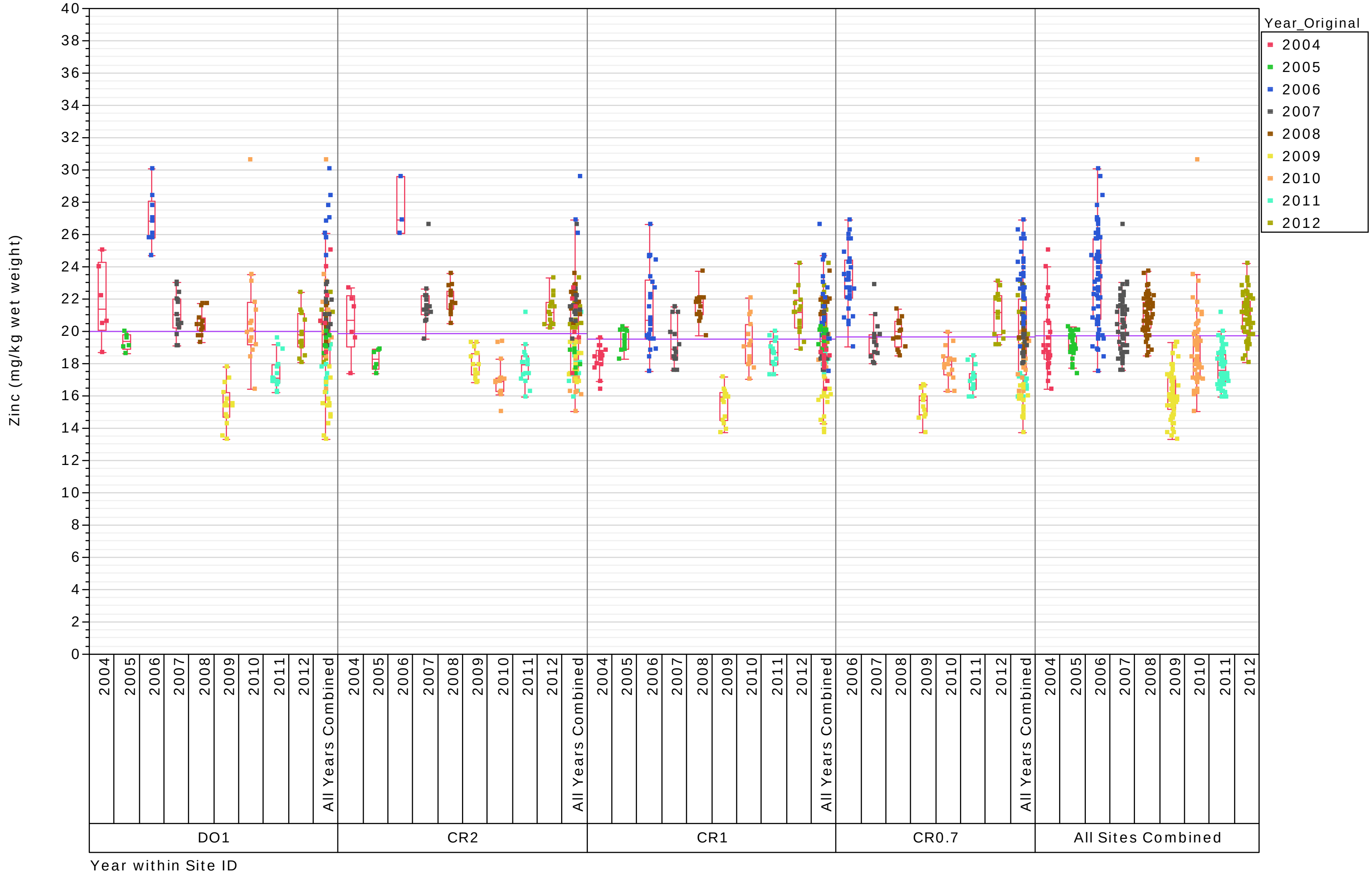


Notes:

Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.3-11 (Page 2 of 2)

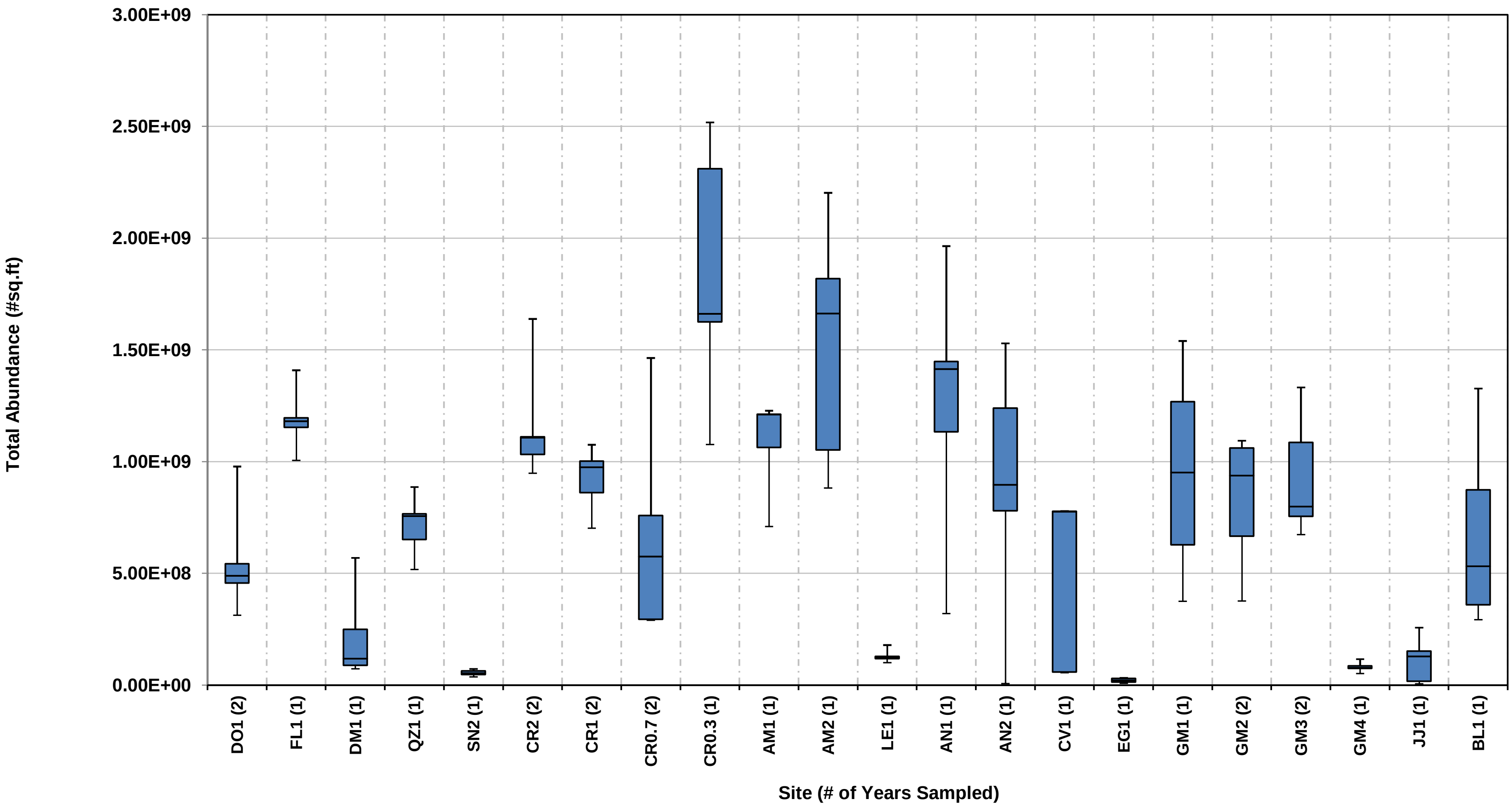
Zinc Concentrations in Slimy Sculpin <55mm Long at Sampling Sites within the Crooked Creek Drainage, Grouped by Site (2004-2012)



Notes:

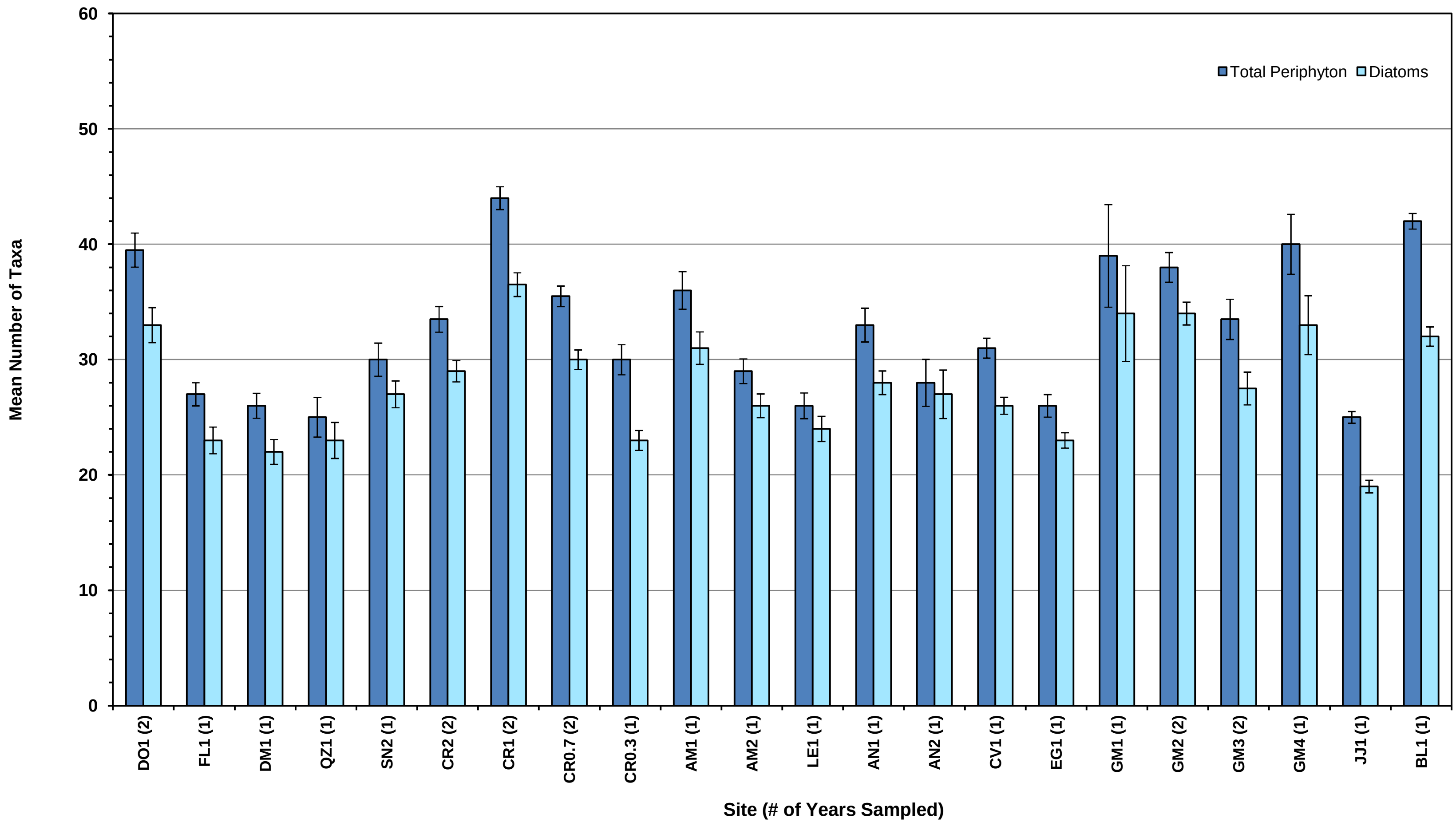
Refer to Table 2.5-1 for method detection limits. = Mean for grouping.

Figure 3.5-1
Periphyton Abundance for Sites within the Crooked Creek Drainage (2013 - 2014)



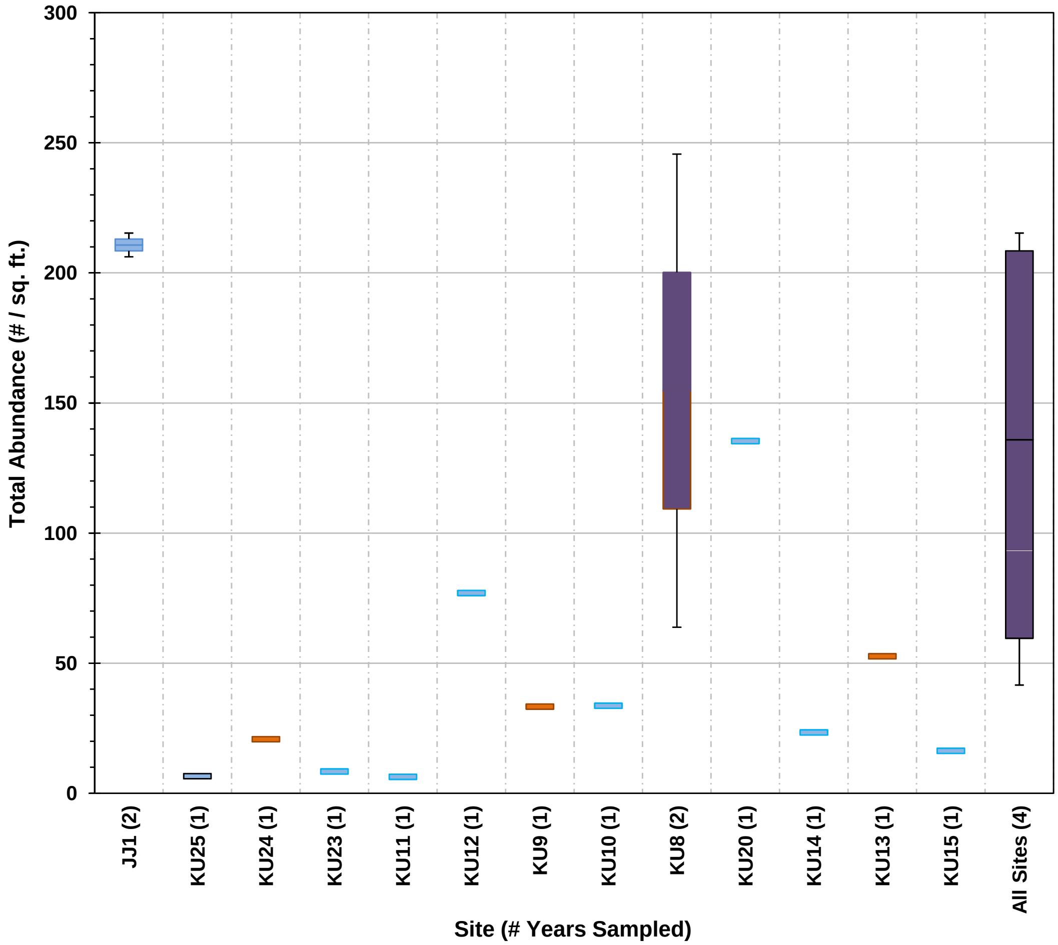
Notes:
Boxes represent the 25th and 75th percentiles for total abundance of five replicates. Black line within each box represents the median abundance of five replicates. Error bars represent the standard error.

Figure 3.5-2
Mean Number of Total Algal Taxa and Diatom Taxa for Sites within the Crooked Creek Drainage (2013 - 2014)



Notes:
Table represents the mean number of taxa across five replicates. Error bars represent the standard error.

Figure 6.1-1
Macroinvertebrate Abundance for Sites near the Jungjuk Port Site and Along the Drainages Crossed by the Mine Access Road, Grouped by Site (2007-2012)



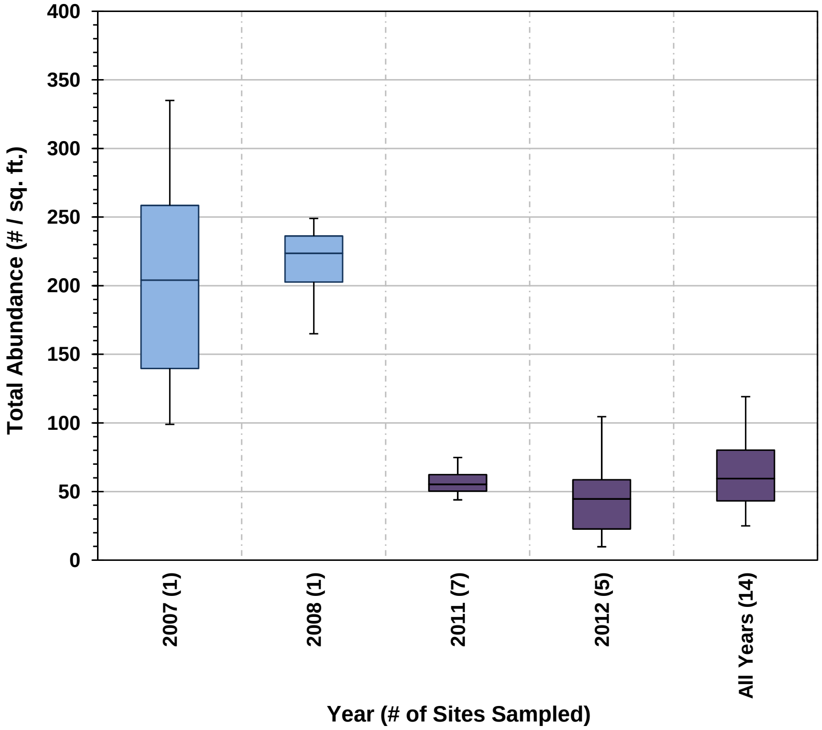
Notes:
For sample site locations, refer to Figure 1.1-1.

Both Ponar and Surber sampling methods used. Data were combined to form a composite data set.

Only Ponar sampling method used

Only Surber sampling method used

Figure 6.1-2
Macroinvertebrate Abundance for Sites near the Jungjuk Port Site and Along the Drainage Crossed by the Mine Access Road, Grouped by Year (2007-2012)

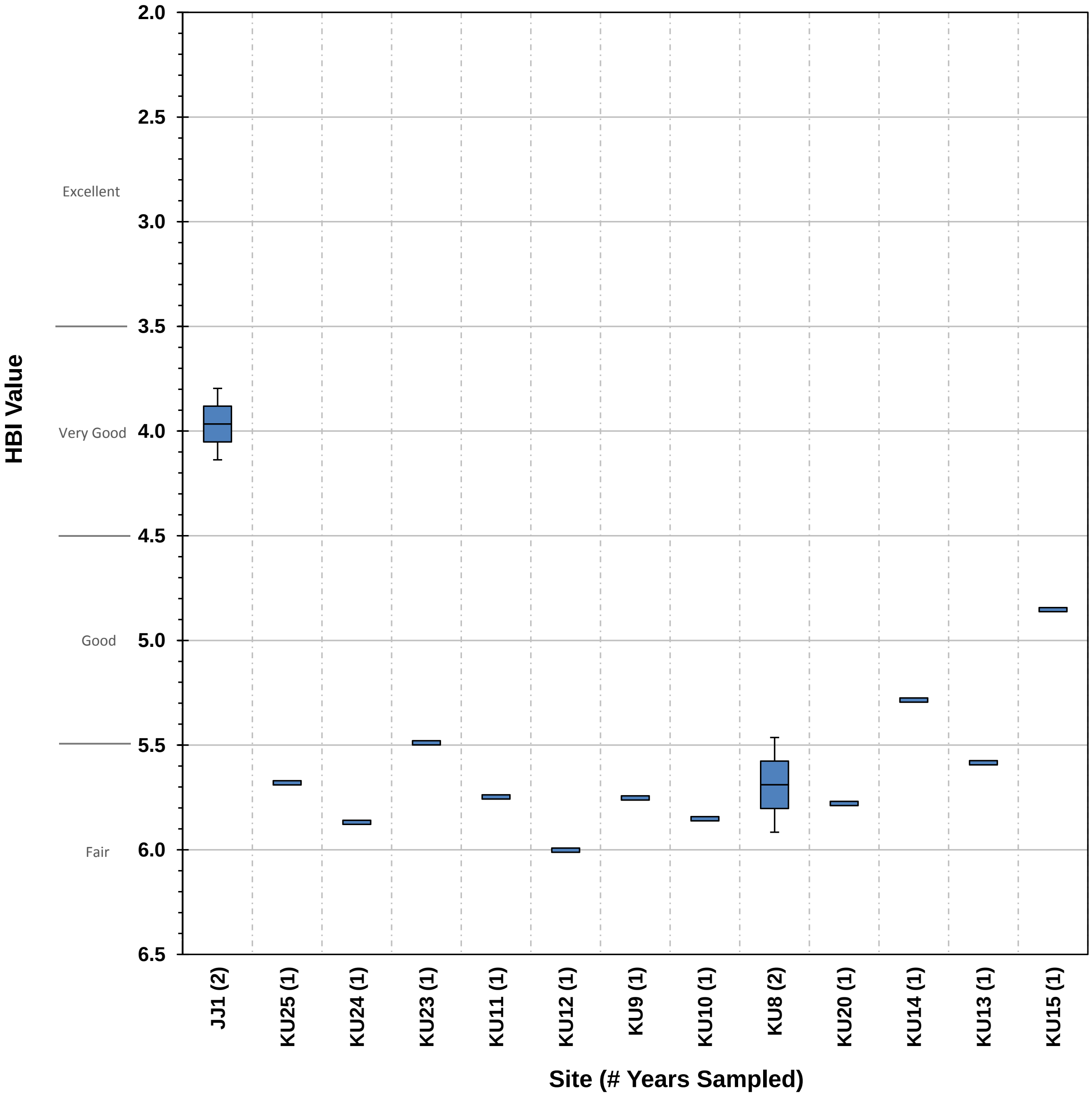


Notes:
For sample site locations, refer to Figure 1.1-1.

Both Ponar® and Surber sampling methods used. Data were combined to form a composite data set.

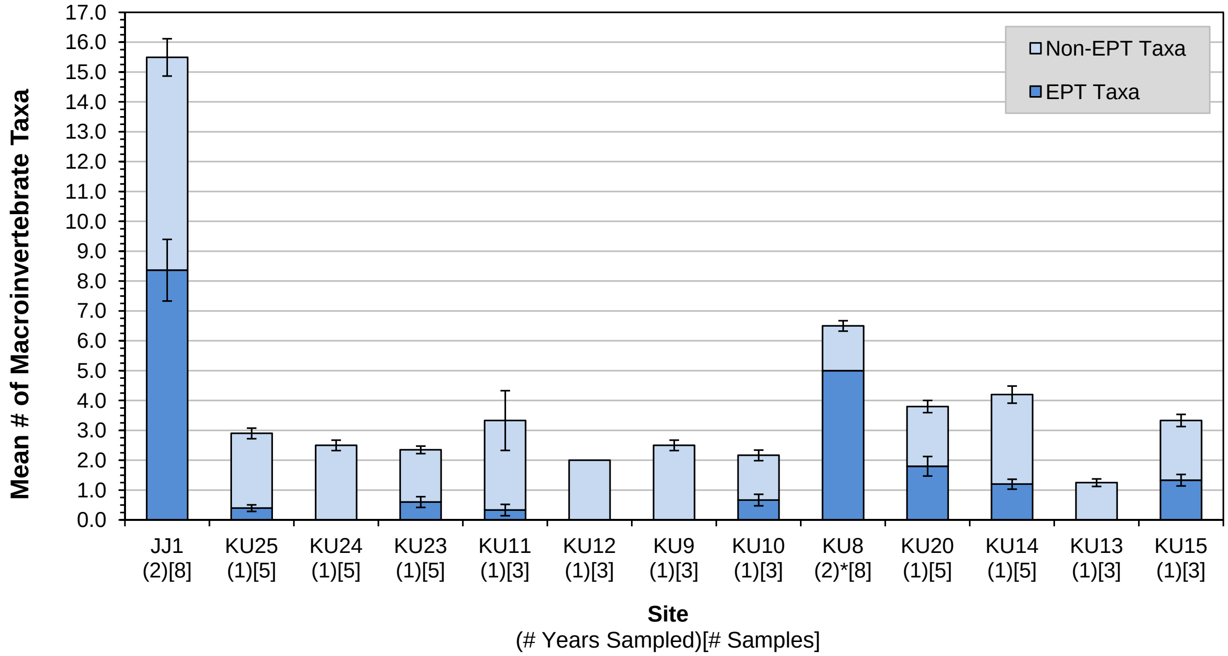
Only Surber sampling method used

Figure 6.1-3
Hilsenhoff Biotic Index (HBI)[1] for Aquatic Macroinvertebrates within the Mine Access Road and Jungjuk Port Site (2007-2012)



Notes:
For sample site locations, refer to Figure 1.1-1.
1) The Hilsenhoff Biotic Index (HBI) was developed using tolerance values for macroinvertebrates in Wisconsin streams (Hilsenhoff 1987, 1988). HBI takes into account the tolerance value and number of individuals of each taxon in the sample and rates streams on a scale of 0 (excellent water quality) to 10 (polluted). Values are as follows: 0.00-3.50 (excellent), 3.51-4.50 (very good), 4.51-5.50 (good), 5.51-6.50 (fair), 6.51-7.50 (fairly poor), 7.51-8.50 (poor), and 8.51-10.00 (very poor).
2) Site KU8 was sampled by surber in 2011 and ponar in 2012.

Figure 6.1-4
Mean Number of EPT and Non-EPT Macroinvertebrate Taxa (Combined for Total Mean Number of Taxa) Found at Sites within the Mine Access Road and the Jungjuk Port Site (2004-2012)



Notes:
For sample site locations, refer to Figure 1.1-1.
*Data set includes data collected using both Surber and Ponar sampling methods.
Error bars represent one standard error.

10.0 APPENDIX

Appendix A
Donlin Gold Project Aquatic Sampling Matrix (2004-2014)

Watershed	Stream Name	Project	Sub Project	Site or Reach	Location: Latitude	Location: Longitude	Years Sampled: 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Crooked Creek	Donlin Creek	Core Program	Aerial	DOR3	62.162945	-158.02995	•	•	•	•	•	•	•	•	•	•	•	11
				DOR2	62.13138	-158.13177	•	•	•	•	•	•	•	•	•	•	•	11
				DOR1	62.087879	-158.166685	•	•	•	•	•	•	•	•	•	•		10
			Ground - Biomonitoring + metals	DO1	62.09588	-158.16086	•	•	•	•	•	•	•	•	•			9
	Flat Creek	Core Program	Aerial	FLR1	62.103159	-158.235034	•	•	•	•	•	•	•		•			8
			Ground - Biomonitoring	FL1	62.07869	-158.22037	•	•	•	•	•	•						6
	Dome Creek	Core Program	Aerial	DMR1	62.068616	-158.113832					•		•		•			3
			Ground - Biomonitoring	DM1	62.08156	-158.15794					•	•						2
	Quartz Gulch	Core Program	Ground - Biomonitoring	QZ1	62.07806	-158.17928						•						1
	Snow Gulch	Core Program	Aerial	SNR1	62.051429	-158.157587		•	•	•	•	•	•		•			7
			Ground - Biomonitoring	SN1	62.06799	-158.19064			•									1
				SN2	62.06194	-158.18391			•	•	•	•		•	•	•		7
	Queen Gulch	Core Program	Ground - Biomonitoring	QU1	62.05879	-158.21972							•					1
	Crooked Creek	Core Program	Aerial	CRR5	62.07679	-158.22074	•	•	•	•	•	•	•	•	•	•	•	11
				CRR4	62.043531	-158.25602	•	•	•	•	•	•	•	•	•	•	•	11
				CRR3	61.99911	-158.26268	•	•	•	•	•	•	•	•	•	•	•	11
				CRR2	61.958731	-158.265537	•	•	•	•	•	•	•	•	•	•	•	11
				CRR1	61.90227	-158.176173	•	•	•	•	•	•	•	•	•	•	•	11
			Ground - Biomonitoring	CR0.3	61.87118	-158.12645			•	•	•	•	•					5
			Ground - Biomonitoring + metals	CR2	62.04409	-158.25466	•	•	•	•	•	•	•	•	•			9
				CR1	61.99911	-158.26268	•	•	•	•	•	•	•	•	•			9
				CR0.7	61.98088	-158.26043			•	•	•	•	•	•	•			7
			Fish Weir	Weir	61.87749	-158.13988					•	•	•	•	•			5
			Ground - Adult Fish Metals	AFMA1	61.90318	-158.17212							•					1
				AFMA2	61.8928866	-158.16232							•					1
				AFMA3	62.010087	-158.2624737							•					1
				AFMA5	61.9440177	-158.2416204							•					1
				AFMA6	61.958729	-158.2649946							•					1
				AFMA7	61.966577	-158.26564							•					1
				AFMA8	61.9139832	-158.1888886							•					1
			Ground - Off Channel	BW1	62.0728329	-158.220481										•	•	2
				BW2	62.041883	-158.262672										•	•	2
				BW3	62.0372527	-158.261823										•	•	2
				BW4	62.0330697	-158.255764										•	•	2
				BW5	62.0313247	-158.254303										•	•	2
				BW6	62.030033	-158.254772										•	•	2
				BW7	62.042258	-158.259602										•	•	2
				BW8	62.0381406	-158.260148										•	•	2
				BW9	62.0084214	-158.26162										•	•	2
				BW10	62.0048889	-158.258339										•	•	2
				BW11	61.9939097	-158.26303										•	•	2
				BW12	61.9899479	-158.262011										•	•	2
		Mine Access Road	Ground - Culverts and Bridges	BR3 (see CR1)	62.0285311	-158.2567903												
	Lewis Gulch	Core Program	Ground - Biomonitoring	LE1	62.04902	-158.22965						•						1
	American Creek	Core Program	Aerial	AMR1	62.020509	-158.14683		•	•	•	•	•	•	•	•			8
			Ground - Biomonitoring	AM2	62.02552	-158.19938							•					1
				AM1	62.03892	-158.24591	•	•	•	•	•	•		•				7
			Ground - presence/absence	AM4	62.028159	-158.121535								•				1
				AM3	62.018626	-158.13311								•				1
	Grouse Creek	Core Program	Aerial	GRR1	62.04975	-158.285639					•		•		•			3
			Ground - Biomonitoring	GR1	62.04477	-158.27194					•							1
	Omega Gulch	Core Program	Ground - Biomonitoring	OM1	62.02188	-158.24318						•						1

Appendix A
Donlin Gold Project Aquatic Sampling Matrix (2004-2014)

	Anaconda Creek	Core Program	Aerial	ANR1	62.00181	-158.163236		•	•	•	•	•	•	•	•			8
			Ground - Biomonitoring	AN2	62.00147	-158.19104			•	•	•	•						4
				AN1	61.99957	-158.257	•	•	•	•	•	•		•				7
	Crevice Creek	Core Program	Aerial	CVR1	61.981586	-158.148565		•	•	•	•	•	•	•	•			8
			Ground - Biomonitoring	CV1	61.98334	-158.25012			•	•	•	•						4
	Eagle Creek	Core Program	Aerial	EGR1	61.988972	-158.354417						•	•	•	•			4
			Ground - Biomonitoring	EG1	61.98708	-158.27827						•						1
	Unnamed (BC)	Core Program	Ground - Biomonitoring	BC1	61.96397	-158.25635							•					1
	Unnamed (AC)	Core Program	Ground - Biomonitoring	AC1	61.94896	-158.24227							•					1
	Getmuna Creek	Core Program	Aerial	GMR1	61.898097	-158.383824				•	•	•	•	•	•	•		7
				GMR2	61.91063	-158.503307				•	•	•	•	•	•	•		7
				GMR3	61.866602	-158.448412				•	•	•	•	•	•	•		7
				GMR4	61.820653	-158.507024						•	•	•	•	•		5
				GMR5	61.8432328	-158.4180495								•	•	•		3
			Ground - Biomonitoring	GM4	61.896945	-158.385648									•			1
				GM2	61.898705	-158.391377									•			1
				GM1	61.91521	-158.24043				•	•	•						3
			Ground - Biomonitoring + metals	GM3	61.901276	-158.359436									•	•		2
		Mine Access Road	Ground - Culverts and Bridges	BR47 (see GM2)	61.8857465	-158.4216526												
				BR48 (see GM4)	61.872269	-158.4251016												
	Getmuna Creek T	Mine Access Road	Aerial	FNR1	61.8432328	-158.4180495									•			1
			Ground - Culverts and Bridges	BR49	61.8681	-158.4245						•						1
				CU43	61.918	-158.4449						•						1
	Bell Creek	Core Program	Aerial	BLR1	61.9727455	-157.9992671								•	•	•	•	4
				BLR2	62.0076676	-157.9383747								•	•	•		3
				BLR3	61.998731	-158.0160778								•	•	•		3
			Ground - Biomonitoring	BL1	61.9073522	-158.1652269								•	•			2
Kuskokwim River	Kuskokwim River	Mine Access Road	Ground - Jungjuk Port Site	KU8	61.794385	-158.215117								•	•			2
				KU9	61.790125	-158.143743								•	•			2
				KU10	61.791323	-158.158002								•				1
				KU11	61.814735	-158.10905								•				1
				KU12	61.81309	-158.108043								•				1
				KU13	61.787077	-158.222958								•				1
				KU14	61.790117	-158.220108								•	•			2
				KU15	61.785538	-158.224078								•				1
				KU20	61.7928767	-158.21815									•			1
				KU23	61.8160073	-158.11394									•			1
				KU24	61.817308	-158.11326									•			1
				KU25	61.8180455	-158.11248									•			1
	Jungjuk Creek	Mine Access Road	Aerial	JJR1	61.807679	-158.308985				•			•	•	•			4
			Ground - Biomonitoring	JJ1	61.7995	-158.245				•	•							2
			Ground - Culverts and Bridges	BR61	61.8021969	-158.2924133								•				1
				BR63	61.8081468	-158.3132425								•				1
				CU59	61.8012122	-158.2311261								•				1
				CU60	61.8013713	-158.2518181								•				1
				CU62	61.8036959	-158.3029078								•				1

Notes:
See Figure 1.1-1 for sampling site and reach locations. Coordinates for aerial reaches represent the end of the reach. Coordinates are in NAD83 Decimal Degrees

Appendix B

Sample Dates, Times, and Results of the Whole Effluent Toxicity (WET) Tests for Water Quality Parameters and Toxicity Tests for *Ceriodaphnia dubia* , and Fathead Minnows from Crooked Creek Site CR0.7 (2008)

Sample Collection		Sample Receipt										
Date	Time	Date	Time	Lapsed Time (hh:mm)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Temp (°C)	pH	Alkalinity (mg/L)	Hardness (mg/L)	Ammonia (mg/L)	Chlorine (mg/L)
7/29/2008	1835	7/31/2008	0800	37:25	241	12	1.2	8.5	97	238	0	<0.01
8/4/2008	NTR[1]	8/5/2008	1010	<34:10	365	12.5	3.9	8.2	122	155	0	<0.01
8/7/2008	1835	8/8/2008	1215	18:40	238	10.6	5.4	7.9	112	119	0	<0.01
9/22/2008	1017	9/23/2008	1420	30:03	251	9.5	2.1	8	113	123	0	<0.01
9/24/2008	0917	9/25/2008	0900	23:43	192	10.1	4.2	8.2	101	116	0	<0.01
9/26/2008	0850	9/27/2008	0930	24:40	198	10.4	4.8	8.3	109	118	0	<0.01
				Mean	**247.5**	**10.9**	**3.6**	**8.2**	**109.0**	**144.8**		
				SD	*62.4*	*1.2*	*1.6*	*0.2*	*9.0*	*47.9*		

Summary of Toxicity Test Results for *Ceriodaphnia dubia*

TC[2]	% Adult Survival	Births Mean	Births Min	Births Max
Control (0%)	90	19.7	0	30
12.5%	100	19.9	3	30
25.0%	80	23.9	0	36
50.0%	90	21.4	0	40
75.0%	100	25.2	15	33
100.0%	100	25.7	17	28

Growth Results for Fathead Minnows (*Pimephales promelas*)

TC[2]	% Survival	Dry Weight (mg) Mean	Dry Weight (mg) Min	Dry Weight (mg) Max
Control (0%)	98	0.406	0.330	0.455
12.5%	95	0.400	0.357	0.438
25.0%	100	0.401	0.371	0.435
50.0%	100	0.455	0.388	0.483
75.0%	90	0.405	0.353	0.429
100.0%	95	0.433	0.352	0.495

Notes:

1) NTR-No Time Recorded

2) TC-Toxic Concentration

Appendix C

Macroinvertebrate Bioassessment Metrics for Sites within the Crooked Creek Drainage (2004-2014)

			General Metrics							Diversity Indices		Biotic Indices
Stream	Site	Year	Total Abundance (# / ft²)	Total Taxa #	EPT Taxa #	EPT %	Dominant Taxa %	Chironomidae %	EPT Chironomidae Ratio	Shannon (H)	Evenness (e)	HBI
Donlin Creek	DO1.0	2004	151.20	19	11	19.18	72.49	72.49	0.26	1.28	0.44	5.22
		2005	319.20	20	13	53.20	37.41	37.41	1.42	2.10	0.70	4.14
		2006	348.40	20	10	12.51	77.04	77.04	0.16	1.10	0.37	5.53
		2007	27.60	19	10	36.23	18.84	18.84	1.92	2.49	0.84	4.49
		2008	168.20	23	14	35.43	49.35	49.35	0.72	1.98	0.63	4.64
		2009	392.40	22	13	27.93	69.06	69.06	0.40	1.27	0.41	4.93
		2010	592.60	28	15	20.25	69.36	69.36	0.29	1.35	0.41	5.22
		2011	100.00	13	9	32.00	49.20	49.20	0.65	1.70	0.66	4.74
		2012	99.40	18	11	39.64	49.50	49.50	0.80	1.84	0.64	4.58
Flat Creek	FL1.0	2004	380.80	21	13	9.03	76.58	76.58	0.12	1.09	0.36	5.62
		2005	540.80	22	13	28.22	59.10	59.10	0.48	1.51	0.49	5.04
		2006	400.40	20	11	22.18	54.80	54.80	0.40	1.63	0.55	5.17
		2007	339.67	20	11	22.77	35.82	35.82	0.64	2.05	0.68	4.63
		2008	267.60	17	10	25.49	36.32	22.42	1.14	1.77	0.62	4.39
		2009	1,063.60	20	11	15.78	75.87	75.87	0.21	0.96	0.32	5.31
Dome Creek	DM1.0	2008	73.80	18	10	46.88	20.87	13.28	3.53	2.16	0.75	3.60
		2009	237.80	15	7	68.38	40.54	15.73	4.35	1.87	0.69	2.96
Quartz Creek	QZ1.0	2009	259.20	15	6	51.70	45.37	42.28	1.22	1.21	0.45	3.41
Snow Gulch	SN2.0	2007	108.00	15	7	26.11	54.81	54.81	0.48	1.54	0.57	4.71
		2008	40.20	14	8	13.43	52.74	27.86	0.48	1.44	0.55	4.98
		2009	141.60	21	10	34.46	55.51	55.51	0.62	1.64	0.54	4.57
		2011	74.40	9	6	35.75	52.69	52.69	0.68	1.37	0.62	4.05
		2012	81.20	12	7	28.08	48.77	48.77	0.58	1.74	0.70	4.70
		2013	95.60	15	8	16.53	78.45	78.45	0.21	1.03	0.38	2.19
Queen Gulch	QU1.0	2010	435.33	13	4	59.04	25.11	14.24	4.15	1.75	0.68	3.93
Crooked Creek	CR2.0	2004	156.20	17	11	43.79	36.75	36.75	1.19	1.81	0.64	4.74
		2005	277.40	23	14	49.68	32.23	32.23	1.54	2.15	0.69	4.27
		2006	528.60	24	13	13.20	37.19	37.19	0.36	1.69	0.53	5.17
		2007	108.80	20	12	26.29	58.27	4.78	5.50	1.68	0.56	4.78
		2008	63.00	15	9	49.84	22.54	15.56	3.20	2.22	0.82	3.71
		2009	524.20	22	13	34.07	44.75	44.75	0.76	1.89	0.61	4.83
		2010	47.00	26	11	19.15	31.49	31.49	0.61	2.33	0.71	4.93
		2011	96.00	14	8	38.13	41.04	41.04	0.93	1.98	0.75	4.43
		2012	110.20	17	11	38.66	47.19	47.19	0.82	1.78	0.63	4.44
	CR1.0	2004	127.40	22	12	47.10	38.93	38.93	1.21	2.09	0.68	4.49
		2005	377.20	24	16	43.74	31.07	31.07	1.41	1.99	0.63	4.66
		2006	338.60	19	10	38.22	34.26	22.74	1.68	1.83	0.62	4.93
		2007	210.60	23	13	20.61	37.70	32.86	0.63	1.72	0.55	5.14
		2008	99.20	17	10	42.54	28.43	18.35	2.32	2.08	0.73	4.14
		2009	571.93	22	11	31.85	55.60	55.60	0.57	1.59	0.51	4.97
		2010	34.80	18	6	28.16	32.76	32.76	0.86	2.24	0.78	4.98
		2011	187.80	13	8	33.44	55.06	55.06	0.61	1.48	0.58	4.91
		2012	121.60	17	10	34.54	61.51	61.51	0.56	1.40	0.49	4.36
	CR0.7	2006	351.20	20	13	41.40	40.26	40.26	1.03	2.01	0.67	4.80
		2007	100.20	21	10	29.54	36.13	36.13	0.82	2.05	0.67	5.00
		2008	166.00	19	13	20.84	64.82	64.82	0.32	1.47	0.50	5.06
		2009	349.53	23	12	36.16	56.78	56.78	0.64	1.60	0.51	4.77
		2010	633.40	26	10	18.10	74.89	74.89	0.24	1.15	0.35	5.45
		2011	143.00	15	9	29.09	62.94	62.94	0.46	1.43	0.53	4.81
		2012	95.80	17	11	25.05	70.15	70.15	0.36	1.21	0.43	4.75
	CR0.3	2006	455.60	21	12	33.14	48.73	48.73	0.68	1.92	0.63	4.77
		2007	75.00	19	11	36.80	43.20	43.20	0.85	2.03	0.69	4.42
		2008	106.80	15	7	24.53	45.88	45.88	0.53	1.75	0.65	4.59
		2009	594.80	22	13	19.54	63.28	63.28	0.31	1.57	0.51	5.34
		2010	657.40	22	13	22.21	62.52	62.52	0.36	1.49	0.48	5.29
American Creek	AM1.0	2004	176.00	18	11	33.41	42.61	21.82	1.53	1.67	0.58	3.40
		2005	140.40	19	9	44.02	42.02	42.02	1.05	1.89	0.64	4.34
		2006	150.40	15	7	43.75	33.38	33.38	1.31	1.90	0.70	4.41
		2007	95.80	19	9	30.69	39.67	22.96	1.34	1.79	0.61	4.34
		2008	99.20	14	8	52.42	27.02	18.75	2.80	1.78	0.67	3.93
		2009	391.20	21	11	10.43	74.03	74.03	0.14	1.09	0.36	5.26
	AM2.0	2010	587.00	21	7	14.76	68.99	8.12	1.82	1.30	0.43	3.34
Grouse Creek	GR1.0	2008	66.60	12	6	18.92	51.65	6.01	3.15	1.59	0.64	3.71
Omega Gulch	OM1.0	2009	79.80	11	4	64.66	41.35	10.03	6.45	1.60	0.67	2.38
Anaconda Creek	AN1.0	2005	48.20	12	7	76.76	36.51	11.62	6.61	1.89	0.76	3.39
		2006	75.80	14	6	32.72	22.43	11.61	2.82	2.05	0.78	4.35
		2008	13.60	9	3	44.12	25.00	19.12	2.31	1.81	0.82	4.49
		2009	109.00	15	9	52.84	29.17	29.17	1.81	1.85	0.68	3.81
	AN2.0	2006	30.20	15	7	50.99	22.52	20.53	2.48	2.03	0.75	4.36
		2007	23.80	13	5	26.89	26.89	26.89	1.00	2.07	0.81	4.40
		2008	3.60	6	2	11.11	38.89	38.89	0.29	1.57	0.87	4.83
		2009	78.60	17	9	54.96	37.66	37.66	1.46	1.93	0.68	3.83
Crevice Creek	CV1.0	2006	141.80	16	7	18.48	35.26	35.26	0.52	1.78	0.64	4.51
		2007	125.20	17	7	7.51	63.10	9.58	0.78	1.27	0.45	3.63
		2008	47.20	15	9	38.14	46.61	1.27	30.00	1.71	0.63	3.45
		2009	184.80	14	8	20.78	55.19	21.65	0.96	1.34	0.51	3.78
Eagle Creek	EG1.0	2009	59.00	14	6	68.81	29.83	18.31	3.76	1.92	0.73	3.35
Getmuna Creek	GM1.0	2007	333.00	22	13	59.76	32.33	30.33	1.97	1.87	0.60	4.32
		2008	247.20	20	13	31.31	59.47	59.47	0.53	1.57	0.52	4.79
		2009	801.20	26	15	31.63	60.98	60.98	0.52	1.53	0.47	4.92
	GM2.0	2012	75.80	12	9	15.83	79.68	79.68	0.20	0.95	0.38	5.27
	GM3.0	2012	122.60	12	8	33.44	49.27	49.27	0.68	1.60	0.64	4.73
		2013	187.60	15	9	12.69	79.32	79.32	0.16	0.96	0.36	5.37
		2014	200.40	12	9	40.73	50.64	50.64	0.80	1.51	0.61	4.21
Bell Creek	GM4.0	2012	179.00	13	8	74.19	29.39	8.38	8.85	2.08	0.81	3.51
	BL1.0	2011	48.80	11	7	21.72	70.08	70.08	0.31	1.22	0.51	5.15

Notes:

For sample site locations, refer to Figure 1.1-1. Chironomidae genera grouped as one taxon for multi-year comparisons. Refer to the text for definitions of metrics.

Appendix D (Page 1 of 12)

Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

DO1.0						
(n years=9) (n reps=45)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	244.3	168.2	27.6	592.6	181.3	0.7
# Taxa	20.2	20.0	13.0	28.0	4.1	0.2
# EPT Taxa	11.8	11.0	9.0	15.0	2.0	0.2
% EPT Taxa	30.7	32.0	12.5	53.2	12.4	0.4
% Dominant Taxon	54.7	49.5	18.8	77.0	19.1	0.3
% Chironomidae	54.7	49.5	18.8	77.0	19.1	0.3
EPT/Chironomidae Ratio	0.7	0.7	0.2	1.9	0.6	0.8
Diversity Indices						
Shannon (H)	1.68	1.70	1.10	2.49	0.46	0.28
Evenness (e)	0.57	0.63	0.37	0.84	0.17	0.29
Biotic Indices						
HBI	4.83	4.74	4.14	5.53	0.43	0.09
% Composition Per Order						
Ephemeroptera	20.51	21.74	9.99	39.72	10.09	0.49
Plecoptera	8.50	8.54	1.78	13.91	3.49	0.41
Trichoptera	1.70	1.27	0.20	6.52	1.90	1.12
Diptera	62.68	61.24	42.03	83.87	16.05	0.26
Oligochaeta	3.11	0.41	--	18.84	6.08	1.96
Acariformes	3.47	2.19	0.12	13.80	4.24	1.22
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	0.01	--	--	0.13	0.04	3.00
Collembola	0.01	--	--	0.05	0.02	2.04
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	0.01	--	--	0.10	0.03	3.00
Turbellaria	--	--	--	--	--	--

FL1.0						
(n years =6) (n reps =28)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	498.8	390.6	267.6	1063.6	290.9	0.6
# Taxa	20.0	20.0	17.0	22.0	1.7	0.1
# EPT Taxa	11.5	11.0	10.0	13.0	1.2	0.1
% EPT Taxa	20.6	22.5	9.0	28.2	7.0	0.3
% Dominant Taxon	56.4	56.9	35.8	76.6	18.0	0.3
% Chironomidae	54.1	56.9	22.4	76.6	21.6	0.4
EPT/Chironomidae Ratio	0.5	0.4	0.1	1.1	0.4	0.7
Diversity Indices						
Shannon (H)	1.50	1.57	0.96	2.05	0.41	0.27
Evenness (e)	0.50	0.52	0.32	0.68	0.14	0.29
Biotic Indices						
HBI	5.03	5.10	4.39	5.62	0.45	0.09
% Composition Per Order						
Ephemeroptera	10.09	10.07	1.64	20.48	6.45	0.64
Plecoptera	9.23	9.41	2.99	15.16	5.01	0.54
Trichoptera	1.26	0.95	0.22	2.45	1.00	0.79
Diptera	74.56	72.19	62.91	85.66	8.41	0.11
Oligochaeta	1.24	0.84	0.36	2.69	0.92	0.75
Acariformes	3.63	3.89	0.37	8.25	2.86	0.79
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.00	--	--	0.02	0.01	2.45
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

DM1.0						
(n years =2) (n reps =10)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	155.8	155.8	73.8	237.8	116.0	0.7
# Taxa	16.5	16.5	15.0	18.0	2.1	0.1
# EPT Taxa	8.5	8.5	7.0	10.0	2.1	0.2
% EPT Taxa	57.6	57.6	46.9	68.4	15.2	0.3
% Dominant Taxon	30.7	30.7	20.9	40.5	13.9	0.5
% Chironomidae	14.5	14.5	13.3	15.7	1.7	0.1
EPT/Chironomidae Ratio	3.9	3.9	3.5	4.3	0.6	0.1
Diversity Indices						
Shannon (H)	2.02	2.02	1.87	2.16	0.20	0.10
Evenness (e)	0.72	0.72	0.69	0.75	0.04	0.05
Biotic Indices						
HBI	3.28	3.28	2.96	3.60	0.45	0.14
% Composition Per Order						
Ephemeroptera	28.27	28.27	25.65	30.89	3.71	0.13
Plecoptera	29.10	29.10	15.72	42.47	18.92	0.65
Trichoptera	0.26	0.26	0.25	0.27	0.01	0.05
Diptera	32.07	32.07	24.31	39.84	10.98	0.34
Oligochaeta	9.07	9.07	5.13	13.01	5.57	0.61
Acariformes	0.04	0.04	--	0.08	0.06	1.41
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.08	0.08	--	0.17	0.12	1.41
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	1.10	1.10	0.27	1.93	1.18	1.07

QZ1.0						
(n years =1) (n reps =5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	259.2	259.2	259.2	259.2	--	--
# Taxa	15.0	15.0	15.0	15.0	--	--
# EPT Taxa	6.0	6.0	6.0	6.0	--	--
% EPT Taxa	51.7	51.7	51.7	51.7	--	--
% Dominant Taxon	45.4	45.4	45.4	45.4	--	--
% Chironomidae	42.3	42.3	42.3	42.3	--	--
EPT/Chironomidae Ratio	1.2	1.2	1.2	1.2	--	--
Diversity Indices						
Shannon (H)	1.21	1.21	1.21	1.21	--	--
Evenness (e)	0.45	0.45	0.45	0.45	--	--
Biotic Indices						
HBI	3.41	3.41	3.41	3.41	--	--
% Composition Per Order						
Ephemeroptera	0.85	0.85	0.85	0.85	--	--
Plecoptera	50.85	50.85	50.85	50.85	--	--
Trichoptera	--	--	--	--	--	--
Diptera	43.21	43.21	43.21	43.21	--	--
Oligochaeta	3.55	3.55	3.55	3.55	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.23	0.23	0.23	0.23	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	1.31	1.31	1.31	1.31	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

SN2.0						
(n years =6) (n reps =30)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	90.2	88.4	40.2	141.6	34.1	0.4
# Taxa	14.3	14.5	9.0	21.0	4.0	0.3
# EPT Taxa	7.7	7.5	6.0	10.0	1.4	0.2
% EPT Taxa	25.7	27.1	13.4	35.8	9.1	0.4
% Dominant Taxon	57.2	53.8	48.8	78.5	10.7	0.2
% Chironomidae	53.0	53.8	27.9	78.5	16.2	0.3
EPT/Chironomidae Ratio	0.5	0.5	0.2	0.7	0.2	0.3
Diversity Indices						
Shannon (H)	1.46	1.49	1.03	1.74	0.25	0.17
Evenness (e)	0.56	0.56	0.38	0.70	0.11	0.19
Biotic Indices						
HBI	4.20	4.64	2.19	4.98	1.03	0.25
% Composition Per Order						
Ephemeroptera	11.99	12.88	7.46	16.81	3.65	0.30
Plecoptera	12.97	13.01	5.47	20.70	5.73	0.44
Trichoptera	0.77	0.68	--	1.67	0.56	0.73
Diptera	60.09	61.63	33.83	82.22	15.51	0.26
Oligochaeta	14.02	6.82	0.81	52.74	19.80	1.41
Acariformes	0.06	--	--	0.21	0.09	1.59
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.08	--	--	0.28	0.12	1.60
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	0.02	--	--	0.14	0.06	2.45

QU1.0						
(n years =1) (n reps =3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	435.3	435.3	435.3	435.3	--	--
# Taxa	13.0	13.0	13.0	13.0	--	--
# EPT Taxa	4.0	4.0	4.0	4.0	--	--
% EPT Taxa	59.0	59.0	59.0	59.0	--	--
% Dominant Taxon	25.1	25.1	25.1	25.1	--	--
% Chironomidae	14.2	14.2	14.2	14.2	--	--
EPT/Chironomidae Ratio	4.1	4.1	4.1	4.1	--	--
Diversity Indices						
Shannon (H)	1.75	1.75	1.75	1.75	--	--
Evenness (e)	0.68	0.68	0.68	0.68	--	--
Biotic Indices						
HBI	3.93	3.93	3.93	3.93	--	--
% Composition Per Order						
Ephemeroptera	24.04	24.04	24.04	24.04	--	--
Plecoptera	34.99	34.99	34.99	34.99	--	--
Trichoptera	--	--	--	--	--	--
Diptera	39.51	39.51	39.51	39.51	--	--
Oligochaeta	1.23	1.23	1.23	1.23	--	--
Acariformes	0.08	0.08	0.08	0.08	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	0.15	0.15	0.15	0.15	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

CR2.0						
(n years =9) (n reps =45)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	212.4	110.2	47.0	528.6	190.1	0.9
# Taxa	19.8	20.0	14.0	26.0	4.2	0.2
# EPT Taxa	11.3	11.0	8.0	14.0	1.9	0.2
% EPT Taxa	34.8	38.1	13.2	49.8	12.9	0.4
% Dominant Taxon	39.1	37.2	22.5	58.3	10.4	0.3
% Chironomidae	32.3	36.7	4.8	47.2	13.9	0.4
EPT/Chironomidae Ratio	1.7	0.9	0.4	5.5	1.7	1.0
Diversity Indices						
Shannon (H)	1.95	1.89	1.68	2.33	0.24	0.12
Evenness (e)	0.66	0.64	0.53	0.82	0.09	0.14
Biotic Indices						
HBI	4.59	4.74	3.71	5.17	0.43	0.09
% Composition Per Order						
Ephemeroptera	22.61	24.17	11.09	36.55	9.52	0.42
Plecoptera	10.51	9.23	1.02	26.35	7.44	0.71
Trichoptera	1.63	0.63	--	5.19	1.89	1.16
Diptera	57.58	54.67	38.50	81.04	13.12	0.23
Oligochaeta	3.51	2.55	0.38	11.62	3.57	1.02
Acariformes	3.21	2.55	0.18	11.25	3.55	1.11
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	0.39	--	--	3.40	1.13	2.93
Collembola	0.46	--	--	3.83	1.27	2.79
Copepoda	--	--	--	--	--	--
Gastropoda	0.01	--	--	0.08	0.03	3.00
Mollusca	--	--	--	--	--	--
Ostracoda	0.10	--	--	0.85	0.28	2.74
Turbellaria	--	--	--	--	--	--

CR1.0						
(n years =9) (n reps =45)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	229.9	187.8	34.8	571.9	169.6	0.7
# Taxa	19.4	19.0	13.0	24.0	3.6	0.2
# EPT Taxa	10.7	10.0	6.0	16.0	2.9	0.3
% EPT Taxa	35.6	34.5	20.6	47.1	8.3	0.2
% Dominant Taxon	41.7	37.7	28.4	61.5	12.3	0.3
% Chironomidae	38.8	32.9	18.3	61.5	15.3	0.4
EPT/Chironomidae Ratio	1.1	0.9	0.6	2.3	0.6	0.6
Diversity Indices						
Shannon (H)	1.82	1.83	1.40	2.24	0.30	0.16
Evenness (e)	0.62	0.62	0.49	0.78	0.10	0.16
Biotic Indices						
HBI	4.73	4.91	4.14	5.14	0.34	0.07
% Composition Per Order						
Ephemeroptera	25.58	25.00	13.82	38.49	8.62	0.34
Plecoptera	7.54	5.49	1.72	18.42	6.03	0.80
Trichoptera	2.46	0.86	0.18	8.63	3.14	1.28
Diptera	59.90	60.13	50.08	75.12	7.37	0.12
Oligochaeta	1.61	1.92	--	2.87	1.06	0.66
Acariformes	2.03	1.11	0.07	10.86	3.39	1.67
Amphipoda	--	--	--	--	--	--
Cladocera	0.01	--	--	0.09	0.03	3.00
Coleoptera	0.39	--	--	3.45	1.15	2.91
Collembola	0.35	--	--	1.72	0.70	1.99
Copepoda	0.13	--	--	1.15	0.38	3.00
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

CR0.7						
(n years =7) (n reps =35)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	262.7	166.0	95.8	633.4	196.1	0.7
# Taxa	20.1	20.0	15.0	26.0	3.7	0.2
# EPT Taxa	11.1	11.0	9.0	13.0	1.6	0.1
% EPT Taxa	28.6	29.1	18.1	41.4	8.2	0.3
% Dominant Taxon	58.0	62.9	36.1	74.9	14.7	0.3
% Chironomidae	58.0	62.9	36.1	74.9	14.7	0.3
EPT/Chironomidae Ratio	0.6	0.5	0.2	1.0	0.3	0.5
Diversity Indices						
Shannon (H)	1.56	1.47	1.15	2.05	0.36	0.23
Evenness (e)	0.52	0.51	0.35	0.67	0.12	0.23
Biotic Indices						
HBI	4.95	4.81	4.75	5.45	0.25	0.05
% Composition Per Order						
Ephemeroptera	17.47	14.10	7.79	32.63	8.80	0.50
Plecoptera	7.48	7.23	1.78	12.32	3.44	0.46
Trichoptera	3.25	1.54	0.84	8.54	3.00	0.92
Diptera	67.53	68.67	55.07	78.43	7.86	0.12
Oligochaeta	1.83	1.48	0.28	5.42	1.74	0.95
Acariformes	2.23	1.93	--	6.71	2.17	0.98
Amphipoda	--	--	--	--	--	--
Cladocera	0.01	--	--	0.04	0.01	2.65
Coleoptera	0.05	--	--	0.27	0.10	1.93
Collembola	0.12	--	--	0.38	0.17	1.50
Copepoda	0.01	--	--	0.07	0.03	2.65
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	0.02	--	--	0.13	0.05	2.65
Turbellaria	--	--	--	--	--	--

CR0.3						
(n years =5) (n reps =25)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	377.9	455.6	75.0	657.4	272.2	0.7
# Taxa	19.8	21.0	15.0	22.0	2.9	0.1
# EPT Taxa	11.2	12.0	7.0	13.0	2.5	0.2
% EPT Taxa	27.2	24.5	19.5	36.8	7.4	0.3
% Dominant Taxon	52.7	48.7	43.2	63.3	9.5	0.2
% Chironomidae	52.7	48.7	43.2	63.3	9.5	0.2
EPT/Chironomidae Ratio	0.5	0.5	0.3	0.9	0.2	0.4
Diversity Indices						
Shannon (H)	1.75	1.75	1.49	2.03	0.23	0.13
Evenness (e)	0.59	0.63	0.48	0.69	0.09	0.15
Biotic Indices						
HBI	4.88	4.77	4.42	5.34	0.42	0.09
% Composition Per Order						
Ephemeroptera	14.76	13.48	8.61	24.54	5.87	0.40
Plecoptera	8.87	6.98	2.32	15.92	6.58	0.74
Trichoptera	3.61	3.36	--	7.73	3.04	0.84
Diptera	63.77	57.30	52.53	76.16	11.41	0.18
Oligochaeta	6.65	5.87	0.52	18.16	6.97	1.05
Acariformes	2.32	2.52	--	4.80	1.82	0.78
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	0.02	--	--	0.09	0.04	2.24
Turbellaria	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

AM1.0						
(n years =6) (n reps =30)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	175.5	145.4	95.8	391.2	110.1	0.6
# Taxa	17.7	18.5	14.0	21.0	2.7	0.2
# EPT Taxa	9.2	9.0	7.0	11.0	1.6	0.2
% EPT Taxa	35.8	38.6	10.4	52.4	14.7	0.4
% Dominant Taxon	43.1	40.8	27.0	74.0	16.3	0.4
% Chironomidae	35.5	28.2	18.8	74.0	20.8	0.6
EPT/Chironomidae Ratio	1.4	1.3	0.1	2.8	0.9	0.6
Diversity Indices						
Shannon (H)	1.69	1.79	1.09	1.90	0.30	0.18
Evenness (e)	0.59	0.63	0.36	0.70	0.12	0.21
Biotic Indices						
HBI	4.28	4.34	3.40	5.26	0.61	0.14
% Composition Per Order						
Ephemeroptera	27.65	28.64	5.57	47.38	14.03	0.51
Plecoptera	7.43	6.87	4.44	12.50	3.03	0.41
Trichoptera	0.70	0.38	--	2.71	1.00	1.43
Diptera	48.01	42.54	20.16	88.45	25.35	0.53
Oligochaeta	15.71	13.02	0.68	39.67	15.63	1.00
Acariformes	0.38	0.23	0.11	0.84	0.31	0.82
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	0.03	--	--	0.21	0.09	2.45
Collembola	0.03	--	--	0.14	0.06	1.79
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	0.04	--	--	0.20	0.08	1.92

AM2.0						
(n years =1) (n reps =3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	587.0	587.0	587.0	587.0	--	--
# Taxa	21.0	21.0	21.0	21.0	--	--
# EPT Taxa	7.0	7.0	7.0	7.0	--	--
% EPT Taxa	14.8	14.8	14.8	14.8	--	--
% Dominant Taxon	69.0	69.0	69.0	69.0	--	--
% Chironomidae	8.1	8.1	8.1	8.1	--	--
EPT/Chironomidae Ratio	1.8	1.8	1.8	1.8	--	--
Diversity Indices						
Shannon (H)	1.30	1.30	1.30	1.30	--	--
Evenness (e)	0.43	0.43	0.43	0.43	--	--
Biotic Indices						
HBI	3.34	3.34	3.34	3.34	--	--
% Composition Per Order						
Ephemeroptera	8.23	8.23	8.23	8.23	--	--
Plecoptera	6.02	6.02	6.02	6.02	--	--
Trichoptera	0.51	0.51	0.51	0.51	--	--
Diptera	80.92	80.92	80.92	80.92	--	--
Oligochaeta	3.12	3.12	3.12	3.12	--	--
Acariformes	0.17	0.17	0.17	0.17	--	--
Amphipoda	0.17	0.17	0.17	0.17	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.11	0.11	0.11	0.11	--	--
Copepoda	0.06	0.06	0.06	0.06	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	0.68	0.68	0.68	0.68	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

GR1.0						
(n years =1) (n reps =5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	66.6	66.6	66.6	66.6	--	--
# Taxa	12.0	12.0	12.0	12.0	--	--
# EPT Taxa	6.0	6.0	6.0	6.0	--	--
% EPT Taxa	18.9	18.9	18.9	18.9	--	--
% Dominant Taxon	51.7	51.7	51.7	51.7	--	--
% Chironomidae	6.0	6.0	6.0	6.0	--	--
EPT/Chironomidae Ratio	3.2	3.2	3.2	3.2	--	--
Diversity Indices						
Shannon (H)	1.59	1.59	1.59	1.59	--	--
Evenness (e)	0.64	0.64	0.64	0.64	--	--
Biotic Indices						
HBI	3.71	3.71	3.71	3.71	--	--
% Composition Per Order						
Ephemeroptera	16.22	16.22	16.22	16.22	--	--
Plecoptera	2.40	2.40	2.40	2.40	--	--
Trichoptera	0.30	0.30	0.30	0.30	--	--
Diptera	64.86	64.86	64.86	64.86	--	--
Oligochaeta	16.22	16.22	16.22	16.22	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

OM1.0						
(n years =1) (n reps =5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	79.8	79.8	79.8	79.8	--	--
# Taxa	11.0	11.0	11.0	11.0	--	--
# EPT Taxa	4.0	4.0	4.0	4.0	--	--
% EPT Taxa	64.7	64.7	64.7	64.7	--	--
% Dominant Taxon	41.4	41.4	41.4	41.4	--	--
% Chironomidae	10.0	10.0	10.0	10.0	--	--
EPT/Chironomidae Ratio	6.5	6.5	6.5	6.5	--	--
Diversity Indices						
Shannon (H)	1.60	1.60	1.60	1.60	--	--
Evenness (e)	0.67	0.67	0.67	0.67	--	--
Biotic Indices						
HBI	2.38	2.38	2.38	2.38	--	--
% Composition Per Order						
Ephemeroptera	0.25	0.25	0.25	0.25	--	--
Plecoptera	64.41	64.41	64.41	64.41	--	--
Trichoptera	--	--	--	--	--	--
Diptera	16.54	16.54	16.54	16.54	--	--
Oligochaeta	17.29	17.29	17.29	17.29	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	1.25	1.25	1.25	1.25	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	0.25	0.25	0.25	0.25	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

AN1.0

(n years =4) (n reps =20)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	61.7	62.0	13.6	109.0	40.5	0.7
# Taxa	12.5	13.0	9.0	15.0	2.6	0.2
# EPT Taxa	6.3	6.5	3.0	9.0	2.5	0.4
% EPT Taxa	51.6	48.5	32.7	76.8	18.7	0.4
% Dominant Taxon	28.3	27.1	22.4	36.5	6.2	0.2
% Chironomidae	17.9	15.4	11.6	29.2	8.3	0.5
EPT/Chironomidae Ratio	3.4	2.6	1.8	6.6	2.2	0.6
Diversity Indices						
Shannon (H)	1.90	1.87	1.81	2.05	0.11	0.06
Evenness (e)	0.76	0.77	0.68	0.82	0.06	0.08
Biotic Indices						
HBI	4.01	4.08	3.39	4.49	0.51	0.13
% Composition Per Order						
Ephemeroptera	30.07	31.38	16.36	41.18	10.49	0.35
Plecoptera	11.21	11.86	2.94	18.17	7.05	0.63
Trichoptera	10.33	0.54	--	40.25	19.95	1.93
Diptera	31.69	34.61	14.52	43.01	12.83	0.40
Oligochaeta	15.25	14.88	6.22	25.00	9.84	0.65
Acariformes	0.95	0.66	--	2.49	1.20	1.26
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.50	0.26	--	1.47	0.69	1.39
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

AN2.0

(n years =4) (n reps =20)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	34.1	27.0	3.6	78.6	31.8	0.9
# Taxa	12.8	14.0	6.0	17.0	4.8	0.4
# EPT Taxa	5.8	6.0	2.0	9.0	3.0	0.5
% EPT Taxa	36.0	38.9	11.1	55.0	20.7	0.6
% Dominant Taxon	31.5	32.3	22.5	38.9	8.1	0.3
% Chironomidae	31.0	32.3	20.5	38.9	8.8	0.3
EPT/Chironomidae Ratio	1.3	1.2	0.3	2.5	0.9	0.7
Diversity Indices						
Shannon (H)	1.90	1.98	1.57	2.07	0.23	0.12
Evenness (e)	0.78	0.78	0.68	0.87	0.08	0.10
Biotic Indices						
HBI	4.36	4.38	3.83	4.83	0.41	0.09
% Composition Per Order						
Ephemeroptera	17.99	16.02	2.52	37.40	16.76	0.93
Plecoptera	14.80	14.90	5.56	23.84	7.48	0.51
Trichoptera	3.20	1.35	--	10.08	4.67	1.46
Diptera	46.58	44.60	30.46	66.67	15.33	0.33
Oligochaeta	15.26	17.88	3.05	22.22	8.99	0.59
Acariformes	1.62	1.26	--	3.97	1.97	1.21
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	0.55	0.33	--	1.53	0.72	1.32

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

CV1.0						
(n years =4) (n reps =20)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	124.8	133.5	47.2	184.8	57.5	0.5
# Taxa	15.5	15.5	14.0	17.0	1.3	0.1
# EPT Taxa	7.8	7.5	7.0	9.0	1.0	0.1
% EPT Taxa	21.2	19.6	7.5	38.1	12.7	0.6
% Dominant Taxon	50.0	50.9	35.3	63.1	11.9	0.2
% Chironomidae	16.9	15.6	1.3	35.3	14.8	0.9
EPT/Chironomidae Ratio	8.1	0.9	0.5	30.0	14.6	1.8
Diversity Indices						
Shannon (H)	1.52	1.52	1.27	1.78	0.26	0.17
Evenness (e)	0.56	0.57	0.45	0.64	0.09	0.17
Biotic Indices						
HBI	3.84	3.70	3.45	4.51	0.47	0.12
% Composition Per Order						
Ephemeroptera	18.09	16.98	4.47	33.90	12.10	0.67
Plecoptera	3.03	3.03	1.83	4.24	0.98	0.32
Trichoptera	0.11	--	--	0.42	0.21	2.00
Diptera	66.79	70.10	50.00	76.95	12.25	0.18
Oligochaeta	11.45	13.48	2.06	16.77	6.58	0.58
Acariformes	0.44	0.45	--	0.85	0.45	1.02
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.06	0.05	--	0.14	0.07	1.17
Copepoda	--	--	--	--	--	--
Gastropoda	0.04	--	--	0.16	0.08	2.00
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

EG1.0						
(n years =1) (n reps =5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	59.0	59.0	59.0	59.0	--	--
# Taxa	14.0	14.0	14.0	14.0	--	--
# EPT Taxa	6.0	6.0	6.0	6.0	--	--
% EPT Taxa	68.8	68.8	68.8	68.8	--	--
% Dominant Taxon	29.8	29.8	29.8	29.8	--	--
% Chironomidae	18.3	18.3	18.3	18.3	--	--
EPT/Chironomidae Ratio	3.8	3.8	3.8	3.8	--	--
Diversity Indices						
Shannon (H)	1.92	1.92	1.92	1.92	--	--
Evenness (e)	0.73	0.73	0.73	0.73	--	--
Biotic Indices						
HBI	3.35	3.35	3.35	3.35	--	--
% Composition Per Order						
Ephemeroptera	15.59	15.59	15.59	15.59	--	--
Plecoptera	30.85	30.85	30.85	30.85	--	--
Trichoptera	22.37	22.37	22.37	22.37	--	--
Diptera	23.73	23.73	23.73	23.73	--	--
Oligochaeta	4.75	4.75	4.75	4.75	--	--
Acariformes	0.68	0.68	0.68	0.68	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	0.34	0.34	0.34	0.34	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	1.69	1.69	1.69	1.69	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

GM1.0						
(n years =3) (n reps =13)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	460.5	333.0	247.2	801.2	298.2	0.6
# Taxa	22.7	22.0	20.0	26.0	3.1	0.1
# EPT Taxa	13.7	13.0	13.0	15.0	1.2	0.1
% EPT Taxa	40.9	31.6	31.3	59.8	16.3	0.4
% Dominant Taxon	50.9	59.5	32.3	61.0	16.1	0.3
% Chironomidae	50.3	59.5	30.3	61.0	17.3	0.3
EPT/Chironomidae Ratio	1.0	0.5	0.5	2.0	0.8	0.8
Diversity Indices						
Shannon (H)	1.66	1.57	1.53	1.87	0.18	0.11
Evenness (e)	0.53	0.52	0.47	0.60	0.07	0.13
Biotic Indices						
HBI	4.68	4.79	4.32	4.92	0.31	0.07
% Composition Per Order						
Ephemeroptera	22.90	21.93	19.62	27.16	3.86	0.17
Plecoptera	6.38	6.81	3.20	9.14	3.00	0.47
Trichoptera	11.62	1.27	0.24	33.33	18.81	1.62
Diptera	55.39	64.89	34.23	67.05	18.35	0.33
Oligochaeta	1.63	0.90	0.52	3.48	1.61	0.98
Acariformes	1.98	0.72	0.32	4.90	2.54	1.28
Amphipoda	--	--	--	--	--	--
Cladocera	0.03	--	--	0.10	0.06	1.73
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	0.03	--	--	0.10	0.06	1.73
Turbellaria	0.02	--	--	0.07	0.04	1.73

GM2.0						
(n years =1) (n reps =5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	75.8	75.8	75.8	75.8	--	--
# Taxa	12.0	12.0	12.0	12.0	--	--
# EPT Taxa	9.0	9.0	9.0	9.0	--	--
% EPT Taxa	15.8	15.8	15.8	15.8	--	--
% Dominant Taxon	79.7	79.7	79.7	79.7	--	--
% Chironomidae	79.7	79.7	79.7	79.7	--	--
EPT/Chironomidae Ratio	0.2	0.2	0.2	0.2	--	--
Diversity Indices						
Shannon (H)	0.95	0.95	0.95	0.95	--	--
Evenness (e)	0.38	0.38	0.38	0.38	--	--
Biotic Indices						
HBI	5.27	5.27	5.27	5.27	--	--
% Composition Per Order						
Ephemeroptera	6.33	6.33	6.33	6.33	--	--
Plecoptera	5.01	5.01	5.01	5.01	--	--
Trichoptera	4.49	4.49	4.49	4.49	--	--
Diptera	80.21	80.21	80.21	80.21	--	--
Oligochaeta	3.96	3.96	3.96	3.96	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

GM3.0						
(n years =3) (n reps =15)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	170.2	187.6	122.6	200.4	41.7	0.2
# Taxa	13.7	14.0	12.0	15.0	1.5	0.1
# EPT Taxa	8.7	9.0	8.0	9.0	0.6	0.1
% EPT Taxa	29.0	33.4	12.7	40.7	14.6	0.5
% Dominant Taxon	59.7	50.6	49.3	79.3	17.0	0.3
% Chironomidae	59.7	50.6	49.3	79.3	17.0	0.3
EPT/Chironomidae Ratio	0.5	0.7	0.2	0.8	0.3	0.6
Diversity Indices						
Shannon (H)	1.43	1.60	0.96	1.73	0.41	0.29
Evenness (e)	0.55	0.64	0.36	0.66	0.17	0.31
Biotic Indices						
HBI	4.90	4.73	4.60	5.37	0.41	0.08
% Composition Per Order						
Ephemeroptera	19.24	19.36	9.17	29.20	10.02	0.52
Plecoptera	5.18	4.08	2.67	8.78	3.20	0.62
Trichoptera	4.63	0.85	0.16	12.87	7.15	1.54
Diptera	62.68	53.19	50.08	84.75	19.18	0.31
Oligochaeta	5.94	1.49	--	16.31	9.02	1.52
Acariformes	2.28	1.07	--	5.79	3.08	1.35
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	0.05	--	--	0.16	0.09	1.73
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

GM4.0						
(n years =1) (n reps =5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	179.0	179.0	179.0	179.0	--	--
# Taxa	13.0	13.0	13.0	13.0	--	--
# EPT Taxa	8.0	8.0	8.0	8.0	--	--
% EPT Taxa	74.2	74.2	74.2	74.2	--	--
% Dominant Taxon	29.4	29.4	29.4	29.4	--	--
% Chironomidae	8.4	8.4	8.4	8.4	--	--
EPT/Chironomidae Ratio	8.9	8.9	8.9	8.9	--	--
Diversity Indices						
Shannon (H)	2.08	2.08	2.08	2.08	--	--
Evenness (e)	0.81	0.81	0.81	0.81	--	--
Biotic Indices						
HBI	3.51	3.51	3.51	3.51	--	--
% Composition Per Order						
Ephemeroptera	63.69	63.69	63.69	63.69	--	--
Plecoptera	10.50	10.50	10.50	10.50	--	--
Trichoptera	--	--	--	--	--	--
Diptera	14.19	14.19	14.19	14.19	--	--
Oligochaeta	11.62	11.62	11.62	11.62	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Summary Statistics for Sites within the Crooked Creek Drainage (2004-2014)

BL1.0 *(n years =2) (n reps =10)*	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	35.3	35.3	21.8	48.8	19.1	0.5
# Taxa	10.5	10.5	10.0	11.0	0.7	0.1
# EPT Taxa	7.0	7.0	7.0	7.0	--	--
% EPT Taxa	41.6	41.6	21.7	61.5	28.1	0.7
% Dominant Taxon	49.7	49.7	29.4	70.1	28.8	0.6
% Chironomidae	49.3	49.3	28.4	70.1	29.4	0.6
EPT/Chironomidae Ratio	1.2	1.2	0.3	2.2	1.3	1.1
Diversity Indices						
Shannon (H)	1.49	1.49	1.22	1.75	0.37	0.25
Evenness (e)	0.64	0.64	0.51	0.76	0.18	0.28
Biotic Indices						
HBI	4.04	4.04	2.94	5.15	1.56	0.39
% Composition Per Order						
Ephemeroptera	17.66	17.66	11.48	23.85	8.75	0.50
Plecoptera	21.18	21.18	10.25	32.11	15.46	0.73
Trichoptera	2.75	2.75	--	5.50	3.89	1.41
Diptera	50.79	50.79	30.28	71.31	29.02	0.57
Oligochaeta	4.74	4.74	1.23	8.26	4.97	1.05
Acariformes	2.87	2.87	--	5.74	4.06	1.41
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--
Turbellaria	--	--	--	--	--	--

Notes:

For sample site locations, refer to Figure 1.1-1. Chironomidae genera grouped as one taxon for multi-year comparisons.

1) Refer to the text for definitions of metrics.

n years = Number of years site has been sampled

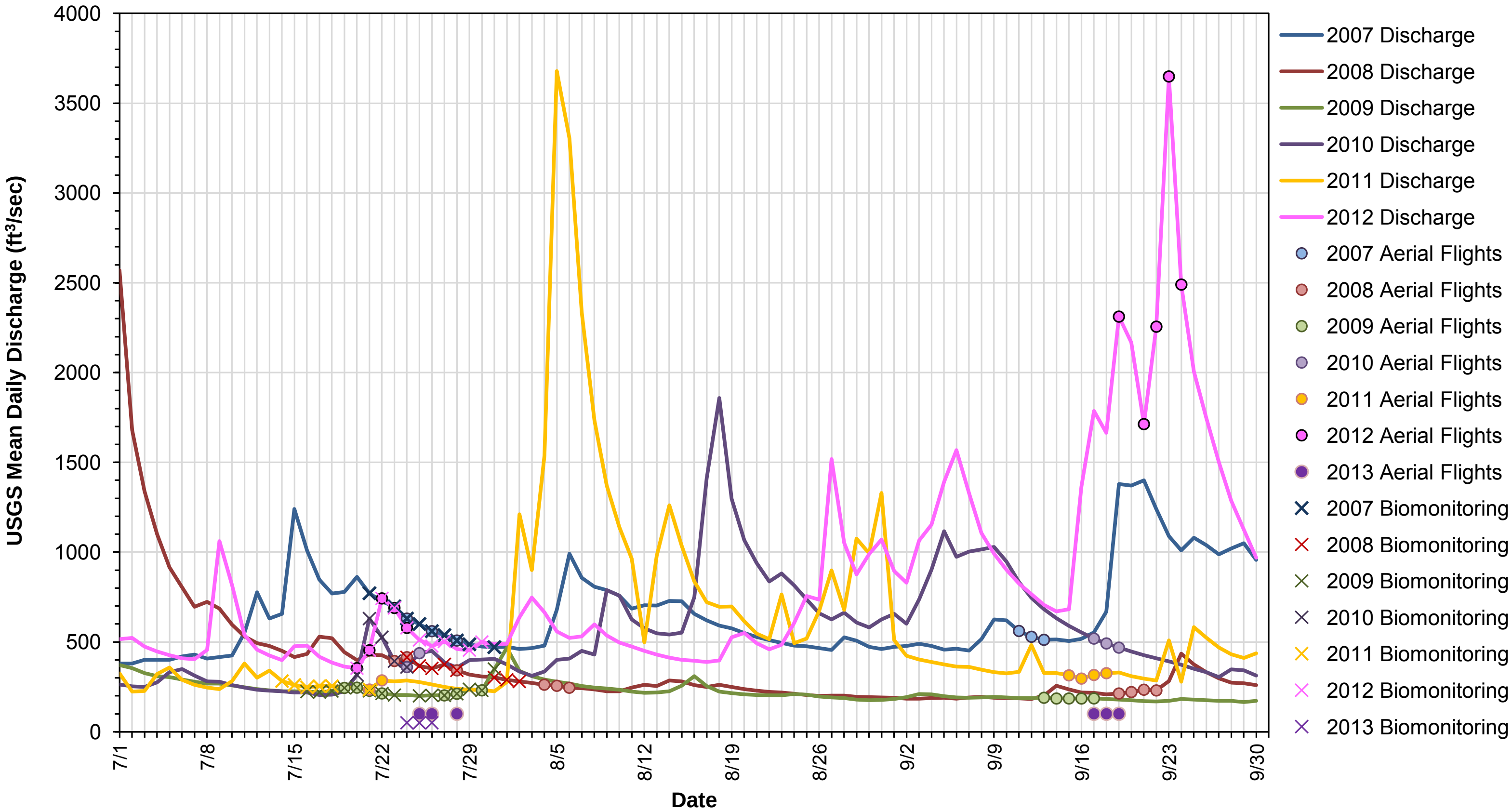
n reps = Total number of replicates sampled

SD = Standard deviation of the mean; CV = Coefficient of variance of the mean

Mean = Average of all samples for all years

Appendix E

Mean Daily Discharge and Aerial and Biomonitoring Survey Dates for Crooked Creek (July through September, 2007-2013)



Notes:
Discharge data was collected from USGS gauge 15304010 CROOKED C AB AIRPORT RD NR CROOKED CREEK AK. No discharge data available for 2013 or 2014.

Appendix F
Crooked Creek Aerial Salmon Redd Counts (2009-2014)

Season	Stream Name	Reach	2009	2010	2011	2012	2013	2014	Total	
Summer	Donlin Creek	DOR1	--	0	2	0	0	2	0.8	0.44%
		DOR2	--	0	2	0	0	0	0.4	0.22%
		DOR3	--	0	0	0	0	ns	0.0	0.00%
		Total	**0**	**0**	**4**	**0**	**0**	**2**	**1.2**	**0.67%**
	Flat Creek	FLR1	--	--	--	0	--	ns	0.0	0.00%
	Dome Creek	DMR1	--	--	--	0	--	ns	0.0	0.00%
	Snow Gulch	SNR1	--	--	--	0	--	ns	0.0	0.00%
	Crooked Creek	CRR1	--	50	44	29	59	24	41.2	22.88%
		CRR2	--	20	43	21	97	101	56.4	31.32%
		CRR3	--	6	2	1	3	0	2.4	1.33%
		CRR4	--	0	3	0	3	6	2.4	1.33%
		CRR5	--	0	0	0	0	0	0.0	0.00%
		Total	**0**	**76**	**92**	**51**	**162**	**131**	**102.4**	**56.86%**
	American Creek	AMR1	--	0	0	0	--	ns	0.0	0.00%
	Anaconda Creek	ANR1	--	0	0	0	--	ns	0.0	0.00%
	Crevice Creek	CVR1	--	0	0	0	--	ns	0.0	0.00%
	Eagle Creek	EGR1	--	0	0	0	--	ns	0.0	0.00%
	Getmuna Creek	GMR1	--	67	103	12	90	ns	68.0	37.76%
		GMR2	--	0	6	2	0	ns	2.0	1.11%
		GMR3	--	0	2	0	10	ns	3.0	1.67%
		GMR4	--	--	0	0	0	ns	0.0	0.00%
		GMR5	--	--	0	0	0	ns	0.0	0.00%
		Total	**0**	**67**	**111**	**14**	**100**	**ns**	**73.0**	**40.53%**
	49.0 Creek	FNR1	--	--	--	0	--	ns	0.0	0.00%
	Bell Creek	BLR1	--	--	0	0	1	13	3.5	1.94%
		BLR2	--	--	0	0	0	ns	0.0	0.00%
		BLR3	--	--	0	0	0	ns	0.0	0.00%
		Total	**0**	**0**	**0**	**0**	**1**	**13**	**3.5**	**1.94%**
Summer Total			**0**	**143**	**207**	**65**	**263**	**146**	**164.8**	**100.00%**
Fall	Donlin Creek	DOR1	21	3	16	--	0	0	8.0	3.11%
		DOR2	23	5	36	--	0	9	14.6	5.68%
		DOR3	0	46	80	--	0	ns	31.5	12.26%
		Total	**44**	**54**	**132**	**0**	**0**	**9**	**54.1**	**21.05%**
	Flat Creek	FLR1	0	0	0	--	--	ns	0.0	0.00%
	Dome Creek	DMR1	11	1	2	--	--	ns	4.7	1.82%
	Snow Gulch	SNR1	--	0	0	--	--	ns	0.0	0.00%
	Crooked Creek	CRR1	101	16	23	--	0	34	34.8	13.54%
		CRR2	97	19	10	--	0	23	29.8	11.60%
		CRR3	29	2	18	--	0	12	12.2	4.75%
		CRR4	6	1	23	--	0	14	8.8	3.42%
		CRR5	6	3	13	--	0	2	4.8	1.87%
		Total	**239**	**41**	**87**	**0**	**0**	**85**	**90.4**	**35.18%**
	American Creek	AMR1	0	0	1	--	--	ns	0.3	0.13%
	Anaconda Creek	ANR1	0	0	0	--	--	ns	0.0	0.00%
	Crevice Creek	CVR1	0	0	0	--	--	ns	0.0	0.00%
	Eagle Creek	EGR1	0	0	0	--	--	ns	0.0	0.00%
	Getmuna Creek	GMR1	62	29	50	--	0	21	32.4	12.61%
		GMR2	9	16	63	--	1	0	17.8	6.93%
		GMR3	6	9	30	--	4	0	9.8	3.81%
		GMR4	2	9	3	--	0	0	2.8	1.09%
		GMR5	--	--	0	--	0	0	0.0	0.00%
		Total	**79**	**63**	**146**	**0**	**5**	**21**	**62.8**	**24.44%**
	49.0 Creek	FNR1	--	--	1	--	--	ns	1.0	0.39%
	Bell Creek	BLR1	--	--	66	--	2	12	26.7	10.38%
		BLR2	--	--	33	--	2	0	11.7	4.54%
		BLR3	--	--	13	--	3	0	5.3	2.08%
		Total	**0**	**0**	**112**	**0**	**7**	**12**	**43.7**	**16.99%**
Fall Total			**373**	**159**	**481**	**0**	**12**	**127**	**257.0**	**100.00%**
Grand Total			**101**	**67**	**103**	**29**	**97**	**273**	**79.4**	

Notes:

ns = not surveyed

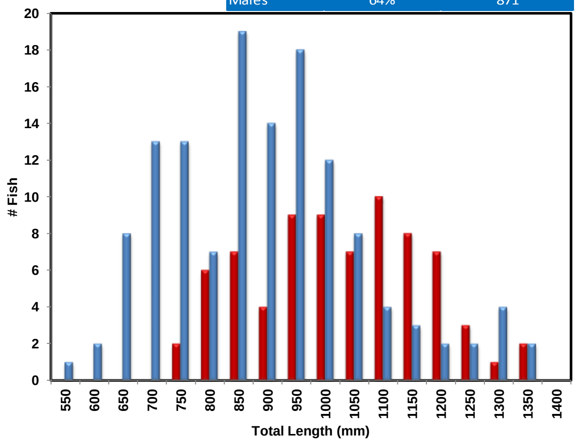
Aerial flights and redd counts conducted July 19-28, 2009-2014; and September 13-24, 2009-2014.

Appendix G

Size Distribution and Sex Ratios for Chinook, Chum, and Coho Salmon Observed at the Crooked Creek Weir (2008-2012)

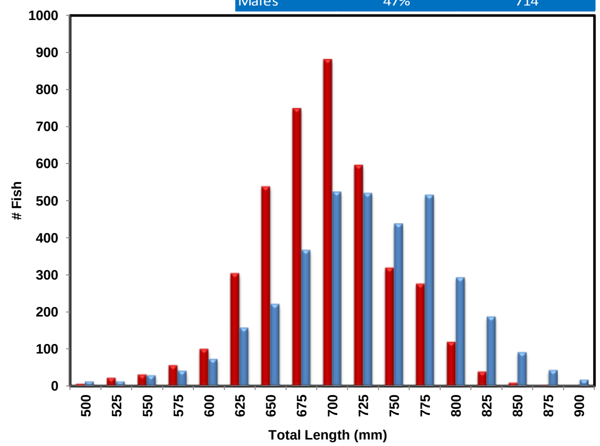
CHINOOK

	Sex Ratio	Mean Length (mm)
Females	36%	997
Males	64%	871



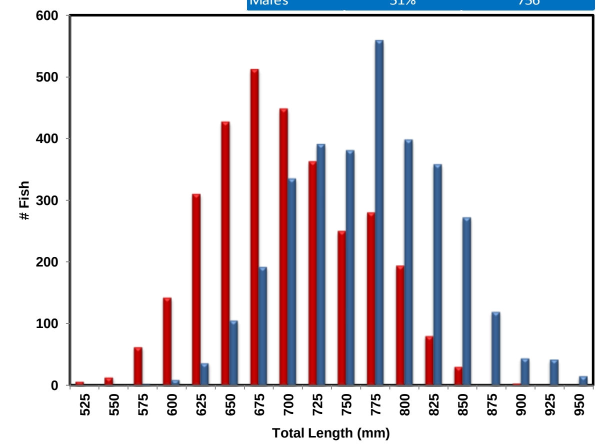
COHO

	Sex Ratio	Mean Length (mm)
Females	53%	680
Males	47%	714



CHUM

	Sex Ratio	Mean Length (mm)
Females	49%	684
Males	51%	756



Appendix H
Summary of Trapping Results within the Crooked Creek Drainage (2004-2013)

		# of Fish Caught per 3 Traps								
SITE	Year	Chinook (juvenile)	Coho (juvenile)	Dolly Varden	Arctic Grayling	Longnose Sucker	Slimy Sculpin	Burbot	Nine-spine Stickleback	Total
DO1	2004	0	0	4	0	0	0	0	0	4
	2005	0	6	1	0	0	1	0	0	8
	2006	0	0	0	0	0	3	0	0	3
	2007	0	2	2	0	0	2	1	0	7
	2008	0	0	0	0	0	2	1	0	3
	2009	0	0	0	0	0	1	0	0	1
	2010	0	2	0	0	0	0	1	0	3
	2011	0	0	0	0	0	1	0	0	1
	2012	0	0	0	0	0	3	0	0	3
	Mean	--	1.1	0.8	--	--	1.4	0.3	--	3.7
	Range	--	(0 to 6)	(0 to 4)	--	--	(0 to 3)	(0 to 1)	--	(1 to 8)
FL1	2004	0	0	0	0	0	0	0	0	0
	2005	0	0	3	0	0	1	0	0	4
	2006	0	0	0	0	0	6	1	0	7
	2007	0	0	3	0	0	1	0	0	4
	2008	0	0	0	0	0	0	0	0	0
	2009	0	0	0	0	0	0	0	0	0
	Mean	--	--	1.0	--	--	1.3	0.2	--	2.5
	Range	--	--	(0 to 3)	--	--	(0 to 6)	(0 to 1)	--	(0 to 7)
DM1	2008	0	0	2	0	0	0	0	0	2
	2009	0	0	4	0	0	0	0	0	4
	Mean	--	--	3.0	--	--	--	--	--	3.0
	Range	--	--	(2 to 4)	--	--	--	--	--	(2 to 4)
QZ1	2009	0	0	0	0	0	0	0	0	0
SN1	2006	0	0	0	0	0	0	0	0	0
SN2	2006	0	0	0	0	0	0	0	0	0
	2007	0	0	4	0	0	0	0	0	4
	2008	0	0	0	0	0	0	0	0	0
	2009	0	0	2	0	0	0	0	0	2
	2011	0	0	1	0	0	0	0	0	1
	2012	0	0	0	0	0	0	0	0	0
	2013	0	0	0	0	0	0	0	0	0
	Mean	--	--	1.0	--	--	--	--	--	1.0
	Range	--	--	(0 to 4)	--	--	--	--	--	(0 to 4)
CR2	2004	1	1	0	0	0	2	1	0	5
	2005	0	0	0	0	0	0	0	0	0
	2006	0	0	0	0	0	2	0	0	2
	2007	1	0	1	0	0	1	0	0	3
	2008	0	0	2	0	0	2	0	0	4
	2009	0	1	2	0	0	1	1	0	5
	2010	0	2	0	0	0	5	0	0	7
	2011	0	0	0	0	0	1	0	0	1
	2012	0	0	0	0	0	8	0	0	8
	Mean	0.2	0.4	0.6	--	--	2.4	0.2	--	3.9
	Range	(0 to 1)	(0 to 2)	(0 to 2)	--	--	(0 to 8)	(0 to 1)	--	(0 to 8)
CR1	2004	0	0	0	0	0	0	1	0	1
	2005	7	0	0	0	0	1	0	0	8
	2006	0	0	0	0	0	4	0	0	4
	2007	0	0	0	0	0	1	2	0	3
	2008	0	0	1	0	0	5	1	0	7
	2009	0	0	0	0	0	2	0	0	2
	2010	0	3	0	0	0	3	0	0	6
	2011	0	0	0	0	0	0	0	0	0

Appendix H
Summary of Trapping Results within the Crooked Creek Drainage (2004-2013)

	2012	0	0	0	0	0	0	0	0	0
	Mean	0.8	0.3	0.1	--	--	1.8	0.4	--	3.4
	Range	(0 to 7)	(0 to 3)	(0 to 1)	--	--	(0 to 5)	(0 to 2)	--	(0 to 8)
CR0.7	2006	0	0	0	0	0	3	0	0	3
	2007	0	0	1	0	0	6	2	1	10
	2008	0	0	1	0	0	3	0	0	4
	2009	0	1	1	0	0	3	2	0	7
	2010	0	6	0	0	0	3	0	0	9
	2011	0	0	0	0	0	1	0	0	1
	2012	0	0	0	0	0	1	1	0	2
	Mean	--	1.0	0.4	--	--	2.9	0.7	0.1	5.1
	Range	--	(0 to 6)	(0 to 1)	--	--	(1 to 6)	(0 to 2)	(0 to 1)	(1 to 10)
CR0.3	2006	0	6	2	0	0	5	0	0	13
	2007	5	6	2	0	0	5	0	0	16
	2008	1	5	0	3	0	3	0	0	3
	2009	3	0	1	0	1	0	0	0	7
	2010	4	1	0	0	1	2	0	0	8
	Mean	2.6	3.6	1.0	0.6	0.4	3.0	--	--	9.4
	Range	(0 to 5)	(0 to 6)	(0 to 2)	(0 to 3)	(0 to 1)	(0 to 5)	--	--	(3 to 16)
LE1	2009	0	0	0	0	0	0	0	0	0
AM1	2004	0	0	3	0	0	1	0	0	4
	2005	0	0	3	0	0	1	0	0	0
	2006	0	0	0	0	0	0	0	0	8
	2007	0	0	0	0	0	8	0	0	0
	2008	0	0	0	0	0	0	0	0	0
	2009	0	0	0	0	0	0	0	0	3
	Mean	--	--	1.0	--	--	1.7	--	--	2.5
	Range	--	--	(0 to 3)	--	--	(0 to 8)	--	--	(0 to 8)
AM2	2010	0	0	2	0	0	0	0	0	2
GR1	2008	0	0	0	0	0	2	0	0	2
OM1	2009	0	0	0	0	0	0	0	0	0
AN1	2004	0	0	0	0	0	1	0	0	1
	2005	0	0	0	0	0	3	0	0	3
	2006	0	0	0	0	0	0	0	0	0
	2007	0	0	1	0	0	4	0	0	5
	2008	0	0	0	0	0	26	0	0	26
	2009	0	0	0	0	0	2	0	0	2
	2011	0	0	0	0	0	4	0	0	4
	Mean	--	--	0.1	--	--	5.7	--	--	5.9
	Range	--	--	(0 to 1)	--	--	(0 to 26)	--	--	(0 to 26)
AN2	2006	0	0	2	0	0	0	0	0	2
	2007	0	0	0	0	0	0	0	0	0
	2008	0	0	1	0	0	0	0	0	1
	2009	0	0	0	0	0	0	0	0	0
	Mean	--	--	0.8	--	--	--	--	--	0.8
	Range	--	--	(0 to 2)	--	--	--	--	--	(0 to 2)
CV1	2006	0	0	0	0	0	0	0	0	0
	2007	0	0	0	0	0	0	0	0	0
	2008	0	0	0	0	0	0	0	0	0
	2009	0	0	1	0	0	2	0	0	3
	Mean	--	--	0.3	--	--	0.5	--	--	0.8
	Range	--	--	(0 to 1)	--	--	(0 to 2)	--	--	(0 to 3)
EG1	2009	0	0	1	0	0	2	0	0	3
BC1	2010	0	0	3	0	0	0	0	0	3
AC1	2010	0	0	0	0	0	0	0	0	0
GM1	2007	19	8	3	0	0	0	0	0	30
	2008	0	0	3	0	0	5	0	0	8

Appendix H

Summary of Trapping Results within the Crooked Creek Drainage (2004-2013)

	2009	0	0	3	0	0	0	0	0	3
	Mean	6.3	2.7	3.0	--	--	1.7	--	--	13.7
	Range	(0 to 19)	(0 to 8)	(3 to 3)	--	--	(0 to 5)	--	--	(3 to 30)
GM2	2012	0	2	4	0	0	0	0	0	6
GM3	2012	0	1	34	0	0	1	0	0	36
	2013	0	2	5	0	0	0	0	0	7
	2014	0	6	2	0	0	2	0	0	10
	Mean	--	3.0	13.7	--	--	1.0	--	--	17.7
	Range	--	(1 to 6)	(5 to 34)	--	--	(0 to 2)	--	--	(7 to 36)
GM4	2012	0	22	30	0	0	0	0	0	52
BL1	2011	0	1	0	0	0	2	0	0	3
	2012	0	0	0	0	0	1	0	0	1
	Mean	--	0.5	--	--	--	1.5	--	--	2.0
	Range	--	(0 to 1)	--	--	--	(1 to 2)	--	--	(1 to 3)
Grand Total		41	78	139	3	5	155	15	1	442

Notes:

Refer to Figure 1.1-1 for biomonitoring site locations.

DO=Donlin Creek; FL=Flat Creek; DM=Dome Creek; QZ=Quartz Creek; SN=Snow Gulch; CR=Crooked Creek; LE=Lewis Gulch; AM=American Creek; GR=Grouse Creek; OM=Omega Gulch; AN=Anaconda Creek; CV=Crevice Creek; EG=Eagle Creek; BC=BC Creek; GM=Getmuna Creek; BL=Bell Creek

Mean = total # of fish caught in 3 traps each year/the number of years sampled n(y).

-- Species not captured at sampling site

Appendix I

Average Percent Solids and Wet Weight to Dry Weight Conversion Factors for Slimy Sculpin Tissue Metals Samples (2006-2014)

Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Average Percent Solids	24.87	24.17	19.87	20.15	20.50	19.97	21.78	21.98	21.80
Standard Deviation (Percent Solids)	1.06	1.14	0.68	1.61	1.32	1.95	0.94	0.51	0.51
Multiplier to Convert Wet Weight to Dry Weight	4.08	4.17	5.04	5.00	4.98	5.05	4.60	4.55	4.59

Appendix J (Page 1 of 6)

Scaled Statistics of Metal Concentrations in Slimy Sculpin <55mm Long within the Crooked Creek Drainage (2004-2012)

Response Aluminum (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	74.960504	1.656582	45.25	<.0001*
Year[2004]	-1.902102	5.922778	-0.32	0.7481
Year[2005]	15.794195	5.922778	2.67	0.0077*
Year[2006]	31.225247	3.970296	7.86	<.0001*
Year[2007]	6.7949456	4.110322	1.65	0.0985
Year[2008]	-20.04005	4.110322	-4.88	<.0001*
Year[2009]	-23.32172	4.110322	-5.67	<.0001*
Year[2010]	2.6932789	4.110322	0.66	0.5124
Year[2011]	19.888279	4.110322	4.84	<.0001*
Year[2012]	-30.63005	4.110322	-7.45	<.0001*
Year[All Years Combined]	-0.502014	2.771481	-0.18	0.8563
Site ID[DO1]	-0.284947	2.783988	-0.10	0.9185
Site ID[CR2]	3.4800348	2.851631	1.22	0.2225
Site ID[CR1]	0.5298735	2.531758	0.21	0.8343
Site ID[CR0.7]	-3.670431	2.729379	-1.34	0.1789
Site ID[All Sites Combined]	-0.054531	2.431051	-0.02	0.9821

Response Arsenic (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.3014998	0.005369	56.16	0.0000*
Year[2004]	0.0081665	0.019194	0.43	0.6706
Year[2005]	0.0489072	0.019194	2.55	0.0109*
Year[2006]	0.1301834	0.012867	10.12	<.0001*
Year[2007]	0.0066224	0.013321	0.50	0.6192
Year[2008]	-0.008044	0.013321	-0.60	0.5460
Year[2009]	-0.082494	0.013321	-6.19	<.0001*
Year[2010]	-0.040094	0.013321	-3.01	0.0027*
Year[2011]	0.0092057	0.013321	0.69	0.4896
Year[2012]	-0.070411	0.013321	-5.29	<.0001*
Year[All Years Combined]	-0.002041	0.008982	-0.23	0.8202
Site ID[DO1]	-0.140776	0.009022	-15.60	<.0001*
Site ID[CR2]	0.1685077	0.009241	18.23	<.0001*
Site ID[CR1]	-0.008212	0.008205	-1.00	0.3171
Site ID[CR0.7]	-0.017106	0.008845	-1.93	0.0533
Site ID[All Sites Combined]	-0.002415	0.007878	-0.31	0.7593

Appendix J (Page 2 of 6)

Scaled Statistics of Metal Concentrations in Slimy Sculpin <55mm Long within the Crooked Creek Drainage (2004-2012)

Response Cadmium (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.0178301	0.000155	115.28	0.0000*
Year[2004]	-0.001008	0.000553	-1.82	0.0685
Year[2005]	0.0045103	0.000553	8.16	<.0001*
Year[2006]	0.0098819	0.000371	26.66	<.0001*
Year[2007]	0.0013011	0.000384	3.39	0.0007*
Year[2008]	-0.001326	0.000384	-3.45	0.0006*
Year[2009]	-0.005907	0.000384	-15.39	<.0001*
Year[2010]	-0.004416	0.000384	-11.51	<.0001*
Year[2011]	-0.001566	0.000384	-4.08	<.0001*
Year[2012]	-0.001367	0.000384	-3.56	0.0004*
Year[All Years Combined]	-0.000104	0.000259	-0.40	0.6872
Site ID[DO1]	-0.001436	0.00026	-5.53	<.0001*
Site ID[CR2]	-0.002015	0.000266	-7.57	<.0001*
Site ID[CR1]	0.0006518	0.000236	2.76	0.0059*
Site ID[CR0.7]	0.0027053	0.000255	10.62	<.0001*
Site ID[All Sites Combined]	9.4577e-5	0.000227	0.42	0.6770

Response Chromium (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.2789465	0.010826	25.77	<.0001*
Year[2004]	-0.081537	0.038708	-2.11	0.0353*
Year[2005]	0.0962405	0.038708	2.49	0.0130*
Year[2006]	-0.117354	0.025947	-4.52	<.0001*
Year[2007]	-0.111013	0.026863	-4.13	<.0001*
Year[2008]	-0.111113	0.026863	-4.14	<.0001*
Year[2009]	-0.217263	0.026863	-8.09	<.0001*
Year[2010]	0.0504867	0.026863	1.88	0.0604
Year[2011]	-0.03918	0.026863	-1.46	0.1449
Year[2012]	0.5329367	0.026863	19.84	<.0001*
Year[All Years Combined]	-0.002202	0.018113	-0.12	0.9032
Site ID[DO1]	0.0042861	0.018194	0.24	0.8138
Site ID[CR2]	0.0778549	0.018637	4.18	<.0001*
Site ID[CR1]	-0.00385	0.016546	-0.23	0.8160
Site ID[CR0.7]	-0.076247	0.017838	-4.27	<.0001*
Site ID[All Sites Combined]	-0.002044	0.015888	-0.13	0.8977

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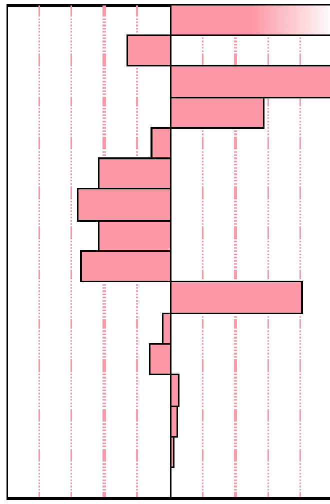
Scaled Statistics of Metal Concentrations in Slimy Sculpin <55mm Long within the Crooked Creek Drainage (2004-2012)

Response Copper (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.725583	0.009444	76.83	0.0000*
Year[2004]	-0.079439	0.033765	-2.35	0.0188*
Year[2005]	0.308339	0.033765	9.13	<.0001*
Year[2006]	0.1764367	0.022634	7.80	<.0001*
Year[2007]	-0.032004	0.023433	-1.37	0.1722
Year[2008]	-0.136021	0.023433	-5.80	<.0001*
Year[2009]	-0.174154	0.023433	-7.43	<.0001*
Year[2010]	-0.133354	0.023433	-5.69	<.0001*
Year[2011]	-0.167204	0.023433	-7.14	<.0001*
Year[2012]	0.2494291	0.023433	10.64	<.0001*
Year[All Years Combined]	-0.012028	0.0158	-0.76	0.4466
Site ID[DO1]	-0.035225	0.015871	-2.22	0.0266*
Site ID[CR2]	0.0160354	0.016257	0.99	0.3241
Site ID[CR1]	0.0124145	0.014433	0.86	0.3899
Site ID[CR0.7]	0.0061409	0.01556	0.39	0.6932
Site ID[All Sites Combined]	0.0006345	0.013859	0.05	0.9635

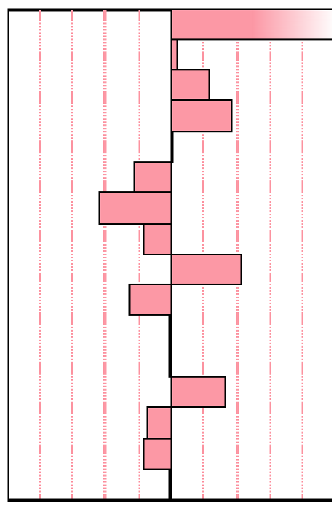


Response Iron (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	93.56881	2.736908	34.19	<.0001*
Year[2004]	2.9606185	9.78527	0.30	0.7623
Year[2005]	18.556915	9.78527	1.90	0.0581
Year[2006]	28.742755	6.559493	4.38	<.0001*
Year[2007]	0.724218	6.790835	0.11	0.9151
Year[2008]	-17.58912	6.790835	-2.59	0.0097*
Year[2009]	-33.45412	6.790835	-4.93	<.0001*
Year[2010]	-12.47245	6.790835	-1.84	0.0665
Year[2011]	33.424218	6.790835	4.92	<.0001*
Year[2012]	-19.89745	6.790835	-2.93	0.0034*
Year[All Years Combined]	-0.995596	4.578881	-0.22	0.8279
Site ID[DO1]	-0.899929	4.599544	-0.20	0.8449
Site ID[CR2]	25.59964	4.7113	5.43	<.0001*
Site ID[CR1]	-10.84329	4.182823	-2.59	0.0096*
Site ID[CR0.7]	-12.79946	4.509321	-2.84	0.0046*
Site ID[All Sites Combined]	-1.056964	4.016442	-0.26	0.7925



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Scaled Statistics of Metal Concentrations in Slimy Sculpin <55mm Long within the Crooked Creek Drainage (2004-2012)

Response Lead (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.028209	0.001757	16.06	<.0001*
Year[2004]	-0.004416	0.006281	-0.70	0.4822
Year[2005]	-0.005268	0.006281	-0.84	0.4018
Year[2006]	-0.001513	0.004211	-0.36	0.7194
Year[2007]	-0.002396	0.004359	-0.55	0.5827
Year[2008]	-0.009869	0.004359	-2.26	0.0237*
Year[2009]	-0.014911	0.004359	-3.42	0.0006*
Year[2010]	0.0039309	0.004359	0.90	0.3673
Year[2011]	0.0050459	0.004359	1.16	0.2473
Year[2012]	0.0288209	0.004359	6.61	<.0001*
Year[All Years Combined]	0.000575	0.002939	0.20	0.8449
Site ID[DO1]	-0.000576	0.002953	-0.20	0.8454
Site ID[CR2]	-0.002823	0.003024	-0.93	0.3508
Site ID[CR1]	0.0081364	0.002685	3.03	0.0025*
Site ID[CR0.7]	-0.005165	0.002895	-1.78	0.0746
Site ID[All Sites Combined]	0.0004268	0.002578	0.17	0.8685

Response Manganese (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	13.252238	0.348707	38.00	<.0001*
Year[2004]	1.2060986	1.246733	0.97	0.3335
Year[2005]	5.1590615	1.246733	4.14	<.0001*
Year[2006]	2.3906977	0.83574	2.86	0.0043*
Year[2007]	-0.981879	0.865215	-1.13	0.2566
Year[2008]	-2.808212	0.865215	-3.25	0.0012*
Year[2009]	-0.352045	0.865215	-0.41	0.6842
Year[2010]	-1.150379	0.865215	-1.33	0.1839
Year[2011]	-1.793879	0.865215	-2.07	0.0383*
Year[2012]	-1.307045	0.865215	-1.51	0.1311
Year[All Years Combined]	-0.362419	0.583391	-0.62	0.5345
Site ID[DO1]	2.8822791	0.586024	4.92	<.0001*
Site ID[CR2]	-1.907512	0.600263	-3.18	0.0015*
Site ID[CR1]	-0.817661	0.53293	-1.53	0.1252
Site ID[CR0.7]	-0.127704	0.574529	-0.22	0.8241
Site ID[All Sites Combined]	-0.029403	0.511732	-0.06	0.9542

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Scaled Statistics of Metal Concentrations in Slimy Sculpin <55mm Long within the Crooked Creek Drainage (2004-2012)

Response Mercury (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.0332243	0.000249	133.25	0.0000*
Year[2004]	-0.004696	0.000891	-5.27	<.0001*
Year[2005]	0.0025966	0.000891	2.91	0.0036*
Year[2006]	0.0019313	0.000598	3.23	0.0013*
Year[2007]	0.0011244	0.000619	1.82	0.0693
Year[2008]	0.0084028	0.000619	13.58	<.0001*
Year[2009]	-0.006441	0.000619	-10.41	<.0001*
Year[2010]	2.2767e-5	0.000619	0.04	0.9706
Year[2011]	-0.002141	0.000619	-3.46	0.0006*
Year[2012]	-0.000951	0.000619	-1.54	0.1246
Year[All Years Combined]	0.0001498	0.000417	0.36	0.7197
Site ID[DO1]	-0.003051	0.000419	-7.28	<.0001*
Site ID[CR2]	0.0075804	0.000429	17.66	<.0001*
Site ID[CR1]	-0.002413	0.000381	-6.33	<.0001*
Site ID[CR0.7]	-0.001875	0.000411	-4.56	<.0001*
Site ID[All Sites Combined]	-0.000241	0.000366	-0.66	0.5099

Response Selenium (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.913745	0.005815	157.12	0.0000*
Year[2004]	0.1509728	0.020792	7.26	<.0001*
Year[2005]	0.0957876	0.020792	4.61	<.0001*
Year[2006]	-0.003312	0.013938	-0.24	0.8122
Year[2007]	0.1122224	0.014429	7.78	<.0001*
Year[2008]	-0.066278	0.014429	-4.59	<.0001*
Year[2009]	-0.054111	0.014429	-3.75	0.0002*
Year[2010]	-0.151611	0.014429	-10.51	<.0001*
Year[2011]	-0.246944	0.014429	-17.11	<.0001*
Year[2012]	0.1783891	0.014429	12.36	<.0001*
Year[All Years Combined]	-0.015117	0.009729	-1.55	0.1205
Site ID[DO1]	-0.056213	0.009773	-5.75	<.0001*
Site ID[CR2]	0.0927388	0.010011	9.26	<.0001*
Site ID[CR1]	-0.067751	0.008888	-7.62	<.0001*
Site ID[CR0.7]	0.0355823	0.009581	3.71	0.0002*
Site ID[All Sites Combined]	-0.004358	0.008534	-0.51	0.6097

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Scaled Statistics of Metal Concentrations in Slimy Sculpin <55mm Long within the Crooked Creek Drainage (2004-2012)

Response Zinc (mg/kg wet weight)

Scaled Estimates

Nominal factors expanded to all levels

Term	Scaled Estimate	Std Error	t Ratio	Prob>|t|
Intercept	19.684569	0.076072	258.76	0.0000*
Year[2004]	-0.08291	0.271982	-0.30	0.7605
Year[2005]	-0.497725	0.271982	-1.83	0.0675
Year[2006]	3.6386069	0.182321	19.96	<.0001*
Year[2007]	0.7432416	0.188752	3.94	<.0001*
Year[2008]	1.3082416	0.188752	6.93	<.0001*
Year[2009]	-3.563425	0.188752	-18.88	<.0001*
Year[2010]	-0.893425	0.188752	-4.73	<.0001*
Year[2011]	-1.918425	0.188752	-10.16	<.0001*
Year[2012]	1.1899082	0.188752	6.30	<.0001*
Year[All Years Combined]	0.0759122	0.12727	0.60	0.5510
Site ID[DO1]	0.3384865	0.127845	2.65	0.0082*
Site ID[CR2]	0.3078378	0.130951	2.35	0.0189*
Site ID[CR1]	-0.312344	0.116262	-2.69	0.0073*
Site ID[CR0.7]	-0.308707	0.125337	-2.46	0.0139*
Site ID[All Sites Combined]	-0.025273	0.111637	-0.23	0.8209

Notes:

Scales Estimates - Parameter estimates are highly dependent on the scale of the factor. If you convert a factor from grams to kilograms, the parameter estimates change by a multiple of a thousand. If the same change is applied to a squared (quadratic) term, the scale changes by a multiple of a million. If you are interested in the effect size, then you should examine the estimates in a more scale-invariant fashion. This means converting from an arbitrary scale to a meaningful one so that the sizes of the estimates relate to the size of the effect on the response. In JMP software, the Scaled Estimates give coefficients corresponding to factors that are scaled to have a mean of zero and a range of two. If the factor is symmetrically distributed in the data then the scaled factor will have a range from -1 to 1. This corresponds to the scaling used in the design of experiments (DOE) tradition. Thus, for a simple regressor, the scaled estimate is half the predicted response change as the regression factor travels its whole range. *Prob>|t| is less than 0.05.

APPENDIX K: METALS CONCENTRATIONS OF ALL SAMPLES OF SLIMY SCULPIN <55MM LONG WITHIN THE CROOKED CREEK DRAINAGE (2004-2014) (10 pages)

				Metal Concentrations										
			Solids	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Zn
Sampling Site	Year	Sample	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
DO1	**2004**		25.1	66.9	0.18	0.015	0.20	0.73	103.0	0.026	30.20	0.021	1.00	24.0
			23.8	47.6	0.14	0.015	0.18	0.64	66.6	0.020	16.50	0.020	1.07	18.7
			25.1	96.9	0.17	0.021	0.25	0.69	149.0	0.056	17.90	0.023	1.06	20.6
			25.8	169.0	0.22	0.027	0.35	0.78	227.0	0.058	28.30	0.023	0.98	25.0
			24.2	95.4	0.18	0.018	0.31	0.71	130.0	0.040	23.80	0.022	0.93	20.5
			24.8	313.0	0.21	0.018	0.49	0.81	432.0	0.084	24.80	0.029	0.98	22.2
	2004 Average		**24.8**	**131.5**	**0.18**	**0.019**	**0.30**	**0.73**	**184.6**	**0.047**	**23.58**	**0.023**	**1.00**	**21.8**
	2004 Max		**25.8**	**313.0**	**0.22**	**0.027**	**0.49**	**0.81**	**432.0**	**0.084**	**30.20**	**0.029**	**1.07**	**25.0**
	2004 Min		**23.8**	**47.6**	**0.14**	**0.015**	**0.18**	**0.64**	**66.6**	**0.020**	**16.50**	**0.020**	**0.93**	**18.7**
	2004 StdDev		**0.7**	**98.0**	**0.03**	**0.005**	**0.11**	**0.06**	**132.5**	**0.024**	**5.48**	**0.003**	**0.05**	**2.4**
	2005		--	134.0	0.18	0.017	0.43	0.80	134.0	0.028	26.90	0.035	0.75	18.6
			--	153.0	0.23	0.020	0.55	0.95	196.0	0.035	22.30	0.035	0.91	19.1
			--	141.0	0.17	0.017	0.54	0.86	145.0	0.027	20.80	0.033	0.88	19.6
			--	102.0	0.17	0.017	0.74	0.85	105.0	0.021	19.30	0.025	0.79	20.0
			--	66.6	0.16	0.020	0.25	0.83	104.0	0.018	20.30	0.031	0.92	19.7
			--	91.1	0.16	0.021	0.33	0.97	101.0	0.024	29.30	0.034	0.78	19.0
	2005 Average		**--**	**114.6**	**0.18**	**0.019**	**0.47**	**0.88**	**130.8**	**0.026**	**23.15**	**0.032**	**0.84**	**19.3**
	2005 Max		**--**	**153.0**	**0.23**	**0.021**	**0.74**	**0.97**	**196.0**	**0.035**	**29.30**	**0.035**	**0.92**	**20.0**
	2005 Min		**--**	**66.6**	**0.16**	**0.017**	**0.25**	**0.80**	**101.0**	**0.018**	**19.30**	**0.025**	**0.75**	**18.6**
	2005 StdDev		**--**	**33.4**	**0.03**	**0.002**	**0.18**	**0.07**	**36.7**	**0.006**	**4.03**	**0.004**	**0.07**	**0.5**
	2006		25.7	141.0	0.25	0.023	0.17	0.90	161.0	0.033	17.70	0.048	0.80	30.1
			24.0	84.8	0.24	0.022	0.24	0.86	92.1	0.021	12.80	0.037	0.70	27.0
			25.3	126.0	0.27	0.026	0.10	0.94	136.0	0.031	15.80	0.045	0.60	28.4
			24.6	90.8	0.26	0.023	0.10	0.85	124.0	0.027	15.90	0.038	0.70	27.8
			25.9	96.8	0.21	0.021	0.10	0.81	104.0	0.023	14.10	0.035	0.60	26.8
			25.4	68.1	0.24	0.023	0.10	0.77	85.9	0.019	14.50	0.041	0.70	26.1
			25.7	50.9	0.24	0.021	0.10	0.79	69.9	0.016	14.90	0.030	0.80	25.8
			24.9	102.0	0.25	0.024	0.10	0.87	111.0	0.026	13.70	0.034	0.80	25.8
			24.8	81.4	0.26	0.021	0.10	0.77	89.0	0.022	14.70	0.033	0.80	24.7
	2006 Average		**25.1**	**93.5**	**0.25**	**0.023**	**0.12**	**0.84**	**108.1**	**0.024**	**14.90**	**0.038**	**0.72**	**26.9**
	2006 Max		**25.9**	**141.0**	**0.27**	**0.026**	**0.24**	**0.94**	**161.0**	**0.033**	**17.70**	**0.048**	**0.80**	**30.1**
	2006 Min		**24.0**	**50.9**	**0.21**	**0.021**	**0.10**	**0.77**	**69.9**	**0.016**	**12.80**	**0.030**	**0.60**	**24.7**
	2006 StdDev		**0.6**	**27.6**	**0.02**	**0.002**	**0.05**	**0.06**	**28.3**	**0.006**	**1.43**	**0.006**	**0.08**	**1.6**
	2007		25.2	54.8	0.19	0.017	0.12	0.72	96.2	0.021	27.30	0.030	1.00	23.0
			23.1	65.1	0.17	0.017	0.11	0.70	77.1	0.021	12.10	0.031	1.00	20.7
			23.4	67.9	0.16	0.021	0.11	0.76	84.0	0.022	12.90	0.043	0.90	21.8
			26.1	63.4	0.18	0.017	0.13	0.67	79.4	0.023	13.10	0.013	1.00	22.9
			23.2	52.9	0.17	0.016	0.14	0.66	62.6	0.016	12.50	0.079	0.90	19.8
			23.8	126.0	0.17	0.023	0.15	0.81	161.0	0.035	17.60	0.041	0.90	20.2
			22.4	58.2	0.15	0.016	0.11	0.63	71.7	0.023	14.30	0.033	1.30	19.1
			22.8	88.0	0.18	0.024	0.11	0.77	107.0	0.029	16.10	0.034	0.90	21.0
			22.7	75.8	0.18	0.019	0.14	0.70	84.9	0.027	15.80	0.029	0.80	21.0
			24.1	68.6	0.15	0.015	0.12	0.62	81.0	0.020	13.20	0.029	0.90	20.5
			24.0	55.2	0.15	0.015	0.12	0.65	69.9	0.019	13.30	0.035	0.90	20.4
			24.0	88.9	0.22	0.017	0.14	0.73	171.0	0.033	14.20	0.014	0.80	21.9
			24.2	70.2	0.19	0.024	0.12	0.71	87.9	0.023	14.50	0.031	0.90	22.0
			23.1	39.8	0.15	0.012	0.11	0.57	47.1	0.014	12.40	0.031	0.90	19.1
			23.0	38.0	0.14	0.018	0.11	0.61	49.0	0.015	14.20	0.035	0.80	22.4
	2007 Average		**23.7**	**67.5**	**0.17**	**0.018**	**0.12**	**0.69**	**88.7**	**0.023**	**14.90**	**0.034**	**0.93**	**21.1**
	2007 Max		**26.1**	**126.0**	**0.22**	**0.024**	**0.15**	**0.81**	**171.0**	**0.035**	**27.30**	**0.079**	**1.30**	**23.0**
	2007 Min		**22.4**	**38.0**	**0.14**	**0.012**	**0.11**	**0.57**	**47.1**	**0.014**	**12.10**	**0.013**	**0.80**	**19.1**
	2007 StdDev		**1.0**	**21.8**	**0.02**	**0.004**	**0.01**	**0.06**	**35.2**	**0.006**	**3.75**	**0.015**	**0.12**	**1.3**
	2008		20.2	89.7	0.19	0.023	0.16	0.71	107.0	0.043	16.20	0.035	0.88	21.7
			20.3	72.4	0.18	0.013	0.20	0.57	97.9	0.025	15.40	0.038	0.86	20.4
			20.3	76.8	0.15	0.020	0.26	0.63	102.0	0.025	15.60	0.038	0.71	20.8
			20.0	71.9	0.14	0.017	0.17	0.59	91.3	0.024	11.20	0.040	0.70	20.2
			20.3	119.0	0.17	0.018	0.24	0.62	130.0	0.031	15.60	0.038	0.67	21.6
			19.9	83.9	0.15	0.017	0.25	0.59	106.0	0.024	15.70	0.041	0.63	20.4
			20.4	87.1	0.17	0.017	0.22	0.63	119.0	0.028	13.60	0.038	0.62	20.6
			20.3	81.9	0.19	0.020	0.18	0.67	100.0	0.025	13.90	0.038	0.67	21.7
			20.3	81.3	0.15	0.020	0.25	0.62	98.0	0.025	16.40	0.039	0.70	20.2
			20.3	80.1	0.15	0.016	0.19	0.61	94.3	0.025	13.20	0.040	0.60	20.6
			20.4	72.7	0.20	0.019	0.17	0.67	88.4	0.024	12.80	0.041	0.65	19.3
			20.2	76.3	0.14	0.017	0.18	0.57	115.0	0.024	15.80	0.037	0.65	20.1
			20.1	134.0	0.15	0.021	0.19	0.61	148.0	0.031	14.30	0.041	0.60	20.2
			19.7	37.4	0.16	0.015	0.10	0.52	65.0	0.014	12.20	0.035	0.61	19.7
			20.1	79.8	0.19	0.020	0.28	0.63	96.2	0.025	16.30	0.037	0.64	19.7
	2008 Average		**20.2**	**83.0**	**0.17**	**0.018**	**0.20**	**0.62**	**103.9**	**0.026**	**14.55**	**0.038**	**0.68**	**20.5**
	2008 Max		**20.4**	**134.0**	**0.20**	**0.023**	**0.28**	**0.71**	**148.0**	**0.043**	**16.40**	**0.041**	**0.88**	**21.7**
	2008 Min		**19.7**	**37.4**	**0.14**	**0.013**	**0.10**	**0.52**	**65.0**	**0.014**	**11.20**	**0.035**	**0.60**	**19.3**
	2008 StdDev		**0.2**	**21.5**	**0.02**	**0.003**	**0.05**	**0.05**	**19.2**	**0.006**	**1.65**	**0.002**	**0.09**	**0.7**

								Metal Concentrations					
			Solids	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Zn
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sampling Site	**Year**	**Sample**												
DO1 cont.	**2009**		17.8	63.5	0.11	0.008	0.08	0.53	65.7	0.013	8.28	0.029	0.67	15.8
			19.4	58.6	0.23	0.017	0.06	0.50	148.0	0.018	209.00	0.028	0.75	17.1
			17.8	39.8	0.11	0.010	0.05	0.52	45.7	0.010	9.56	0.023	0.58	15.5
			18.9	41.3	0.11	0.009	0.10	0.44	49.5	0.011	9.59	0.027	0.67	15.5
			17.5	31.4	0.11	0.007	0.07	0.56	40.2	0.009	9.41	0.030	0.61	14.8
			18.3	43.2	0.11	0.009	0.07	0.43	52.7	0.012	10.10	0.019	0.64	15.4
			16.7	59.6	0.09	0.011	0.06	0.45	60.6	0.014	10.50	0.023	0.50	13.5
			19.1	88.1	0.14	0.015	0.12	0.57	92.9	0.020	13.40	0.037	0.64	17.8
			18.5	48.7	0.11	0.010	0.06	0.48	56.3	0.012	8.88	0.026	0.59	15.4
			17.8	22.6	0.11	0.009	0.03	0.41	31.1	0.007	7.85	0.028	0.63	14.3
			20.0	42.4	0.10	0.008	0.06	0.57	49.7	0.011	9.58	0.033	0.56	14.7
			18.6	40.6	0.10	0.008	0.05	0.48	47.4	0.011	8.40	0.026	0.58	15.4
			19.1	40.3	0.10	0.010	0.04	0.50	53.6	0.011	9.59	0.029	0.64	13.3
			17.5	31.9	0.10	0.010	0.04	0.41	36.8	0.008	11.40	0.021	0.59	16.2
			20.9	33.8	0.11	0.013	0.05	0.56	41.0	0.009	9.95	0.027	0.72	16.8
	2009 Average		**18.5**	**45.7**	**0.12**	**0.010**	**0.06**	**0.49**	**58.1**	**0.012**	**23.03**	**0.027**	**0.62**	**15.4**
	2009 Max		**20.9**	**88.1**	**0.23**	**0.017**	**0.12**	**0.57**	**148.0**	**0.020**	**209.00**	**0.037**	**0.75**	**17.8**
	2009 Min		**16.7**	**22.6**	**0.09**	**0.007**	**0.03**	**0.41**	**31.1**	**0.007**	**7.85**	**0.019**	**0.50**	**13.3**
	2009 StdDev		**1.1**	**16.2**	**0.03**	**0.003**	**0.02**	**0.06**	**28.8**	**0.003**	**51.46**	**0.005**	**0.06**	**1.2**
	2010		21.5	76.2	0.15	0.019	0.12	0.68	78.1	0.038	10.80	0.031	1.10	19.9
			21.7	69.9	0.12	0.011	0.14	0.57	66.9	0.021	8.83	0.038	0.81	18.4
			20.9	51.9	0.13	0.010	0.19	0.55	52.2	0.030	9.77	0.038	0.81	20.6
			22.4	102.0	0.15	0.018	0.25	0.70	90.8	0.095	15.60	0.005	0.97	23.1
			21.0	79.5	0.11	0.010	0.18	0.58	64.4	0.025	8.36	0.033	0.76	16.4
			20.8	123.0	0.19	0.013	0.52	0.86	117.0	0.042	12.40	0.029	1.33	30.6
			20.2	68.7	0.13	0.012	0.15	0.59	65.6	0.026	10.40	0.033	0.89	19.4
			20.7	73.1	0.13	0.010	0.14	0.61	79.5	0.024	21.00	0.030	0.75	20.1
			20.5	86.0	0.13	0.013	0.14	0.76	83.2	0.061	9.98	0.026	0.86	21.8
			21.0	81.7	0.15	0.015	0.19	0.65	74.0	0.054	10.40	0.028	0.72	19.6
			20.2	91.7	0.14	0.015	0.15	0.63	79.6	0.026	10.80	0.027	0.75	18.8
			20.0	92.0	0.15	0.013	0.16	0.63	90.6	0.028	9.48	0.032	0.81	21.3
			20.5	99.8	0.16	0.015	0.29	0.71	98.8	0.031	11.20	0.025	0.85	23.5
			21.2	67.5	0.14	0.011	0.16	0.60	64.5	0.024	10.30	0.036	0.88	19.2
			21.1	125.0	0.15	0.022	0.40	0.87	116.0	0.038	17.50	0.030	0.98	20.5
	2010 Average		**20.9**	**85.9**	**0.14**	**0.014**	**0.21**	**0.67**	**81.4**	**0.038**	**11.79**	**0.029**	**0.88**	**20.9**
	2010 Max		**22.4**	**125.0**	**0.19**	**0.022**	**0.52**	**0.87**	**117.0**	**0.095**	**21.00**	**0.038**	**1.33**	**30.6**
	2010 Min		**20.0**	**51.9**	**0.11**	**0.010**	**0.12**	**0.55**	**52.2**	**0.021**	**8.36**	**0.005**	**0.72**	**16.4**
	2010 StdDev		**0.6**	**20.3**	**0.02**	**0.004**	**0.11**	**0.10**	**18.7**	**0.020**	**3.52**	**0.008**	**0.16**	**3.2**
	2011		18.3	53.2	0.12	0.016	0.15	0.53	60.5	0.024	10.80	0.032	0.92	18.9
			17.0	42.0	0.13	0.011	0.08	0.55	49.4	0.021	16.60	0.030	0.57	19.6
			18.3	51.5	0.10	0.014	0.12	0.51	58.3	0.023	7.66	0.027	0.85	17.8
			18.0	76.3	0.11	0.014	0.17	0.49	98.1	0.030	8.12	0.026	0.85	17.9
			17.0	56.9	0.13	0.014	0.18	0.61	60.0	0.021	13.70	0.029	0.55	17.9
			16.8	106.0	0.30	0.018	0.22	0.53	166.0	0.042	14.10	0.024	0.72	16.8
			17.0	95.6	0.12	0.016	0.21	0.56	106.0	0.030	11.40	0.021	0.81	17.4
			16.7	61.9	0.11	0.013	0.14	0.51	68.2	0.025	8.89	0.024	0.82	17.1
			17.0	51.8	0.10	0.010	0.12	0.46	58.5	0.019	9.39	0.020	0.73	16.2
			16.7	53.2	0.10	0.013	0.16	0.47	58.9	0.020	9.53	0.022	0.76	16.7
			15.7	81.5	0.16	0.014	0.21	0.47	108.0	0.031	12.70	0.022	0.74	17.0
			17.0	59.4	0.11	0.012	0.15	0.48	69.2	0.025	7.99	0.032	0.59	16.3
			17.1	84.8	0.14	0.014	0.17	0.51	137.0	0.033	24.80	0.024	0.70	16.9
			15.5	92.1	0.17	0.016	0.14	0.62	87.7	0.031	18.00	0.022	0.55	19.2
			16.3	77.7	0.11	0.014	0.14	0.47	83.4	0.028	9.13	0.024	0.63	16.9
	2011 Average		**17.0**	**69.6**	**0.13**	**0.014**	**0.16**	**0.52**	**84.6**	**0.027**	**12.19**	**0.025**	**0.72**	**17.5**
	2011 Max		**18.3**	**106.0**	**0.30**	**0.018**	**0.22**	**0.62**	**166.0**	**0.042**	**24.80**	**0.032**	**0.92**	**19.6**
	2011 Min		**15.5**	**42.0**	**0.10**	**0.010**	**0.08**	**0.46**	**49.4**	**0.019**	**7.66**	**0.020**	**0.55**	**16.2**
	2011 StdDev		**0.8**	**19.4**	**0.05**	**0.002**	**0.04**	**0.05**	**33.3**	**0.006**	**4.71**	**0.004**	**0.12**	**1.0**
	2012		21.4	35.7	0.13	0.016	1.09	0.72	63.8	0.019	11.00	0.018	1.35	21.2
			22.4	40.4	0.14	0.016	1.41	1.04	80.1	0.060	13.00	0.022	1.21	19.9
			22.6	28.1	0.12	0.015	0.67	0.80	48.3	0.021	11.30	0.030	1.28	19.0
			22.5	34.8	0.11	0.017	0.44	0.71	56.9	0.018	10.80	0.022	1.26	19.9
			23.9	32.9	0.14	0.013	0.64	0.82	56.0	0.031	13.20	0.026	1.23	21.1
			22.9	27.3	0.13	0.015	0.91	0.90	55.2	0.031	13.40	0.022	1.27	21.3
			21.8	25.8	0.10	0.013	0.87	0.74	55.8	0.017	10.20	0.031	1.18	19.8
			22.6	25.2	0.13	0.019	0.38	0.72	47.7	0.016	12.90	0.027	1.20	22.4
			23.4	42.8	0.14	0.020	0.34	0.70	64.5	0.018	11.80	0.027	1.37	20.7
			23.1	31.6	0.13	0.014	0.33	0.65	53.0	0.023	10.70	0.028	1.19	19.2
			22.8	27.9	0.11	0.013	0.67	0.64	50.7	0.014	11.80	0.029	1.13	19.3
			21.8	35.5	0.13	0.014	1.15	0.89	68.0	0.105	10.30	0.026	1.12	18.1
			21.7	44.7	0.12	0.015	2.18	1.05	77.2	0.065	11.00	0.028	1.16	19.4
			21.9	46.2	0.12	0.014	2.16	1.21	82.3	0.092	13.10	0.027	1.21	18.5
			21.1	36.7	0.12	0.015	1.31	1.05	80.9	0.089	11.90	0.019	1.13	18.3
	2012 Average		**22.4**	**34.4**	**0.12**	**0.015**	**0.97**	**0.84**	**62.7**	**0.041**	**11.76**	**0.025**	**1.22**	**19.9**
	2012 Max		**23.9**	**46.2**	**0.14**	**0.020**	**2.18**	**1.21**	**82.3**	**0.105**	**13.40**	**0.031**	**1.37**	**22.4**
	2012 Min		**21.1**	**25.2**	**0.10**	**0.013**	**0.33**	**0.64**	**47.7**	**0.014**	**10.20**	**0.018**	**1.12**	**18.1**
	2012 StdDev		**0.8**	**6.9**	**0.01**	**0.002**	**0.60**	**0.17**	**12.3**	**0.032**	**1.11**	**0.004**	**0.08**	**1.2**

				Metal Concentrations										
			Solids	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Zn
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sampling Site	Year	Sample												
CR2	2004		23.5	45.8	0.43	0.010	0.23	0.59	59.1	0.015	8.95	0.028	1.09	19.9
			23.7	72.1	0.54	0.017	0.20	0.72	90.2	0.024	16.40	0.030	1.15	22.7
			22.6	35.2	0.39	0.012	0.18	0.56	55.8	0.014	7.30	0.029	1.00	17.4
			23.2	65.5	0.54	0.016	0.31	0.68	91.1	0.022	11.90	0.032	1.05	22.0
			24.0	59.0	0.45	0.019	0.21	0.66	78.9	0.018	9.82	0.034	1.12	19.6
			25.0	106.0	0.53	0.015	0.30	0.68	117.0	0.030	11.50	0.044	1.06	21.5
	2004 Average		**23.7**	**63.9**	**0.48**	**0.015**	**0.24**	**0.65**	**82.0**	**0.021**	**10.98**	**0.032**	**1.08**	**20.5**
	2004 Max		**25.0**	**106.0**	**0.54**	**0.019**	**0.31**	**0.72**	**117.0**	**0.030**	**16.40**	**0.044**	**1.15**	**22.7**
	2004 Min		**22.6**	**35.2**	**0.39**	**0.010**	**0.18**	**0.56**	**55.8**	**0.014**	**7.30**	**0.028**	**1.00**	**17.4**
	2004 StdDev		**0.8**	**24.6**	**0.07**	**0.003**	**0.05**	**0.06**	**22.8**	**0.006**	**3.15**	**0.006**	**0.05**	**1.9**
	2005		--	68.1	0.62	0.019	0.29	0.83	92.1	0.019	19.20	0.046	0.91	18.9
			--	91.9	0.64	0.018	0.42	0.87	143.0	0.024	20.60	0.043	0.82	17.4
			--	79.6	0.58	0.017	0.36	0.83	108.0	0.025	15.40	0.046	0.85	18.8
			--	91.1	0.60	0.021	0.27	0.87	125.0	0.030	22.40	0.044	0.89	17.7
			--	101.0	0.59	0.019	0.38	0.89	118.0	0.021	19.80	0.046	0.89	18.7
			--	118.0	0.64	0.020	0.37	0.94	135.0	0.033	22.50	0.042	0.86	17.9
	2005 Average		**--**	**91.6**	**0.61**	**0.019**	**0.35**	**0.87**	**120.2**	**0.025**	**19.98**	**0.045**	**0.87**	**18.2**
	2005 Max		**--**	**118.0**	**0.64**	**0.021**	**0.42**	**0.94**	**143.0**	**0.033**	**22.50**	**0.046**	**0.91**	**18.9**
	2005 Min		**--**	**68.1**	**0.58**	**0.017**	**0.27**	**0.83**	**92.1**	**0.019**	**15.40**	**0.042**	**0.82**	**17.4**
	2005 StdDev		**--**	**17.2**	**0.03**	**0.001**	**0.06**	**0.04**	**18.5**	**0.005**	**2.62**	**0.002**	**0.03**	**0.6**
	2006		26.1	129.0	0.56	0.023	0.10	0.92	134.0	0.032	11.60	0.045	0.80	29.6
			25.6	80.1	0.53	0.023	0.11	0.87	101.0	0.021	11.00	0.047	1.00	26.9
			26.2	139.0	0.59	0.028	0.10	0.93	147.0	0.033	13.70	0.043	0.90	26.1
	2006 Average		**26.0**	**116.0**	**0.56**	**0.025**	**0.10**	**0.90**	**127.3**	**0.029**	**12.10**	**0.045**	**0.90**	**27.5**
	2006 Max		**26.2**	**139.0**	**0.59**	**0.028**	**0.11**	**0.93**	**147.0**	**0.033**	**13.70**	**0.047**	**1.00**	**29.6**
	2006 Min		**25.6**	**80.1**	**0.53**	**0.023**	**0.10**	**0.87**	**101.0**	**0.021**	**11.00**	**0.043**	**0.80**	**26.1**
	2006 StdDev		**0.3**	**31.5**	**0.03**	**0.003**	**0.01**	**0.03**	**23.7**	**0.007**	**1.42**	**0.002**	**0.10**	**1.8**
	2007		24.7	89.1	0.40	0.016	0.70	0.75	105.0	0.025	9.22	0.045	1.20	22.2
			23.6	82.7	0.48	0.019	0.30	0.78	107.0	0.027	9.13	0.039	1.40	21.6
			23.2	72.4	0.52	0.014	0.10	0.72	105.0	0.027	10.00	0.041	1.20	21.4
			23.5	48.6	0.37	0.013	0.10	0.69	60.5	0.026	7.60	0.037	1.30	20.6
			24.5	92.9	0.44	0.022	0.10	0.84	118.0	0.040	13.00	0.047	1.10	21.9
			25.9	80.8	0.42	0.016	0.40	0.75	105.0	0.028	13.00	0.042	1.20	22.2
			24.7	91.6	0.52	0.021	0.20	0.74	135.0	0.027	9.83	0.043	1.30	22.6
			23.6	61.1	0.43	0.012	0.20	0.63	81.9	0.022	8.37	0.054	1.30	20.7
			24.4	65.6	0.36	0.013	0.10	0.68	78.6	0.023	8.65	0.039	1.20	21.3
			25.1	72.7	0.50	0.020	0.20	0.98	91.3	0.028	11.80	0.045	1.30	26.6
			23.2	85.4	0.39	0.017	0.20	0.74	87.5	0.025	8.83	0.042	1.20	21.5
			24.9	80.4	0.53	0.017	0.10	0.73	128.0	0.032	22.80	0.042	1.30	21.2
			24.8	96.6	0.44	0.016	0.20	0.70	114.0	0.029	9.49	0.039	1.30	21.3
			23.9	118.0	0.55	0.019	0.10	0.73	139.0	0.034	12.30	0.036	1.20	21.0
			24.2	56.4	0.37	0.012	0.10	0.61	68.6	0.020	6.35	0.039	1.60	19.5
	2007 Average		**24.3**	**79.6**	**0.45**	**0.016**	**0.21**	**0.74**	**101.6**	**0.028**	**10.69**	**0.042**	**1.27**	**21.7**
	2007 Max		**25.9**	**118.0**	**0.55**	**0.022**	**0.70**	**0.98**	**139.0**	**0.040**	**22.80**	**0.054**	**1.60**	**26.6**
	2007 Min		**23.2**	**48.6**	**0.36**	**0.012**	**0.10**	**0.61**	**60.5**	**0.020**	**6.35**	**0.036**	**1.10**	**19.5**
	2007 StdDev		**0.8**	**17.6**	**0.06**	**0.003**	**0.16**	**0.09**	**23.4**	**0.005**	**3.87**	**0.004**	**0.12**	**1.5**
	2008		19.1	38.8	0.42	0.012	0.12	0.59	76.9	0.018	6.67	0.035	0.86	20.5
			19.4	42.8	0.40	0.015	0.19	0.60	74.6	0.019	8.04	0.046	0.96	21.2
			20.2	40.3	0.42	0.013	0.15	0.61	68.6	0.014	6.80	0.047	0.97	21.4
			20.2	32.2	0.38	0.012	0.10	0.59	65.1	0.010	8.32	0.052	1.05	23.6
			19.8	48.0	0.52	0.013	0.18	0.60	89.8	0.016	8.14	0.049	1.00	22.2
			19.9	32.3	0.39	0.015	0.13	0.67	69.6	0.012	7.03	0.049	0.99	21.7
			19.5	37.5	0.52	0.013	0.11	0.59	64.6	0.010	7.10	0.049	0.88	22.5
			20.0	47.2	0.42	0.015	0.23	0.67	81.7	0.012	6.31	0.059	0.93	22.3
			19.8	48.6	0.42	0.017	0.16	0.64	84.7	0.014	6.81	0.049	0.99	22.4
			20.4	47.2	0.43	0.015	0.14	0.63	82.7	0.013	6.75	0.041	0.92	21.6
			20.1	38.3	0.43	0.011	0.13	0.65	71.4	0.012	6.87	0.055	0.96	22.3
			19.6	42.8	0.63	0.012	0.22	0.59	78.4	0.014	6.48	0.046	0.90	21.0
			20.7	57.9	0.44	0.015	0.21	0.65	81.6	0.017	6.80	0.049	1.14	22.9
			19.9	43.3	0.41	0.013	0.26	0.64	70.9	0.014	7.37	0.046	0.86	21.8
			20.5	58.2	0.48	0.015	0.18	0.69	94.6	0.019	7.85	0.048	0.89	22.8
	2008 Average		**19.9**	**43.7**	**0.45**	**0.014**	**0.17**	**0.63**	**77.0**	**0.014**	**7.16**	**0.048**	**0.95**	**22.0**
	2008 Max		**20.7**	**58.2**	**0.63**	**0.017**	**0.26**	**0.69**	**94.6**	**0.019**	**8.32**	**0.059**	**1.14**	**23.6**
	2008 Min		**19.1**	**32.2**	**0.38**	**0.011**	**0.10**	**0.59**	**64.6**	**0.010**	**6.31**	**0.035**	**0.86**	**20.5**
	2008 StdDev		**0.4**	**7.8**	**0.07**	**0.002**	**0.05**	**0.03**	**8.9**	**0.003**	**0.64**	**0.005**	**0.08**	**0.8**

								Metal Concentrations					
			Solids %	Al mg/kg	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Pb mg/kg	Mn mg/kg	Hg mg/kg	Se mg/kg	Zn mg/kg
Sampling Site	**Year**	**Sample**												
CR2 cont.	**2009**		45.1	50.4	0.34	0.020	0.07	0.70	92.1	0.018	10.00	0.025	1.08	17.3
			22.4	33.5	0.32	0.012	0.02	0.59	55.7	0.012	9.10	0.020	1.16	16.9
			21.2	54.5	0.32	0.017	0.06	0.67	82.7	0.017	13.90	0.022	1.13	16.8
			21.1	41.4	0.33	0.013	0.05	0.60	78.7	0.012	6.77	0.044	1.19	17.0
			19.8	22.3	0.31	0.011	0.02	0.53	45.4	0.008	6.88	0.022	1.15	17.9
			21.7	34.6	0.31	0.015	0.03	0.68	59.7	0.012	9.00	0.025	1.12	18.6
			21.8	20.1	0.28	0.010	0.02	0.54	31.9	0.007	9.75	0.037	0.90	18.4
			22.7	32.7	0.26	0.010	0.03	0.58	49.7	0.009	6.98	0.048	0.97	19.3
			23.0	34.0	0.31	0.011	0.03	0.59	53.2	0.011	7.90	0.031	0.99	17.6
			22.2	35.3	0.29	0.013	0.05	0.59	54.0	0.011	6.60	0.037	1.22	17.4
			22.0	56.8	0.37	0.013	0.08	0.65	76.7	0.017	10.50	0.036	1.30	17.6
			22.6	20.7	0.27	0.012	0.02	0.57	37.8	0.009	7.26	0.027	1.21	18.6
			21.0	46.7	0.32	0.013	0.05	0.60	68.2	0.013	11.10	0.026	1.16	17.9
			22.3	28.3	0.27	0.011	0.03	0.61	42.6	0.009	8.47	0.031	1.17	19.0
			21.5	28.2	0.37	0.011	0.03	0.67	52.6	0.012	7.80	0.043	1.12	19.3
	2009 Average		**21.9**	**36.0**	**0.31**	**0.013**	**0.04**	**0.61**	**58.7**	**0.012**	**8.80**	**0.032**	**1.12**	**18.0**
	2009 Max		**23.4**	**56.8**	**0.37**	**0.020**	**0.08**	**0.70**	**92.1**	**0.018**	**13.90**	**0.048**	**1.30**	**19.3**
	2009 Min		**19.8**	**20.1**	**0.26**	**0.010**	**0.02**	**0.53**	**31.9**	**0.007**	**6.60**	**0.020**	**0.90**	**16.8**
	2009 StdDev		**0.9**	**11.8**	**0.03**	**0.003**	**0.02**	**0.05**	**17.5**	**0.003**	**2.02**	**0.009**	**0.10**	**0.8**
	2010		18.3	60.1	0.37	0.015	0.66	0.58	89.9	0.078	13.80	0.036	0.90	17.1
			18.3	53.0	0.27	0.011	0.68	0.56	60.1	0.022	6.36	0.037	0.90	16.2
			18.6	54.5	0.28	0.010	1.24	0.56	71.3	0.037	7.83	0.042	0.80	17.0
			18.7	67.4	0.31	0.012	0.21	0.61	71.7	0.027	7.60	0.040	0.80	16.9
			18.7	65.4	0.30	0.010	0.17	0.53	67.7	0.025	8.07	0.039	0.90	16.9
			18.7	47.1	0.28	0.011	0.19	0.57	51.0	0.022	7.61	0.043	0.80	17.1
			19.0	321.0	1.10	0.015	1.12	0.69	268.0	0.079	28.80	0.044	0.80	16.3
			18.6	62.8	0.28	0.009	0.69	0.58	70.4	0.028	7.15	0.036	0.80	16.3
			17.6	68.1	0.26	0.010	0.22	0.52	72.5	0.018	6.97	0.038	0.80	15.0
			19.4	83.6	0.31	0.014	0.65	0.64	88.1	0.027	9.28	0.034	1.00	18.3
			20.2	77.2	0.31	0.011	0.81	0.62	81.4	0.039	8.52	0.043	1.00	19.4
			19.3	328.0	1.75	0.033	0.69	0.94	590.0	0.123	14.30	0.043	0.90	16.8
			19.1	54.4	0.26	0.009	0.25	0.58	56.0	0.021	8.77	0.037	0.80	17.0
			18.0	88.3	0.32	0.015	0.30	0.61	87.7	0.022	9.47	0.036	0.80	16.1
			23.5	119.0	0.54	0.013	0.89	0.70	191.0	0.049	20.90	0.053	1.00	19.3
	2010 Average		**19.1**	**103.3**	**0.46**	**0.013**	**0.58**	**0.62**	**127.8**	**0.041**	**11.03**	**0.040**	**0.87**	**17.0**
	2010 Max		**23.5**	**328.0**	**1.75**	**0.033**	**1.24**	**0.94**	**590.0**	**0.123**	**28.80**	**0.053**	**1.00**	**19.4**
	2010 Min		**17.6**	**47.1**	**0.26**	**0.009**	**0.17**	**0.52**	**51.0**	**0.018**	**6.36**	**0.034**	**0.80**	**15.0**
	2010 StdDev		**1.4**	**91.6**	**0.42**	**0.006**	**0.35**	**0.10**	**140.4**	**0.030**	**6.24**	**0.005**	**0.08**	**1.2**
	2011		20.7	60.1	0.33	0.013	0.09	0.54	75.9	0.019	9.27	0.052	0.78	17.0
			19.1	68.8	0.35	0.013	0.10	0.50	85.7	0.019	9.00	0.035	0.78	17.3
			20.6	77.6	0.37	0.015	0.15	0.51	91.8	0.021	8.52	0.052	0.82	16.3
			21.4	82.7	0.40	0.013	0.16	0.60	94.3	0.026	12.00	0.041	0.65	17.9
			19.5	235.0	1.58	0.017	0.49	0.98	590.0	0.019	26.70	0.051	0.61	18.7
			20.4	85.0	0.38	0.018	0.16	0.56	97.5	0.024	8.58	0.031	0.62	17.4
			20.6	57.6	0.33	0.013	0.08	0.50	71.0	0.022	8.72	0.035	0.68	18.1
			20.6	76.1	0.39	0.018	0.10	0.58	95.0	0.041	12.00	0.038	0.68	16.9
			22.2	466.0	2.13	0.018	2.96	1.04	1170.0	0.151	25.50	0.040	0.59	17.4
			22.9	508.0	1.39	0.029	2.10	0.92	767.0	0.075	17.30	0.045	0.54	18.2
			20.8	77.4	0.37	0.014	0.13	0.55	91.4	0.026	10.70	0.049	0.58	18.5
			21.0	104.0	0.49	0.017	0.28	0.63	176.0	0.027	11.80	0.039	0.71	18.1
			21.2	72.3	0.50	0.016	0.12	0.65	107.0	0.082	12.20	0.041	0.62	21.2
			21.6	122.0	0.58	0.018	0.83	0.66	287.0	0.152	15.10	0.032	0.59	19.2
			21.0	52.4	0.32	0.013	0.10	0.52	67.7	0.019	10.70	0.054	0.48	15.9
	2011 Average		**20.9**	**143.0**	**0.66**	**0.016**	**0.52**	**0.65**	**257.8**	**0.048**	**13.21**	**0.042**	**0.65**	**17.9**
	2011 Max		**22.9**	**508.0**	**2.13**	**0.029**	**2.96**	**1.04**	**1170.0**	**0.152**	**26.70**	**0.054**	**0.82**	**21.2**
	2011 Min		**19.1**	**52.4**	**0.32**	**0.013**	**0.08**	**0.50**	**67.7**	**0.019**	**8.52**	**0.031**	**0.48**	**15.9**
	2011 StdDev		**0.9**	**146.6**	**0.56**	**0.004**	**0.85**	**0.18**	**327.3**	**0.046**	**5.79**	**0.008**	**0.09**	**1.3**
	2012		21.3	56.2	0.36	0.017	0.34	1.39	97.7	0.021	10.80	0.045	1.17	22.5
			21.0	45.7	0.30	0.012	1.93	3.27	108.0	0.021	9.40	0.038	1.11	20.4
			21.4	40.5	0.30	0.013	0.63	1.26	71.3	0.015	9.46	0.045	1.11	21.7
			21.3	39.3	0.33	0.013	0.73	0.88	69.2	0.014	10.90	0.042	0.96	21.8
			21.7	36.9	0.31	0.014	0.59	0.77	73.5	0.013	8.95	0.043	1.07	22.2
			21.2	50.0	0.34	0.017	1.50	0.76	93.6	0.018	10.30	0.043	1.05	20.4
			22.0	41.0	0.32	0.015	1.04	0.69	77.3	0.012	10.30	0.042	1.11	20.5
			21.5	45.1	0.35	0.015	0.66	0.71	71.5	0.012	9.69	0.042	1.13	21.5
			22.2	32.8	0.35	0.014	1.14	0.67	71.4	0.011	9.48	0.047	1.09	21.0
			21.3	26.9	0.32	0.015	0.41	0.64	59.5	0.011	9.47	0.042	0.95	20.7
			21.5	31.2	0.36	0.014	0.38	0.68	84.4	0.015	9.30	0.035	1.15	20.2
			20.6	37.8	0.37	0.014	0.51	0.85	165.0	0.036	11.50	0.043	0.98	20.2
			21.6	47.7	0.36	0.016	0.63	0.77	78.0	0.014	8.37	0.043	1.20	21.5
			21.6	40.3	0.36	0.016	0.47	0.71	76.2	0.014	9.50	0.044	1.23	21.2
			22.1	26.9	0.34	0.015	0.43	0.68	62.1	0.012	9.17	0.042	1.21	23.3
	2012 Average		**21.5**	**39.9**	**0.34**	**0.015**	**0.76**	**0.98**	**83.9**	**0.016**	**9.77**	**0.042**	**1.10**	**21.3**
	2012 Max		**22.2**	**56.2**	**0.37**	**0.017**	**1.93**	**3.27**	**165.0**	**0.036**	**11.50**	**0.047**	**1.23**	**23.3**
	2012 Min		**20.6**	**26.9**	**0.30**	**0.012**	**0.34**	**0.64**	**59.5**	**0.011**	**8.37**	**0.035**	**0.95**	**20.2**
	2012 StdDev		**0.4**	**8.3**	**0.02**	**0.001**	**0.46**	**0.67**	**26.0**	**0.006**	**0.83**	**0.003**	**0.09**	**0.9**

				Metal Concentrations										
			Solids	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Zn
Sampling Site	Year	Sample	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
CR1	**2004**		24.6	44.0	0.27	0.016	0.10	0.62	59.0	0.015	9.70	0.030	0.96	18.5
			24.0	47.9	0.31	0.012	0.09	0.62	58.1	0.016	13.50	0.028	1.06	18.5
			24.4	41.3	0.26	0.016	0.12	0.62	49.0	0.015	12.50	0.030	1.06	19.1
			23.4	47.3	0.28	0.016	0.09	0.60	54.4	0.017	12.00	0.031	0.97	18.3
			23.4	53.5	0.33	0.016	0.09	0.59	62.9	0.018	10.50	0.034	1.16	18.8
			22.4	56.1	0.29	0.017	0.14	0.68	60.7	0.022	11.00	0.026	1.04	17.7
			23.7	41.3	0.26	0.016	0.10	0.59	52.9	0.013	11.10	0.027	1.04	16.4
			24.2	41.3	0.28	0.015	0.10	0.61	52.3	0.015	13.70	0.029	1.14	18.0
			24.1	58.1	0.30	0.020	0.11	0.58	63.8	0.016	9.55	0.030	1.15	19.6
			23.8	58.2	0.26	0.015	0.15	0.63	63.4	0.019	11.90	0.026	1.09	18.7
			24.9	51.6	0.28	0.020	0.25	0.60	62.8	0.028	8.84	0.027	1.22	18.5
			23.8	62.8	0.33	0.023	0.22	0.68	70.8	0.022	14.40	0.025	1.05	19.1
			23.7	104.0	0.35	0.015	0.28	0.61	153.0	0.038	17.30	0.025	1.00	16.9
			24.5	41.6	0.29	0.015	0.33	0.60	54.0	0.016	9.91	0.034	0.94	18.4
			24.3	64.0	0.28	0.015	0.14	0.61	68.0	0.022	13.50	0.028	0.92	17.9
	2004 Average		**23.9**	**54.2**	**0.29**	**0.016**	**0.15**	**0.62**	**65.7**	**0.019**	**11.96**	**0.029**	**1.05**	**18.3**
	2004 Max		**24.9**	**104.0**	**0.35**	**0.023**	**0.33**	**0.68**	**153.0**	**0.038**	**17.30**	**0.034**	**1.22**	**19.6**
	2004 Min		**22.4**	**41.3**	**0.26**	**0.012**	**0.09**	**0.58**	**49.0**	**0.013**	**8.84**	**0.025**	**0.92**	**16.4**
	2004 StdDev		**0.6**	**15.9**	**0.03**	**0.003**	**0.08**	**0.03**	**24.9**	**0.006**	**2.25**	**0.003**	**0.09**	**0.8**
	2005		--	73.6	0.33	0.023	0.16	1.84	84.1	0.023	14.70	0.030	1.19	20.1
			--	78.4	0.29	0.025	0.31	0.89	91.6	0.026	14.70	0.031	1.25	19.7
			--	71.2	0.32	0.029	0.23	1.03	94.5	0.028	15.10	0.038	1.12	20.1
			--	243.0	0.39	0.024	1.09	1.10	264.0	0.046	18.50	0.034	1.05	19.7
			--	86.1	0.32	0.026	0.60	1.02	104.0	0.027	16.10	0.033	1.11	20.3
			--	118.0	0.33	0.027	0.27	1.07	124.0	0.029	16.70	0.030	0.99	19.2
			--	60.6	0.31	0.020	0.29	1.25	79.0	0.020	14.40	0.034	1.10	18.9
			--	72.0	0.29	0.025	0.52	0.97	90.5	0.024	15.80	0.035	1.03	18.9
			--	48.0	0.30	0.026	0.28	1.43	71.7	0.022	15.30	0.032	1.11	20.0
			--	52.8	0.27	0.021	0.29	1.24	76.2	0.017	13.40	0.038	1.07	18.9
			--	73.3	0.31	0.025	0.23	1.30	89.6	0.026	14.30	0.032	1.16	19.4
			--	59.6	0.31	0.026	0.37	0.87	79.0	0.019	17.40	0.035	1.15	18.8
			--	62.4	0.29	0.025	0.23	1.24	84.7	0.019	15.20	0.038	1.07	20.1
			--	63.2	0.33	0.024	0.29	1.09	85.9	0.021	16.80	0.031	1.06	18.3
			--	63.6	0.32	0.027	0.23	1.13	81.0	0.024	16.30	0.030	1.09	19.5
	2005 Average		**--**	**81.7**	**0.31**	**0.025**	**0.36**	**1.16**	**100.0**	**0.025**	**15.65**	**0.033**	**1.10**	**19.5**
	2005 Max		**--**	**243.0**	**0.39**	**0.029**	**1.09**	**1.84**	**264.0**	**0.046**	**18.50**	**0.038**	**1.25**	**20.3**
	2005 Min		**--**	**48.0**	**0.27**	**0.020**	**0.16**	**0.87**	**71.7**	**0.017**	**13.40**	**0.030**	**0.99**	**18.3**
	2005 StdDev		**--**	**47.5**	**0.03**	**0.002**	**0.23**	**0.24**	**47.1**	**0.007**	**1.34**	**0.003**	**0.07**	**0.6**
	2006		24.2	134.0	0.43	0.027	0.10	0.77	137.0	0.034	14.70	0.035	0.80	20.5
			24.7	170.0	0.46	0.030	0.13	0.81	167.0	0.044	16.40	0.034	0.80	22.1
			24.4	144.0	0.42	0.029	0.10	0.82	141.0	0.033	15.50	0.033	0.80	20.4
			23.7	136.0	0.41	0.027	0.17	0.75	134.0	0.033	14.00	0.034	0.70	18.9
			24.9	149.0	0.44	0.028	0.12	0.83	146.0	0.040	16.10	0.037	0.80	21.5
			24.4	106.0	0.40	0.025	0.10	0.83	110.0	0.023	16.10	0.029	1.10	19.7
			23.6	113.0	0.45	0.029	0.09	0.85	120.0	0.031	14.60	0.031	1.00	20.8
			23.6	67.1	0.39	0.023	0.15	0.76	78.5	0.018	14.30	0.028	1.00	17.5
			23.6	71.6	0.37	0.020	0.09	0.73	80.6	0.018	12.60	0.027	0.90	18.4
			22.8	82.8	0.42	0.023	0.09	0.76	90.6	0.019	15.00	0.033	1.00	18.8
			23.8	101.0	0.44	0.028	0.09	0.77	104.0	0.025	14.80	0.032	0.90	19.5
			23.4	81.5	0.43	0.024	0.09	0.71	86.3	0.019	13.40	0.027	1.00	19.6
			23.8	107.0	0.45	0.032	0.09	0.85	112.0	0.027	14.70	0.028	0.90	20.1
			23.7	89.2	0.42	0.031	0.09	0.81	101.0	0.024	16.00	0.035	0.90	19.8
			23.2	106.0	0.39	0.028	0.11	0.76	111.0	0.028	14.80	0.032	0.80	19.5
			25.4	91.2	0.45	0.024	0.10	0.81	99.5	0.025	13.70	0.040	1.00	22.3
			23.9	105.0	0.42	0.034	0.71	0.87	114.0	0.026	15.40	0.037	0.80	20.7
			25.3	92.1	0.42	0.034	0.10	0.99	98.2	0.027	16.10	0.035	0.70	24.4
			24.0	82.4	0.47	0.022	0.10	0.80	106.0	0.023	12.20	0.038	0.70	23.0
			24.5	75.5	0.49	0.025	0.10	0.91	93.3	0.021	11.50	0.046	0.70	24.6
			24.5	87.6	0.54	0.027	0.10	0.99	110.0	0.026	12.30	0.044	0.80	22.7
			23.7	90.0	0.55	0.021	0.09	0.93	118.0	0.023	24.50	0.045	0.80	23.4
			25.0	82.9	0.51	0.020	0.10	0.88	105.0	0.021	14.60	0.037	0.70	24.7
			24.7	114.0	0.51	0.024	0.10	0.89	130.0	0.028	16.00	0.039	0.70	26.6
			23.6	129.0	0.52	0.025	0.12	0.98	140.0	0.030	14.40	0.038	0.70	24.7
	2006 Average		**24.1**	**104.3**	**0.45**	**0.026**	**0.13**	**0.83**	**113.3**	**0.027**	**14.95**	**0.035**	**0.84**	**21.4**
	2006 Max		**25.4**	**170.0**	**0.55**	**0.034**	**0.71**	**0.99**	**167.0**	**0.044**	**24.50**	**0.046**	**1.10**	**26.6**
	2006 Min		**22.8**	**67.1**	**0.37**	**0.020**	**0.09**	**0.71**	**78.5**	**0.018**	**11.50**	**0.027**	**0.70**	**17.5**
	2006 StdDev		**0.7**	**26.5**	**0.05**	**0.004**	**0.12**	**0.08**	**21.9**	**0.007**	**2.40**	**0.005**	**0.12**	**2.4**

Sampling Site	Year	Sample	Solids %	Al mg/kg	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Pb mg/kg	Mn mg/kg	Hg mg/kg	Se mg/kg	Zn mg/kg
			Metal Concentrations											
CR1 cont.	2007		23.6	89.0	0.34	0.026	0.20	0.68	109.0	0.035	13.50	0.025	0.90	21.2
			24.7	137.0	0.31	0.023	0.20	0.67	117.0	0.038	12.20	0.049	0.80	21.2
			23.6	74.0	0.35	0.023	0.10	0.67	78.2	0.030	13.70	0.027	0.78	21.5
			23.3	101.0	0.29	0.024	0.10	0.66	100.0	0.031	11.00	0.020	0.91	19.9
			23.8	98.1	0.35	0.021	0.10	0.66	110.0	0.032	12.70	0.024	0.93	19.2
			23.9	114.0	0.29	0.023	0.50	0.71	111.0	0.032	12.50	0.026	0.86	18.9
			23.4	73.0	0.27	0.018	0.10	0.64	71.9	0.022	9.09	0.022	0.82	18.4
			24.3	68.7	0.29	0.020	0.10	0.65	78.0	0.020	9.97	0.024	0.95	18.7
			24.0	116.0	0.34	0.022	0.20	0.70	99.5	0.033	11.90	0.032	0.85	21.5
			22.8	62.8	0.31	0.017	0.10	0.58	60.5	0.018	9.20	0.028	0.83	18.3
			24.1	63.0	0.30	0.017	0.10	0.60	65.3	0.018	11.20	0.026	0.89	19.8
			23.7	65.7	0.32	0.019	0.10	0.59	78.5	0.021	10.80	0.029	0.88	17.6
			22.2	74.6	0.30	0.019	0.10	0.60	79.7	0.021	12.60	0.029	0.95	18.3
			22.3	68.6	0.30	0.020	0.10	0.62	69.8	0.021	10.90	0.025	0.79	18.4
			22.7	81.6	0.30	0.021	0.10	0.71	79.5	0.023	10.10	0.025	0.80	17.6
	2007 Average		**23.5**	**85.8**	**0.31**	**0.021**	**0.15**	**0.65**	**87.2**	**0.026**	**11.42**	**0.027**	**0.86**	**19.4**
	2007 Max		**24.7**	**137.0**	**0.35**	**0.026**	**0.50**	**0.71**	**117.0**	**0.038**	**13.70**	**0.049**	**0.95**	**21.5**
	2007 Min		**22.2**	**62.8**	**0.27**	**0.017**	**0.10**	**0.58**	**60.5**	**0.018**	**9.09**	**0.020**	**0.78**	**17.6**
	2007 StdDev		**0.7**	**22.7**	**0.02**	**0.003**	**0.11**	**0.04**	**18.6**	**0.007**	**1.46**	**0.007**	**0.06**	**1.4**
	2008		20.7	41.7	0.27	0.017	0.11	0.55	59.7	0.028	9.91	0.036	0.84	22.1
			19.9	49.1	0.26	0.020	0.21	0.58	84.1	0.034	10.70	0.046	0.73	21.0
			20.4	40.5	0.27	0.017	0.16	0.58	57.0	0.014	8.74	0.040	0.87	19.7
			20.5	63.7	0.30	0.021	0.13	0.59	74.9	0.018	9.41	0.039	0.87	21.0
			20.5	48.1	0.30	0.018	0.18	0.60	72.0	0.015	9.81	0.041	0.90	22.1
			20.1	50.9	0.29	0.016	0.17	0.59	63.4	0.014	10.00	0.040	0.81	21.5
			19.9	68.0	0.33	0.018	0.18	0.63	123.0	0.021	9.93	0.039	0.84	22.0
			20.8	45.4	0.28	0.015	0.14	0.56	57.4	0.013	8.24	0.041	0.85	21.8
			21.2	46.3	0.30	0.020	0.20	0.58	62.8	0.014	11.10	0.046	0.88	23.7
			20.3	48.1	0.32	0.020	0.11	0.61	58.6	0.015	8.92	0.045	0.84	22.1
			20.4	69.7	0.31	0.020	0.15	0.60	80.5	0.020	9.09	0.038	0.80	20.8
			20.7	46.5	0.29	0.018	0.18	0.56	57.9	0.014	11.20	0.041	0.83	21.2
			20.4	61.1	0.30	0.021	0.25	0.61	74.4	0.017	9.77	0.040	0.87	21.9
			20.6	53.3	0.31	0.021	0.14	0.60	69.5	0.015	11.10	0.050	0.89	20.6
			20.3	24.8	0.24	0.015	0.09	0.55	39.3	0.009	8.80	0.037	0.87	21.8
	2008 Average		**20.4**	**50.5**	**0.29**	**0.018**	**0.16**	**0.58**	**69.0**	**0.017**	**9.78**	**0.041**	**0.85**	**21.6**
	2008 Max		**21.2**	**69.7**	**0.33**	**0.021**	**0.25**	**0.63**	**123.0**	**0.034**	**11.20**	**0.050**	**0.90**	**23.7**
	2008 Min		**19.9**	**24.8**	**0.24**	**0.015**	**0.09**	**0.55**	**39.3**	**0.009**	**8.24**	**0.036**	**0.73**	**19.7**
	2008 StdDev		**0.3**	**11.6**	**0.02**	**0.002**	**0.04**	**0.02**	**18.7**	**0.006**	**0.93**	**0.004**	**0.04**	**0.9**
	2009		22.1	60.0	0.24	0.010	0.08	0.51	61.3	0.015	9.09	0.030	0.71	15.7
			20.9	71.1	0.23	0.010	0.10	0.55	64.4	0.017	9.97	0.028	0.80	16.3
			21.4	122.0	0.28	0.015	0.15	0.54	115.0	0.026	11.40	0.028	0.77	16.4
			20.6	77.3	0.22	0.012	0.08	0.55	75.9	0.018	10.00	0.037	0.75	16.0
			19.3	59.0	0.22	0.012	0.08	0.53	58.5	0.014	10.30	0.021	0.67	15.9
			19.3	60.6	0.21	0.012	0.06	0.53	65.8	0.017	9.46	0.024	0.72	16.2
			20.6	120.0	0.28	0.012	0.14	0.52	113.0	0.028	20.10	0.027	0.66	14.5
			19.5	56.9	0.22	0.013	0.06	0.54	55.4	0.014	9.90	0.026	0.72	17.2
			18.8	65.9	0.19	0.010	0.09	0.53	60.9	0.015	8.42	0.023	0.66	14.3
			18.2	81.5	0.23	0.013	0.08	0.54	77.2	0.019	11.20	0.020	0.67	15.6
			18.6	139.0	0.24	0.008	0.18	0.45	123.0	0.031	11.60	0.024	0.62	13.9
			17.4	78.4	0.20	0.010	0.09	0.50	76.2	0.019	9.30	0.024	0.68	13.7
			20.6	57.5	0.22	0.011	0.06	0.50	53.6	0.013	9.22	0.023	0.75	14.7
			20.8	90.1	0.24	0.016	0.09	0.56	84.4	0.020	11.10	0.028	0.76	15.9
			21.3	48.6	0.23	0.009	0.09	0.52	48.5	0.012	8.79	0.024	0.76	16.1
	2009 Average		**20.0**	**79.2**	**0.23**	**0.012**	**0.09**	**0.52**	**75.5**	**0.018**	**10.66**	**0.026**	**0.71**	**15.5**
	2009 Max		**22.1**	**139.0**	**0.28**	**0.016**	**0.18**	**0.56**	**123.0**	**0.031**	**20.10**	**0.037**	**0.80**	**17.2**
	2009 Min		**17.4**	**48.6**	**0.19**	**0.008**	**0.06**	**0.45**	**48.5**	**0.012**	**8.42**	**0.020**	**0.62**	**13.7**
	2009 StdDev		**1.3**	**27.3**	**0.02**	**0.002**	**0.03**	**0.03**	**23.7**	**0.006**	**2.79**	**0.004**	**0.05**	**1.0**
	2010		22.3	84.8	0.27	0.015	0.20	0.58	72.8	0.026	13.10	0.027	0.64	22.1
			21.9	55.9	0.21	0.012	0.16	0.54	52.3	0.017	13.40	0.023	0.71	21.2
			21.0	42.1	0.23	0.012	0.14	0.51	41.8	0.017	12.20	0.027	0.67	20.4
			21.3	74.9	0.24	0.014	0.48	0.62	70.5	0.029	13.10	0.029	0.59	19.8
			21.6	63.0	0.23	0.012	0.53	0.61	60.7	0.025	10.70	0.033	0.57	19.1
			21.9	50.5	0.22	0.012	0.17	0.53	49.6	0.024	13.10	0.029	0.59	19.0
			21.5	47.4	0.22	0.011	0.07	0.48	45.1	0.018	11.30	0.041	0.62	17.0
			21.6	69.1	0.25	0.012	0.10	0.54	63.4	0.024	12.10	0.027	0.64	18.4
			22.5	94.0	0.25	0.015	0.15	0.55	81.7	0.029	14.60	0.023	0.64	19.4
			21.6	37.2	0.22	0.010	0.09	0.45	37.6	0.016	11.30	0.028	0.54	17.7
			22.2	65.6	0.25	0.013	0.19	0.56	63.5	0.023	15.80	0.027	0.73	21.0
			22.3	46.3	0.24	0.009	0.07	0.47	44.2	0.019	11.60	0.029	0.59	18.2
			22.2	66.5	0.24	0.012	0.10	0.50	58.6	0.023	11.80	0.026	0.63	19.2
			21.8	66.6	0.24	0.012	0.19	0.51	61.7	0.023	11.80	0.029	0.63	17.9
			21.8	44.7	0.22	0.012	0.11	0.48	48.0	0.021	12.30	0.041	0.57	18.0
	2010 Average		**21.8**	**60.6**	**0.23**	**0.012**	**0.18**	**0.53**	**56.8**	**0.022**	**12.55**	**0.029**	**0.62**	**19.2**
	2010 Max		**22.5**	**94.0**	**0.27**	**0.015**	**0.53**	**0.62**	**81.7**	**0.029**	**15.80**	**0.041**	**0.73**	**22.1**
	2010 Min		**21.0**	**37.2**	**0.21**	**0.009**	**0.07**	**0.45**	**37.6**	**0.016**	**10.70**	**0.023**	**0.54**	**17.0**
	2010 StdDev		**0.4**	**16.3**	**0.02**	**0.002**	**0.14**	**0.05**	**12.6**	**0.004**	**1.35**	**0.005**	**0.05**	**1.4**

								Metal Concentrations					
			Solids %	Al mg/kg	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Pb mg/kg	Mn mg/kg	Hg mg/kg	Se mg/kg	Zn mg/kg
Sampling Site	**Year**	**Sample**												
CR1 cont.	**2011**		22.4	128.0	0.25	0.022	0.22	0.61	114.0	0.043	10.90	0.031	0.70	20.0
			21.3	106.0	0.24	0.018	0.20	0.55	98.2	0.035	9.26	0.023	0.63	19.0
			21.1	107.0	0.22	0.017	0.18	0.52	90.9	0.037	9.59	0.025	0.59	17.3
			21.9	84.3	0.24	0.017	0.16	0.54	81.2	0.031	10.60	0.024	0.62	18.9
			19.9	109.0	0.23	0.016	0.19	0.51	94.2	0.039	9.16	0.023	0.54	17.9
			20.2	88.4	0.24	0.018	0.16	0.55	91.4	0.033	12.30	0.023	0.50	17.3
			22.2	94.3	0.24	0.018	0.16	0.57	84.3	0.046	12.00	0.032	0.68	19.7
			21.5	87.6	0.23	0.017	0.17	0.52	80.0	0.032	9.92	0.027	0.65	18.7
			22.4	101.0	0.22	0.018	0.15	0.58	89.4	0.032	9.32	0.026	0.74	18.3
			21.9	90.2	0.22	0.016	0.15	0.54	80.5	0.031	11.00	0.024	0.64	18.7
			22.6	108.0	0.26	0.020	0.17	0.55	109.0	0.038	12.30	0.023	0.74	19.6
			22.2	72.3	0.21	0.016	0.12	0.52	65.5	0.027	9.57	0.025	0.71	18.6
			21.4	81.8	0.21	0.016	0.15	0.50	78.5	0.028	11.00	0.028	0.76	19.4
			21.3	90.4	0.22	0.016	0.17	0.53	84.6	0.031	10.10	0.033	0.72	17.9
			21.1	99.5	0.21	0.017	0.18	0.54	95.9	0.031	10.70	0.025	0.58	18.1
	2011 Average		**21.6**	**96.5**	**0.23**	**0.017**	**0.17**	**0.54**	**89.2**	**0.034**	**10.51**	**0.026**	**0.65**	**18.6**
	2011 Max		**22.6**	**128.0**	**0.26**	**0.022**	**0.22**	**0.61**	**114.0**	**0.046**	**12.30**	**0.033**	**0.76**	**20.0**
	2011 Min		**19.9**	**72.3**	**0.21**	**0.016**	**0.12**	**0.50**	**65.5**	**0.027**	**9.16**	**0.023**	**0.50**	**17.3**
	2011 StdDev		**0.8**	**13.9**	**0.02**	**0.002**	**0.02**	**0.03**	**12.3**	**0.005**	**1.08**	**0.003**	**0.08**	**0.8**
	2012		21.0	55.7	0.20	0.014	2.54	3.74	98.4	0.983	9.88	0.030	0.80	24.2
			21.3	45.1	0.23	0.014	1.84	2.26	74.2	0.446	10.80	0.030	0.83	21.9
			20.7	46.0	0.20	0.014	0.43	1.03	56.4	0.114	10.40	0.030	0.87	21.5
			21.5	53.4	0.23	0.016	1.01	0.94	71.7	0.096	11.40	0.034	0.86	21.2
			22.5	63.9	0.22	0.017	1.55	0.93	83.5	0.077	10.10	0.030	0.87	21.7
			20.9	46.8	0.24	0.015	0.74	0.71	60.5	0.033	10.30	0.028	0.80	21.3
			21.6	59.2	0.23	0.014	1.27	0.78	66.8	0.047	10.60	0.028	0.96	21.2
			22.1	55.4	0.22	0.019	0.57	0.81	63.6	0.047	8.21	0.026	0.87	20.5
			22.0	44.2	0.21	0.015	0.69	0.66	55.8	0.023	8.50	0.030	0.85	18.9
			21.0	53.8	0.20	0.016	0.86	0.97	67.5	0.063	9.49	0.027	0.89	20.6
			20.8	83.6	0.32	0.017	1.16	1.01	126.0	0.081	39.30	0.025	0.85	19.3
			21.8	40.4	0.20	0.013	0.84	0.86	54.9	0.067	8.93	0.026	0.80	19.9
			21.3	66.4	0.21	0.016	1.58	0.81	68.1	0.040	9.35	0.032	0.81	20.2
			22.1	60.2	0.24	0.018	0.54	0.79	68.5	0.030	12.30	0.029	0.87	22.8
			22.0	60.2	0.23	0.016	1.32	0.87	75.8	0.044	10.20	0.029	0.90	22.4
	2012 Average		**21.5**	**55.6**	**0.23**	**0.016**	**1.13**	**1.14**	**72.8**	**0.146**	**11.98**	**0.029**	**0.86**	**21.2**
	2012 Max		**22.5**	**83.6**	**0.32**	**0.019**	**2.54**	**3.74**	**126.0**	**0.983**	**39.30**	**0.034**	**0.96**	**24.2**
	2012 Min		**20.7**	**40.4**	**0.20**	**0.013**	**0.43**	**0.66**	**54.9**	**0.023**	**8.21**	**0.025**	**0.80**	**18.9**
	2012 StdDev		**0.6**	**10.9**	**0.03**	**0.002**	**0.57**	**0.81**	**18.6**	**0.253**	**7.63**	**0.002**	**0.04**	**1.4**
CR0.7	**2006**		25.9	83.6	0.42	0.031	0.10	0.90	93.5	0.021	16.80	0.030	1.20	22.6
			25.5	116.0	0.48	0.036	0.10	1.25	115.0	0.034	14.80	0.032	1.20	23.5
			25.1	86.1	0.44	0.034	0.10	0.96	94.4	0.027	16.10	0.030	1.10	22.7
			24.8	96.5	0.41	0.030	0.10	0.95	97.6	0.024	15.70	0.029	0.90	23.9
			25.2	100.0	0.42	0.029	0.10	0.94	98.9	0.024	15.60	0.032	0.90	22.0
			24.5	88.8	0.38	0.029	0.10	0.94	89.3	0.024	12.10	0.030	0.90	22.1
			24.5	99.7	0.41	0.033	0.10	0.94	102.0	0.025	16.10	0.032	0.90	23.2
			24.4	284.0	0.44	0.022	0.62	0.90	175.0	0.039	13.70	0.032	0.90	22.5
			24.1	105.0	0.42	0.029	0.15	0.93	116.0	0.029	13.20	0.032	0.90	21.4
			24.7	115.0	0.42	0.028	0.25	0.91	112.0	0.025	12.20	0.032	0.90	22.7
			23.4	99.3	0.41	0.026	0.09	0.94	103.0	0.023	11.20	0.026	0.90	20.8
			23.7	105.0	0.52	0.026	0.12	0.95	109.0	0.023	12.10	0.030	0.90	20.9
			24.4	92.1	0.40	0.025	0.54	0.91	104.0	0.026	12.10	0.029	0.80	20.4
			24.4	69.9	0.36	0.028	0.10	0.85	81.9	0.021	10.80	0.027	0.80	19.0
			26.2	91.8	0.42	0.036	0.15	1.03	99.3	0.025	19.70	0.031	1.00	23.6
			25.0	70.5	0.40	0.030	0.12	0.94	184.0	0.031	25.20	0.027	0.80	23.4
			26.2	79.9	0.41	0.032	0.10	0.89	88.5	0.022	19.10	0.031	1.00	24.3
			26.8	107.0	0.42	0.035	0.13	1.14	121.0	0.035	17.70	0.036	1.10	26.9
			26.5	89.0	0.42	0.030	0.11	0.92	101.0	0.031	16.20	0.038	1.10	26.0
			25.5	97.5	0.41	0.041	0.10	1.21	109.0	0.042	22.70	0.029	1.00	25.7
			28.2	88.3	0.40	0.040	0.11	1.06	98.9	0.027	21.30	0.036	1.00	26.3
			25.5	59.8	0.43	0.030	0.20	0.94	76.1	0.018	11.80	0.028	1.00	22.2
			27.0	495.0	0.81	0.042	0.74	1.34	639.0	0.086	37.60	0.031	1.20	23.2
			25.7	53.4	0.42	0.037	0.10	0.99	79.7	0.020	15.60	0.028	1.20	24.5
			26.1	61.6	0.42	0.036	0.10	0.94	91.2	0.024	17.40	0.035	1.20	23.5
			26.8	112.0	0.47	0.038	0.10	1.09	121.0	0.035	21.90	0.030	1.20	25.7
			25.5	70.2	0.43	0.032	0.10	0.95	85.2	0.023	15.40	0.035	1.20	24.9
			24.4	64.0	0.38	0.037	0.10	0.91	80.6	0.018	15.30	0.028	1.00	20.6
			24.6	85.0	0.41	0.030	0.10	0.94	96.9	0.024	16.00	0.039	1.10	24.3
	2006 Average		**25.3**	**109.2**	**0.43**	**0.032**	**0.17**	**0.98**	**122.9**	**0.028**	**16.74**	**0.031**	**1.01**	**23.2**
	2006 Max		**28.2**	**495.0**	**0.81**	**0.042**	**0.74**	**1.34**	**639.0**	**0.086**	**37.60**	**0.039**	**1.20**	**26.9**
	2006 Min		**23.4**	**53.4**	**0.36**	**0.022**	**0.09**	**0.85**	**76.1**	**0.018**	**10.80**	**0.026**	**0.80**	**19.0**
	2006 StdDev		**1.1**	**84.3**	**0.08**	**0.005**	**0.17**	**0.12**	**102.1**	**0.013**	**5.40**	**0.003**	**0.14**	**1.9**

								Metal Concentrations						
			Solids	Al	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Zn
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sampling Site	**Year**	**Sample**												
CR0.7 cont.	**2007**		26.5	83.4	0.31	0.022	0.19	0.68	90.0	0.024	11.80	0.028	1.17	19.3
			24.1	60.2	0.28	0.019	0.24	0.61	69.2	0.020	11.90	0.082	1.13	19.6
			24.3	61.7	0.28	0.017	0.13	0.61	69.2	0.020	12.40	0.025	1.02	18.6
			27.2	85.0	0.32	0.024	0.29	0.95	107.0	0.032	12.70	0.029	1.07	20.3
			24.3	209.0	0.29	0.027	0.31	0.73	172.0	0.040	11.30	0.022	1.04	19.8
			25.0	133.0	0.29	0.023	0.24	0.73	148.0	0.038	12.80	0.034	0.99	18.1
			24.6	86.2	0.31	0.018	0.14	0.64	86.7	0.025	11.80	0.032	1.07	18.4
			26.4	94.0	0.36	0.021	0.23	0.95	104.0	0.042	15.30	0.037	1.01	22.9
			23.7	92.2	0.30	0.019	0.15	0.61	88.4	0.023	11.50	0.028	0.96	19.1
			24.5	95.9	0.33	0.023	0.14	0.71	107.0	0.026	12.20	0.028	0.95	19.8
			26.3	114.0	0.30	0.030	0.18	0.78	116.0	0.031	11.70	0.033	1.15	19.8
			26.5	81.7	0.29	0.021	0.20	0.60	81.7	0.022	10.40	0.031	1.07	18.7
			25.9	118.0	0.34	0.025	0.21	0.78	115.0	0.037	14.80	0.028	1.00	21.0
			23.4	53.5	0.28	0.016	0.11	0.58	69.0	0.019	10.30	0.027	0.94	19.8
			25.8	42.1	0.27	0.014	0.13	0.54	48.5	0.013	9.43	0.039	0.95	18.0
	2007 Average		**25.2**	**94.0**	**0.30**	**0.021**	**0.19**	**0.70**	**98.1**	**0.027**	**12.02**	**0.034**	**1.03**	**19.5**
	2007 Max		**27.2**	**209.0**	**0.36**	**0.030**	**0.31**	**0.95**	**172.0**	**0.042**	**15.30**	**0.082**	**1.17**	**22.9**
	2007 Min		**23.4**	**42.1**	**0.27**	**0.014**	**0.11**	**0.54**	**48.5**	**0.013**	**9.43**	**0.022**	**0.94**	**18.0**
	2007 StdDev		**1.2**	**40.2**	**0.03**	**0.004**	**0.06**	**0.12**	**31.9**	**0.009**	**1.54**	**0.014**	**0.07**	**1.2**
	2008		18.8	32.3	0.24	0.012	0.07	0.50	41.8	0.012	9.64	0.027	0.88	20.5
			18.5	40.7	0.29	0.020	0.15	0.53	48.3	0.045	9.82	0.040	0.99	20.6
			18.4	35.4	0.26	0.014	0.15	0.52	46.4	0.011	9.07	0.049	0.98	19.6
			18.9	40.4	0.24	0.013	0.15	0.52	50.8	0.013	8.63	0.037	1.00	19.6
			18.9	43.8	0.29	0.018	0.13	0.64	57.0	0.015	9.37	0.042	0.94	18.8
			19.1	40.9	0.27	0.017	0.14	0.53	48.7	0.012	10.30	0.046	0.92	18.7
			19.5	54.5	0.29	0.019	0.15	0.58	58.8	0.015	10.40	0.039	0.89	21.4
			19.1	42.2	0.25	0.018	0.12	0.53	55.4	0.012	11.60	0.038	0.81	18.5
			18.0	42.3	0.24	0.013	0.10	0.53	48.8	0.013	9.26	0.037	0.82	19.0
			19.1	40.0	0.26	0.014	0.10	0.51	45.0	0.011	9.66	0.029	0.85	20.1
			18.7	43.9	0.30	0.015	0.13	0.51	48.7	0.013	9.50	0.039	0.89	19.5
			19.4	62.2	0.26	0.016	0.18	0.54	66.1	0.035	10.20	0.035	0.89	20.0
			18.7	36.5	0.27	0.014	0.14	0.48	44.1	0.010	9.54	0.040	0.87	20.9
			19.1	38.8	0.26	0.015	0.15	0.52	77.0	0.014	17.40	0.040	0.94	20.5
			19.4	43.2	0.29	0.022	0.26	0.55	50.3	0.013	9.33	0.039	0.90	20.6
	2008 Average		**18.9**	**42.5**	**0.27**	**0.016**	**0.14**	**0.53**	**52.5**	**0.016**	**10.25**	**0.038**	**0.90**	**19.9**
	2008 Max		**19.5**	**62.2**	**0.30**	**0.022**	**0.26**	**0.64**	**77.0**	**0.045**	**17.40**	**0.049**	**1.00**	**21.4**
	2008 Min		**18.0**	**32.3**	**0.24**	**0.012**	**0.07**	**0.48**	**41.8**	**0.010**	**8.63**	**0.027**	**0.81**	**18.5**
	2008 StdDev		**0.4**	**7.4**	**0.02**	**0.003**	**0.04**	**0.04**	**9.3**	**0.010**	**2.10**	**0.006**	**0.06**	**0.9**
	2009		21.7	29.1	0.21	0.012	0.04	0.57	34.0	0.010	7.91	0.026	1.06	16.7
			20.4	33.1	0.24	0.014	0.03	0.64	36.7	0.010	7.70	0.023	1.11	16.5
			21.1	32.9	0.22	0.014	0.03	0.68	38.0	0.009	9.97	0.027	1.09	16.6
			21.7	35.0	0.22	0.015	0.04	0.63	38.0	0.009	8.36	0.025	1.08	15.1
			19.7	36.6	0.21	0.014	0.04	0.57	38.3	0.009	8.22	0.023	0.99	15.3
			20.9	85.9	0.24	0.012	0.11	0.54	78.0	0.020	10.50	0.025	0.96	15.7
			19.9	26.1	0.19	0.012	0.02	0.55	29.9	0.008	7.62	0.019	0.89	14.8
			20.9	33.4	0.21	0.011	0.04	0.49	36.4	0.010	9.15	0.019	0.98	16.0
			20.9	41.5	0.24	0.013	0.04	0.60	45.1	0.011	9.68	0.019	0.99	16.0
			19.4	51.3	0.23	0.012	0.05	0.55	51.1	0.014	9.24	0.020	0.91	16.0
			20.7	55.4	0.25	0.018	0.06	0.61	56.3	0.015	10.20	0.023	0.91	15.7
			19.6	51.0	0.21	0.015	0.05	0.58	52.1	0.013	10.30	0.021	0.93	14.7
			19.0	73.2	0.21	0.013	0.07	0.55	64.6	0.017	9.37	0.021	0.90	15.8
			17.3	44.0	0.19	0.013	0.05	0.54	44.6	0.012	9.09	0.019	0.84	13.7
			20.7	55.4	0.22	0.013	0.06	0.58	54.7	0.013	8.69	0.023	0.90	14.6
	2009 Average		**20.3**	**45.6**	**0.22**	**0.013**	**0.05**	**0.58**	**46.5**	**0.012**	**9.07**	**0.022**	**0.97**	**15.5**
	2009 Max		**21.7**	**85.9**	**0.25**	**0.018**	**0.11**	**0.68**	**78.0**	**0.020**	**10.50**	**0.027**	**1.11**	**16.7**
	2009 Min		**17.3**	**26.1**	**0.19**	**0.011**	**0.02**	**0.49**	**29.9**	**0.008**	**7.62**	**0.019**	**0.84**	**13.7**
	2009 StdDev		**1.1**	**16.8**	**0.02**	**0.002**	**0.02**	**0.05**	**13.0**	**0.003**	**0.96**	**0.003**	**0.08**	**0.8**
	2010		21.4	40.0	0.19	0.013	0.19	0.51	41.7	0.018	11.60	0.033	0.70	17.1
			21.8	64.6	0.21	0.018	1.05	0.63	64.9	0.035	14.80	0.032	0.80	17.3
			19.9	82.0	0.23	0.013	0.38	0.54	72.9	0.025	11.90	0.048	0.70	17.9
			20.6	61.4	0.25	0.014	0.35	0.57	61.9	0.026	12.50	0.039	0.70	18.4
			20.3	69.9	0.19	0.013	0.12	0.54	60.2	0.032	11.40	0.034	0.60	16.3
			19.3	88.1	0.21	0.019	0.65	0.57	80.2	0.038	14.10	0.032	0.70	18.2
			20.6	55.1	0.20	0.016	0.72	0.58	55.4	0.027	13.30	0.032	0.70	18.2
			19.5	50.6	0.18	0.012	0.11	0.46	46.3	0.019	11.40	0.034	0.60	16.3
			19.8	52.8	0.20	0.012	0.09	0.51	49.0	0.019	12.20	0.031	0.60	17.9
			20.5	40.4	0.19	0.015	0.15	0.54	40.9	0.028	13.90	0.031	0.70	17.7
			20.1	39.8	0.20	0.013	0.51	0.53	41.9	0.042	13.00	0.034	0.60	18.3
			19.9	73.7	0.19	0.013	0.15	0.59	66.9	0.022	13.50	0.035	0.60	19.9
			19.8	79.8	0.22	0.018	0.16	0.62	69.1	0.034	15.90	0.030	0.60	19.4
			19.5	52.9	0.21	0.015	0.19	0.58	48.2	0.035	13.70	0.035	0.60	19.1
			19.9	60.4	0.20	0.015	0.20	0.55	53.0	0.024	11.80	0.034	0.80	17.6
	2010 Average		**20.2**	**60.8**	**0.21**	**0.015**	**0.33**	**0.56**	**56.8**	**0.028**	**13.00**	**0.034**	**0.67**	**18.0**
	2010 Max		**21.8**	**88.1**	**0.25**	**0.019**	**1.05**	**0.63**	**80.2**	**0.042**	**15.90**	**0.048**	**0.80**	**19.9**
	2010 Min		**19.3**	**39.8**	**0.18**	**0.012**	**0.09**	**0.46**	**40.9**	**0.018**	**11.40**	**0.030**	**0.60**	**16.3**
	2010 StdDev		**0.7**	**15.5**	**0.02**	**0.002**	**0.28**	**0.04**	**12.3**	**0.007**	**1.34**	**0.004**	**0.07**	**1.0**

								Metal Concentrations					
			Solids %	Al mg/kg	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Pb mg/kg	Mn mg/kg	Hg mg/kg	Se mg/kg	Zn mg/kg
Sampling Site	**Year**	**Sample**												
CR0.7 cont.	**2011**		20.0	73.9	0.23	0.016	0.12	0.52	83.3	0.023	9.35	0.029	0.50	15.9
			20.0	54.8	0.19	0.017	0.10	0.51	58.6	0.020	9.27	0.027	0.67	16.9
			20.5	68.0	0.21	0.018	0.10	0.55	72.4	0.026	9.83	0.036	0.70	16.7
			20.2	87.2	0.21	0.019	0.13	0.52	90.2	0.026	8.79	0.027	0.53	16.4
			19.5	53.7	0.19	0.014	0.09	0.47	59.4	0.022	10.10	0.029	0.63	15.9
			20.5	80.2	0.21	0.018	0.11	0.52	83.4	0.024	9.88	0.026	0.52	17.2
			20.2	47.0	0.21	0.013	0.09	0.50	53.4	0.019	8.22	0.030	0.49	17.2
			20.8	77.3	0.23	0.019	0.12	0.53	86.7	0.026	11.00	0.031	0.62	16.6
			20.7	87.9	0.21	0.020	0.12	0.54	87.3	0.025	12.00	0.030	0.64	17.0
			20.7	76.4	0.23	0.017	0.11	0.53	73.2	0.026	9.36	0.039	0.74	17.1
			20.9	81.2	0.22	0.021	0.12	0.58	87.8	0.028	10.60	0.036	0.71	17.4
			20.6	75.3	0.23	0.018	0.11	0.56	82.6	0.024	9.60	0.029	0.66	18.2
			21.2	63.3	0.22	0.021	0.09	0.55	65.8	0.022	9.87	0.029	0.70	17.9
			21.0	59.7	0.24	0.015	0.08	0.52	66.6	0.021	10.80	0.030	0.73	18.5
			20.1	67.1	0.22	0.016	0.11	0.51	71.0	0.035	9.55	0.029	0.75	16.4
	2011 Average		**20.5**	**70.2**	**0.22**	**0.017**	**0.11**	**0.53**	**74.8**	**0.024**	**9.88**	**0.031**	**0.64**	**17.0**
	2011 Max		**21.2**	**87.9**	**0.24**	**0.021**	**0.13**	**0.58**	**90.2**	**0.035**	**12.00**	**0.039**	**0.75**	**18.5**
	2011 Min		**19.5**	**47.0**	**0.19**	**0.013**	**0.08**	**0.47**	**53.4**	**0.019**	**8.22**	**0.026**	**0.49**	**15.9**
	2011 StdDev		**0.5**	**12.5**	**0.01**	**0.002**	**0.01**	**0.03**	**12.1**	**0.004**	**0.93**	**0.003**	**0.09**	**0.8**
	2012		22.6	39.3	0.22	0.018	0.24	3.71	71.2	0.112	10.70	0.032	1.02	21.1
			22.3	50.3	0.30	0.025	0.32	0.95	123.0	0.029	46.80	0.035	1.16	22.0
			23.5	47.8	0.25	0.020	0.17	0.85	65.8	0.017	12.50	0.033	1.20	23.1
			22.4	40.1	0.22	0.020	0.15	0.68	56.8	0.017	10.70	0.039	1.25	19.9
			21.9	56.3	0.22	0.021	0.18	0.71	78.8	0.023	12.00	0.029	1.13	19.2
			23.0	41.1	0.23	0.018	0.23	0.79	66.1	0.016	10.50	0.035	1.11	22.3
			22.8	38.9	0.22	0.020	0.57	0.83	62.5	0.023	10.50	0.028	1.21	19.8
			22.9	34.5	0.21	0.018	0.28	0.72	58.6	0.019	10.10	0.026	1.14	21.2
			23.2	48.6	0.23	0.019	0.26	0.70	63.7	0.017	11.20	0.038	1.23	21.9
			22.8	53.2	0.24	0.023	0.43	0.68	71.9	0.019	10.70	0.027	1.19	22.8
			22.9	45.7	0.23	0.021	1.04	0.70	70.5	0.017	11.50	0.038	1.23	22.1
			23.1	38.2	0.23	0.021	0.36	0.66	63.8	0.015	12.50	0.033	1.25	22.2
			22.4	49.2	0.23	0.020	0.53	0.69	71.3	0.018	13.80	0.034	1.19	19.2
			22.7	57.5	0.24	0.022	0.81	0.68	77.7	0.020	13.40	0.023	1.23	20.8
			22.7	69.7	0.23	0.024	0.26	0.69	104.0	0.023	16.40	0.034	1.25	19.5
	2012 Average		**22.7**	**47.4**	**0.23**	**0.021**	**0.39**	**0.93**	**73.7**	**0.026**	**14.22**	**0.032**	**1.19**	**21.1**
	2012 Max		**23.5**	**69.7**	**0.30**	**0.025**	**1.04**	**3.71**	**123.0**	**0.112**	**46.80**	**0.039**	**1.25**	**23.1**
	2012 Min		**21.9**	**34.5**	**0.21**	**0.018**	**0.15**	**0.66**	**56.8**	**0.015**	**10.10**	**0.023**	**1.02**	**19.2**
	2012 StdDev		**0.4**	**9.3**	**0.02**	**0.002**	**0.26**	**0.77**	**17.7**	**0.024**	**9.17**	**0.005**	**0.06**	**1.3**
GM3	**2012**		19.5	12.7	0.17	0.009	0.40	0.63	27.5	0.007	5.56	0.059	1.34	20.8
			21.0	37.8	0.22	0.014	0.14	0.58	54.2	0.013	7.41	0.060	1.36	20.6
			22.0	16.4	0.19	0.014	0.08	0.62	33.6	0.007	7.38	0.054	1.47	21.1
			20.8	13.6	0.19	0.011	0.10	0.48	31.0	0.006	5.80	0.054	1.25	19.7
			21.2	18.8	0.21	0.012	0.10	0.53	44.1	0.009	8.74	0.057	1.39	19.3
			21.2	18.7	0.20	0.015	0.09	0.50	37.3	0.008	6.65	0.049	1.41	19.8
			22.0	21.1	0.25	0.014	1.24	7.64	57.9	0.476	8.02	0.042	1.39	27.8
			19.3	32.2	0.30	0.011	0.99	2.17	102.0	0.128	11.60	0.042	1.09	20.7
			20.7	40.1	0.25	0.014	1.45	1.73	75.7	0.094	7.46	0.045	1.42	20.9
			19.6	26.6	0.22	0.011	0.73	1.18	48.6	0.049	7.67	0.054	1.20	20.0
			20.6	30.7	0.19	0.014	0.10	0.54	55.8	0.012	7.00	0.044	1.23	17.7
			20.1	63.5	0.23	0.012	0.35	0.58	98.4	0.021	10.10	0.039	1.29	20.3
			20.7	37.7	0.23	0.012	0.24	0.49	65.9	0.013	6.99	0.050	1.30	18.1
			21.0	35.1	0.25	0.012	0.18	0.52	59.2	0.013	8.40	0.071	1.32	22.2
	2012 Average		**20.7**	**28.9**	**0.22**	**0.012**	**0.44**	**1.30**	**56.5**	**0.061**	**7.77**	**0.051**	**1.32**	**20.6**
	2012 Max		**22.0**	**63.5**	**0.30**	**0.015**	**1.45**	**7.64**	**102.0**	**0.476**	**11.60**	**0.071**	**1.47**	**27.8**
	2012 Min		**19.3**	**12.7**	**0.17**	**0.009**	**0.08**	**0.48**	**27.5**	**0.006**	**5.56**	**0.039**	**1.09**	**17.7**
	2012 StdDev		**0.8**	**13.7**	**0.03**	**0.002**	**0.47**	**1.90**	**23.0**	**0.125**	**1.60**	**0.009**	**0.10**	**2.4**
	2013		22.0	64.1	0.23	0.014	0.13	0.58	84.1	0.018	7.51	0.079	1.25	22.8
			22.1	56.7	0.24	0.018	0.12	0.53	79.5	0.015	9.09	0.059	1.25	21.9
			22.9	59.7	0.25	0.016	0.14	0.56	82.1	0.016	9.74	0.101	1.20	22.7
			21.9	38.9	0.20	0.014	0.11	0.56	61.0	0.011	8.36	0.051	1.30	21.3
			22.7	63.3	0.24	0.017	0.18	0.58	80.2	0.017	10.80	0.083	1.20	23.2
			22.7	54.2	0.25	0.013	0.12	0.58	80.2	0.014	7.89	0.074	1.34	20.6
			22.4	39.8	0.26	0.015	0.11	0.55	62.9	0.013	8.66	0.071	1.39	23.6
			21.9	86.1	0.29	0.016	0.21	0.63	123.0	0.023	12.50	0.067	1.43	22.4
			21.6	67.9	0.24	0.014	0.14	0.55	95.0	0.015	7.88	0.054	1.22	20.4
			21.8	52.2	0.22	0.020	0.11	0.62	68.0	0.011	8.19	0.053	1.48	23.0
			21.1	44.7	0.21	0.018	0.13	0.57	61.5	0.014	8.64	0.054	1.33	22.7
			21.4	72.8	0.23	0.014	0.15	0.51	105.0	0.017	9.35	0.051	1.29	21.2
			22.3	62.5	0.24	0.019	0.16	0.60	76.3	0.014	9.06	0.061	1.34	24.6
			21.6	58.5	0.24	0.014	0.15	0.58	81.0	0.016	8.41	0.059	1.46	25.2
			21.6	51.6	0.24	0.018	0.14	0.58	80.7	0.015	8.28	0.094	1.31	22.8
			21.7	49.8	0.24	0.014	0.12	0.55	67.5	0.015	7.81	0.066	1.19	21.9
	2013 Average		**22.0**	**57.7**	**0.24**	**0.016**	**0.14**	**0.57**	**80.5**	**0.015**	**8.89**	**0.067**	**1.31**	**22.5**
	2013 Max		**22.9**	**86.1**	**0.29**	**0.020**	**0.21**	**0.63**	**123.0**	**0.023**	**12.50**	**0.101**	**1.48**	**25.2**
	2013 Min		**21.1**	**38.9**	**0.20**	**0.013**	**0.11**	**0.51**	**61.0**	**0.011**	**7.51**	**0.051**	**1.19**	**20.4**
	2013 StdDev		**0.5**	**12.2**	**0.02**	**0.002**	**0.03**	**0.03**	**16.4**	**0.003**	**1.27**	**0.015**	**0.09**	**1.3**

Sampling Site	Year	Sample	Solids %	Al mg/kg	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Pb mg/kg	Mn mg/kg	Hg mg/kg	Se mg/kg	Zn mg/kg
			Metal Concentrations											
GM3 cont.	**2014**		21.8	65.5	0.35	0.011	0.18	0.60	129.0	0.055	14.40	0.040	1.13	18.9
			--	52.5	0.35	0.012	0.22	0.56	128.0	0.027	11.70	0.034	1.13	18.4
			--	60.9	0.49	0.009	0.24	0.62	215.0	0.025	19.70	0.031	1.13	18.4
			--	54.6	0.61	0.013	0.16	0.64	217.0	0.020	19.80	0.031	1.19	21.7
			--	184.0	1.29	0.019	0.63	0.81	818.0	0.076	56.20	0.034	1.21	20.4
			--	67.7	0.47	0.013	0.20	0.58	176.0	0.023	20.40	0.028	1.08	18.7
			--	50.5	0.37	0.011	0.14	0.64	111.0	0.019	12.20	0.036	1.14	20.1
			--	40.4	0.40	0.011	0.22	0.66	130.0	0.020	14.10	0.033	1.23	18.0
			--	44.5	0.35	0.011	0.18	0.63	132.0	0.020	16.00	0.032	1.04	18.5
			--	51.1	0.43	0.009	0.26	0.63	182.0	0.020	16.70	0.035	1.08	18.3
			--	55.2	0.41	0.011	0.53	0.57	136.0	0.023	16.50	0.030	1.00	18.0
			--	53.7	0.39	0.015	0.21	0.62	134.0	0.023	16.20	0.037	1.15	18.4
			--	45.2	0.40	0.010	0.31	0.60	134.0	0.019	13.80	0.029	1.04	17.2
			--	42.5	0.35	0.011	0.16	0.61	103.0	0.017	15.30	0.035	1.15	18.9
			--	50.2	0.44	0.010	0.29	0.67	138.0	0.017	15.60	0.031	1.09	20.1
	2014 Average		21.8	61.2	0.47	0.012	0.26	0.63	192.2	0.027	18.57	0.033	1.12	18.9
	2014 Max		**21.8**	**184.0**	**1.29**	**0.019**	**0.63**	**0.81**	**818.0**	**0.076**	**56.20**	**0.040**	**1.23**	**21.7**
	2014 Min		**21.8**	**40.4**	**0.35**	**0.009**	**0.14**	**0.56**	**103.0**	**0.017**	**11.70**	**0.028**	**1.00**	**17.2**
	2014 StdDev		**n/a**	**34.9**	**0.24**	**0.002**	**0.14**	**0.06**	**176.5**	**0.016**	**10.72**	**0.003**	**0.06**	**1.2**
			10578.8	**37960.2**	**156.62**	**9.154**	**144.18**	**379.53**	**48890.0**	**15.522**	**6702.55**	**18.198**	**485.48**	**10406.2**

Notes:

Al=Aluminum, As=Arsenic, Cd=Cadmium, Cr=Chromium, Cu=Copper, Fe=Iron, Pb=Lead, Mn=Manganese, Hg=Mercury, Se=Selenium, Zn=Zinc. Method detection limits (MDL) for each analyte are listed in Table 2.5-1. SD (standard deviation) = the measure of the spread of a dataset; CV = (coefficient of variation) = measure of variation in a dataset (SD/Mean); Mean = arithemic average of the dataset; Median = halfway value of an ordered dataset; Min = smallest number of the dataset; Max = largest number of a dataset; For analysis purposes, all samples that were non-detectable were calculated at the MDL level for that sample; Each sample consisted of a composite of several specimens to enable adequate matrix for analysis; Samples were collected from July 20-27, 2012, July 24, 2013, and July 25, 2014.

Appendix L

Macroinvertebrate Bioassessment Metrics for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

				General Metrics							Diversity Indices		Biotic Indices
Project	Method	Site ID	Year	Total Abundance (# / ft²)	Total Taxa #	EPT Taxa #	EPT %	Dominant Taxa %	Chironomidae %	EPT Chironomidae Ratio	Shannon (H)	Evenness (e)	HBI
Jungjuk Port Site	*Surber*	KU8.0	2011	245.67	10.00	5.00	14.52	70.42	70.42	0.21	1.14	0.49	5.47
		KU10.0	2011	32.67	4.00	1.00	2.04	92.86	92.86	0.02	0.33	0.24	5.86
		KU11.0	2011	5.33	4.00	1.00	6.25	81.25	81.25	0.08	0.69	0.50	5.75
		KU12.0	2011	76.00	2.00	--	--	99.12	99.12	--	0.05	0.07	5.99
		KU13.0	2011	51.67	3.00	--	--	56.13	56.13	--	0.72	0.65	5.57
		KU14.0	2012	22.40	6.00	3.00	10.71	82.14	82.14	0.13	0.71	0.40	5.54
		KU20.0	2012	134.40	11.00	6.00	3.13	91.67	91.67	0.03	0.43	0.18	5.90
		KU23.0	2012	7.40	6.00	3.00	8.11	86.49	86.49	0.09	0.61	0.34	5.68
		KU25.0	2012	5.60	7.00	2.00	7.14	78.57	78.57	0.09	0.90	0.46	5.71
	Ponar®	KU8.0	2012	53.20	2.00	--	--	93.23	93.23	--	0.25	0.36	5.93
		KU9.0	2011	32.33	2.00	--	--	76.29	76.29	--	0.55	0.79	5.76
		KU15.0	2011	15.33	5.00	2.00	13.04	60.87	60.87	0.21	1.05	0.65	5.02
		KU24.0	2012	19.80	2.00	--	--	87.88	87.88	--	0.37	0.53	5.88
Mine Access Road	*Surber*	JJ1.0	2008	215.33	16.00	9.00	42.57	42.41	42.41	1.00	1.94	0.70	4.14
			2007	206.20	27.00	14.00	46.07	33.85	33.85	1.36	2.26	0.69	3.73

Notes:

For sample site locations, refer to Figure 1.1-1. Chironomidae genera grouped as one taxon for multi-year comparisons. Refer to the text for definitions of metrics.

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Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

JJ1 (sample method: Surber)						
(year 2007-08) (n reps =8)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	210.8	210.8	206.2	215.3	6.5	0.03
# Taxa	21.5	21.5	16.0	27.0	7.8	0.36
# EPT Taxa	11.5	11.5	9.0	14.0	3.5	0.31
% EPT Taxa	44.3	44.3	42.6	46.1	2.5	0.06
% Dominant Taxon	38.1	38.1	33.9	42.4	6.1	0.16
% Chironomidae	38.1	38.1	33.9	42.4	6.1	0.16
EPT/Chironomidae Ratio	1.2	1.2	1.0	1.4	0.3	0.21
Diversity Indices						
Shannon (H)	2.1	2.1	1.9	2.3	0.2	0.11
Evenness (e)	0.7	0.7	0.7	0.7	0.0	0.01
Biotic Indices						
HBI	3.9	3.9	3.7	4.1	0.3	0.07
% Composition Per Order						
Ephemeroptera	25.8	25.8	17.9	33.6	11.1	0.43
Plecoptera	17.0	17.0	8.7	25.3	11.8	0.69
Trichoptera	1.6	1.6	0.3	2.8	1.8	1.13
Diptera	44.3	44.3	42.0	46.6	3.3	0.07
Oligochaeta	8.6	8.6	7.9	9.3	1.0	0.12
Acariformes	2.6	2.6	2.2	2.9	0.5	0.19
Amphipoda	0.0	0.0	--	0.1	0.1	1.41
Gastropoda	0.0	0.0	--	0.1	0.1	1.41
Ostracoda	0.1	0.1	--	0.2	0.1	1.41

KU8 (sample method: Surber)						
(year 2011) (n reps = 3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	245.7	245.7	245.7	245.7	--	--
# Taxa	10.0	10.0	10.0	10.0	--	--
# EPT Taxa	5.0	5.0	5.0	5.0	--	--
% EPT Taxa	14.5	14.5	14.5	14.5	--	--
% Dominant Taxon	70.4	70.4	70.4	70.4	--	--
% Chironomidae	70.4	70.4	70.4	70.4	--	--
EPT/Chironomidae Ratio	0.2	0.2	0.2	0.2	--	--
Diversity Indices						
Shannon (H)	1.1	1.1	1.1	1.1	--	--
Evenness (e)	0.5	0.5	0.5	0.5	--	--
Biotic Indices						
HBI	5.5	5.5	5.5	5.5	--	--
% Composition Per Order						
Ephemeroptera	12.3	12.3	12.3	12.3	--	--
Plecoptera	2.2	2.2	2.2	2.2	--	--
Trichoptera	--	--	--	--	--	--
Diptera	71.2	71.2	71.2	71.2	--	--
Oligochaeta	8.5	8.5	8.5	8.5	--	--
Acariformes	5.7	5.7	5.7	5.7	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

KU8 (sample method: Ponar®)

(year 2012) (n reps = 4)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	53.2	53.2	53.2	53.2	--	--
# Taxa	2.0	2.0	2.0	2.0	--	--
# EPT Taxa	NA	NA	0.0	0.0	--	--
% EPT Taxa	NA	NA	0.0	0.0	--	--
% Dominant Taxon	93.2	93.2	93.2	93.2	--	--
% Chironomidae	93.2	93.2	93.2	93.2	--	--
EPT/Chironomidae Ratio	NA	NA	0.0	0.0	--	--
Diversity Indices						
Shannon (H)	0.2	0.2	0.2	0.2	--	--
Evenness (e)	0.4	0.4	0.4	0.4	--	--
Biotic Indices						
HBI	5.9	5.9	5.9	5.9	--	--
% Composition Per Order						
Ephemeroptera	--	--	--	--	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	--	--	--	--	--	--
Diptera	93.2	93.2	93.2	93.2	--	--
Oligochaeta	6.8	6.8	6.8	6.8	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Cladocera	--	--	--	--	--	--
Coleoptera	--	--	--	--	--	--
Collembola	--	--	--	--	--	--
Copepoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Mollusca	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

KU9 (sample method: Ponar®)

(year 2011) (n reps = 3)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	32.3	32.3	32.3	32.3	--	--
# Taxa	2.0	2.0	2.0	2.0	--	--
# EPT Taxa	NA	NA	0.0	0.0	--	--
% EPT Taxa	NA	NA	0.0	0.0	--	--
% Dominant Taxon	76.3	76.3	76.3	76.3	--	--
% Chironomidae	76.3	76.3	76.3	76.3	--	--
EPT/Chironomidae Ratio	NA	NA	0.0	0.0	--	--
Diversity Indices						
Shannon (H)	0.5	0.5	0.5	0.5	--	--
Evenness (e)	0.8	0.8	0.8	0.8	--	--
Biotic Indices						
HBI	5.8	5.8	5.8	5.8	--	--
% Composition Per Order						
Ephemeroptera	--	--	--	--	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	--	--	--	--	--	--
Diptera	76.3	76.3	76.3	76.3	--	--
Oligochaeta	23.7	23.7	23.7	23.7	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

KU10 (sample method: Surber)						
(year 2011) (n reps = 3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	32.7	32.7	32.7	32.7	--	--
# Taxa	4.0	4.0	4.0	4.0	--	--
# EPT Taxa	1.0	1.0	1.0	1.0	--	--
% EPT Taxa	2.0	2.0	2.0	2.0	--	--
% Dominant Taxon	92.9	92.9	92.9	92.9	--	--
% Chironomidae	92.9	92.9	92.9	92.9	--	--
EPT/Chironomidae Ratio	0.0	0.0	0.0	0.0	--	--
Diversity Indices						
Shannon (H)	0.3	0.3	0.3	0.3	--	--
Evenness (e)	0.2	0.2	0.2	0.2	--	--
Biotic Indices						
HBI	5.9	5.9	5.9	5.9	--	--
% Composition Per Order						
Ephemeroptera	--	--	--	--	--	--
Plecoptera	2.0	2.0	2.0	2.0	--	--
Trichoptera	--	--	--	--	--	--
Diptera	92.9	92.9	92.9	92.9	--	--
Oligochaeta	2.0	2.0	2.0	2.0	--	--
Acariformes	3.1	3.1	3.1	3.1	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

KU11 (sample method: Surber)						
(year 2011) (n reps = 3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	5.3	5.3	5.3	5.3	--	--
# Taxa	4.0	4.0	4.0	4.0	--	--
# EPT Taxa	1.0	1.0	1.0	1.0	--	--
% EPT Taxa	6.3	6.3	6.3	6.3	--	--
% Dominant Taxon	81.3	81.3	81.3	81.3	--	--
% Chironomidae	81.3	81.3	81.3	81.3	--	--
EPT/Chironomidae Ratio	0.1	0.1	0.1	0.1	--	--
Diversity Indices						
Shannon (H)	0.7	0.7	0.7	0.7	--	--
Evenness (e)	0.5	0.5	0.5	0.5	--	--
Biotic Indices						
HBI	5.8	5.8	5.8	5.8	--	--
% Composition Per Order						
Ephemeroptera	6.3	6.3	6.3	6.3	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	--	--	--	--	--	--
Diptera	87.5	87.5	87.5	87.5	--	--
Oligochaeta	--	--	--	--	--	--
Acariformes	6.3	6.3	6.3	6.3	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

KU12 (sample method: Surber)						
(year 2011) (n reps = 3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	76.0	76.0	76.0	76.0	--	--
# Taxa	2.0	2.0	2.0	2.0	--	--
# EPT Taxa	NA	NA	0.0	0.0	--	--
% EPT Taxa	NA	NA	0.0	0.0	--	--
% Dominant Taxon	99.1	99.1	99.1	99.1	--	--
% Chironomidae	99.1	99.1	99.1	99.1	--	--
EPT/Chironomidae Ratio	NA	NA	0.0	0.0	--	--
Diversity Indices						
Shannon (H)	0.1	0.1	0.1	0.1	--	--
Evenness (e)	0.1	0.1	0.1	0.1	--	--
Biotic Indices						
HBI	6.0	6.0	6.0	6.0	--	--
% Composition Per Order						
Ephemeroptera	--	--	--	--	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	--	--	--	--	--	--
Diptera	99.1	99.1	99.1	99.1	--	--
Oligochaeta	0.9	0.9	0.9	0.9	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

KU13 (sample method: Ponar®)						
(year 2011) (n reps = 3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	51.7	51.7	51.7	51.7	--	--
# Taxa	3.0	3.0	3.0	3.0	--	--
# EPT Taxa	NA	NA	0.0	0.0	--	--
% EPT Taxa	NA	NA	0.0	0.0	--	--
% Dominant Taxon	56.1	56.1	56.1	56.1	--	--
% Chironomidae	56.1	56.1	56.1	56.1	--	--
EPT/Chironomidae Ratio	NA	NA	0.0	0.0	--	--
Diversity Indices						
Shannon (H)	0.7	0.7	0.7	0.7	--	--
Evenness (e)	0.7	0.7	0.7	0.7	--	--
Biotic Indices						
HBI	5.6	5.6	5.6	5.6	--	--
% Composition Per Order						
Ephemeroptera	--	--	--	--	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	--	--	--	--	--	--
Diptera	56.1	56.1	56.1	56.1	--	--
Oligochaeta	43.2	43.2	43.2	43.2	--	--
Acariformes	0.6	0.6	0.6	0.6	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

KU14 (sample method: Surber)						
(year 2012) (n reps = 5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	22.4	22.4	22.4	22.4	--	--
# Taxa	6.0	6.0	6.0	6.0	--	--
# EPT Taxa	3.0	3.0	3.0	3.0	--	--
% EPT Taxa	10.7	10.7	10.7	10.7	--	--
% Dominant Taxon	82.1	82.1	82.1	82.1	--	--
% Chironomidae	82.1	82.1	82.1	82.1	--	--
EPT/Chironomidae Ratio	0.1	0.1	0.1	0.1	--	--
Diversity Indices						
Shannon (H)	0.7	0.7	0.7	0.7	--	--
Evenness (e)	0.4	0.4	0.4	0.4	--	--
Biotic Indices						
HBI	5.5	5.5	5.5	5.5	--	--
% Composition Per Order						
Ephemeroptera	4.5	4.5	4.5	4.5	--	--
Plecoptera	5.4	5.4	5.4	5.4	--	--
Trichoptera	0.9	0.9	0.9	0.9	--	--
Diptera	83.0	83.0	83.0	83.0	--	--
Oligochaeta	6.3	6.3	6.3	6.3	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

KU15 (sample method: Ponar®)						
(year 2011) (n reps = 3)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	15.3	15.3	15.3	15.3	--	--
# Taxa	5.0	5.0	5.0	5.0	--	--
# EPT Taxa	2.0	2.0	2.0	2.0	--	--
% EPT Taxa	13.0	13.0	13.0	13.0	--	--
% Dominant Taxon	60.9	60.9	60.9	60.9	--	--
% Chironomidae	60.9	60.9	60.9	60.9	--	--
EPT/Chironomidae Ratio	0.2	0.2	0.2	0.2	--	--
Diversity Indices						
Shannon (H)	1.1	1.1	1.1	1.1	--	--
Evenness (e)	0.7	0.7	0.7	0.7	--	--
Biotic Indices						
HBI	5.0	5.0	5.0	5.0	--	--
% Composition Per Order						
Ephemeroptera	--	--	--	--	--	--
Plecoptera	13.0	13.0	13.0	13.0	--	--
Trichoptera	--	--	--	--	--	--
Diptera	60.9	60.9	60.9	60.9	--	--
Oligochaeta	23.9	23.9	23.9	23.9	--	--
Acariformes	2.2	2.2	2.2	2.2	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

KU20 (sample method: Surber)

(year 2012) (n reps = 5)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	134.4	134.4	134.4	134.4	--	--
# Taxa	11.0	11.0	11.0	11.0	--	--
# EPT Taxa	6.0	6.0	6.0	6.0	--	--
% EPT Taxa	3.1	3.1	3.1	3.1	--	--
% Dominant Taxon	91.7	91.7	91.7	91.7	--	--
% Chironomidae	91.7	91.7	91.7	91.7	--	--
EPT/Chironomidae Ratio	0.0	0.0	0.0	0.0	--	--
Diversity Indices						
Shannon (H)	0.4	0.4	0.4	0.4	--	--
Evenness (e)	0.2	0.2	0.2	0.2	--	--
Biotic Indices						
HBI	5.9	5.9	5.9	5.9	--	--
% Composition Per Order						
Ephemeroptera	2.4	2.4	2.4	2.4	--	--
Plecoptera	0.4	0.4	0.4	0.4	--	--
Trichoptera	0.3	0.3	0.3	0.3	--	--
Diptera	94.3	94.3	94.3	94.3	--	--
Oligochaeta	2.5	2.5	2.5	2.5	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

KU23 (sample method: Surber)

(year 2012) (n reps = 5)	Mean	Median	Min	Max	SD	CV
General Metrics[1]						
Abundance (# / ft^2)	7.4	7.4	7.4	7.4	--	--
# Taxa	6.0	6.0	6.0	6.0	--	--
# EPT Taxa	3.0	3.0	3.0	3.0	--	--
% EPT Taxa	8.1	8.1	8.1	8.1	--	--
% Dominant Taxon	86.5	86.5	86.5	86.5	--	--
% Chironomidae	86.5	86.5	86.5	86.5	--	--
EPT/Chironomidae Ratio	0.1	0.1	0.1	0.1	--	--
Diversity Indices						
Shannon (H)	0.6	0.6	0.6	0.6	--	--
Evenness (e)	0.3	0.3	0.3	0.3	--	--
Biotic Indices						
HBI	5.7	5.7	5.7	5.7	--	--
% Composition Per Order						
Ephemeroptera	5.4	5.4	5.4	5.4	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	2.7	2.7	2.7	2.7	--	--
Diptera	91.9	91.9	91.9	91.9	--	--
Oligochaeta	--	--	--	--	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

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Macroinvertebrate Bioassessment Statistics Summary for Sites within the Mine Access Road Drainages and Jungjuk Port Site (2007-2012)

KU24 (sample method: Ponar®)						
(year 2012) (n reps = 5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	19.8	19.8	19.8	19.8	--	--
# Taxa	2.0	2.0	2.0	2.0	--	--
# EPT Taxa	NA	NA	0.0	0.0	--	--
% EPT Taxa	NA	NA	0.0	0.0	--	--
% Dominant Taxon	87.9	87.9	87.9	87.9	--	--
% Chironomidae	87.9	87.9	87.9	87.9	--	--
EPT/Chironomidae Ratio	NA	NA	0.0	0.0	--	--
Diversity Indices						
Shannon (H)	0.4	0.4	0.4	0.4	--	--
Evenness (e)	0.5	0.5	0.5	0.5	--	--
Biotic Indices						
HBI	5.9	5.9	5.9	5.9	--	--
% Composition Per Order						
Ephemeroptera	--	--	--	--	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	--	--	--	--	--	--
Diptera	87.9	87.9	87.9	87.9	--	--
Oligochaeta	12.1	12.1	12.1	12.1	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

KU25 (sample method: Surber)						
(year 2012) (n reps = 5)	**Mean**	**Median**	**Min**	**Max**	**SD**	**CV**
General Metrics[1]						
Abundance (# / ft^2)	5.6	5.6	5.6	5.6	--	--
# Taxa	7.0	7.0	7.0	7.0	--	--
# EPT Taxa	2.0	2.0	2.0	2.0	--	--
% EPT Taxa	7.1	7.1	7.1	7.1	--	--
% Dominant Taxon	78.6	78.6	78.6	78.6	--	--
% Chironomidae	78.6	78.6	78.6	78.6	--	--
EPT/Chironomidae Ratio	0.1	0.1	0.1	0.1	--	--
Diversity Indices						
Shannon (H)	0.9	0.9	0.9	0.9	--	--
Evenness (e)	0.5	0.5	0.5	0.5	--	--
Biotic Indices						
HBI	5.7	5.7	5.7	5.7	--	--
% Composition Per Order						
Ephemeroptera	3.6	3.6	3.6	3.6	--	--
Plecoptera	--	--	--	--	--	--
Trichoptera	3.6	3.6	3.6	3.6	--	--
Diptera	89.3	89.3	89.3	89.3	--	--
Oligochaeta	3.6	3.6	3.6	3.6	--	--
Acariformes	--	--	--	--	--	--
Amphipoda	--	--	--	--	--	--
Gastropoda	--	--	--	--	--	--
Ostracoda	--	--	--	--	--	--

Notes:

For sample site locations, refer to Figure 1.1-1. Chironomidae genera grouped as one taxon for multi-year comparisons.

1) Refer to the text for definitions of metrics.

year = year site has been sampled; n reps = total number of replicates sampled

Mean = Average of all samples for all years; SD = Standard deviation of the mean; CV = Coefficient of variance of the mean

Appendix N

Summary of Trapping Results within the Mine Access Road Drainages (2007-2008)

		# of Fish Caught per 3 Traps									
SITE	**Year**	**Chinook (juvenile)**	**Coho (juvenile)**	**Dolly Varden**	**Arctic grayling**	**Longnose sucker**	**Slimy sculpin**	**Alaska blackfish**	**Burbot**	**Nine-spine stickleback**	**Total**
JJ1	2007	0	10	5	0	0	0	0	0	0	**15**
	2008	0	0	5	0	0	0	0	0	0	**5**
	Mean	**0.0**	**5.0**	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**10.0**

Notes:

Refer to Figure 1.1-1 for biomonitoring site locations.

JJ=Jungjuk Creek

Mean = total # of fish caught in 3 traps each year / the number of years sampled

Appendix O

Summary of Bridge and Culvert Stream Crossing Surveys within the Mine Access Road Drainages

Structure	Site	Stream Name	Fish Present?	Chinook salmon	Chum salmon	Coho salmon	Dolly Varden	Arctic grayling	Round whitefish	Slimy sculpin	Alaska blackfish	Burbot
Bridges	[1]BR3	Crooked Creek	Y	X	X	X	X	X	X	X	X	X
	[2]BR47	N.F. Getmuna Creek	Y	X	X	X (n = 16)	X (n = 36)	X (n = 1)		X (n = 59)		
	[3]BR48	S.F. Getmuna Creek	Y	X	X	X (n = 9)	X (n = 17)	X		X (n = 31)		
	[4]BR49	Unnamed (FN)	Y			X (n = 7)	X (n = 4)	X (n = 1)		X (n = 2)		
	[4]BR61	Jungjuk Creek	Y				X (n = 25)					
	[4]BR63	Jungjuk Creek	Y				X (n = 16)					
Culverts	CU43	Unnamed	N									
	CU59	Jungjuk Creek Trib	N									
	CU60	Jungjuk Creek Trib	N									
	CU62	Jungjuk Creek Trib	N									

Notes:

Refer to Figure 1.1-1 for bridge and culvert locations. Major stream crossings spanned by bridges or bottomless culverts were not electrofished.

1) Fish data for BR3 is a compilation of CR1, CR2 (see Table 3.2-6) and aerial reach CR-R4 (see Table 3.2-2).

2) Fish data for BR47 is based on aerial survey data from reach GM-R3 (see Table 3.2-2).

3) Fish data for BR48 is based on aerial survey data from reach GM-R2 (see Table 3.2-2) and efish survey data at BR49 (Table 3.2-6).

4) Number of fish sampled shown in parentheses. If no numbers are present, acutal counts are unavailable at specific location.

5) X denotes if species present.

Appendix P
Water Quality Standards for Alaska

Dissolved Parameter	Source[4]	Units	Alaska	Alaska Aquatic Life Standards		Human Health Criteria		Alaska
			Drinking Water Standard (Tap)	Acute	Chronic	HHC (water and aquatic organisms)	HHC (aquatic organisms only)	Stock water and Irrigation water (Agriculture)
pH	1	(pH units)	6.0-8.5	6.5-8.5	6.5-8.5	---	---	5-9
Conductivity		(μS/cm)	---	---	---	---	---	---
Total Alkalinity	1	(mg/L)[1]	---	---	20	---	---	---
Acidity		(mg/L)[1]	---	---	---	---	---	---
Hardness		(mg/L)[1]	---	---	---	---	---	---
TDS	1	(mg/L)	500	1000	1000	---	---	1000
Chloride	2	(mg/L)	---	860	230	---	---	---
Ammonia	2	(mg N/L)	---	2.1-32.6	0.4-2.5	---	---	---
Aluminum	2	(mg/L)	---	0.75	0.087	---	---	5
Arsenic	2	(mg/L)	0.01	0.34	0.15	---	---	0.05-0.1
Cadmium	2	(mg/L)	0.005	[3]0.0014	[3]0.00019	---	---	0.01
Calcium		(mg/L)	---	---	---	---	---	---
Chromium	2	(mg/L)	0.1 (total)	[2]III,0.409; VI,0.004	[2]III,0.053; VI,0.005	---	---	0.1 (total)
Copper	2	(mg/L)	---	[2]0.009	[2]0.006	1.3	---	0.2
Iron	2	(mg/L)	---	---	1	---	---	5
Lead	2	(mg/L)	---	[3]0.041	[3]0.002	---	---	0.05-5.0
Manganese	2	(mg/L)	---	---	---	0.05	0.1	0.2
Mercury	2	(mg/L)	0.002	0.0014	0.00077	0.0018	0.00094	---
Selenium	2	(mg/L)	0.05	---	0.005	0.17	11	0.01-0.02
Zinc	2	(mg/L)	---	[2]0.08	[2]0.08	9.1	69	2

Notes:

--- indicates there is no standard for this parameter.

The aquatic life standards for ammonia are pH and temperature dependent. Assuming a near neutral pH, the most stringent acute and chronic aquatic life standards for ammonia are 24 mg/l and 2.18 mg/l, respectively.

1) (mg $CaCO_3$/L)

2) These were hardness-dependant calculations, in which 66.6 was the averaged hardness for Crooked Creek. (Averaged hardness is a rough estimate taken from the USGS website, Bethel Division, Alaska, Hydrological Unit Code 19030501)

3) Hardness-dependant criteria were taken from Appendix A in the "Alaska Water Quality Criteria Manual for Toxic And Other Deleterious Organic and Inorganic Substances" report by the Department of Environmental Conservation revised on December 12, 2008 (http://www.dec.state.ak.us/water/wqsar/wqs/index.htm).

4) Source:

1. Alaska Department of Environmental Conservation, Water Quality Standards (18 AAC 70) Amended as of April 8, 2012.
2. Alaska Department of Environmental Conservation, Alaska Water Quality Criteria Manual For Toxic and Other Deleterious Organic and Inorganic Substances. Amended as of December 12, 2008.

Appendix Q
Adult Salmon Aerial Couts for the Crooked Creek Drainage (2004-2014)

			Crooked Creek Drainage																										
			Reference Streams				Donlin Tribs		Crooked Creek Mainstem					Crooked Creek Tributaries														Crooked Creek Drainage Total	AVG Est. Water Clarity[4]
		REACH	DOR3	DOR2	DOR1	FLR1	DMR1	SNR1	CRR5	CRR4	CRR3	CRR2	CRR1	AMR1	GRR1	ANR1	CVR1	EGR1	GMR5	GMR4	GMR3	GMR2	GMR1	FNR1	BLR3	BLR2	BLR1		
		# Years[1]	(9,10)	(11,11)	(11,11)	(7,8)	(2,5)	(4,9)	(11,11)	(11,10)	(11,10)	(11,10)	(11,10)	(6,8)	(2,2)	(6,8)	(6,8)	(4,3)	(3,3)	(4,5)	(7,7)	(7,7)	(7,8)	(1,2)	(3,3)	(3,3)	(4,4)		
Season	Species	Year																											
Summer	Chinook salmon	2004	0	0	0	0	ns	ns	0	2	4	20	29	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	55	7.0
		2005	ns	0	0	0	ns	ns	6	2	0	6	1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	15	8.0
		2006	0	0	0	0	ns	ns	0	1	1	5	5	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	12	5.3
		2007	0	0	0	0	ns	0	0	1	1	2	0	0	ns	0	0	ns	ns	ns	1	4	44	ns	ns	ns	ns	53	5.8
		2008	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	ns	ns	ns	3	0	15	ns	ns	ns	ns	21	8.1
		2009	0	0	0	0	ns	0	0	3	3	6	10	0	ns	0	0	0	ns	0	11	0	29	ns	ns	ns	ns	62	7.0
		2010	0	0	0	ns	ns	ns	0	0	0	0	0	0	ns	0	0	0	ns	ns	2	0	3	ns	ns	ns	ns	5	4.6
		2011	0	0	0	ns	ns	ns	0	0	0	1	5	0	ns	0	0	0	0	0	0	0	10	ns	0	0	0	16	6.8
		2012	0	0	0	0	0	0	0	0	2	1	5	0	0	0	0	0	0	0	0	0	12	0	0	0	0	20	5.2
		2013	0	0	0	ns	ns	ns	0	0	4	3	0	ns	ns	ns	ns	ns	0	0	0	0	13	ns	0	0	0	20	6.2
		2014	ns	0	5	ns	ns	ns	1	5	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	1	12	NA
		Mean[2]	0.0	0.0	0.5	0.0	0.0	0.0	0.6	1.3	1.4	4.2	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.6	18.0	0.0	0.0	0.0	0.3		
		Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0		
		Max	0	0	5	0	0	0	6	3	4	20	29	0	0	0	0	0	0	0	11	4	44	0	0	0	1		
	Chum salmon	2004	0	1	0	0	ns	ns	0	1	3	134	52	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	191	7.0
		2005	ns	4	7	0	ns	ns	7	15	24	178	291	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	526	8.0
		2006	0	0	0	0	ns	ns	0	0	1	146	280	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	427	5.3
		2007	0	0	2	0	ns	0	8	17	21	89	264	0	ns	0	0	ns	ns	ns	8	113	701	ns	ns	ns	ns	1223	5.8
		2008	0	0	0	0	0	0	0	0	1	30	16	0	0	0	0	ns	ns	ns	4	3	28	ns	ns	ns	ns	82	8.1
		2009	0	1	0	0	ns	0	2	10	4	72	77	0	ns	0	0	0	ns	3	50	8	145	ns	ns	ns	ns	372	7.0
		2010	0	0	0	ns	ns	ns	0	2	3	37	66	0	ns	0	0	0	ns	ns	21	0	142	ns	ns	ns	ns	271	4.6
		2011	0	0	0	ns	ns	ns	0	0	4	177	212	0	ns	0	0	0	0	0	7	0	418	ns	0	0	7	825	6.8
		2012	0	0	0	0	0	0	0	0	1	124	109	0	0	0	0	0	0	0	0	5	72	0	0	0	0	311	5.2
		2013	0	0	0	ns	ns	ns	2	12	4	333	243	ns	ns	ns	ns	ns	0	0	41	0	307	ns	0	0	4	946	6.2
		2014	ns	0	0	ns	ns	ns	1	2	0	150	9	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	162	NA
		Mean[2]	0.0	0.6	0.9	0.0	0.0	0.0	1.9	5.7	6.6	132.0	161.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	18.7	18.4	259.0	0.0	0.0	0.0	3.7		
		Min	0	0	0	0	0	0	0	0	1	30	16	0	0	0	0	0	0	0	0	0	28	0	0	0	0		
		Max	0	4	7	0	0	0	8	17	24	333	291	0	0	0	0	0	0	3	50	113	701	0	0	0	7		
	Coho salmon	2004	0	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	7.0
		2005	ns	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	8.0
		2006	0	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	5.3
		2007	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	5.8
		2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	8.1
		2009	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	7.0
		2010	0	0	0	ns	ns	ns	0	0	0	0	0	0	ns	0	0	0	ns	ns	0	0	0	ns	ns	ns	ns	0	4.6
		2011	0	0	0	ns	ns	ns	0	0	0	0	0	0	ns	0	0	0	0	0	0	0	0	ns	0	0	0	0	6.8
		2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.2
		2013	0	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	0	0	0	0	6.2
		2014	ns	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	0	NA
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Sockeye salmon	2004	0	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	7.0
		2005	ns	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	8.0
		2006	0	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	5.3
		2007	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	5.8
		2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	8.1
		2009	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	0	ns	0	0	0	4	ns	ns	ns	ns	4	7.0
		2010	0	0	0	ns	ns	ns	0	0	0	0	0	0	ns	0	0	0	ns	ns	0	0	1	ns	ns	ns	ns	1	4.6
		2011	0	0	0	ns	ns	ns	0	0	0	0	3	0	ns	0	0	0	0	0	0	0	4	ns	0	0	0	7	6.8
		2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.2
		2013	0	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	0	0	0	0	6.2
		2014	ns	0	0	ns	ns	ns	0	0	0	0	1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	1	NA
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0		
		Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Max	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	4	0	0	0	0		7.0
	Pink salmon	2004	0	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	8.0
		2005	ns	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	5.3
		2006	0	0	0	0	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	5.8
		2007	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	8.1
		2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	7.0
		2009	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	4.6
		2010	0	0	0	ns	ns	ns	0	0	0	0	0	0	ns	0	0	0	ns	ns	0	0	0	ns	ns	ns	ns	0	6.8
		2011	0	0	0	ns	ns	ns	0	0	0	0	0	0	ns	0	0	0	0	0	0	0	0	ns	0	0	0	0	5.2
		2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.2
		2013	0	0	0	ns	ns	ns	0	0	0	1	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	0	0	0	1	6.4
		2014	ns	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	0	NA
		Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Max	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Fall	Chinook salmon	2004	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	4.0
		2005	0	0	0	0	ns	0	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	2.3
		2006	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	0	ns	ns	ns	ns	0	6.7
		2007	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	6.9
		2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	8.6
		2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	7.4
		2010	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	8.8
		2011	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0
		2012	0	0	0	ns	0	0	0	ns	ns	ns	ns	0	ns	0	0	ns	0	0	0	0	0	0	0	0	0	0	5.4

Appendix Q

Adult Salmon Aerial Couts for the Crooked Creek Drainage (2004-2014)

	2013	0	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	0	0	0	0	5.6
	2014	ns	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	ns	ns	0	0	NA
	Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Chum salmon	2004	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	4.0
	2005	0	0	0	0	ns	0	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	2.3
	2006	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	0	ns	ns	ns	ns	0	6.7
	2007	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	6.9
	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	8.6
	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	7.4
	2010	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	8.8
	2011	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0
	2012	0	0	1	ns	0	0	0	ns	ns	ns	ns	0	ns	0	0	ns	0	0	0	0	0	0	0	0	0	1	5.4
	2013	0	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	0	0	0	0	5.6
	2014	ns	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	ns	ns	0	0	NA
	Mean[2]	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Max	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Coho salmon	2004	0	190	56	0	ns	0	27	23	9	3	2	0	ns	1	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	311	4.0
	2005	0	1	0	0	ns	1	1	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	3	2.3
	2006	40	37	3	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	3	ns	ns	ns	ns	83	6.7
	2007	39	15	2	0	ns	0	0	7	8	0	0	0	ns	0	0	ns	ns	ns	30	10	21	ns	ns	ns	ns	132	6.9
	2008	6	62	34	1	1	2	24	38	25	18	14	3	2	0	0	ns	ns	ns	42	40	115	ns	ns	ns	ns	427	8.6
	2009	0	45	58	0	5	0	8	3	15	40	7	0	0	0	0	0	ns	12	47	38	156	ns	ns	ns	ns	434	7.4
	2010	90	18	31	0	0	0	35	5	4	22	8	0	ns	0	0	0	ns	23	31	38	110	ns	ns	ns	ns	415	8.8
	2011	208	58	31	0	0	0	39	36	19	26	3	0	ns	0	0	0	0	57	60	105	67	2	97	122	134	1064	3.0
	2012	8	7	0	ns	0	0	1	ns	ns	ns	ns	0	ns	0	0	ns	0	0	26	14	0	0	0	0	0	56	5.4
	2013	30	3	0	ns	ns	ns	2	0	0	0	0	ns	ns	ns	ns	ns	0	10	19	4	0	ns	5	5	4	82	5.6
	2014	ns	44	0	ns	ns	ns	7	6	2	0	10	ns	ns	ns	ns	ns	0	0	3	0	22	ns	ns	ns	29	123	NA
	Mean[2]	42.1	43.6	19.5	0.1	1.2	0.3	13.1	11.8	8.2	10.9	4.4	0.4	1.0	0.1	0.0	0.0	0.0	17.0	32.3	31.1	54.9	1.0	34.0	42.3	41.8		
	Min	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	4	0	0	0	0	0		
	Max	208	190	58	1	5	2	39	38	25	40	14	3	2	1	0	0	0	57	60	105	156	2	97	122	134		
Sockeye salmon	2004	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	4.0
	2005	0	0	0	0	ns	0	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	2.3
	2006	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	0	ns	ns	ns	ns	0	6.7
	2007	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	6.9
	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	8.6
	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	7.4
	2010	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	8.8
	2011	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0
	2012	0	0	0	ns	0	0	0	ns	ns	ns	ns	0	ns	0	0	ns	0	0	0	0	0	0	0	0	0	0	5.4
	2013	0	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	0	0	0	0	5.6
	2014	ns	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	ns	ns	0	0	NA
	Mean[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Pink salmon	2004	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	4.0
	2005	0	0	0	0	ns	0	0	0	0	0	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	2.3
	2006	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	ns	ns	0	ns	ns	ns	ns	0	6.7
	2007	0	0	0	0	ns	0	0	0	0	0	0	0	ns	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	6.9
	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	ns	ns	0	0	0	ns	ns	ns	ns	0	8.6
	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	7.4
	2010	0	0	0	0	0	0	0	0	0	0	0	0	ns	0	0	0	ns	0	0	0	0	ns	ns	ns	ns	0	8.8
	2011	0	0	0	0	0	0	0	0	0	0	1	0	ns	0	0	0	0	0	0	0	0	0	0	0	0	1	3.0
	2012	0	0	0	ns	0	0	0	ns	ns	ns	ns	0	ns	0	0	ns	0	0	0	0	0	0	0	0	0	0	5.4
	2013	0	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	0	0	0	0	5.6
	2014	ns	0	0	ns	ns	ns	0	0	0	0	0	ns	ns	ns	ns	ns	0	0	0	0	0	ns	ns	ns	0	0	NA
	Mean2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Max	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Notes:

ns = not surveyed

1) # Years sampled = (# Summer Surveys,# Fall Surveys)

2) Mean = (total # fish seen)/(# years surveyed)

3) RA= percent relative abundance

4) Estimated water clarity on a 1-10 scale based on field observations during sampling: 1= completely turbid, 10= completely clear

Refer to Figure 1.1-1 for aerial reach locations and adult salmon distributions within the Crooked Creek drainage.

Summer aerial flight dates for Chinook, chum, sockeye, and pink salmon: July 25, 2004; July 23, 2005; July 19-20, 2006; July 24-28, 2007; July 23-25, 2008; July 19-22, 2009; July 24-25, 2010; July 21-22, 2011; July 20-24, 2012; July 25-28, 2013; July 26, 2014. Fall aerial flight dates for coho salmon: September 23-24, 2004; September 26-27, 2005; September 19-20, 2006; September 11-13, 2007; September 18-20, 2008; September 13-15, 2009; September 17-18, 2010; September 15-18, 2011; September 19-24, 2012; September 17-19, 2013; September 18-20,2014.