Susitna-Watana Hydroelectric Project
(FERC No. 14241)

River Productivity Study
Study Plan Section 9.8

2014 Study Implementation Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
δ13C	Carbon-13 isotopic signature, reported in parts per thousand (per mil, ‰)
δ15N	Nitrogen-15 isotopic signature, reported in parts per thousand (per mil, ‰)
°C	degrees Celsius
°F	degrees Fahrenheit
µg	micrograms
µm	micrometer
µS	microsiemen
‰	parts per thousand (per mil)
ADF&G	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
AFDM	ash free dry mass
AMSL	Above Mean Sea Level
ANCOVA	Analysis of Covariance
BOM	benthic organic matter
C	carbon
CIRWG	Cook Inlet Regional Working Group
cm	centimeter
cm^2	square centimeter
C_{max}	maximum consumption rate
COC	chain of custody
CP	capture probability
CPOM	coarse particulate organic matter
df	degrees of freedom
EMAP	Environmental Monitoring and Assessment Program
EPT	Ephemeroptera, Plecoptera, and Trichoptera, insect orders of typically sensitive taxa
DO	dissolved oxygen
DOC	dissolved organic carbon
FA	Focus Area
FBOM	fine benthic organic matter
FERC	Federal Energy Regulatory Commission
FFG	functional feeding groups
FL	Fork length
FPOM	fine particulate organic matter
ft	foot (feet)
ft2	square feet
ft3	cubic foot (feet)
g	gram
GRP	growth rate potential
H'	Shannon-Wiener diversity index, calculated to represent diversity

Abbreviation	Definition
HCl	hydrochloric acid
HDPE	high-density polyethylene
HSC	habitat suitability curve
HSI	habitat suitability index
hyp	hypothesis
in	inch(es)
in2	square inch(es)
IP	Implementation Plan
ISR	Initial Study Report
J	joule
J’	Pielou’s J’, an index of community evenness
K_d	light extinction coefficient
L	liter(s)
LWD	large woody debris
M	molar, molarity (= moles of solute per liter of solution)
m^2	square meter(s)
MANCOVA	Multivariate analysis of covariance
MDN	marine-derived nutrients
mg	milligram(s)
MixSIAR	A Bayesian stable isotope mixing model
mm	millimeter(s)
mV	millivolt(s)
N	nitrogen
NAWQA	National Water-Quality Assessment
NO2	nitrite
NO3	nitrate
NTU	nephelometric turbidity unit
OHWM	ordinary high water mark
OM	organic matter
ORP	Oxidation-Reduction Potential
oz	ounce(s)
p	P-value or calculated probability. The estimated probability of rejecting the null hypothesis (H0) of a study question when that hypothesis is true.
PAR	photosynthetic active radiation
pCO_2	partial pressure of carbon dioxide
pH	measure of how acidic/basic water is, range goes from 0 – 14.
PIT-tag	Passive Integrated Transponder tags used to individually identify animals and monitor their movements.
PMCMR	Pairwise Multiple Comparisons of Mean Rank
PRM	Project River Mile
QAPP	quality assurance project plan

Abbreviation	Definition
QA/QC	quality assurance/quality control
RD	reaction distance
RM	river mile
RP	River Productivity
RSP	Revised Study Plan
SD	standard deviation
SIA	stable isotope analysis
SL	standard length
SPD	Study Plan Determination
spp.	species
SRP	Soluble Reactive Phosphorus
TEF	trophic enrichment factors
TKA	Talkeetna River
TKN	Total Kjeldaho Nitrogen
TP	Total Phosphorus
UAF	University of Alaska-Fairbanks
U.S.	United States
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1. INTRODUCTION

On December 14, 2012, Alaska Energy Authority (AEA) filed its Revised Study Plan (RSP) with the Federal Energy Regulatory Commission (FERC or Commission) for the Susitna-Watana Project, FERC Project No. 14241, which included 58 individual study plans (AEA 2012). Included within the RSP was the River Productivity Study, Section 9.8. RSP Section 9.8 focuses on collecting baseline data to assist in evaluating the effects of Project-induced changes in flow and the interrelated environmental factors upon the benthic macroinvertebrate and algal communities in the Middle and Upper Susitna River. On April 1, 2013 FERC issued its final study determination (April 1 Study Plan Determination [SPD]) that included approval for RSP Section 9.8 with modifications (FERC 2013).

In 2013 and 2014, AEA adopted the FERC recommended modifications and implemented them with the variances presented in the Initial Study Report (ISR) for Study 9.8 (AEA 2014a). The ISR for Study 9.8, River Productivity, presented activities required to complete the Study Plan (ISR Part C, Section 7.1; AEA 2014a). This year-end report presents an update on activities conducted during 2014. Field work in 2014 was largely focused on data collection to support the needs of the trophic modeling and stable isotope analysis objectives of the study. This report includes a discussion of the following four field activities that AEA completed in 2014 (ISR Part C, Section 7.2; AEA 2014a):

1. Estimate drift of invertebrates (RSP Section 9.8.4.5; AEA 2012), as modified in ISR Part C Section 7.1.2.2 (AEA 2014a);
2. Conduct trophic modeling and stable isotope analysis (RSP Section 9.8.4.7; AEA 2012) as modified in ISR Part C Section 7.1.2.4 (AEA 2014a);
3. Analyze fish diet (RSP Section 9.8.4.11; AEA 2012) as modified in ISR Part C, Section 7.1.2.5 (AEA 2014a);
4. Measure productivity in selected Susitna River tributaries and lakes above Devils Canyon, as described in ISR Part C, Section 7.1.2.7 (AEA 2014a).

Field data collection efforts in 2014 associated with items 1 – 3 above, were briefly summarized in the *2014 Field Season River Productivity Progress Report Technical Memorandum* (R2 and UAF 2014a) in September 2014, and are elaborated upon herein. This report also contains summaries of the laboratory analyses for 2013 samples completed and presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014, and of the *Fish Diet Sample Size Sufficiency Analysis Technical Memorandum* (UAF and R2 2014) in December 2014. Finally, the report presents preliminary results of the 2013 data sets that were not available for inclusion in the 2013 technical memorandum. These data include: benthic macroinvertebrates on large woody debris (RSP Section 9.8.4.5; AEA 2012), adult emergence samples, and the organic matter estimates from benthic and drift samples.

2. STUDY OBJECTIVES

The study objectives for Study 9.8, River Productivity, were established in the Study Plan (RSP Section 9.8.1). The overarching goal of this study is to collect baseline data to assist in evaluating the effects of Project-induced changes in flow and the interrelated environmental factors (temperature, substrate, water quality) upon the benthic macroinvertebrate and algal communities in the Middle and Lower Susitna River. Individual objectives that address this goal and were accomplished in 2014:

- Synthesize existing literature on the impacts of hydropower development and operations (including temperature and turbidity) on benthic macroinvertebrate and algal communities. This objective was completed and is included in the ISR Part A, Appendix A (AEA 2014a).
- Characterize the pre-Project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the Middle and Lower Susitna River.
- Estimate drift of benthic macroinvertebrates in selected habitats within the Middle and Lower Susitna River to assess food availability to juvenile and resident fishes.
- Conduct a feasibility study in 2013 to evaluate the suitability of using reference sites on the Talkeetna River to monitor long-term Project-related change in benthic productivity.
- Conduct a trophic analysis to describe the food web relationships within the current riverine community within the Middle and Lower Susitna River.
- Characterize the invertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).
- Characterize organic matter resources (e.g., available for macroinvertebrate consumers) including coarse particulate organic matter, fine particulate organic matter, and suspended organic matter in the Middle and Lower Susitna River.
- Estimate benthic macroinvertebrate colonization rates in the Middle Susitna Segment under pre-Project baseline conditions to assist in evaluating future post-Project changes to productivity in the Middle Susitna River.
- Characterize the pre-Project benthic macroinvertebrate communities, with regard to species composition and abundance, and algal production in selected Susitna River tributaries and lake systems located above Devils Canyon.

3. STUDY AREA

As established by the Study Plan (RSP Section 9.8.3; AEA 2012), the River Productivity Study conducted field sampling in 2014 throughout the Middle Segment and upper portion of the Lower Segment on the Susitna River (Figures 3-1 and 3-2). The Middle Susitna River Segment encompasses the 85-mile section of river between the proposed Watana Dam site and the Chulitna River confluence, located at Project River Mile (PRM) 102.4 (River Mile [RM] 98.6)

(Figure 3-1). Sampling has been conducted at various distances from the proposed dam site to document longitudinal variability, and estimate the effects that the proposed Project will have on benthos in the river system downstream. The Lower Susitna River Segment, defined as the approximate 102-mile section of river between the Three Rivers Confluence and Cook Inlet (Figure 3-2), has been sampled in this study to document the current conditions within the upper portions of the segment, and help to understand any potential Project operation effects on benthic communities within the mainstem Susitna River below the Three Rivers Confluence. The Talkeetna River is an approximate 85-mile long tributary of the Susitna River, joining with the Susitna and Chulitna rivers at the Three Rivers Confluence (Figure 3-1). Sampling activities on the Talkeetna River in 2013 only, and sites were located approximately 8.5 – 9 miles upstream from the mouth, as an effort to assess the feasibility of the Talkeetna River as a reference site for post-Project monitoring activities.

In addition, the River Productivity Study team collected benthic macroinvertebrate and algal samples once during the summer of 2014 within nine selected tributaries located above Devils Canyon within the Middle and Upper Susitna River basin (Figure 3-3) and three lakes (Tyone Lake, Susitna Lake, and Lake Louise) within the Tyone River drainage basin in the Upper Susitna River basin (Figures 3-3 and 3-4). This objective is a variance, as it is a proposed modification described in ISR Part C, Section 7.1.2.7 (AEA 2014a).

4. METHODS AND VARIANCES IN 2014

This study employed a variety of field methods to build on the existing benthic macroinvertebrate and algal community information in the Middle Susitna River. The following sections provide brief descriptions of study site selection, sampling timing, the approach, and methods that were used to accomplish each objective of this study.

4.1. River Productivity Implementation Plan

This study report includes a description of the sampling scheme consistent with the final sampling scheme detailed in the River Productivity Implementation Plan (IP) filed with FERC on March 1, 2013 (R2 2013a), with the exception of specific variances as described within each section.

4.2. Site Selection

AEA implemented the methods as described in the Study Plan with the exception of variances explained below (Section 4.2.3.).

Sampling on the Susitna River was stratified by river segment and mainstem habitat type, as defined in the Project-specific habitat classification scheme (e.g., main channel, tributary mouth, side channel, side slough, and upland slough). Sampling occurred at five stations on the Susitna River, each station with three to five sites (establishing sites at all macrohabitat types present within the station), for a total of 21 sites. In the Middle River Segment, two stations were located between the dam site and the upper end of Devils Canyon, and two stations were located between Devils Canyon and Talkeetna (Table 4.2-1; Figure 3-1). All stations established within the Middle River Segment were located at Focus Areas stablished by the Fish and Aquatic Instream Flow Study (R2 2013b; R2 2013c), in an attempt to correlate macroinvertebrate data with additional environmental data (flow, substrates, temperature, water quality, riparian habitat, etc.) collected by other studies (e.g., Baseline Water Quality Study, Study 5.5), and for macroinvertebrate habitat suitability curve and habitat suitability index (HSC/HSI) development. Many of these Focus Areas were also used for collecting target fish species for trophic analysis (RSP Section 9.8.4.7; AEA 2012).

To determine to what extent, if any, the Project operations may affect benthic communities, as well as the influence that the two tributaries may have on those communities below the confluence of the Three Rivers, one station was located in the upper portion of the Lower River (Figure 3-2).

Data collection station and site locations are described below.

4.2.1. **Middle River Stations / Focus Areas**

Within the Middle River, each one of the four sampling locations was located within a Focus Area (Table 4.2-1; Figure 3-1 and Figures 4.2-1 through 4.2-4). Two stations between the proposed dam site and Devils Canyon were established in Focus Area (FA)-184 (Watana Dam) and FA-173 (Stephan Lake Complex). Between Devils Canyon and Talkeetna, two stations were established in FA-141 (Indian River) and FA-104 (Whiskers Slough).

FA-184 (Watana Dam) is located approximately 1.4 miles downstream of the proposed dam site and provides a mainstem site and a side channel site within its 1-mile extent (Figure 4.2-1; Table 4.2-1). In order to meet the objective of sampling sites at 3 or more habitats, it was necessary to move outside of the FA-184 (Watana Dam) to include a site at the mouth of Tsusena Creek. In 2014, a formal location for drift sampling above the mouth of Tsusena Creek was determined, as opposed to using the mainstem site as was done in 2013. FA-173 (Stephan Lake Complex) is located approximately 11.7 miles downstream of the proposed dam site and contains a complex of main channel and off-channel habitats within a wide floodplain, thus representing the greatest channel complexity within its geomorphic reach (MR-2; Figure 4.2-2). FA-173 (Stephan Lake Complex) provided a mainstem site, a side channel site which also served as the above-tributary mouth drift sampling location, a side slough site, an upland slough site, and a small tributary mouth site within its 1.8-mile extent (Table 4.2-1). .

Below Devils Canyon, FA-141 (Indian River) and FA-104 (Whiskers Slough) were selected due to the diversity of main- and off-channel habitats that they contained, and documented fish use in and nearby these Focus Areas. FA-141 (Indian River) includes the Indian River confluence, which is a primary Middle Susitna River tributary with high levels of fish use. FA-141 (Indian River) provided a mainstem site, a tributary mouth site, a side channel site, and an upland slough site, as well as a drift sampling location above the tributary mouth, within its 1.6-mile extent (Figure 4.2-3; Table 4.2-1). FA-104 (Whiskers Slough) is located approximately 2.4 miles upstream of the confluence of the Chulitna and Susitna rivers, making it the downstream-most station in the Middle River for the River Productivity Study. This Focus Area contains the confluence of Whiskers Creek, side channels, and side slough habitats that have been documented as supporting juvenile and adult fish use. FA-104 (Whiskers Slough) provided a main channel site, a side-channel site, a side slough site which also served as the above-tributary mouth drift sampling location, an upland slough site, and a tributary mouth site within its 1.2-mile extent (Figure 4.2-4; Table 4.2-1).

4.2.2. **Lower River Station**

Within the Lower River, one study station, with four sampling sites was established in conjunction with Fish Distribution and Abundance (Study 9.6) sampling activities on the Lower Susitna River around the Montana Creek mouth area (Table 4.2-1, Figures 3-2 and 4.2-5). This Lower River station (River Productivity Station 81 [RP-81] [Montana Creek]) was located within a 1.2-mile reach beginning approximately 21 miles downstream of the confluence with the Chulitna and Talkeetna rivers. This area was complex, with split channels, side channels, upland sloughs, and tributary mouths (Figure 4.2-5). Four sites were established at Station RP-81 (Montana Creek) including: 1) a mainstem site, 2) a side channel site, 3) an upland slough site, and 4) a tributary mouth site, with an additional drift sampling location above the mouth of (Table 4.2-1).

4.2.3. **Variances**

4.2.3.1. *Site Selection in the Middle and Lower Susitna River*

The methods for characterizing pre-Project benthic macroinvertebrate and algal communities in the Middle and Lower Susitna River were conducted as in 2013, at sites as described in the Study Plan except for those changes detailed as variances in ISR Part A, Section 4.2.4 (AEA 2014a), which include: 1) moving the Lower River site from Trapper Creek to Montana Creek, which had no effect on any of the study objectives, as it establishes one study station within the Lower River Segment (ISR Section 4.2.4.1); 2) replacing the upland slough sites at FA-173 (Stephan Lake Complex) with a small unnamed tributary mouth (ISR Section 4.2.4.2), which had no effect on accomplishing the study objectives. Lack of permission to access Cook Inlet Regional Working Group (CIRWG) land in 2013 prevented sampling at the upland slough site. However, in 2014, land access for CIRWG lands was permitted, and this upland slough site was sampled (RP-173-5).

4.2.3.2. *Tributaries and Lakes above Devils Canyon*

In the ISR Part C, Section 7.1.2.7 (AEA 2014a), AEA proposed a modification "*with the stated objective to characterize the pre-Project benthic macroinvertebrate communities, with regard to species composition and abundance, and algal production in selected Susitna River tributaries and lake systems located above Devils Canyon.*" In July 2014, nine Susitna River tributaries and three lake systems were selected based on historic estimates of salmon production potential provided in Barrick et al. (1983). The three lakes were all located within the Tyone River system. The nine tributaries that AEA sampled in 2014 were selected to ensure representation from habitats that connect to each of the three upper river reaches that would be subject to different potential effects: two selected tributaries drain into the mainstem Susitna River within the reach below the proposed dam site and upstream of Devils Canyon, four tributaries drain into the reach that would be inundated by the proposed reservoir, and three tributaries drain into the reach upstream of the proposed reservoir (Table 4.2-2).

Within the Middle and Upper River basins, one site was established on each of nine selected tributaries located above Devils Canyon in the Middle and Upper Susitna River basin (Table 4.2-2, Figure 3-3). For tributaries that would drain into the proposed reservoir inundation zone, sampling was conducted near the upper extent of known Chinook presence (approximately 3,000 feet [ft] above mean sea level [AMSL]). For tributaries outside the proposed reservoir inundation zone, sampling was conducted between the mouth of the tributary and either 3,000 ft AMSL or the downstream-most fish barrier. In addition, three lakes (Tyone Lake, Susitna Lake, and Lake Louise) were sampled once during the summer period to characterize the productivity of these lacustrine habitats under the current, baseline condition. Each lake, due to their large size, was stratified into three sampling sites in relation to the orientation to the lake outlet (upper, middle, lower), as well as representative of the range of available depths (shallow, mid-depth, deep) within each lake (Figure 3-4).

4.3. Characterize the Pre-Project Benthic Macroinvertebrate and Algal Communities with Regard to Species Composition and Abundance in the Middle and Lower Susitna River

No field work was conducted for this objective in 2014; for 2013, lab analysis for algae was presented in the ISR (ISR Part A, Section 5.2; AEA 2014a). However, 2013 lab analysis for several macroinvertebrate sample sets was completed, post filing of the ISR. Thus, the results for macroinvertebrates were presented in *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014. In 2014, additional analysis was also completed on the 2013 results of adult emergence traps and macroinvertebrates collected from woody debris; these results are presented in Section 5.1 of this report.

4.3.1. **2013 Field Collection**

Emergence trap collection methods were conducted as described in the ISR Part A, Section 4.4.1. (AEA 2014a). Additional data review and analysis since the ISR showed a total of 65 collection visits were made to retrieve and reset emergence trap samples over the course of the 2013 open-water season. A total of 47 samples were collected from the 20 study sites and submitted to the taxonomy laboratory in 2013 (Table 4.3-1). These totals supersede those given in Table 4.4-3 in the ISR (Part A, Section 4.4.1.; AEA 2014a). Consistent with the ISR, a loss of 19 samples was recorded due to a number of disturbances, including bear damage, boat traffic, and fluctuating flow conditions.

Of the 47 samples retrieved, 27 samples were collected from traps that were intact and appeared undisturbed; however, 20 samples were noted to be either damaged by wildlife, or stranded on the shoreline due to receding water levels or by boat traffic (Table 4.3-2). The sample bottles of these 20 disturbed samples still contained ethanol preservative with specimens, and were thus retained as samples; however, their exact sampling durations are unknown, as they were found out of the water at the time of retrieval. For purposes of reporting, sample metrics were calculated assuming the full sampling duration.

Sampling methods for large woody debris (LWD) in the Susitna River were conducted as described in the ISR Part A, Section 4.4.1. (AEA 2014a). Pieces of LWD were not prevalent at all sites. A total of 155 samples were collected from 16 of the 20 sites in 2013 (ISR Part A, Section 4.4.1.; AEA 2014a). Pieces of wood were mostly located in tributary mouths and off-channel macrohabitats; main channel sites rarely provided suitable LWD. Size distribution of available woody debris pieces sampled shows that a majority (84.5 percent) were between 1- to 4-inches in diameter; only 11.6 percent of those suitable pieces found and processed were above the defined 4-inch diameter for LWD (Figure 4.3-1).

4.3.2. **Macroinvertebrate Metrics**

Upon receipt of data results, the taxonomic composition of each sample was used to generate a taxa-abundance matrix. The matrix was reviewed and adjusted for different levels of taxonomy. When identifying macroinvertebrates, some specimens were either too immature or too damaged for identification at the genus-level, and could only be assigned to a higher taxonomic level (e.g., family, subfamily, order). For instance, a sample may contain individuals identifiable only to the mayfly family Baetidae, yet also contain individuals clearly identified to one or more genera within this family (e.g., *Baetis tricaudatus*, *Diphetor hageni*). This situation can lead to inflated estimates of the number of taxa in a sample.

To prevent the inflation of metrics, the abundances of these "parent" taxa were distributed proportionately among their composite taxa. This apportioning is similar to the method used by the United States Geological Survey (USGS) National Water-Quality Assessment (NAWQA) studies to correct for "ambiguous taxa" (Cuffney et al. 1997). The abundances of "parent" taxa (orders, families) were retained in analysis when there were no composite taxa identified in the sample.

After applying the corrective measures used in preparing the taxa-abundance matrix, the data were used to calculate a number of descriptive metrics commonly used in aquatic ecological studies. These metrics were classified as abundance measures, richness measures, composition measures, and functional feeding groups.

4.3.2.1. *Abundance Measures*

Macroinvertebrate abundance is represented by *density*, which is the total number of individuals collected in a unit area. Subsample enumerations were expanded to provide a density estimate (e.g., individuals/m²) for each sample.

4.3.2.2. *Richness Measures*

Metrics used to describe macroinvertebrate species richness include: taxa richness, Ephemeroptera Plecoptera Trichoptera (EPT) taxa, Chironomid taxa, diversity, and evenness.

Taxa richness is the number of different types, or taxa, of invertebrates occurring in a given sample. This metric is reported for individual sampling efforts, such as emergence traps (Section 5.1.1.1.) and composite D-net sweeps (Section 5.8.2.1.), and is used for overall summaries of samples collected at each site during the study year. When considering a collection of replicate samples at a site, two different taxa richness values are generated for this report:

During an individual sampling event (Spring, Summer, Fall), the *mean taxa richness* is the average number of taxa collected from the replicate samples collected at a site, not the site's total taxa richness. By averaging the taxa richness of the samples, the influence of rare taxa is minimized, thus reducing the taxa richness score.

The *total taxa richness* for a site is simply a tally of all unique taxa collected at a site during an individual sampling event, utilizing all collected samples. Thus, the occurrence of rare taxa is given a weight equal to common taxa. As a result, total taxa richness indicates larger estimates of taxa richness than mean taxa richness. While total taxa richness may not lend itself to statistical analysis in the short-term study, it provides a measure of contrast between sites, and may become statistically useful in the long-term program.

EPT taxa is the number of taxa from the insect orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). Following protocols from numerous state and federal agencies, taxa richness values were calculated separately for each order. Both mean and total EPT taxa count values were determined.

Chironomid taxa is the number of taxa from the insect family Chironomidae (midges, Order = Diptera). Because Chironomidae are typically dominant in Alaskan streams (Oswood 1989), identifications were made to genus level to fully reflect the taxonomic richness in the Susitna River. This metric reflects the contribution of chironomids to the taxa richness measure. Both mean and total chironomid taxa count values were determined.

Ecological diversity is a measure of community structure defined by the relationship between the number of distinct taxa and their relative abundance. The *Shannon-Wiener diversity index* (H') was calculated (log e) to represent diversity. This index usually lies between 1.5 and 3.5 for ecological data. Higher index numbers indicate greater diversity, and the presence of a complex ecological community. Diversity usually decreases with impaired habitat or water quality, or increased disturbance. *Pielou's J'*, an index of community evenness, was also calculated. Values range from 0 to 1.0. Higher values indicate a more even spread in the community.

4.3.2.3. *Composition Measures*

The relative abundance of major taxonomic groups provides information on a stream community's structure and the relative contribution of the populations to the total fauna (Barbour et al. 1999). Eight major taxonomic groups were used to describe the community structure in our analysis: Ephemeroptera, Plecoptera, Trichoptera, Coleoptera (beetles), Chironomidae (midges), Diptera (true flies other than midges), Other Insects, and Non-insects. Composition measures of certain taxonomic groups are often used as indicators of impairment in streams. For example, an increase in the relative abundance of non-insect taxa, or a decrease in the relative abundance of EPT taxa, may indicate environmental stress in a stream. For emergence trap samples, Hymenoptera and Hemiptera were added in place of Other Insects, due to the prevalence of terrestrial insects in the samples. Additionally, the relative abundances of aquatic taxa and terrestrial taxa were added for emergence trap sample results.

The *EPT:Chironomid ratio* is a ratio of the abundance of Ephemeroptera, Plecoptera, Trichoptera in relation to chironomids. The ratio ranges from 0 to 1, with scores below 0.5 indicating more Chironomidae in the community.

The *percent dominant taxa* metric is the relative abundance of the most abundant taxa in a sample: the most abundant taxon, and the top three most abundant taxa, were calculated. Disturbances usually cause the abundance of a few taxa to increase and an elevation of the percent dominance of the most abundant taxa.

4.3.2.4. *Functional Feeding Groups*

Benthic macroinvertebrate taxa abundances were allocated into functional-feeding group categories according to their preferred methods of gathering food, based on determinations of the primary feeding mechanism by Barbour et al. (1999). The major functional-feeding groups used in our analysis were: collector-gatherers, collector-filterers, scrapers, shredders, predators, and parasites as defined by Cummins et al. (2008). All other functional feeding groups, and any individuals with unclassified or unknown feeding mechanisms, were consolidated into a seventh group, “Others.” Data are presented as a percent of the total sample abundance.

4.4. Estimate Drift of Invertebrates in Selected Habitats within the Middle and Lower Susitna River to Assess Food Availability to Juvenile and Resident Fishes

In 2014, AEA implemented the field methods for the collection of drifting invertebrates as described in the Study Plan (River Productivity IP Section 2.1, R2 2013a; FERC 2013) with the exception of variances explained below (Section 4.4.1). Invertebrate drift sampling for 2014 was conducted in support of trophic analysis and fish diet sampling efforts at all sites within the five established sampling stations to allow for comparisons between the drift component and availability of invertebrates for fish predation. Three sampling events were conducted from June through October in 2014 to capture seasonal variation in community structure and productivity. The timing of events was influenced by availability of open water for sampling. Information on the specific sampling timing is provided in Table 4.4-1.

Sampling was conducted in fast-water habitats, when they were present, within all established sites (Tables 4.2-1 and 4.4-2). In addition, at all tributary mouth sites, a drift net pair was deployed upstream of the site, to collect information on the relative contribution of tributaries to fish prey resources in the mainstem Susitna River. A total of 108 drift samples were taken during the 2014 field season (Table 4.4-2). The use of drift nets is not advised with currents less than 0.16 feet per second (0.05 meters per second); thus, a plankton tow net (243-micrometer (µm) mesh net with a 8-inch opening) was used at still water sites, taking five replicate horizontal tows along transects across the channel. A total of 105 plankton tows were collected from 9 of the 21 sites (Table 4.4-2).

Invertebrate drift and plankton tow samples were shipped to and processed by Ecoanalysts, Inc. (Moscow, Idaho) using methods similar to those used for benthic samples (Barbour et al. 1999; Major and Barbour 2001). Organic matter (OM) content from drift samples was retained and analyzed by size (coarse and fine particulate OM) as discussed in Section 4.8. Drift results for 2014 are presented in Section 5.2 of this report. Data received was prepared for benthic macroinvertebrate samples as detailed in Section 4.3. Density was measured by volume, per cubic foot, and all metrics dependent upon density estimates reflect this as well. For composition measures, zooplankton was broken out from Non-insects, due to its prevalence in plankton tow samples.

Lab analysis for the 2013 data collected was completed post-ISR filing in June 2014, and results were presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014.

4.4.1. Variances

The methods for estimating drift of invertebrates (RSP Section 9.8.4.5; AEA 2012) were employed as described in the Study Plan with the exception of the variances implemented in 2013, as described in ISR Part A, Section 4.5.1 (AEA 2014a) which include: 1) collecting plankton tows at 5 still water sites; and 2) estimating dry weights for macroinvertebrate taxa using length-weight relationship data from UAF as opposed to direct oven-dried biomass weights.

4.5. Conduct a Feasibility Study in 2013 to Evaluate the Suitability of Using Reference Sites on the Talkeetna River to Monitor Long-term Project-related Change in Benthic Productivity

No field work was conducted for this objective in 2014. However, 2013 lab analysis was completed post-ISR filing in June 2014, and results were presented in *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014.

4.6. Conduct a Trophic Analysis, Using Trophic Modeling and Stable Isotope Analysis, to Describe the Food Web Relationships in the Current Riverine Community within the Middle and Lower Susitna River

4.6.1. Develop a Trophic Model to Estimate How Environmental Factors and Food Availability Affect the Growth Rate Potential of Focal Fish Species under Current and Future Conditions

In 2014, AEA implemented field methods as described in the Study Plan (River Productivity IP Sections 2.10.1; R2 2013a; FERC 2013) with variances and one modification, the addition of Arctic Grayling as a target species for the trophic analysis, as detailed in ISR Part C Section 7.1.2.4 (AEA 2014a). To determine how water temperature, food availability, and food quality influence the growth of juvenile salmon and resident stream salmonids, field data from the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (Study 9.6), and this River Productivity Study was analyzed using a bioenergetics approach. This analysis allowed comparisons of observed growth rates, estimated consumption rates, and estimated growth efficiency (i.e., the grams [g] of growth achieved per g of food consumed) among different habitats under the environmental conditions observed during 2013 and 2014. The inputs to the bioenergetics models were growth (seasonal weight-at-age), water temperature, diet composition, and the energy density of prey of each prey category.

4.6.1.1. *Observed fish growth rates*

Growth rates were determined by aging scales using methods as described in ISR Part A Section 4.7.1. (AEA 2014a). Fish ages were determined using scales and temporal length distribution data (DeVries and Frie 1996, Isely and Grabowski 2007). All fish sampled in this study were aged, except for a small number for which all scales were regenerated or otherwise unreadable. Ages were assigned based on the presence of annuli and the number of circuli. Length-frequency data were used to determine the size of age-0 Chinook and Coho salmon during the spring sampling events. During Sampling Event 1 (Spring) in both years, the size range of fish sampled by the River Productivity Study (≥ 50 millimeter [mm] fork length [FL]) only partially overlapped with the size distribution of age-0 Chinook and Coho salmon, based on examination of the length-frequency distributions of these species sampled by the Fish Distribution and Abundance in the Middle and Lower River Studies within the study area of the River Productivity Study (Fig 5.4-1). Thus, the modal size of this age class was determined from the length-frequency distributions. The modal fork length in each year was converted to wet weight (W, g) for input to the model using length-weight relationships developed for juvenile Chinook and Coho salmon:

$$W = 5.94 \times 10^{-6}\ FL^{3.13}\ (n = 10{,}418,\ r^2 = 0.96,\ p < 0.0001), \qquad (1)$$

in the Middle and Lower Susitna River based on the combined length and weight data collected in 2013 and 2014 by the River Productivity and Fish Distribution and Abundance in the Middle and Lower River Studies. These weight data were used as the starting points for simulations of age-0 Chinook and Coho salmon during early summer.

The mean weight at age was determined for all other age-classes and seasons based on age-length relationships from fish aged by scales. Weight data were analyzed statistically to test for differences between years and among habitat types after taking date into account. For each salmon species and age class, an Analysis of Covariance (ANCOVA) model was fit including a Julian date as a covariate and main effects of year and habitat as well as all possible interactions. These models were refined using backwards selection, iteratively removing the least significant term until all remaining terms were significant, based on an alpha level of 0.05 (Kutner et al. 2005). Based on these results, the seasonal weight-at-age data were pooled among habitats that did not differ statistically. This approach highlighted meaningful differences in growth among habitat types, while enhancing sample sizes within modeled groups to reduce any potential effects of random variability. Sample sizes for Arctic Grayling and Rainbow Trout were not sufficient for statistical comparisons of seasonal weight-at-age among habitats, partly because the available sample size was spread across larger numbers of age classes.

4.6.1.2. *Bioenergetics modeling*

Field data were compiled to generate growth, temperature, and diet composition inputs for bioenergetics model simulations representing two periods in each year early summer, representing growth between the spring and summer sampling events, and late summer, representing growth between the summer and fall sampling events. The early summer simulations corresponded to calendar days June 21 through August 20, 2013 (59 days) and June 14 through August 13, 2014 (57 days). The late summer simulations corresponded to calendar days August 21 through September 30, 2013 (34 days) and August 14 through September 23, 2014 (47 days). The start and end dates corresponded to the midpoints of each sampling event.

Hourly water temperatures were recorded by submerged temperature loggers deployed at all sampling sites. Temperature loggers were deployed during Sampling Event 1 (Spring) and were retrieved during Sampling Event 3 (Fall). Diet composition was determined from stomach contents (Section 5.5). For modeling purposes, all diet items were grouped into five categories: aquatic life-stages of freshwater-derived prey (such as chironomid larvae and pupae), terrestrial life-stages of freshwater-derived prey (such as adult chironomid midges), terrestrial invertebrates (such as ants and caterpillars), fish and non-salmonid fish eggs, and salmon eggs. We estimated the energy density (Joule [J]/g wet weight) of these categories as 3,365 for aquatic life-stages of freshwater-derived prey (McCarthy et al. 2009), 4,225 for terrestrial life-stages of freshwater-derived prey (McCarthy et al. 2009), and 5,250 for terrestrial invertebrates (McCarthy et al. 2009), 5,235 for fish and non-salmonid fish eggs, based on the mean size of fish prey found in stomach contents (27 mm FL, 0.2 g) and a size-based energy density relationship for sockeye salmon (Beauchamp et al. 1989), and 9,000 for salmon eggs (Armstrong 2010).

Using these input data, Wisconsin bioenergetics models (Hanson et al. 1997) were used to estimate the consumption rate (g wet mass / day) of prey by juvenile Chinook Salmon and Coho Salmon during the spring-summer and summer-fall intervals between sampling events. The models were implemented in the program R (R Core Team 2015) using custom code (A. G. Hansen, University of Washington and E. R. Schoen, University of Alaska Fairbanks, unpublished) that replicated the standard Fish Bioenergetics 3.0 software package (Hanson et al. 1997) in a scripted framework that facilitated running repeated simulations for the sensitivity analysis. Bioenergetics models used physiological parameters developed for Chinook Salmon (Stewart and Ibarra 1991; Plumb and Moffitt 2015) and Coho Salmon (Stewart and Ibarra 1991). The models iteratively adjusted the ration size of simulated fish, expressed as a proportion P of the theoretical maximum consumption rate (C_{max}), until the simulated growth equaled the observed growth. Lower values of P (near zero) indicated that growth was limited by low food intake, while higher values near 1 indicated that feeding rates were high and growth was mostly limited by thermal constraints on digestion and metabolism or by the quality of food. Growth efficiency (g total growth / g total consumption) was computed for each simulation to indicate the percent of energy intake that was allocated to growth as opposed to metabolism and waste. These metrics were then compared to determine whether growth was limited primarily by water temperature, food consumption, or food quality in the study area, and whether these limiting factors differed among years, seasons, or habitats (McCarthy et al. 2009).

The growth rates of age-1 Chinook Salmon and age-2 Coho Salmon were not modeled because nearly all fish in these age-classes migrated out of the study area after Sampling Event 1 (Spring). Arctic Grayling and Rainbow Trout sample sizes were not sufficient to determine seasonal growth rates, so these species were not modeled.

4.6.1.3. *Growth rate potential modeling*

In addition to the descriptive bioenergetics analysis described above, a growth rate potential (GRP) analysis was evaluated as a potential prospective approach for predicting fish growth rates under changing environmental conditions. GRP models were developed for age-1 Coho Salmon, for which detailed foraging model parameters were available (Piccolo et al. 2008). Model parameters were also available for age-1 Rainbow Trout (Piccolo et al. 2008), but this species was not modeled in this study because very few age-1 Rainbow Trout were captured in the study. The GRP models linked a simple drift foraging model based on the model of Hughes and Dill (1990) to a Wisconsin bioenergetics model (Stewart and Ibarra 1991).

The drift foraging model estimated the consumption rate (g / day) of a drift-feeding age-1 Coho Salmon at each site during each sampling event. The model assumed that fish would detect all prey passing within a given reaction distance (RD) of their feeding position, and that they would successfully capture and consume some fraction of these prey defined by a capture probability (CP). The model estimated RD and CP based on water velocity-dependent relationships derived from laboratory feeding trials using wild, age-1 (70-80 mm FL) Coho Salmon from the Situk River, Alaska (Piccolo et al. 2008). These foraging parameters were applied in the current study to estimate Coho Salmon feeding rates based on field measurements of water velocity and drift invertebrate biomass density. The experiments of Piccolo et al. (2008) were conducted in clear water conditions (turbidity = 0.3 nephelometric turbity units [NTU]), so the parameters were adjusted to account for the effects of elevated turbidity levels on foraging rates in the Susitna River. No turbidity-dependent reaction distance relationship was available specifically for Coho Salmon, so a declining log-linear relationship between RD and turbidity for juvenile Chinook Salmon (Gregory and Northcote 1993) was applied. This relationship was transformed to predict the percent reduction in RD under a given turbidity level T, relative to the maximum RD that would be predicted under clear-water conditions (RD_{max}):

$$RD = RD_{max} (1 - 0.42 \log T) \qquad (2)$$

The model was only applied at sites for which the water velocity was at least 0.95 ft per second (0.29 m / second), because juvenile Coho Salmon did not consistently hold station and drift feed at lower velocities during feeding experiments (Piccolo et al. 2008). Salmon were assumed to feed continuously during daylight hours (Hughes and Dill 1990; Nislow et al. 2000). The duration of daylight (including civil twilight) was determined for the midpoint of each sampling period using data from the United States (U.S.) Naval Observatory Astronomical Applications Dept. (http://aa.usno.navy.mil/cgi-bin/aa_rstablew.pl).

The resulting consumption rates were input to a bioenergetics model for Coho Salmon with an initial body size specified as 5.3 g (representing 80 mm FL), a generic dietary energy density (3800 J / g, representing a mix of aquatic and terrestrial invertebrates [McCarthy et al. 2009]), and a 7-day mean water temperature measured at the site during the given season. The output, mass-specific growth rate potential (growth [g] / body weight [g] / day) was calculated for each site and sampling event where adequate data were available. Growth rate potential values were evaluated as a potentially useful metric of habitat quality integrating the effects of prey density, temperature, water velocity, and turbidity. A sensitivity analysis was conducted to determine which of these environmental factors were most influential in determining salmon growth rates. Each variable was adjusted +/- 20% from the values measured in the field, and growth rate potential was recalculated to determine model sensitivity.

Growth rate potential model results were compared to empirical growth data for sites and growth intervals (early summer or late summer) for which 1) an adequate sample size of juvenile Coho

Salmon ($n \geq 4$) was collected in two consecutive sampling events to allow the estimation of an observed growth rate for the interval between the events, and 2) growth rate potential models were available for both sampling events, allowing estimation of growth-rate potential for the interval. Only one site met these criteria, RP-141-1. Empirical growth rates and model-derived growth rate potential estimates were available for both early summer and late summer 2013 at this site. Due to the lack of corresponding data, the predictive power of the growth rate potential approach was not evaluated statistically. Instead, the model predictions were examined graphically.

Additionally, lab analysis of 2013 field samples was completed post-ISR filing in June 2014, and results were presented in *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014.

4.6.2. Conduct Stable Isotope Analysis of Food Web Components to Help Determine Energy Sources and Pathways in the Riverine Communities

In 2014, AEA implemented field methods as described in the Study Plan (River Productivity IP Sections 2.11; April 2013 SPD) with the exception of variances explained below (Section 4.6.3), and with one modification, the addition of Arctic Grayling as a target species for the trophic analysis, as detailed in ISR Part C Section 7.1.2.4 (AEA 2014a). To better understand the trophic relationships in the Middle and Lower Susitna River, stable isotope sampling was conducted at four stations; one in the Lower River (RP-81 [Montana Creek]) and three in the Middle River (FA-104 [Whiskers Slough], FA-141 [Indian River], and FA-184 [Watana Dam]) (Table 4.2-1 and Figures 3-1 and 3-2). A total of 1,557 samples were analyzed for stable isotope analysis (SIA) from multiple study components, including benthic macroinvertebrates, benthic algae, benthic organic matter, invertebrates and organic matter in drift samples, emergent aquatic insects, salmon carcasses, and fin clips from fish (Table 4.6-1). Samples were collected at all sites within these four stations, for a total of 16 sites, in conjunction with other related sampling efforts undertaken at each site/habitat type (Sections 4.4, 4.7, and 4.8).

For collection of stable isotope tissues from benthic macroinvertebrates and benthic organic matter (BOM), qualitative sampling was conducted using either a modified Hess sampler or a 243-µm D-frame kick net (Figure 4.6-1). Three composite samples were collected from each site, yielding a targeted wet weight of approximately 10 g (0.35 ounce [oz]) BOM, and 2 to 5 g (0.07 to 0.17 oz) for each of four functional feeding groups of benthic macroinvertebrates. Separation of macroinvertebrates from organic matter, identification, and sorting into feeding groups was conducted using a dissecting microscope in the lab at the University of Alaska-Fairbanks (UAF). Macroinvertebrates were sorted into functional feeding groups that each comprised a single composited sample to be used for stable isotope analysis (Table 4.6-1). A total of 589 benthic macroinvertebrate sample components and 144 benthic organic matter sample components were analyzed in 2014.

For collection of the benthic algae component for stable isotope analysis at each site, three composite samples representative of the algae assemblage present in each habitat type were taken, targeting a wet weight of 10 g (0.35 oz). Each composite sample was collected by thoroughly brushing the top and side surfaces of five haphazardly selected rocks and retaining the loosened algal material for analysis in the lab at UAF. A total of 142 benthic algae sample components were analyzed in 2014 (Table 4.6-1).

For collection of stable isotope material from drifting invertebrates and organic matter (seston), qualitative sampling was conducted using a pair of drift nets with 250-µm mesh (Figure 4.6-1). Two composite samples were collected from each site where drift sampling could be conducted, yielding a targeted wet weight of approximately 10 g (0.35 oz) seston, and 2 to 5 g (0.07 to 0.17 oz) for each composite sample of benthic macroinvertebrates. A total of 102 drift sample components and 96 seston sample components were analyzed in 2014 (Table 4.6-1). All samples were preserved in 70-percent ethanol and returned to UAF for further analysis.

For collection of stable isotopes from emerging adult aquatic insects, sample material was taken from emergence traps that were deployed at two off-channel sites per focus area (Figure 4.6-1). Off-channel sites were chosen for deployment in order to reduce damage and loss by boat wakes. Traps were set for a period of between 2 and 4 days. Upon collection from traps, any invertebrates present in the traps were transferred to a sample bottle, preserved in 70-percent ethanol, and returned to UAF for analysis. A total of 61 emergent insect samples components were analyzed in 2014.

Spawning salmon carcass tissue samples were collected as encountered between site RP-81 (Montana Creek) and FA-184 (Watana Dam) (Figures 3-1, and 3-2). A total of up to 40 tissue samples per year from a combination of Pink, Chum, Coho, Sockeye, and Chinook salmon were targeted for collection for stable isotope analysis of marine-derived nutrients (MDN). When and where possible, tissue samples were taken from spawning salmon carcass tissues by excising 2 to 5 g (0.07 to 0.17 oz) of muscle tissue approximately 1 to 3 inches behind the dorsal fin. A total of 9 carcasses were collected during summer and fall for stable isotope analysis (Table 4.6-1). All samples were preserved in 70-percent ethanol and returned to UAF for further analysis.

Stable isotope samples were collected non-lethally from fish selected and sampled as part of the fish diet analysis (Section 4.7) for targeted fish species (juvenile Chinook Salmon, Coho Salmon, Arctic Grayling, and Rainbow Trout). A total of up to 8 fish per target species per site were sampled, if present; a total of 445 fish samples were analyzed in 2014 (Table 4.6-1). Tissue samples were obtained by clipping a small portion (at least 0.25 square centimeter [cm^2] [0.04 in^2]) of the caudal fin with sterilized sharp scissors. Caudal fin tissue regenerates rapidly and is unlikely to affect the growth or survival of large fish; however it may cause a reduction in survival for fish smaller than 50 mm (2 in) FL. Therefore, fish smaller than this size selected for stable isotope sampling were euthanized, and used as a whole-fish sample. All samples were preserved in 70 percent ethanol and returned to UAF for further analysis.

All sample types for stable isotope analysis were oven dried at 60 degrees Celsius (°C) (140 degrees Fahrenheit [°F]) to a constant weight and ground to a homogenous powder. Algae samples were treated with 1 molar (M) hydrochloric acid (HCl) solution to remove inorganic carbonates that may affect sample carbon-13 isotopic signature ($\delta^{13}C$) values. All invertebrate samples, salmon carcass tissue, and salmon eggs were treated with a chloroform-methanol solution to remove lipids from fatty tissues that typically have more variable and depleted $\delta^{13}C$ signatures relative to other tissue types (Sotiropoulos et al. 2004), and that may ultimately affect the comparability of isotopic values of samples with varying lipid content. Subsamples of approximately 2.0-2.5 milligrams (mg) for algae, 0.3-0.4 mg for OM, and 0.2-0.4 mg for animal tissue were weighed to the nearest 0.001 mg on a micro- analytical balance and placed into tin capsules. Samples were combusted and analyzed in an isotope-ratio mass spectrometer interfaced with an elemental analyzer at the Alaska Stable Isotope Facility at UAF.

Results of stable isotope analysis will be used in conjunction with the bioenergetics model (Section 4.6.1) and the fish diet analysis (Section 4.7) to describe and quantify the energy pathways and trophic relationships supporting salmonid production in the food web of the study area.

To characterize baseline isotopic variability, mean $\delta^{13}C$ values of benthic algae, benthic organic matter, and seston organic matter were compared across macrohabitat types, along an upstream to downstream continuum, and among seasons. Stable isotope ratios for all sample types were tested for normality using the Shapiro-Wilk test. Many distributions were non-normal, so the non-parametric Kruskal-Wallis H-test was used for all comparisons. If the differences in mean $\delta^{13}C$ values were statistically significant, the test was followed with the nonparametric Nemenyi post-hoc comparisons test using the R package Pairwise Multiple Comparisons of Mean Rank (PMCMR) (Pohlert 2014). Prior to conducting analysis on basal carbon sources, a nonparametric multiple comparisons test was performed on carbon to nitrogen (C:N) ratios of algae and terrestrial OM to evaluate possible cross-contamination between the two sample types. Algae C:N ratios typically range from 8:1 (Thorp et al. 1998) to 12:1 (Wetzel 1983) and terrestrial OM ranges from 45:1 to 50:1 (Wetzel 1983) or significantly higher than algae (Thorp et al. 1998). Tests revealed that mean algae C:N ratios were significantly lower than that of terrestrial OM (mean $C:N_{algae}$ = 8.7 ± 2.8 standard deviation [SD]; mean $C:N_{OM}$ = 29.8 ± 9.4 SD; $H = 511.62$, $p < 0.001$), indicating that the OM samples were relatively uncontaminated by algae growth. For all tests, alpha was set at 0.05. Means are presented with ± 1 SD.

Multiple linear regressions were used to determine the role of terrestrial OM and algae in the diets of the invertebrate collector, grazer, and shredder primary consumer groups. Because algae $\delta^{13}C$ can be highly variable within reaches and can often overlap with that of terrestrial OM within a given site, using site-specific mixing models to estimate resource contributions to invertebrate consumers would likely produce unacceptable error. Previous studies (Finlay 2001, Bunn et al. 2003, Rasmussen 2010, Jardine et al. 2014) have used a gradient method where spatial variation of source and consumer $\delta^{13}C$ is used to determine overall, watershed-scale contributions of algae (or algae) and terrestrial OM to invertebrate primary consumers. To understand large-scale energy flow to aquatic invertebrates, multiple linear regressions were performed for site-specific mean $\delta^{13}C$ values of primary consumer feeding groups (collectors, grazers, and shredders) and site-specific mean $\delta^{13}C$ values of their potential food sources (algae and terrestrial OM) collected from all locations. Mean $\delta^{13}C$ values of terrestrial OM collected in the stream benthos (-28.0 ± 1.4 part per thousand [‰]) and in seston samples (-27.8 ± 1.2‰) did not differ significantly according to the non-parametric Kruskal-Wallis H-test ($H = 11.98$, $p = 0.46$), so these sample types were pooled as a single terrestrial OM food source. Sample material from some consumer feeding groups was limited or not available at certain sampling events, so all consumer $\delta^{13}C$ values across seasons. Each data point in the regressions therefore represents the mean $\delta^{13}C$ values of a consumer group and source (either algae or terrestrial OM) collected from a particular site across all seasons when sample material was available. Because there is little isotopic fractionation of organic carbon from prey to consumer (DeNiro and Epstein 1978), a slope coefficient close to 1 and a high r^2 value indicates a strong reliance on a particular food source (Finlay 2001; Jardine et al. 2014).

The relative contributions of freshwater, marine, and terrestrial prey to salmon diets were estimated from stable isotope and stomach content data using the Bayesian stable isotope mixing model, MixSIAR (Stock and Semmens 2013). This model uses isotopic values of consumers, prey, and trophic enrichment factors as model inputs. MixSIAR estimates the probability distributions of multiple prey contributions to consumers while accounting for the observed variability in consumer, prey, and trophic enrichment isotopic values. The model also allows the incorporation of prior information from another dataset, such as stomach content data, to further refine estimates of prey contributions to a consumer (Moore and Semmens 2008; Parnell et al. 2010). Informative priors from stomach content data were incorporated in order to mitigate potential temporal biases of these two methods and to obtain more precise estimates when prey sources are isotopically similar. The posterior model outputs presented in this study are therefore a combination of the priors and the maximum likelihood influence of the isotopic data, where prey sources that are well-separated (less correlated) in isotopic space (nitrogen-15 isotopic signature ($\delta^{15}N$) vs. $\delta^{13}C$) provide more useful information for the isotopic data to override influence from priors (Moore and Semmens 2008). Conversely, when the prey sources are isotopically more similar (highly correlated), priors may have more influence in the posterior output (Moore and Semmens 2008). Prior values were calculated separately for each sampling event by multiplying the diet proportion of each prey type (freshwater, terrestrial, or marine) by the sample size of non-empty stomachs. Correlations between posterior estimates of diet proportions are reported for diagnostic purposes in the discussion as Pearson's product-moment correlation coefficients (r).

To select appropriate trophic enrichment factors (TEF) for diet modeling, values from four different literature sources (VanderZanden and Rasmussen 2001; Post 2002; McCutchan et al. 2003; and Trueman et al. 2005) were qualitatively evaluated relative to consumer isotopic signatures after adjusting for trophic enrichments. These literature values were either based primarily on data from aquatic consumers (Vander Zanden and Rasmussen 2001; Post 2002) or specifically from salmonids (Trueman et al. 2005; McCutchan et al. 2003). Consumer values were plotted against that of prey adjusted for each of the sets of TEF values separately to determine if consumer values were within the mixing polygon (Parnell et al. 2010). Values from Post (2002) (0.4 ± 1.3 for $\delta^{13}C$ and 3.4 ± 1.0 for $\delta^{15}N$) were ultimately chosen because the majority of plots evaluated showed that consumers fell within mixing polygons, whereas adjusting for TEF values from the other literature sources resulted in fewer plots where consumers were within mixing polygons.

To compare diet patterns among macrohabitat types, seasons, and reaches, a separate diet model was run for each sampling event where fish were caught for both 2013 and 2014. While MixSIAR allows for up to two covariates and a nested design template, the current version does not simultaneously allow for multiple sets of informative priors to be defined for specific consumer groups; therefore, at the expense of further quantifying variation between consumer groups, separate models were run for each consumer group to more specifically define informative priors from each group's stomach content data. Overall, mean $\delta^{13}C$ values of all aquatic invertebrate functional feeding groups (collectors, grazers, shredders, and predators) were not significantly different (Kruskal-Wallis H-test; $H = 5.23$, $p = 0.16$); therefore, we combined these functional feeding groups into a single “freshwater” invertebrate prey type for each sampling event for use in stable isotope mixing models. Terrestrial invertebrates were absent in drift and benthic samples collected during some sampling events; in these cases, the pooled isotopic signatures of terrestrial prey from other sampling events within the same reach and season were used as a surrogate. The same marine source values were used for all models within a year and consisted of any salmon carcass and egg samples collected across the entire river. Proportional contributions of each prey type are reported as the mean of the posterior distributions with 2.5 and 97.5% lower and upper credible intervals. All models were verified to have converged using Geweke’s criterion and trace plots (Stock and Semmens 2013).

Additionally, lab analysis was completed on 2013 field samples and results were presented in *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014.

4.6.3. **Variances**

The methods for conducting the trophic analysis, using trophic modeling and stable isotope analysis (RSP Section 9.8.4.7; AEA 2012), were conducted as in 2013, in accordance with the Study Plan, with the exception of those changes detailed as variances in ISR Part A, Section 4.7.3 (AEA 2014a) which include: 1) increasing stable isotope site selection from the original two stations (3 sites each) to four stations, resulting in sampling 16 sites total (ISR Part A, Section 4.7.3.1; AEA 2014a); and 2) not utilizing macrohabitat-specific subcutaneous dye marking to track movements of juvenile Chinook Salmon, Coho Salmon or rainbow trout less than 60 mm long (ISR Part A, Section 4.7.3.2; AEA 2014a). In addition, the modification proposed in the ISR Part C, Section 7.1.2.4. (AEA 2014a) to include Arctic Grayling juveniles and adults as target species/lifestages, was conducted as part of the 2014 field collection efforts for the trophic modeling and stable isotope analysis objectives.

4.7. Characterize the Invertebrate Compositions in the Diets of Representative Fish Species in Relationship to their Source (benthic or drift component)

AEA implemented field methods as described in the Study Plan (River Productivity IP Sections 2.7 and 2.8, R2 2013a; FERC 2013) with the exception of variances explained below (Section 4.7.1.), and the addition of Arctic Grayling as a target species for the trophic analysis, a modification detailed in ISR Part C, Section 7.1.2.4 (AEA 2014a).

In support of the bioenergetics modeling (Objective 5, Section 4.6.1), stomach contents were collected from all target species. Arctic Grayling and Rainbow Trout were provisionally categorized as “small” or “large” with a breakpoint of 120 mm (4.7 in) fork length, corresponding to the approximate onset of piscivory of Rainbow Trout in the study area in 2013. The fish collections were coordinated with the Fish Distribution and Abundance in the Middle and Lower Susitna River Study (Study 9.6.) and methods used for collecting fish specimens are described in that study’s Initial Study Report (ISR Study 9.6).

Two fish sampling technicians accompanied the River Productivity crew during all sampling events to each study site in order to fully overlap with invertebrate sampling efforts. Technicians employed multiple methods to sample target fish species including seine nets, fyke nets, minnow traps, backpack electrofishing, and angling. Upon arrival at each study site, the appropriate gear types were chosen and deployed depending on the conditions at each site. Up to 12 baited minnow traps, up to two fyke nets, and seine nets were typically utilized within sites that were characterized by relatively low water velocity such as upland slough and side slough macrohabitat types. Seine nets, a backpacker electrofisher, and angling gear were typically utilized to sample target species within tributary mouth, main channel, and side channel macrohabitat types. Arctic Grayling were most common at main channel and side channel sites within each Focus Area. Juvenile Chinook and Coho salmon were common in catches within off-channel macrohabitat types at RP-81 (Montana Creek), RP-104 (Whiskers Slough), RP-141 (Indian River), and several Chinook Salmon juveniles were caught at main channel sites above Devils Canyon at RP-173 (Stephan Lake Complex) and RP-184 (Watana Dam) during the Spring sampling event. Small Rainbow Trout were rare or absent at all sampling sites (n = 8, Tables 4.7-1 through 4.7-3). Sampling efforts during 2014 resulted in a total catch of 449 target fish species (Tables 4.7-1 through 4.7-3).

Stomach contents were collected from the first eight fish per target species and age class that were captured at each sampling site during the sampling period (Tables 4.7-1 through 4.7-3). Fish were anesthetized with Aqui-S 20-E, measured for fork length (mm), weighed (g), and their stomach contents were flushed with a 10-mL (0.3 oz) syringe assembly (Meehan and Miller 1978). Stomach contents were flushed into a Whirl-Pak bag and preserved in at least 70-percent ethanol. Scale samples and tissue samples for stable isotope analysis were taken from the fish at this time as well, using methods detailed in Section 4.6.

Stomach content samples were examined under a dissecting microscope in the laboratory at UAF. Invertebrate prey items were identified to life stage (i.e., larva, pupa, nymph, or adult) and family when possible, or otherwise to the lowest possible taxonomic level. Invertebrates were categorized as aquatic or terrestrial based on their taxon and life stage (Merritt et al. 2008). Fish prey items were identified to species when possible, or otherwise to the lowest possible taxonomic level. The body lengths of intact prey organisms were measured to the nearest millimeter, and the lengths of partially digested prey were estimated based on intact individuals of the same taxon that appeared similar in size. The dry mass of prey organisms was determined from length-weight regression relationships (ISR Part A, Section 4.9.1.2.; AEA 2014a). All stomach contents were archived in 95-percent ethanol for future verification.

Diet composition data were summarized in terms of diet proportions by dry mass, the most relevant metric for energy flow and food web studies (Chipps and Garvey 2007) and were calculated for each fish and summarized under five broad categories: aquatic life-stages of freshwater-derived prey (such as chironomid larvae and pupae), terrestrial life-stages of freshwater-derived prey (such as adult chironomid midges), terrestrial invertebrates (such as ants and caterpillars), fish and non-salmonid fish eggs, and salmon eggs. The wet mass of fresh salmon eggs was estimated from a length-weight relationship from the literature (Fleming and Ng 1987). The wet mass of prey fish was estimated based on taxon-specific length-mass relationships calculated from fish measured and weighed by the Fish Distribution and Abundance in the Middle and Lower Susitna River Study (Study 9.6.). The dry mass of fish and fish eggs were estimated from wet masses using percent dry mass values of 24.9 percent for *Oncorhynchus* spp., 22.5 percent for sculpins, and 40 percent for fresh salmon eggs (Ashton et al. 1993, Brey et al. 2010). The resulting dry mass values estimated for fish and fish eggs were similar to dry mass values measured directly for similarly sized salmon fry, sculpins, and salmon eggs in other Alaskan rivers (M. Wipfli, unpublished data).

Diet composition data from each species and size class were analyzed using MANCOVA (multivariate analysis of covariance) to identify spatial, temporal, and ontogenetic patterns. Diet proportions were arcsine-square root transformed to meet the assumption of normality (Chipps and Garvey 2007). The transformed diet proportions of five prey categories were specified as response variables in separate MANCOVA models for each species and size class. Each model tested for fixed effects of season, focus area, and habitat type, with fork length as a covariate. Statistical models for Chinook Salmon and Coho Salmon also tested for an effect of year. Year was not included in models for Arctic Grayling, which were only sampled in 2014, or large Rainbow Trout, due to a small sample size in 2013. Small Rainbow Trout diet data were examined graphically, but not tested statistically due to the small sample size. Statistical results were evaluated using a significance level (alpha) of 0.05.

In addition, at the ISR meeting held in October 2014, a request was made to determine whether the 2013 fish diet dataset was sufficient to quantify fish diet composition. In December 2014, AEA filed a technical memorandum, *Fish Diet Sample Size Sufficiency Analysis*, which describes an analysis of the 2013 stomach content data using cumulative prey curves to determine whether this dataset was sufficient to quantify fish diet composition (UAF and R2 2014).

Additionally, 2013 lab analysis was completed post-ISR filing in June 2014, and results were presented in *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014.

4.7.1. Variances

The methods for collecting fish diet information were conducted as in 2013, as described in the ISR Part A, Section 4.9 (AEA 2014a) with variances which included: 1) elimination of field determinations of fish stomach emptiness to reduce uncertainties in sample collection (ISR Part A, Section 4.9.1.1.; AEA 2014a); and 2) estimating dry weights for prey items in stomach contents using length-weight relationship data (ISR Part A, Section 4.9.1.2.; AEA 2014a). In addition, the modification proposed in the ISR Part C, Section 7.1.2.5. (AEA 2014a) to include Arctic Grayling juveniles and adults as target species/lifestages, was conducted as part of the 2014 field collection efforts for the Fish Diet Analysis objective.

4.8. Characterize Organic Matter Resources (e.g., available for macroinvertebrate consumers) Including Coarse Particulate Organic Matter, Fine Particulate Organic Matter, and Suspended Organic Matter in the Middle and Lower Susitna River

AEA implemented the field methods as described in the Study Plan (River Productivity IP Section 2.4, R2 2013a; FERC 2013) with no variances. All lab processing and analysis was conducted as described in the ISR (Part A, Section 4.10; AEA 2014a), with the exception of the variance explained below (Section 4.8.1).

In 2013, a total of 271 Hess samples, 70 petite Ponar grab samples, and 92 drift samples were collected from the 20 study sites and submitted to the taxonomy laboratory, which also processed them for organic matter (OM) content (Table 4.8-1). The 2013 lab analysis for OM was completed in June 2014. In 2014, only drift samples were collected, resulting in a total of 108 drift samples from 20 study sites submitted to the taxonomy laboratory (Table 4.4-2) which also processed them for OM content. Processed sample results were used to calculate estimates of total ash free dry mass (AFDM) weights per unit area for organic matter for each site for each sampling event period, for both benthic organic matter (grams per square meter [g/m^2]) and drift (or seston) organic matter (mg/ft^3). Results for both years are presented in Section 5.6 of this report.

4.8.1. Variances

The methods for collecting organic matter information were conducted, as described in the ISR Part A, Section 4.10 (AEA 2014a) with one variance: 1) For the first sampling event (Spring 2013), the laboratory did not separate benthic OM retained from Hess and petite Ponar subsamples into separate CPOM and fine particulate organic matter (FPOM) fractions, giving only a total OM result; this was limited to only this sampling event for only benthic Hess and Ponar samples.

4.9. Estimate Benthic Macroinvertebrate Colonization Rates in the Middle Susitna River Segment under Pre-Project Baseline Conditions to Assist in Evaluating Future Post-Project Changes to Productivity in the Middle Susitna River

Lab analysis of 2013 field data was completed post-filing ISR in June 2014, and results were presented in *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014.

4.10. Variance: Characterize the Pre-Project Benthic Macroinvertebrate Communities, with Regard to Species Composition and Abundance, and Algal Production in Selected Susitna River Tributaries and Lake Systems Located above Devils Canyon

This objective was listed in the ISR Part C, Section 7.1.2.7 (AEA 2014a) as a proposed modification, and was conducted in the field in 2014 as part of the River Productivity Study. Because a Study Plan Determination regarding the proposed modifications details in the ISR was delayed, this entire objective is a variance to the approved Study Plan.

AEA collected benthic macroinvertebrate and algal samples once during July 2014 in riffle habitats within nine selected tributaries located above Devils Canyon in the Middle and Upper Susitna River basin (Figure 3-3), based on Barrick et al. (1983; APA Doc. 522), in order to characterize the productivity of these habitats within these tributaries under their current, baseline condition. Invertebrate drift sampling was conducted concurrently with benthic macroinvertebrate sampling to allow for comparisons between the drift component and the benthic macroinvertebrate assemblage, as well as revealing the availability of terrestrial invertebrates for fish predation. Sampling in tributaries included the collection of Hess, drift, and algal samples, and water quality measurements within riffle habitats at one representative site. In addition, three lakes (Tyone Lake, Susitna Lake, and Lake Louise) were sampled once during July 2014 to characterize the productivity of these habitats under the current, baseline condition (Figure 3-4). Due the large size of these lakes, three sites were established in each lake, with the collection of Ponar grabs, D-net sweeps (in the littoral shoreline areas), vertical plankton tows, and water quality measurements at each site.

This collection of benthic macroinvertebrates and algae data, along with associated water quality data, was intended to provide a snapshot of the pre-Project condition of habitats in selected tributary and lake systems and the levels of productivity available to support fish populations. A majority of these systems will not be directly affected by the Project; however, passage barriers on some tributaries would be inundated by the reservoir and thus, would provide fish access to currently inaccessible portions of those tributaries. The information gathered in this one-time summer sampling event will provide a basis for understanding the habitats in the middle and upper basins that will be available to support fish after the Project is in operation.

4.10.1. **Benthic Macroinvertebrate Sampling**

AEA implemented the methods as described in the Study Plan (River Productivity IP Section 2.2.). A summary of 2014 activities is provided below.

Benthic macroinvertebrate sampling was conducted in fast-water mesohabitats (typically riffles/runs) within main channel macrohabitats (i.e., main channel, split-main channel). Sampling was conducted using a modified Hess sampler (0.93 ft^2-area) with a 243-micrometer (μm) mesh net (Figure 4.6-1) (Canton and Chadwick 1984; Klemm et al. 1990). Replicate samples (n=5) were collected at each site to allow for statistical testing of results (see Appendix B for imagery of all sampling locations). A total of 45 Hess samples were collected from the nine study sites in 2014 (Table 4.10-1). Measurements of depth, mean water column velocity, and substrate composition were taken concurrently with benthic macroinvertebrate sampling at the sample location.

Within the three lakes, a petite Ponar grab sampler (1 ft^2-area) was used to sample the benthic macroinvertebrate community from the lake bottom substrates. Similar to Hess sample collections, replicate Ponar samples (n=5) were collected to allow for statistical testing of results. A total of 45 Ponar grab samples were collected from the nine lake sites in July 2014 (Table 4.10-2). In addition, qualitative D-net sweep sampling was conducted along the most proximal shoreline at each of the nine stations, collecting benthic macroinvertebrates within littoral shoreline areas. Efforts were limited to moving the D-net (243-μm mesh) rigorously through emergent vegetation and shoreline substrates areas disturbed by kicking for a period of approximately 10-15 minutes. Contents of the net were composited into one sample per site, yielding nine composite D-net sweep samples.

Benthic macroinvertebrate samples were stored in individual containers and immediately preserved in the field with 95-percent ethanol (non-denatured). Samples were shipped to and processed by Ecoanalysts, Inc. (Moscow, Idaho) using sample processing protocols established by the United States Environmental Protection Agency (USEPA) for the Rapid Bioassessment Protocols (Barbour et al. 1999) and modified for use in Alaska (Major and Barbour 2001). Organic matter (OM) content was retained in the benthic samples and analyzed by size (coarse and fine particulate OM) as discussed in Section 4.10.4. Data received for benthic macroinvertebrate samples was prepared and analyzed as detailed in Section 4.3.

4.10.2. **Benthic Algae Sampling**

AEA implemented the methods as described in the Study Plan (River Productivity IP Section 2.3.). To allow for correlation between collections, benthic algae was collected concurrently with benthic macroinvertebrate Hess sampling at all nine tributary sites. Rock surfaces were sampled, based on the methods utilized by the USGS for the NAWQA program (Moulton et al. 2002), the USEPA for the Rapid Bioassessment Protocol (Barbour et al. 1999), and the USEPA for the Environmental Monitoring and Assessment Program (EMAP; Lazorchak et al. 2000; Peck et al. 2006). For the purposes of this study, a PVC pipe area delimiter (1.65 in. diameter) with a neoprene collar at one end was adopted, as recommended by the USEPA methods (Barbour et al. 1999; Lazorchak et al. 2000; Peck et al. 2006).

For each composite algal sample, five rock substrates were randomly collected around the location associated with a Hess sample. Rock substrates were evenly collected at depths of up to 2 feet. At each location where a cobble or rock substrate was collected, measurements of depth and mean water column velocity composition were taken. Light availability was measured at each site location with an underwater light sensor to measure the photosynthetically-active radiation (PAR) available to the algal community. PAR readings were taken from just below the water surface to the stream bottom at regular 10-cm intervals. A turbidity measurement, using a portable turbidity meter, was also taken at the sampling site to determine water clarity at the time of collections.

For each rock, the area delimiter was placed on its upper surface, and the enclosed area on the substrate was scrubbed with a small brush to remove any algal growth. The removed algal material from the enclosed area and brush were then rinsed into a darkened sample container. The five discrete collections taken from five cobbles were combined to make a composited sample, which was placed on ice inside a cooler and kept in the dark until the sample was processed. Five composited samples (one for each Hess sample) were collected at each tributary site, for a total of 45 composited algae samples (Table 4.10-1).

Procedures for processing algal samples were taken directly from the Quantitative Microalgae processing procedures (Moulton et al. 2002). An algae filtration apparatus was used to draw subsamples of the composite sample through a 1.85-inch diameter (47-mm) glass fiber filter. Two subsamples were taken from each composite sample to determine chlorophyll-*a* and AFDM in the laboratory. The subsample filters were folded, wrapped in tinfoil, labeled, and stored in a freezer at -4° F until shipped overnight on dry ice to the processing laboratory in Kirkland, Washington. Benthic algae samples were processed in a laboratory, using Standard Methods (Eaton et al. 1998; SM 10200H, SM 2540G).

Results generated from the tributary collections include estimates of AFDM and chlorophyll-*a*, with the mean and variability (95 percent confidence intervals) calculated for each site and sampling event. Algal sampling for lake sites was conducted as part of the water quality sampling in the water column, as discussed in Section 4.10.5 below.

4.10.3. **Drift and Plankton Tows**

AEA implemented the methods as described in the Study Plan (River Productivity IP Section 2.1.). Invertebrate drift sampling was conducted concurrently with benthic macroinvertebrate sampling at all sites within the five established sampling stations to allow for comparisons between the drift component and the benthic macroinvertebrate community, as well as reveal the availability of terrestrial invertebrates for fish predation.

Invertebrate drift sampling was conducted in fast-water habitats, within all established sites (Table 4.10-1), based on the USEPA's EMAP drift net sampling protocols (Klemm et al. 2000). A set of two drift nets with a 250-µm mesh size were used to collect duplicate samples to allow for statistical testing of results (Klemm et al. 1990; Klemm et al. 2000). Drift sampling was conducted at the top of a site reach during daylight hours, preferably beginning shortly after arrival at a site. Water velocity was recorded with an in-net flow meter (General Oceanics) along with the start and stop times marking the amount of time the nets were actively sampling. In addition, current velocity was measured with a Pygmy current meter at the entrance of the net and at 60 percent of the depth at the start and ends of sampling. Measurements of depth, turbidity, and temperature were also taken with drift samples. A total of 18 drift samples were taken from the nine tributaries during the July 2014 trip (Table 4.10-1).

Within the lake sites, a plankton tow net (80-µm mesh net with an 18-inch opening for deep waters, or a 12-inch opening for shallow waters) was used at each of the lake sites, taking five replicate full-depth vertical tows. A calibrated tow line (in feet) was attached to the tow net and lowered to within 10 feet of the lake bottom (consulting the boat's depth finder), and then slowly pulled to the surface. The receiving bucket was carefully removed, and its contents were washed into an 80-µm mesh screen, rinsed, transferred to a sample bottle. A total of 45 plankton tows were collected from the nine lake sites (Table 4.10-2).

Invertebrate drift and plankton tow samples were stored in individual containers and immediately preserved in the field with 95-percent ethanol (non-denatured). Samples were shipped to and processed by Ecoanalysts, Inc. (Moscow, Idaho) using methods similar to those used for benthic samples (Barbour et al. 1999; Major and Barbour 2001). For plankton tows, the laboratory protocol included measuring and recording lengths (mm) of individual zooplankton, with an average length calculated for later use in determining biomass estimates. Organic matter (OM) content was retained in the drift samples and analyzed by size (coarse and fine particulate OM) as discussed in Section 4.10.4. Data received for benthic macroinvertebrate samples was prepared as detailed in Section 4.3. Drift density was measured by volume, per cubic foot, and all metrics dependent upon density estimates reflect this as well. For plankton tows, density and biomass were calculated by area, per square meter. Zooplankton biomass was determined using the length-weight regressions from Koenings et al. (1987) and Rosen (1981), and was calculated by area, per square meter. Community composition measures were adapted to the most common zooplankton taxa groups identified in the samples, and were determined by both density and biomass.

4.10.4. **Organic Matter**

In order to quantify the organic matter available in the sampled tributaries for river productivity, CPOM and FPOM (specifically fine benthic organic matter (FBOM)) were collected directly from all benthic macroinvertebrate sampling, in Hess and Petite Ponar samples and drift net samples. Therefore, 45 Hess samples, 45 Ponar grabs, and 18 drift samples were processed for organic matter content (Tables 4.10-1, 4.10-2). AEA implemented the methods as described in the Study Plan (River Productivity IP Section 2.4.).

To streamline the collection efforts, Hess sampling devices, and sieves used to rinse and retain sample contents from Hess and grab samplers possessed a net mesh size of 250 µm in order to retain CPOM particles and FBOM in the 250–1,000 µm size range for analysis. All organic debris collected within each Hess and grab sample was retained with the sample and preserved in 95-percent ethanol. Suspended FPOM (seston) was collected from material in invertebrate drift samples, using drift nets with a 250-µm mesh size in order to retain CPOM particles as well as FBOM in the 250–1,000 µm size range for analysis. All organic debris collected within each drift sample was retained with the sample and preserved with 95-percent ethanol.

Processing of benthic macroinvertebrates involved subsampling to acquire a 300-organism fixed-count (±20 percent) subsample. All invertebrates were removed from debris with the aid of a dissecting microscope (7-45x), and sorted debris was retained in a labeled bottle and stored for later for quality assurance/quality control (QA/QC) assessment and organic matter analysis. Organic matter retained from subsampling after organism sorting and processing was separated from inorganic material, rinsed through 1-mm and 250-µm nested sieves, to separate CPOM and FPOM components of the detritus, oven-dried (60°C [140°F]), and weighed. Dried components were combusted and reweighed to determine AFDM weights (g) per subsample amount. Weights were converted to total grams per sample, and per unit area (m^2) according to the subsample proportion, and area or volume sampled by the corresponding device.

4.10.5. **Water Quality**

Water quality sampling at tributary and lakes sites were collected both in-situ with a multi-parameter water quality sonde, and by collecting water samples (grabs) to send to an analytical laboratory for testing. Collection procedures closely followed the guidelines set forth in the Quality Assurance Project Plan (QAPP) for Baseline Water Quality Monitoring Sampling and Analysis Activities for the Susitna-Watana Hydroelectric Project Water Quality Study (URS and Tetra Tech 2013). Measurements in tributaries were taken either in the late morning (10:30-11:30), or mid-afternoon (15:00-16:00), whereas measurements in lakes were taken throughout the day, so some results may vary accordingly.

4.10.5.1. *In-Situ Water Quality Monitoring*

At each site, in situ measurements of dissolved oxygen, pH, general and specific conductance, oxidation-reduction (redox) potential (ORP), PAR, turbidity, and water temperature were made.

A LaMotte® 2020we Portable Turbidity Meter was used to measure turbidity, and a YSI® 556 meter was used to measure the remaining field parameters during each site visit. In stream sampling, PAR was measured with an Apogee® MQ-200 Quantum Sensor with Handheld Meter. In lake sampling, a LiCOR® LI-192 Underwater Quantum Sensor with a LI-250A meter, and a 2009S Lowering Frame was used for measuring PAR (Figure 4.10-1).

Tributary sample sites were located at water depths less than 3 ft (< 1m) deep and field personnel collected samples by positioning the water quality equipment on the nearby bank, or within the stream on larger substrates, and extending the sonde out into the channel. The multimeter sonde was placed on the stream bottom, but within the stream currents, to take parameter readings. Sample vials for the turbidity testing were filled and placed within a calibrated 2020we meter. PAR measurements were taken in depths of 2.5 to 3 feet, recorded in approximately 4 inch (10 cm) increments.

In lake sampling, the YSI sonde was attached to the Lowering frame with the LiCor Quantum Sensor in order to collect water column profiles for in situ measurements at each site location. The units were lowered into the water column, and measurements were collected in 3 feet depth increments until 3 feet above the lake bottom, with a maximum depth of 96 ft (30 m). Measurements at deep sites in Lake Louise (RP-LLO) did not reach the bottom, as those depths exceeded the length of the probe's cable. For LLO-1, final measurements were approximately 10 ft above the lake bottom, and for LLO-2, 37 ft above the bottom. At sites with depths of less than 25 feet, measurements were taken in 1 foot depth increments. For PAR measurements, the depth at which PAR is 1 percent of the ambient light level was marked as the euphotic depth; water quality grab samples were taken at this depth, if present at a sampling site. The series of PAR measurements were used in a regression with depth to calculate the light extinction coefficient (K_d) and euphotic zone depth for each site, as described in Edmundson et al. (2000).

4.10.5.2. *Water Quality Grab Samples*

Water quality grab samples were collected at all site locations to document nutrient levels available to algal growth and productivity. At all tributary sites and lake sites, water samples were collected for Nitrate+Nitrite, Ammonia as N, Total Kjeldahl Nitrogen (TKN), Total Phosphorus (TP), Soluble Reactive Phosphorous (SRP), and Dissolved Organic Carbon (DOC). At all lake sites, additional water samples were collected for Alkalinity and Chlorophyll-a (Table 4.10-3).

Water quality grab samples were collected using a peristaltic pump and non-reactive tubing system, following the QAPP and protocols therein. The peristaltic pump was used to pump water at each sample site into the sample containers. Tributary sample sites were located at water depths less than 3 ft (< 1m) deep and field personnel collected samples by positioning the pump on the nearby bank, or within the stream on larger substrates. The sample tubing was extended out into the stream channel into the current. Once the tubing was positioned and secured, the pump was turned on and ran for several seconds to flush/rinse the pump/tubing system. Samples were collected from the tubing and into the proper sample containers supplied by the contract laboratory and labeled accordingly. Sample containers that did not contain a preservative were rinsed three times with sample water prior to collecting the sample. Field duplicates and field blanks were collected at the Watana Creek site (RP-WAT-1), given the

QAPP protocol that field duplicates be taken a rate of 1 for every 10 water grab samples, and field blanks 1 per every 20 sites.

For lake sampling, water quality grab samples were collected at up to three separate depths in the water column at each site using a Van Dorn vertical water sampler (Figure 4.10-1). The Van Dorn sampler was lowered down through the water column at each lake site, and a messenger was sent down the line to close the sampler at three depths: near surface, the euphotic depth, and 2-3 feet from the lake bottom (Table 4.10-2). For sites with depths greater than 25 feet, near surface depth was approximately 6 feet deep. For sites with depths less than 25 feet, near surface depths were approximately 2 feet deep, and euphotic depths were not available, as higher light levels reached the lake bottom. At one site, RP-LTY-1, depths were 4.5 feet, so only one water quality grab sample was taken (Table 4.10-2). Field duplicates and field blanks were collected at the last site on the final day, on Lake Louise (RP-LLO-3).

Samples were placed on ice in a cooler upon collection in the field. Non-preserved samples were transferred to a deep freezer at the field camp site, where they were stored at -4° F until either delivered to SGS in Anchorage at the conclusion of the week or until shipped overnight on dry ice to the IEH-Aquatic Research in Seattle, Washington at the conclusion of the field trip, within 22 days of the first sample collection. For chlorophyll-*a* samples, AEA followed the methods as described in the Study Plan (River Productivity IP Section 2.3.2.; R2 2013a). An algae filtration apparatus was used to draw approximately 500 ml of the water sample through a 1.85-inch diameter (47-mm) glass fiber filter. The filter was folded, wrapped in tinfoil, labeled, and stored in a freezer at -4° F until shipped overnight on dry ice to the processing laboratory AMTEST in Kirkland, Washington. Each batch of water quality samples had a separate completed chain of custody (COC) sheet that documented and tracked sample possession at all times.

5. RESULTS

5.1. Characterize the Pre-Project Benthic Macroinvertebrate and Algal Communities with Regard to Species Composition and Abundance in the Middle and Lower Susitna River

5.1.1. Benthic Macroinvertebrate and Algal Sampling

No field work was conducted for this objective in 2014. However, the results of the 2013 benthic macroinvertebrate sampling for Hess and petite Ponar samples were reported in Section 3.1. of the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b). The results of 2013 benthic algal sampling was reported in the ISR Part A, Section 5.2. (AEA 2014a). As presented in R2 and UAF (2014b), results from the 2013 benthic macroinvertebrate sampling showed that tributary mouths were generally highest in mean benthic density, taxa richness, and EPT Taxa, and often showed higher percentages of those EPT taxa in community compositions. Side sloughs and upland sloughs displayed seasonal changes with higher densities and taxa richness measures later in the sampling season. Main channel and side channel sites often displayed the lowest density and taxa richness measures in comparison to other macrohabitats, although exceptions were evident such as disconnected side channels. As presented in the ISR Part A, Section 5.2 (AEA 2014a), results from the 2013 benthic algal sampling showed chlorophyll-*a* and AFDM estimates were lower in mainstem macrohabitats (main and side channels) than in other macrohabitat types, especially off-channel habitats (side sloughs, upland sloughs). Data from the next year of study will be reviewed independently to see if these trends hold up over two years and/or if different trends are evident.

Results presented herein include lab results for emergence traps and large woody debris sampling from 2013 efforts.

5.1.1.1. *2013 Adult Insect Emergence Trapping*

Processed sample results for adult emergence traps were used to calculate an assortment of metrics for each of the 20 sites during each collection period. For simplicity, metric results are presented in the broader descriptive classes, with an abundance measure, taxa richness measures, and composition measures. Values for all metrics calculated for emergence traps at the River Productivity study sites over the course of the 2013 sampling season are presented in Tables 5.1-1 through 5.1-10. Results for density are calculated as numbers per square meter per day, and graphically presented in Figures 5.1-1 through 5.1-5.

In 2013, estimates of daily emergence densities were variable among reaches and sampling periods, showing peaks of emergence largely in July and August. Many comparisons amongst sites are precluded due to lost samples and unknown sampling durations; however, observations can be noted. At sites above Devils Canyon, main channel habitats recorded higher daily emergence densities than other macrohabitats, reaching nearly 250 individuals/m^2/day at RP-184-3 in the latter half of July (Figure 5.1-1), and 41.7 individuals/m^2/day at RP-173-2 in early August (Figure 5.1-2). At Middle Reach sites below Devils Canyon (FA-141 [Indian River] and FA-104 [Whiskers Slough]), upland sloughs and tributary mouths were generally higher in daily emergence densities compared to main channels and side channels (Figures 5.1-3 and 5.1-4). In the Lower Reach, daily emergence densities were also higher in the upland slough site (31.6 to 42.2 individuals/m^2/day) compared to those recorded for main and side channel habitats (Figure 5.1-5).

Overall emergence taxa richness during 2013 was also variable were variable among reaches and sampling periods, again showing peaks of emergence largely in July and August. The range of taxa richness recorded was from 2 taxa, at the side channel site RP-104-5 in July and early August sample periods (Table 5.1-7), to 36 taxa, at the upland slough site RP-81-1 for the July period (Table 5.1-9). The EPT taxa richness recorded from emergence trap samples was relatively low, ranging from 0 to 7 taxa in 2013 samples. The highest EPT taxa numbers recorded were 6 taxa at the mouth of Tsusena Creek (RP-184-1) during July, including 3 caddisfly taxa (Tables 5.1-1) and 7 taxa at the RP-81-4 side channel site during July, including 3 stonefly taxa (Table 5.1-9).

Overall adult emergence community composition measures revealed that all sites were dominated by aquatic taxa emerging in samples, generally averaging around 80 to 95 percent of the relative abundance, and comprised largely by chironomids, which were generally 50 percent or higher at most sites (Tables 5.1-1 to 5.1-10). Higher relative abundances of terrestrial taxa were often recorded in samples that were stranded out of the water upon retrieval, generally marked by increased relative abundances of Hemiptera (true bugs), Hymenoptera (sawflies, wasps, bees, and ants), and Other Diptera (true flies) (Tables 5.1-1 to 5.1-10).

The contribution of EPT taxa to community compositions appeared to be influenced by macrohabitat types. The highest relative abundances of emerging stoneflies (primarily Chloroperlidae and Perlodidae) in trap samples were recorded at main channel and side channel sites. In addition, the mouths of the named tributaries (Indian River, Tsusena Creek, Whiskers Creek, and Montana Creek) tended to have greater contributions of caddisflies to the overall community compositions than at other sites. No discernible trend was observed for mayflies, as they varied in relative abundances in nearly all macrohabitats.

5.1.1.1.1. *RP-184 (Watana Dam)*

At the Watana Dam station, estimates of emergence density (individuals/m^2/day) were noticeably higher at the main channel site (RP-184-3) over the July 12-29 period, totaling 239.2 individuals/m^2/day, compared to 25.9 individuals/m^2/day at the mouth of Tsusena Creek (RP-184-1) (Figure 5.1-1). In contrast, emergence densities were significantly lower in later periods.

Taxa richness results ranged from 10 to 28 taxa, with the tributary mouth showing a peak of 28 taxa over the July 12-29 period, dropping to 10 later in the August 21-September 22 period, whereas the main channel site, RP-184-3, showed mean taxa richness ranging from 14 to 28 taxa (Table 5.1-1). Community compositions of the adult emergents were largely aquatic taxa (50.5 to 86.8 percent), comprised mostly of chironomids, Other Diptera (Empididae and Dolichopodidae), and stoneflies (Chloroperlidae and Perlodidae) (Figure 5.1-1, Tables 5.1-1 and 5.1-2). Terrestrial taxa represented between 13.2- and 49.5 percent, comprised of Hemiptera, Hymenoptera, and several taxa of flies (Other Diptera).

5.1.1.1.2. *RP-173 (Stephan Lake Complex)*

Within the RP-173 station, emergence density estimates ranged from 3.6 individuals/m^2/day at RP-173-1 in September, to 41.7 individuals/m^2/day in the main channel (RP-173-2) during the July 29-August 19 period. Lower emergence densities were observed in the final September period.

Taxa richness results ranged from 3 to 26 taxa. At site RP-173-1(unnamed tributary mouth) taxa richness peaked at 21 taxa over the July 11-29 period, dropping to 3 later in the August 31-September 23 period. The side slough site, RP-173-4, showed mean taxa richness shifting from 3 taxa in early August to 26 taxa in late August (Table 5.1-3). Community compositions of the adult emergents were largely aquatic taxa (35.7 to 96.7 percent), generally comprised mostly of chironomids, mayflies (largely Baetidae), and stoneflies (Chloroperlidae and Perlodidae) (Figure 5.1-2, Tables 5.1-3 and 5.1-4). Terrestrial taxa represented between 3.3 and 64.3 percent, mostly represented by several taxa of flies (Other Diptera), as well as some Coleoptera (semi-aquatic beetle taxa), Hemiptera and Hymenoptera.

5.1.1.1.3. *RP-141 (Indian River)*

Emergence density estimates were highest at RP-141-1 (mouth of Indian River), with nearly 116 individuals/m^2/day recorded during the July period, and a peak of 289.8 individuals/m^2/day in the first week of August (an 8-day period) (Figure 5.1-3, Table 5.1-5). Emergence densities at other sites within FA-141 (Indian River) were approximately 10.2 to 53.7 individuals/m^2/day in the July and first half of August periods (Figure 5.1-3, Table 5.1-5). Trap losses or damage prevented data collection for the later periods of the season.

Emergent taxa richnesses were similar among sites, supporting 8 to 14 taxa, with higher taxa richness observed for the July period. The upland slough site, RP-141-4, was an exception with a taxa richness of 21 taxa (Table 5.1-5). Community compositions of the adult emergents were dominated by aquatic taxa (86.5 to 99.6 percent), generally comprised mostly of chironomids, Other Diptera (Empididae during the early August peak at RP-141-1 and Dolichopodidae during the July period at RP-141-4), and stoneflies (Chloroperlidae and Perlodidae) at the side channel site, RP-141-2 (Figure 5.1-3, Tables 5.1-5 and 5.1-6). Terrestrial taxa represented between 0.4 and 13.5 percent, mostly represented by several taxa of flies (Other Diptera), as well as some Coleoptera (semi-aquatic beetle taxa), Hemiptera, and Hymenoptera. As an exception, the sample collected during the early August period at main channel site recorded 63.6 percent terrestrial, which was nearly all Hemiptera, plus several Lepidoptera (moths and butterflies) adults, which were classified as Undetermined, suggesting that the trap may have been stranded for a considerable length of time during its deployment, likely washed ashore by the increased boat traffic observed at that site.

5.1.1.1.4. *RP-104 (Whiskers Slough)*

At RP-104 (Whiskers Slough), emergence densities observed at most sites during 2013 did not exceed 50 individuals/m^2/day, with the exception of the upland slough site (RP-104-4) where higher estimates ranged from 63.2 to 169.9 individuals/m^2/day (Figure 5.1-4, Table 5.1-7). Emergent density estimates were generally lower in the main channel and side channel habitat sites, and were noticeably lower during the final collection period in September (Figure 5.1-4).

Emergent taxa richness in RP-104 generally ranged from 5 taxa to 13 taxa, with exceptions of only 2 taxa collected in traps at the side channel site (RP-104-5), and a maximum of 21 taxa collected at the main channel site (RP-104-2) during the latter half of August (Table 5.1-7). At most sites, community compositions of the adult emergents were dominated by aquatic taxa (41.2 to 100 percent), which were comprised mostly of chironomids, with some peaks in Plecoptera (Chloroperlidae) and Trichoptera (Limnephilidae) (Figure 5.1-4, Tables 5.1-7 and 5.1-8). Terrestrial taxa generally represented between 0 and 48.5 percent, mostly represented by several taxa of flies (Other Diptera), as well as Hymenoptera, and some Coleoptera. As an exception, the sample collected during the late August period at main channel site (RP-104-3) recorded 86 percent terrestrial, which was nearly all Other Diptera, again suggesting that the trap may have been stranded for a considerable length of time during its deployment, likely washed ashore by the increased boat traffic observed at main channel sites in the Middle Reach.

5.1.1.1.5. *RP-81 (Montana Creek)*

Within the Montana Creek study area, RP-81, emergence density estimates were highest within the upland slough site (RP-81-1), with 42.2 individuals/m^2/day recorded during the July period, and a peak of 44.9 individuals/m^2/day in the first half of August (Figure 5.1-5, Table 5.1-9). Emergence densities at the main channel (RP-81-3) and side channel (RP-81-4) sites were approximately 1.8 to 30.6 individuals/m^2/day, (Figure 5.1-5, Table 5.1-9). Trap losses or damage prevented data collection for all but one sample at the tributary mouth site (RP-81-2).

Emergent taxa richness ranged from 3 to 36 taxa among sites. The upland slough site, RP-81-1, recorded that higher taxa richness of 17-36 taxa, but the lowest EPT Taxa (Table 5.1-9). The main channel (RP-81-3) and side channel (RP-81-4) sites showed more consistent EPT taxa during July and August period collections. Community compositions of the adult emergents were dominated by aquatic taxa (33.3 to 100 percent), generally comprised mostly of chironomids and Other Diptera (Empididae, Dolichopodidae, and Ephydridae), along with higher contributions of Plecoptera (Chloroperlidae and Perlodidae) at the main channel and side channel sites (Figure 5.1-5, Tables 5.1-9 and 5.1-10). Terrestrial taxa represented between 0 and 66.7 percent of the community composition, and were largely comprised of several taxa of flies (Other Diptera), as well as some Coleoptera (semi-aquatic beetle taxa), Hemiptera, and Hymenoptera.

5.1.1.2. *2013 Large Woody Debris Sampling*

Processed samples from LWD were used to calculate an assortment of metrics for each site for each sampling event period. For simplicity, metric results are presented in the broader descriptive classes, with an abundance measure, taxa richness measures, and composition measures. Summary results (range, average, and median metric scores) for each study site are presented in Tables 5.1-11 through 5.1-13. Mean values for all metrics calculated for the River Productivity study sites in each seasonal event are presented in Appendix A (Tables A5.1-1 through A5.1-15.) Results for mean density, mean taxa richness, and mean EPT Taxa are graphically presented in Figures 5.1-6 through 5.1-20.

In 2013, benthic macroinvertebrate densities on woody debris were higher overall in larger tributary mouths and off-channel sites compared to main channel and most side channel sites. Mouths of larger named tributaries (Indian River, Montana Creek, Tsusena Creek, Whiskers Creek) had among the highest averaged densities (3,347 – 7,273 individuals/m^2) (Tables 5.1-11 through 5.1-13). Overall densities on woody debris in Middle Reach side sloughs and upland sloughs ranged from an average 1,433 individuals/m^2 at the upland slough at RP-141-4 to 2,690 individuals/m^2 at the side slough at RP-173-4 in FA-173 (Stephan Lake Complex). Side channel macrohabitat sites recorded higher density estimates at RP-81 and RP-104 (1,222 and 2,477 individuals/m^2, respectively) compared to side channels at stations farther upstream (140 – 893 individuals/m^2).

Overall benthic taxa richness on woody debris during 2013 was highest in the larger tributary mouths, ranging from 16.8 to 23.8 taxa. The EPT taxa richness was relatively low on woody debris, ranging from average of 0.3 to 5.5 taxa. Chironomid taxa richness on woody debris contributed 50 percent or more to the average taxa richness at all 2013 sites, and was generally higher in tributaries, as well (Tables 5.1-11 through 5.1-13). Many of the chironomid taxa identified were wood-boring in habit. Diversity scores were more variable, with scores ranging from 1.06 in the main channel in the Lower Reach at RP-81-3, to 2.26 at the mouth of Whiskers Creek (RP-104-1).

Overall benthic community composition measures revealed the relative abundance of the three most abundant taxa present in samples averaged around 53 to 65 percent, with higher percentages predominantly in side channel and main channel macrohabitats (Tables 5.1-11 through 5.1-13). The contribution of EPT taxa to community compositions ranged from 0.8 to 50.3 percent, and appeared to be higher in side channel habitats, although many of these sites also had a lower number of replicate samples representing the overall metric scores. The relative abundance of EPT taxa was generally between 3- to 14 percent for most sites with consistently suitable woody debris available (Tables 5.1-11 through 5.1-13). Relative abundances of chironomids to the benthic communities were generally 50 percent or higher at most sites (Tables 5.1-11 through 5.1-13).

5.1.1.2.1. *RP-184 (Watana Dam)*

At the Watana Dam station, estimates of the mean macroinvertebrate density (individuals/m^2) on woody debris were noticeably higher at the mouth of Tsusena Creek (RP-184-1), ranging from 5,726 individuals/m^2 in the spring to 3,276 individuals/m^2 in the fall (Figure 5.1-6). The side channel and main channel sites (RP-184-2 and 184-3, respectively) did not offer suitable woody debris for sampling, therefore estimates are limited to the one sample at RP-184-2, with 140.1 individuals/m^2 in the summer.

Mean taxa richness on woody debris shows a similar trend, with the tributary mouth averaging approximately 21 to 25 taxa in 2013, and the side channel site showing mean taxa richness of 6 taxa (Figure 5.1-7). Mean EPT taxa richness on woody debris ranged from 5 to 6 taxa at the mouth of Tsusena Creek (Figure 5.1-8).

5.1.1.2.2. *RP-173 (Stephan Lake Complex)*

Within the RP-173 station, mean density estimates on woody debris were variable among the sites, but generally did not exceed 2,000 individuals/m^2. One exception was the side slough macrohabitat site (RP-173-4), where densities ranged from a low of 523.5 individuals/m^2 during the spring to a high of 6,539 individuals/m^2 during the summer (Figure 5.1-9). At the small unnamed tributary mouth (RP-173-1), mean density estimated ranged from 1,387 individuals/m^2 in the spring to 112.2 individuals/m^2 in the fall. The main channel (RP-173-2) and side channel (RP-173-3) sites did not offer suitable woody debris for sampling, therefore estimates are limited to the one sample at RP-173-3, with 588.2 individuals/m^2 in the summer.

Mean taxa richness measures were similar among RP-173 sites, with the tributary mouth, side channel, and the side slough sites maintaining around 13 to 18 taxa (Figure 5.1-10). As an exception, the tributary mouth site decreased from the spring peak of 18 taxa, to 6.67 taxa in the summer, and low of 5 taxa in the fall (Figure 5.1-10). Mean EPT taxa richness was higher at the tributary mouth (RP-173-1) only during the spring event, with a high of 4 taxa, compared to other sites averaging 1 taxa or less (Figure 5.1-11).

5.1.1.2.3. *RP-141 (Indian River)*

Mean density estimates on woody debris were highest at RP-141 (Indian River), with over 10,000 individuals/m^2 recorded in the spring and summer at the mouth of Indian River (RP-141-1) (Figure 5.1-12). Mean densities at the side channel site (RP-141-2) were approximately 900 individuals/m^2 in the summer and fall event period. Mean density estimates at the upland slough site (RP-141-4) gradually increased over the open water season, increasing from 486.6 individuals/m^2 in the spring, to 1,488 individuals/m^2 in the summer, and 1,956 individuals/m^2 in the fall (Figure 5.1-12).

Mean taxa richness measures were similar among sites, with the tributary mouth, side channel, and the upland slough sites supporting 13 to 20 taxa (Figure 5.1-13). Mean EPT taxa richness was higher at the Indian River mouth (RP-141-1) than other sites during the summer and fall, but comparable to the side channel (RP-141-2) in the summer event period, with largely mayfly and stonefly taxa (Figure 5.1-14).

5.1.1.2.4. *RP-104 (Whiskers Slough)*

At RP-104 (Whiskers Slough), mean densities on woody debris were highest in the mouth of Whiskers Creek during the summer and fall months, increasing from a low of 790 individuals/m^2 in the spring, to 4,458 individuals/m^2 for the summer event period, and 4,767 individuals/m^2 in the fall (Figure 5.1-15). In the adjoining side slough upstream from the mouth of the creek, mean densities gradually increased over the sampling season, from 481 individuals/m^2 in the spring, to 3,184 individuals/m^2 by the fall period. Mean densities on woody debris in the upland slough (RP-104-4) and side channel (RP-104-5) ranged from 761 to 2,622 individuals/m^2 in 2013.

Mean taxa richness on woody debris was higher within RP-104 compared to other stations, with sites exceeding 20 taxa during at least one of the seasonal events (Figure 5.1-16). Taxa richness was generally highest during the spring for all sites except the side slough (RP-104-2), with the upland slough recording the highest mean of 30.4 taxa. The tributary mouth site (RP-104-1) maintained the highest mean taxa richness, ranging from 27.5 taxa in the spring to 20.2 taxa in the fall (Figure 5.1-16). Mean taxa richness in the side slough (RP-104-2) increased from a low of 11.7 taxa during the spring, to a high of 25.4 taxa during the fall. The upland slough and side channel sites showed a reduced mean taxa richness in the summer and fall, with an average of 12 to 13.6 taxa (Figure 5.1-16). Mean EPT taxa richness was highest during the spring event, with peaks of 4 to 5 taxa, and summer and fall periods with an average of 2 taxa or less (Figure 5.1-17).

5.1.1.2.5. *RP-81 (Montana Creek)*

At the RP-81 (Montana Creek) station, mean density estimates for woody debris were highest at the mouth of Montana Creek (RP-81-2), averaging over 5,000 individuals/m^2 during the spring and summer periods before dropping to 558 individuals/m^2 during the fall (Figure 5.1-18). Mean density estimates at the other three sites in the study station were less than 2,250 individuals/m^2 in the spring and summer, and ranged from 64 to 391 individuals/m^2 in the fall (Figure 5.1-18).

Mean taxa richness measures on woody debris in the Montana Creek study area were higher during the spring event period, declining during the summer and fall periods. The tributary mouth site (RP-81-2) maintained the highest mean taxa richness, ranging from 22.8 taxa in the spring to 11.8 taxa in the fall event (Figure 5.1-19). Highest mean taxa richness in the side slough (RP-81-1) and side channel (RP-81-5) sites in the spring were both near 20 taxa each.

Mean EPT taxa richness was consistently higher at the side channel site (RP-81-5) than the other three sites, with a mean ranging from 4.2 to 4.8 taxa (Figure 5.1-20).

5.2. Estimate Drift of Invertebrates in Selected Habitats within the Middle and Lower Susitna River to Assess Food Availability to Juvenile and Resident Fishes

A total of 108 drift net samples and 105 plankton tow samples were collected from the 25 sampling locations and submitted to the taxonomy laboratory in 2014 (Table 4.4-2). Processed sample results were used to calculate an assortment of metrics for each site for each sampling event period. Summary results (range, average, and median metric scores) for each study site for a selection of metrics are presented in Tables 5.2-1 through 5.2-3. For simplicity, metric results are presented in the broader descriptive classes as discussed in the methods section for each study station.

Mean values for all drift net and plankton tow metrics calculated for the River Productivity study sites are presented in Appendix A (Tables A5.2-1 through A5.2-10). Results for mean density and taxa richness estimate for drift nets and plankton tows are graphically presented in Figures 5.2-1 through 5.2-10.

Overall estimates within the study sites in 2014 revealed higher densities per cubic foot (ft^3) of water in sites characterized as non-flowing habitats that were sampled with plankton tows compared to flowing water habitats that were sampled with the drift nets. Upland sloughs and side sloughs showed among the highest overall averaged densities via plankton tows (1.14 – 43.82 individuals/ft^3) in the study year (Tables 5.2-1 through 5.2-3). For flowing habitats, mouths of the tributaries (RP-184-1, RP-141-1, RP-104-1, RP-81-2) showed higher overall drift densities as compared to nearby main channel and side channel sites.

Overall drift taxa richness during 2014 was highest in tributary mouths and main channel habitat, followed by side channels; fewer taxa were captured in plankton tows taken in off-channel habitats (side sloughs and upland sloughs) (Tables 5.2-1 through 5.2-3). Both the EPT taxa richness and overall chironomid taxa richness were higher in tributaries and main channel habitats than in the slough habitats. The higher taxa richness in tributary mouths and main channel habitats were also reflected in higher diversity scores for these habitats; diversity often exceeded an overall average score of 2.5 (Tables 5.2-1 through 5.2-3).

In 2014, drift community composition measures revealed the relative abundance by the three most abundant taxa present averaged between 38 to 82 percent for most sites. The dominance of the top three taxa averaged higher in upland and side sloughs as compared to other habitats (64 to 82 percent). Sites above Devils Canyon showed community compositions largely comprised of chironomids, with smaller relative abundances of EPT (averages ranging from 6.3 to 17 percent in flowing water habitats, less than 1 percent in slough habitats) and zooplankton (averages ranging from 0 to 13.3 percent, with higher averages in main and side channels) (Table 5.2-1). At sites below Devils Canyon, flowing water sites (tributary mouths, main channels, and side channels) displayed communities mostly composed of chironomids and a sizeable contribution of EPT (averages ranging from 8 to 24 percent), whereas slow-water habitat sites were comprised of chironomids and a larger relative abundance of zooplankton (averages ranging from 2.5 to 34 percent), especially at upland slough sites (Tables 5.2-2 and 5.2-3). One notable exception was the unusually high zooplankton relative abundance estimate at RP-104-1 (26.4 percent), at the mouth of Whiskers Creek (Table 5.2-2), possibly due to a slower backwater area that sometimes formed upstream of the mouth.

5.2.1. **RP-184 (Watana Dam)**

In 2014, mean drift densities were higher at the mouth of Tsusena Creek (RP-184-1), where they ranged from 2.24 individuals/ft^3 during the spring to 0.88 individuals/ft^3 in the summer (Figure 5.2-1). Mean drift densities in the side channel site peaked to 1.1 and 1.3 individuals/ft^3 in the spring and fall, respectively; main channel sites were lower, ranging from 0.12 to 0.64 individuals/ft^3 in 2014. Mean taxa richness was also higher in the drift at the tributary mouth, showing an average of 55 taxa in the spring, but dropping to 33 taxa in the summer, and to 18 taxa in the fall (Figure 5.2-2). Mean taxa richness for the summer was highest in the main channel sites, averaging 45 taxa at RP-184-3 and 42.5 taxa in the main channel above the mouth of Tsusena Creek (RP-184-4). EPT taxa richness followed a similar trend, with a higher average of EPT taxa collected at the tributary mouth during the spring period (6 taxa), and averages of 7-8 taxa collected in the main channel sites in the summer sampling period. Community compositions for drift at RP-184 show that samples were largely comprised of chironomids in the spring and summer event periods. During the fall period, drift compositions at all sites shifted to higher contributions of simuliids (Other Diptera), ranging from 25.7 percent at RP-184-3, to 73.9 percent at the mouth of Tsusena Creek (RP-184-1). At the main and side channel sites, contributions of zooplankton and other non-insect taxa also increased in the fall.

5.2.2. **RP-173 (Stephan Lake Complex)**

At RP-173, drift densities for drift net samples taken in the tributary mouth, main channel, side channel, and upland slough sites ranged from 0.14 to 0.88 individuals/ft^3 (Figure 5.2-3). Plankton tow density measured at the side slough site and within the side channel and upland slough sites during fall ranged from 0.793 individuals/ft^3 in the summer in the side slough, to 78.3 individuals/ft^3 in the upland slough site during the fall. Mean taxa richness was high in drift net samples, with the tributary mouth site showing the highest average of 49.5 taxa in the summer and dropping to 26.5 taxa in the fall (Figure 5.2-4). Mean taxa richness for the main channel site averaged 42.8 overall in 2014, whereas the side channel site showed an overall average of 20.9 taxa, with a spring average of 30 taxa, rising to 44 taxa in the summer before dropping to an average of 8 taxa (from plankton tows) during the fall. In contrast, plankton tows in the side slough site had an overall average of only 7.4 taxa, ranging from a low of 3.8 taxa in the summer to 13.6 taxa during fall (Figure 5.2-4). Drift net samples also collected higher numbers of EPT taxa than plankton tows, ranging from an average of 0.0 to 9.5 taxa, in comparison to 0.0 to 0.4 taxa for plankton tows.

Community compositions for drift and plankton tows show that samples were largely comprised of chironomids during the spring and summer sampling events. During the fall sampling event, chironomid contributions were reduced. At the small unnamed tributary mouth (RP-173-1), fall drift captured higher amounts of *Baetis* sp. mayflies (37.3 percent), along with simuliid larvae and water mites. Fall drift within the main channel site (RP-173-2) shifted to increased numbers of zooplankton (34 percent), along with simuliids and stoneflies (*Taenionema* sp.). Plankton tows collected during the fall event varied in chironomid compositions, ranging from 34.9 to 56.6 percent relative abundance; in the side channel site (RP-173-3) chironomids still dominated with 56.6 percent of the composition, with 25.7 percent contributed to the hydrophilid beetle *Helophorus* (Other Insects), and 12.7 percent zooplankton. The side slough and upland slough sites also showed increased contributions of *Helophorus*, as well as the ceratopogonid *Dasyhelea* sp. (Other Diptera). Drift net samples consistently collected higher proportions of EPT taxa compared to plankton tows.

5.2.3. RP-141 (Indian River)

In 2014, drift densities were collected in the RP-141 mouth, main channel, and side channel sites, and ranged from 0.006 individuals/ft^3 at the main channel site in the spring, to 1.09 individuals/ft^3at the side channel site during the summer (Figure 5.2-5). Plankton tow density was measured at the upland slough site (RP-141-4) in the slow-water habitat, revealing densities of 1.06 to 3.08 individuals/ft^3, and additionally within the side channel site (RP-141-2) during the fall event due to lower flow conditions, which collected 0.66 individuals/ft^3. Mean drift taxa richness was high overall, with the tributary mouth site (RP-141-1) showing an average of 48.8 taxa for the sampling seasons as well as the highest taxa richness average of 53.3 taxa during the summer (Figure 5.2-6). As flow levels receded over the course of the sampling season, mean taxa richness in the side channel dropped from a high of 36 taxa in summer, to 5.2 taxa in the fall, resulting in an overall average of 15 taxa. Mean taxa richness for the main channel site (RP-141-3) averaged around 33.2 taxa overall, ranging from 10 taxa in the spring to 21.5 taxa during the fall event. In contrast to drift taxa richness, plankton tows resulted in generally lower taxa richness. For example, in the upland slough site (RP-141-4), taxa richness averaged only 9.3 taxa over 2014 sampling, ranging from a low of 8.6 taxa in the fall to 9.8 taxa during the spring (Figure 5.2-6). Drift net samples also collected higher numbers of EPT taxa (average of 1 to 10 taxa) than plankton tows (average of 0.0 to 0.4 taxa).

Community compositions for drift and plankton tows show that samples were largely comprised of chironomids, in higher proportions during the spring and summer sampling events. Drift samples at the mouth of Indian River (RP-141-1) had higher compositions of EPT taxa than other sites, with an overall average of 21.5 percent. Plankton tows collected in the upland slough had a notable contribution of zooplankton, ranging from an average of 6.7 percent in the summer to 11.4 percent during the spring, as well as a larger contribution of Other Diptera, largely larvae from the dipteran family Ceratopogonidae, ranging from 24.3 percent in the spring to 48.3 percent in the fall. Drift net samples consistently collected higher proportions of EPT taxa as compared to plankton tows.

5.2.4. RP-104 (Whiskers Slough)

Mean drift density estimates for sites in the RP-104 station at Whiskers Slough in 2014 ranged from 0.02 individuals/ft^3 at the side channel site (RP-104-5) in the summer to 1.14 individuals/ft^3 at the mouth of Whiskers Creek (RP-104-1) in the spring (Figure 5.2-7). Plankton tows were utilized at the side slough and upland slough sites, and additionally within the tributary mouth site during the summer event, due to lower flow conditions at those locations. Plankton tow densities ranged from 1.0 to 45.9 individuals/ft^3 in the upland slough (RP-104-4), from 0.39 to 4.58 individuals/ft^3 in the side slough sites (RP-104-2 and -2.1), and showed density of 3.47

individuals/ft^3 in the mouth of Whiskers Creek during the summer event period (Figure 5.2-7). Mean taxa richness was higher in the flowing water sites sampled with drift nets, with the tributary mouth site showing a mean of 28 taxa in the spring, and 34 taxa during the fall sampling period, the highest taxa richness recorded within the station in 2014 (Figure 5.2-8). Mean taxa richness for the main channel site averaged around 27.7 taxa overall, whereas the side channel site averaged 19.8 overall, ranging from 16.5 taxa in the spring to 25.5 taxa during the fall event period. In contrast, plankton tows in the side slough sites averaged 6.2 taxa overall during 2014, with the upland slough site averaging slightly higher, at 12.1 taxa overall (Figure 5.2-8). Drift net samples also generally collected higher numbers of EPT taxa than plankton tows in 2014, ranging from an average of 0.5 to 6 EPT taxa, in comparison to 0.0 to 0.8 EPT taxa for plankton tows.

Community compositions for drift and plankton tows in RP-104 reveal a wide variety of taxa represented in the water column. Chironomids were often dominant in both drift and plankton samples, ranging from 20.2 percent in plankton tows in the side slough just above the tributary mouth during the spring, to 80.6 percent in drift samples taken the main channel site (RP-104-3), also in the spring. Overall averages in the relative abundance of chironomids shows that the main channel and side channel sites were higher in chironomid contributions that the off-channel sites. Plankton tows collected in the slough sites also showed notable contributions of Other Diptera, largely ceratopogonids, ranging from an average of 21.7 percent in the summer at RP-104-1 to 67 percent during the summer at RP-104-4. Drift net samples collected higher proportions of EPT taxa throughout the three seasons, compared to plankton tows. Zooplankton contributions were generally higher in plankton tows; the highest relative abundance of zooplankton was collected with plankton tows in the tributary mouth (RP-104-1) during the summer sampling event, comprising an average 41.3 percent of the invertebrates captured at the site. As previously indicated, the lower extent of Whiskers Creek forms a low-flow pool habitat at certain times of the open-water season, and it is likely that this pool contributed to the higher zooplankton presence near the mouth at the confluence with the slough.

5.2.5. **RP-81 (Montana Creek)**

Drift densities in 2014 were calculated for the mouth of Montana Creek, main channel, and side channel sites and ranged from 0.005 individuals/ft^3 in the side channel site (RP-81-4) during the fall period to 0.56 individuals/ft^3 at the mouth of Montana Creek (RP-81-2) in the spring (Figure 5.2-9). Drift densities were consistently higher in the tributary mouth than compared to the other flowing water sites. Plankton tows were utilized at the upland slough site (RP-81-1) in slow-water habitat, averaging 11.4 individuals/ft^3 in summer event period, and 22 individuals/ft^3 in the spring period (Figure 5.2-9).

Mean drift taxa richness was high, with the tributary mouth site showing an overall average of 40.7 taxa, ranging from an average of 31.5 taxa in spring, to an average of 48 taxa in fall (Figure 5.2-10). Mean taxa richness for the main channel site in 2014 averaged around 43 taxa overall, ranging from 33 taxa in spring to 52 taxa in summer. Taxa richness for the side channel site (RP-81-4) averaged 19.3 taxa overall, whereas the side channel site established just upstream from the tributary mouth averaged 30 taxa overall. In contrast, taxa richness in plankton tows was lower. For example, zooplankton taxa richness in the upland slough site averaged 11.75 taxa in spring and 4.6 taxa in fall (Figure 5.2-10). Similar to overall taxa richness, average EPT taxa was higher in the tributary mouth, followed by the main channel. EPT taxa richness was very low in the upland slough site, ranging from 0 to 0.4 taxa.

Community compositions for drift and plankton tows in RP-81 revealed a wide variety of taxa represented in the water column. Drift samples often were dominated by chironomids along with higher contributions of EPT taxa, especially in the main and side channels. Other Diptera (generally simuliids) also were prevalent in drift samples throughout the seasons. Plankton tows collected in the upland slough site also showed dominant contributions of chironomids and ceratopogonids in the spring and summer sampling periods, but during the fall sampling event, zooplankton accounted for nearly 97 percent of the organisms collected. Zooplankton were also present in lower relative abundances in drift net samples throughout the sampling season, ranging from 0.4 percent to 15.1 percent.

Drift sampling results from 2013 reported similar trends as seen in 2014. Lab analysis for several 2013 macroinvertebrate sample sets was completed post-ISR filing, and the results were presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014. (R2 and UAF 2014b). As presented in R2 and UAF (2014b), results from the 2013 drift sampling effort indicated that tributary mouths generally were highest in mean drift density, taxa richness, and EPT Taxa, and often showed higher percentages of those EPT taxa in community compositions. Plankton tows collected within side sloughs and upland sloughs displayed higher densities of zooplankton and non-insect taxa, as well as chironomids, but usually showed very low taxa richness results. Main channel and side channel sites often displayed the lowest drift density and taxa richness measures in comparison to tributary mouths and side sloughs.

5.3. Conduct a Feasibility Study in 2013 to Evaluate the Suitability of Using Reference Sites on the Talkeetna River to Monitor Long-term Project-related Change in Benthic Productivity

No field work was conducted for this objective in 2014. However, 2013 lab analysis was completed post-ISR filing in June 2014, and results were presented in *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014. Results from the benthic macroinvertebrate (R2 and UAF 2014b) and algal sampling (AEA 2014a), generally showed that Talkeetna River side sloughs and upland sloughs displayed higher densities and the side slough showed higher taxa richness measures than were evident at the side channel site. Comparisons to Susitna River data will be completed in the next year of study.

5.4. Conduct a Trophic Analysis, Using Trophic Modeling and Stable Isotope Analysis, to Describe the Food Web Relationships in the Current Riverine Community within the Middle and Lower Susitna River

5.4.1. Develop a Trophic Model to Estimate How Environmental Factors and Food Availability Affect the Growth Rate Potential of Focal Fish Species under Current and Future Conditions

Lab analysis for the 2013 data collected was completed post-ISR filing in June 2014, and results were presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014. Those preliminary fish growth results were subject to change pending completion of genetic analysis to confirm species identifications. Subsequent genetics results provided positive species identifications for 522 of 533 Chinook Salmon and Coho Salmon sampled during the study. The field determinations of the remaining fish were retained or rejected based on the rates of correctly identified fish of each species in each year. In 2013, only 40 percent of fish identified as Chinook Salmon in the field were actually Chinook Salmon based on the genetics results. Therefore, fish identified as Chinook Salmon in 2013 were excluded from subsequent analyses if no genetic verification was available (n = 5). In 2013, 92 percent of fish identified as Coho Salmon in the field were genetically verified as Coho Salmon. In 2014, field determinations were 96 percent correct overall (97 percent for fish identified as Chinook Salmon and 94 percent for fish identified as Coho Salmon in the field). Therefore, the field determination was retained for the fish in these groups.

5.4.1.1. *Fish growth rates*

Length-frequency histograms from fish captured in the Fish Distribution and Abundance Study were used to determine the modal sizes of age-0 Chinook and Coho salmon during the spring sampling periods of 2013 and 2014, because the River Productivity Study was limited to sampling fish ≥ 50 mm FL. These histograms indicated that the modal size of age-0 Chinook and Coho salmon sampled in the River Productivity study area during June was 43 mm FL in 2013 and 39 mm FL in 2014 (Figure 5.4-1). These lengths corresponded to modal weights of 0.8 g in 2013 and 0.6 g in 2014, based on equation 1 (Section 4.6.1.1.).

For all other age classes and seasons, seasonal weight-at-age relationships were determined from fish sampled and aged from scales by the River Productivity study. Age assignments of fish collected in 2013 were re-examined after the species identifications of a subset of these fish were reassigned based on genetics verification of the field determinations. The size-at-age relationships presented in this report supersede the data previously presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) in September 2014.

In 2013, forty-two Chinook Salmon, 158 Coho Salmon, and 36 Rainbow Trout were aged from scales to determine size-at-age relationships (Figures 5.4-2 through 5.4-4). The samples of aged fish ranged from 63-133 mm (ages 0-2) for Chinook Salmon, 48-165 mm (ages 0-2) for Coho Salmon, and 61-301 mm (ages 0-4) for Rainbow Trout. In 2013, all Chinook Salmon sampled during the Spring sampling event were identified as age-1 (Figure 5.4-2). Age-0, age-1, and age-

2 Chinook Salmon were identified in the scale samples collected during the Summer 2013 event, and only age-0 Chinook Salmon were identified in the scale samples collected during Fall 2013. Five Chinook Salmon identified as age-2 were considered somewhat unusual, so they are described in detail here. The age-2 Chinook Salmon were all captured at the same site, an upland slough beaver complex near Indian River (site FDA-141-81-USB2) on August 29, 2013. These fish all had confirmed species identifications based on genetics. These fish were larger than all other Chinook Salmon and most Coho Salmon sampled during the study, ranging from 120-130 mm FL and 17.8-24.6 g, and their scale patterns appeared to show two annuli; however, the scale readers could not be certain that these were not very large age 1 fish. This uncertainty did not affect any subsequent analyses because only the growth rates of age-0 Chinook Salmon were used as inputs to bioenergetics models (see below). In 2013, Coho Salmon scale samples included ages 0-2 during the Spring and Fall event, and ages 0-1 during Summer (Figure 5.4-3). Rainbow Trout ages 0-4 were identified in the scale samples collected (Figure 5.4-4).

In 2014, 163 Chinook Salmon, 137 Coho Salmon, 112 Arctic Grayling, and 18 Rainbow Trout were aged from scales to determine size-at-age relationships (Figures 5.4-5 through 5.4-8). The samples of aged fish ranged from 50-105 mm (ages 0-1) for Chinook Salmon, 48-134 mm (ages 0-2) for Coho Salmon, 50 to 365 mm FL (ages 0-6) for Arctic Grayling, and 50-490 mm (ages 0-5) for Rainbow Trout. In 2014, two age classes of Chinook Salmon were identified in the scale samples collected during the Spring sampling event (ages 0 and 1; Figure 5.4-5). Only age-0 Chinook Salmon were represented in the scale samples collected during the Summer and Fall 2014 sampling events. In 2014, Coho Salmon scale samples included ages 0-2 during the Spring and Fall event, and ages 0-1 during Summer (Figure 5.4-6). Arctic Grayling ages 0-6 and Rainbow Trout ages 0-5 were identified in the scale samples collected (Figures 5.4-7 and 5.4-8).

Age-0 Chinook Salmon grew larger in 2013 than in 2014, and they also differed in size among habitat types during 2014 (Figure 5.4-9). Chinook Salmon were 78 percent greater in mass on average in 2013 than in 2014 (6.8 g vs. 3.8 g, respectively), and this difference was significant ($p < 0.0001$). Chinook Salmon grew faster in 2013 than in 2014 (Julian date X year interaction, $p < 0.01$), and during the fall sampling event, Chinook Salmon were 22 percent larger in 2013 than in 2014. However, these results were interpreted with caution because age-0 Chinook Salmon were sampled at only three sites during summer and fall 2013, and half of these fish were captured in a screwtrap (set at site RP-141-1, the mouth of Indian River), which could potentially select for larger fish than other gears. Age-0 Chinook Salmon were sampled across a larger number of sites in 2014, primarily using baited minnow traps, backpack electrofishers, and seines. During 2014, Chinook Salmon captured in main channel and side channel habitats were 35 percent larger than those captured in off-channel habitats (side sloughs, tributary mouths, and upland sloughs), and this difference among habitat types was significant ($p < 0.001$). To incorporate this difference into the bioenergetics models, separate growth trajectory inputs were compiled for 1) mainstem Susitna River habitats (main channels and side channels), and 2) off-channel habitats (side sloughs, tributary mouths, and upland sloughs). Both habitat types were modeled in 2014; however, in 2013 age-0 Chinook Salmon were only captured in off-channel habitats in sufficient numbers to estimate growth rates.

Age-0 Coho Salmon grew slightly faster in 2013 than in 2014, but exhibited no consistent differences in size or growth rate among habitats. Age-0 Coho Salmon were 13 percent greater in mass on average in 2013 than in 2014 (Figure 5.4-10), and 19 percent greater during fall 2013 than fall 2014, although there was no significant difference in body mass between years (p = 0.15). The growth rate of age-0 Coho Salmon was slightly greater in 2013 than in 2014 (marginally significant effect of Julian date, p = 0.07). The mean weight of age-0 Coho Salmon did not differ among habitats (p = 0.65), although there was a significant interaction between year and habitat: age-0 Coho Salmon in upland sloughs were larger on average in 2014 than in 2013 ($p < 0.0001$). Therefore, growth data were pooled across habitats to generate bioenergetics model inputs for each year. Age-1 Coho Salmon grew significantly faster in 2013 than in 2014 (effect of Julian date, $p < 0.0001$), although they did not differ in overall body mass between years, largely because they weighed less during spring (Figure 5.4-11; p = 0.5). Age-1 Coho Salmon differed in weight among habitats ($p < 0.01$), with larger fish on average in side channels and tributary mouths than in side sloughs or upland sloughs. Therefore, separate growth trajectories were compiled for separate bioenergetics model inputs for 1) side channels and tributary mouths and 2) side sloughs and upland sloughs in each year. Coho Salmon were not captured in main channel habitats.

Ten individual passive integrated transponder (PIT) tagged Chinook Salmon and four Coho Salmon were measured multiple times between late July and late September 2013 at River Productivity sampling stations, providing individual growth trajectory data. These fish exhibited growth rates averaging 1.0 percent of their body mass per day (range: -0.09 – 2.25 percent). Based on their sizes, most of these fish were age 1. Nearly all of these marking and recapture events occurred in side sloughs and upland sloughs in RP-104 (Whiskers Slough) and RP-141 (Indian River). At the time of report preparation, only provisional data were available on growth rates of PIT tagged fish recaptured during the 2014 field season.

5.4.1.2. *Water temperature*

Daily mean water temperatures ranged from 0-17°C during the course of the study, and substantial thermal heterogeneity was recorded on a fine spatial scale among macrohabitats within Focus Areas. Mean temperatures were warmer overall in all habitats during 2013 than 2014, and temperatures varied considerably within years (Table 5.4-1, Figure 5.4-12). Main channels were the warmest and side sloughs were the coldest macrohabitats on average in both years (Table 5.4-1; Figures 5.4-13 and 5.4-14). Tributary mouths were also relatively warm, and upland sloughs were variable, including cold habitats such as RP-104-4 and warm habitats such as RP-81-1. Sites where the stomach contents of juvenile salmon contained salmon eggs were also variable in temperature, ranging from cold (Whiskers side slough, RP-104-2) to warm (Indian River tributary mouth, RP-141-1) (Figure 5.4-15). Comparisons of summary metrics should be viewed among years, habitat types, and stations with caution because temperature loggers were deployed for slightly different dates at each station.

5.4.1.3. *Bioenergetics modeling*

Overall, Chinook Salmon fed at a high rate relative to their physiological capacity, and were often more limited by temperature than by food intake. In 2013, Age-0 Chinook Salmon grew at a rate of nearly 3.5 percent of body weight per day during early summer in tributaries and sloughs, and fed at a rate $P = 0.91$ of their theoretical C_{max} under the observed conditions, indicating that their growth rates were primarily limited by temperature rather than food. Chinook Salmon were not captured in side channel or main channel habitats in 2013. During early summer 2014, Chinook Salmon in tributary mouths and sloughs grew slower than during early summer 2013, and their feeding rate exceeded C_{max} slightly, indicating temperature was the primary factor limiting growth. Chinook Salmon were captured in side channel and main channel habitats during 2014, and these fish fed at a similar rate and grew faster than those captured in sloughs. Growth and consumption rates declined in late summer during both years, with *P*-values falling to 0.52-0.55 (Table 5.4-2). All species and age classes grew faster, relative to their body weight, during early summer than during late summer (Table 5.4-2).

By contrast, age-0 Coho Salmon in all habitats were predominantly food-limited during both years, feeding at rates of P = 0.17-0.29. Age-1 Coho Salmon fed at a similar rate of P = 0.26 in side channels and tributary mouths as well as in side sloughs and upland sloughs, indicating that their growth rates were also primarily food-limited. These feeding rates translated into a faster growth rate in the warmer side channels and tributary mouths (1.08 percent of body weight / day) than in the cooler side sloughs and upland sloughs (0.61 percent of body weight / day) (Table 5.4-2). The mean weight of Age-1 Coho Salmon in sloughs decreased during late summer 2014. However, very few age-1 Coho Salmon were captured during the fall sampling event, even though overall catch rates were high. Thus, this result should be interpreted with caution due to the potential influence of random variability.

The growth efficiency of juvenile salmon also varied widely, ranging from a low of -11 percent for age-1 Coho Salmon in sloughs during late summer 2014 to a high of 31 percent for both age-0 Chinook Salmon in mainstem habitats (main channels and side channels) and Coho Salmon in all habitats during early summer 2013. Overall, salmon exhibited greater growth efficiency during early summer than late summer, indicating that they met their metabolic needs with a smaller fraction of their overall energy intake, leaving more surplus energy to allocate to growth.

The mean mass-specific growth rates (g growth/g body mass/day) of Chinook and Coho salmon ranged from -0.17 to 3.48 percent (Table 5.4-2). This range of values was similar to the -0.09 – 2.25 percent range of growth rates measured for individual PIT tagged fish. To achieve these growth rates, age-0 salmon consumed 8-31 percent of their body weight per day on average. Age-1 Coho Salmon consumed 10-40 percent of their body weight per day, on average (Table 3.4-2).

5.4.1.4. *Growth rate potential modeling*

Growth rate potential was estimated for 49 sampling events for which all necessary field data were available and velocities were sufficient for age-1 Coho Salmon to drift feed consistently (≥ 0.29 m/s). The model predicted that age-1 Coho Salmon would achieve positive growth in 11 of these sets of observed conditions (Table 5.4-3). The conditions supporting positive simulated growth rates encompassed velocities ranging from 0.3-0.4 m/s, turbidity levels 0.6-46 NTU, temperatures 3.6-10.5 degrees C, and invertebrate drift biomass density levels 0.15-5.91 mg dry mass/m^2/s (Table 5.4-3, Figure 5.4-16.) The overall range of growth rate potential values estimated for specific sites by the model (-2.0 – 3.8 percent) was slightly broader than the observed range of growth rates estimated from the observed seasonal weight-at-age data (-0.17 – 3.48 percent).

5.4.2. Conduct Stable Isotope Analysis of Food Web Components to Help Determine Energy Sources and Pathways in the Riverine Communities

5.4.2.1. *2013 Results Summary from Technical Memorandum*

Lab analysis for the 2013 data collected was completed post-ISR filing in June 2014, and results were presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) filed in September 2014. Stable isotope mixing models from 2013 data suggest that both spatial and an upriver-to-downriver trends exist in the relative contributions of freshwater, terrestrial, and marine sources (R2 and UAF 2014b). An increasing proportion of marine sources in the diets of the target fish species from June to October suggests that fish are foraging on energy-rich spawning salmon tissue and eggs as they become available. These data corroborate the findings from the stomach content analysis that juvenile Chinook and Coho Salmon consume substantial amounts of marine-derived food. This is in contrast to prior juvenile salmon diet studies in the Middle Susitna Basin, which found that these species relied almost exclusively on aquatic and terrestrial insects (ADF&G 1983; Hansen and Richards 1985). An upriver-downriver spatial trend was evident in the proportion of marine subsidies consumed, where rearing salmon and resident trout are more heavily influenced by this diet source higher up in the system. The opposite trend was expected; however, more spawning salmon were observed in RP-104 (Whiskers Slough) and RP-141 (Indian River) at the time of sampling than at RP-81 (Montana Creek). The spatial trend may therefore be explained by the overlap of suitable spawning habitats with rearing habitats. Mixing models also suggest differences in dietary contributions between habitat types, where foraging target species in generally clear, oxygenated tributary mouths and side sloughs receive a greater marine subsidy compared to more turbid side channels and less connected upland sloughs. Again, these differences may speak to the overlap of suitable spawning and rearing habitat.

5.4.2.2. *2013 Stable isotope post-genetic analysis modifications*

After the release of 2013 preliminary stable isotope results, 2013 dietary trends were again estimated using Bayesian mixing models with definitive species identifications from genetic analysis as well as informative priors from the stomach content dataset. The updated diet estimates from stable isotope data overall resulted in a greater mean importance of freshwater-derived prey for both Chinook and Coho salmon, with a corresponding decrease in the overall importance of terrestrial prey, and mixed changes for marine-derived prey (Figures 5.4-18 through 5.4-20). These shifts are likely an artifact both of using informative priors from stomach content data, used to weight the posterior diet estimates in models, as well as changes attributed to species reassignments. Despite this major modification, overall seasonal trends in the mean contributions of freshwater, marine, and terrestrial energy sources were largely similar to the preliminary results (Figure 5.4-18). The largest estimate shift for freshwater sources in Chinook and Coho salmon diets occurred for the spring sampling event at RP-81-1 (upland slough; Figures 5.4-18 through 5.4-20; 61.7 percent increase for Chinook Salmon and 41.8 percent increase for Coho Salmon). The freshwater and terrestrial invertebrate endmembers here were isotopically similar and the model was not able to distinguish between these two sources in the diets. Upon incorporation of prior values weighted toward freshwater sources, their proportion in diets increased. Updated model results showed that patterns across macrohabitat types again were comparable to preliminary results (Figure 5.4-19). The importance of marine contributions to Coho Salmon shifted only slightly across all macrohabitats; this was largely the case for Chinook Salmon, with the exception of those rearing in the RP-104-2 side slough where marine importance decreased compared to initial results (Figure 5.4-19). All field-identified Chinook captured at the RP-104-5 side channel were genetically identified as Coho (Figure 5.4-19). Despite reassigning many Chinook Salmon individuals to Coho Salmon, both species generally appear to occupy similar broad-scale foraging niches within different macrohabitat groupings (Figure 5.4-19). Patterns across River Productivity study stations were also similar to those reported in the 2013 ISR, where marine-derived prey contributed increasing proportions for both species from downstream to upstream reaches (Figure 5.4-20).

5.4.2.3. *2014 Stable Isotope Analysis*

To characterize baseline isotopic variability, mean $\delta^{13}C$ values of benthic algae, benthic organic matter, and seston organic matter were compared across macrohabitat types, along an upstream to downstream gradient, and among seasons. Understanding relative $\delta^{13}C$ values (degree of ^{13}C-enrichment) of carbon sources across space and time is useful in describing predominant sources of baseline isotopic variability that ultimately affect that of aquatic consumers (Finlay and Kendall 2007).

Algae $\delta^{13}C$ values showed significant differences by macrohabitat type and reach, but not by season. Compared across macrohabitat types, algae exhibited the most enriched $\delta^{13}C$ values at glacial main channels (mean $\delta^{13}C$ = -24.69‰) and side channels (-24.01‰), followed by tributary mouths (-27.84‰), upland sloughs (-30.84‰) and side sloughs (-32.01‰) (Figure 5.4-21). Pairwise comparisons of algal $\delta^{13}C$ values pooled by reach showed that mean $\delta^{13}C$ values were most depleted at RP-104 (-28.38‰) and most ^{13}C-enriched at RP-184 (-24.66‰), with intermediate mean values at RP-81 (-26.77‰) and RP-141 (-26.49‰) (p-value range: 0.004 – 0.341; Figure 5.4-22). Mean algae $\delta^{13}C$ values did not vary significantly by season (p-value range: 0.31 – 0.57; Figure 5.4-23).

Pooled across all sites and seasons for 2014, mean organic matter $\delta^{13}C$ did not differ significantly between benthic and drift sample types (mean $\delta^{13}C_{OMB}$ = -27.83‰, $\delta^{13}C_{OMD}$ = -27.82‰, p = 0.807). Therefore, OM sample types were pooled for the following analyses. OM samples showed little variation between macrohabitat types (mean $\delta^{13}C$ range: -28.7‰ to -27.07‰), but similar to algae, sample $\delta^{13}C$ values from glacial main and side channels were significantly higher compared to samples from tributary mouths and slough habitats (p-value range: <0.001 to 0.021; Figure 5.4-21). Pairwise comparisons of mean OM $\delta^{13}C$ pooled by reach showed that samples from RP-184 were significantly ^{13}C-enriched (-27.23‰; p-value range: <0.001 to 0.040) compared to samples from all other reaches (RP 81: -28.08‰, RP-104: -28.08‰, RP-141: -27.70‰; Figure 5.4-22). Pooled across sites within each season, mean OM $\delta^{13}C$ was significantly enriched in summer (-28.06‰) compared to spring (-28.06‰) and fall samples (-28.01‰) (p-values < 0.001; Figure 5.4-23).

Averaged over all sites and seasons, larval and emergent aquatic invertebrate feeding groups (shredders, collectors, predators, and grazers) did not show any significant differences in mean $\delta^{13}C$ (p-value range: 0.265 to 0.999). Together, all aquatic invertebrate feeding groups averaged -28.56‰ and were significantly depleted ($p < 0.001$) relative to mean terrestrial $\delta^{13}C$ values

(26.34‰). Aquatic invertebrate mean $\delta^{13}C$ exhibited the same pattern by macrohabitat type as algae, where samples from main channels (-26.95‰) and side channels (-26.76‰) were most ^{13}C-enriched, followed by tributary mouths (-28.04‰), upland sloughs (-32.69‰), and the side slough (-33.45‰; Figure 5.4-21). Some of these differences were significant (p-value range: < 0.001 to 0.994). Pooled by reach, aquatic invertebrates again showed the same $\delta^{13}C$ pattern as algae, where RP-104 invertebrates were collectively most depleted (-31.19‰), RP-184 invertebrates were most ^{13}C-enriched (-26.69‰), and those from RP-81 and RP-141 exhibited intermediate values (-28.01 and -27.98‰, respectively), resulting in an overall insignificant trend from downstream to upstream across reaches (p-value range: < 0.001 to 0.157; Figure 5.4-22. Aquatic invertebrate mean $\delta^{13}C$ did not differ by season (p-value range: 0.067 to 0.830; Figure 5.4-23).

Strong correlations between $\delta^{13}C$ signatures suggested that all freshwater invertebrate feeding groups relied primarily on freshwater, rather than terrestrial sources of carbon (Figure 5.4-24). Site-specific mean algal $\delta^{13}C$ predicted site-specific mean primary consumer $\delta^{13}C$ better than did terrestrial organic matter (OM) $\delta^{13}C$ for all freshwater primary consumer groups. All simple linear regressions of collector, grazer, and shredder invertebrate $\delta^{13}C$ against algal $\delta^{13}C$ were significant ($p < 0.02$) and resulted in relatively high r^2 values (range: 0.48-0.80), whereas all relationships of invertebrate groups to terrestrial OM were not significant ($p > 0.05$) and had very low r^2 values (range: 0.01-0.2; Figure 5.4-24). Collectors had the strongest reliance on algal carbon sources, followed by grazers and shredders.

Contributions of freshwater, terrestrial, and marine diet sources to each target fish species were estimated using a Bayesian stable isotope mixing model (MixSIAR; Stock and Semmens 2013) and compared across macrohabitat types, study reaches, and seasons. Mixing model results suggest that for juvenile Chinook and Coho salmon, freshwater and terrestrial sources contributed substantially to consumer tissue, while marine-derived food was less important. In general, marine sources contributed substantially to Rainbow Trout as compared to other fish species, while freshwater prey were most important to Arctic Grayling.

Mixing model results suggested that juvenile Chinook Salmon consumed primarily freshwater sources in 2014, while terrestrial invertebrates and salmon eggs were secondary prey items. Across all sites and seasons, freshwater prey comprised an average of 59.6 percent ± 14.2 SD of juvenile Chinook Salmon diets, while the overall mean contribution of terrestrial prey was 27.5 percent ± 13.4 SD (Tables 5.4-4 through 5.4-6; Figure 5.4-25); marine-derived prey were least important in their diets across all sites and seasons (mean: 12.9 percent ± 8.2 SD) (Tables 5.4-4 through 5.4-6; Figure 5.4-25). In 2014, contributions of each prey source among habitat types showed less contrasting seasonal trends compared to the previous year. Mixing models for Chinook Salmon caught in main channel, side channel, and tributary mouth sites showed the importance of freshwater prey to diets either decreasing slightly from spring to fall or with the lowest overall contribution during the summer. Terrestrial prey showed complementary seasonal trends for fish in the same macrohabitats, where mean contributions either increased from spring to fall or peaked in summer. Seasonal trends of marine contributions were highly variable among sites sampled, however in sites where spawning salmon were observed in relatively higher densities (RP-141 tributary mouth and upland slough), the mean contribution of marine prey sources increased slightly from summer to fall. Fish sampled in most sites showed a decrease in the mean contribution of marine sources from spring to summer. Macrohabitat types sampled in 2014 also showed significant overlap in the possible mean contributions of each prey source, with notable exceptions at previously mentioned sites where spawning salmon were observed in relatively higher densities and a higher proportion of stomach contents contained salmon eggs. Comparisons of diet composition by distance from the river mouth did not yield any consistent or significant patterns (box colors, Figure 5.4-25).

Overall food resource contributions for Coho Salmon were similar to those for juvenile Chinook Salmon, where freshwater prey were the primary food source (61.8 percent ± 12.7 SD), followed by terrestrial (23.6 percent ± 21.6 SD) and marine-derived food sources (14.5 percent ± 8.2 SD) (Tables 5.4-4 through 5.4-6; Figure 5.4-26). Trends for all sources were largely mixed but consistent across seasons, with the exception of Coho Salmon at the RP-81 upland slough, where freshwater prey noticeably declined from spring to fall, complemented by an increase in terrestrial sources. Spatial comparisons of contributions also did not reveal any major trends. Sources across all macrohabitats were fairly consistent in Coho Salmon diets, and there was not any apparent trend from upriver to downriver Focus Areas.

Low sample sizes for Arctic Grayling precluded stable isotope diet analysis for most sites where they were captured. The majority of sites where sample sizes were sufficient and mixing models could be completed are within RP-184 (Tables 5.4-4 through 5.4-6; Figure 5.4-27). Across all sites and seasons, freshwater food sources were slightly more important to juvenile and adult Arctic Grayling relative to juvenile salmon (mean: 64.1 percent ± 13.9 SD), while terrestrial source contributions were comparable (27.5 percent ± 13.3 SD) and marine-derived contributions were significantly reduced (8.4 percent ± 6.1 SD) (Figure 5.4-27). Marine prey was of low importance across all macrohabitats (RP-184 tributary mouth, main channel, and side channel, and RP-141 main channel). Terrestrial contributions were slightly higher at the RP-184 tributary mouth compared to other macrohabitats, however this did not appear to be a significant difference. When pooled across seasons, mixing models did not reveal any significant trends for any energy source (Tables 5.4-4 through 5.4-6; Figure 5.4-28).

Mixing models for Rainbow Trout were pooled by season and size class due to low sample sizes (Figure 5.4-28). Overall, freshwater and terrestrial sources were less important (respective means: 51.0 percent ± 15.5 SD; 16.1 percent ± 11.4 SD) compared to juvenile Salmon and Arctic Grayling, while marine-derived sources made up a significantly greater proportion of diets (mean: 32.9 percent ± 14.6 SD) (Figure 5.4-28). Contributions of each source exhibited very little change across seasons.

5.5. Characterize the Invertebrate Compositions in the Diets of Representative Fish Species in Relationship to their Source (benthic or drift component)

5.5.1. 2013 Results Summary from Technical Memorandum

Lab analysis for the 2013 data collected was completed post-ISR filing in June 2014, and results were presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) filed in September 2014. All three target fish species fed heavily on salmon eggs and fish during the three sampling periods between June and September 2013. This pattern was relatively consistent across the three Focus Areas studied and in three out of four macrohabitat types, with the exception of upland sloughs. These diet data are interpreted with caution and focus on the broad trends in the data because of the relatively low sample sizes. Still, these results contrast prior studies which found that juvenile Chinook Salmon and Coho Salmon consumed primarily aquatic invertebrates during 1982, with very little consumption of salmon eggs and no consumption of fish (ADF&G 1983; Hansen and Richards 1985). These historical data indicate that juvenile Chinook and Coho salmon consumed salmon eggs at Indian River in late September. However, there is no evidence that they utilized salmon eggs during other spawning runs or at other sites within the Susitna Basin.

5.5.2. **2014 Overall Dietary Patterns**

Stomach content analysis indicated that stream salmonids consumed primarily freshwater-derived food resources overall, and the importance of terrestrial and marine-derived diet items varied on temporal, spatial, and ontogenetic patterns. In 2013, 3,035 prey items were identified and measured from 195 fish with non-empty stomachs. In 2014, 39,597 prey items were identified and measured from 410 fish with non-empty stomachs. Overall, both size classes of Arctic Grayling, juvenile Chinook Salmon, and small Rainbow Trout consumed primarily freshwater prey (including aquatic and terrestrial adult life-stages; Figure 5.5-1). However, large Rainbow Trout preyed more heavily on fish and fish eggs than on invertebrates overall, and juvenile Coho and Chinook Salmon also relied heavily on salmon eggs at certain times and places (Figure 5.5-1). Both salmon species and Rainbow Trout relied much more heavily on salmon eggs during 2013 than during 2014 (Figure 5.5-2, Appendix A, Tables A5.5-2 through A5.5-4). Grayling were only sampled in 2014, and no salmon eggs were identified in their stomach contents. A graphical examination of Chinook Salmon, Coho Salmon, and Rainbow Trout consumption of salmon eggs indicated that all three species exhibited an ontogenetic shift to ovivory at roughly 55-85 mm FL (Figure 5.5-3). The smallest fish of each species documented to consume salmon eggs were a 55 mm FL Chinook Salmon, a 62 mm FL Coho Salmon, and an 84 mm FL Rainbow Trout (Figure 5.5-3).

Fish prey comprised a substantial fraction of fish stomach contents collected during some sampling events; however, much of this piscivory appeared to be an artifact of the sampling methods, rather than an accurate indication of diet composition. The majority of prey fish specimens (76 percent of the numbers and 90 percent of the total mass) were collected from the stomach contents of fish captured using passive gear types (i.e., screw traps, fyke nets, and minnow traps) where fish had an extended opportunity to feed on smaller fish concentrated inside the trap or net. Relatively few instances of piscivory were documented for fish captured using active methods (i.e., angling, electrofishing, or seining). To avoid the possibility of bias due to net feeding, prey fish collected from the stomachs of fish captured in passive gears were excluded from the diet analysis. The smallest piscivorous fish sampled in active gears were a 50-mm FL Coho Salmon and a 104-mm FL Arctic Grayling (Figure 5.5-4).

5.5.2.1. *Arctic Grayling*

The diet composition of small Arctic Grayling differed significantly among seasons and habitats, but not as a function of FL or Focus Area (MANCOVA; Table 5.5-1). During all seasons, small Arctic Grayling consumed primarily freshwater prey (Figure 5.5-5). Terrestrial invertebrates comprised most of the remainder of the diet. During spring, small Arctic Grayling also consumed very small fish (21-25 mm standard length [SL]). These prey fish were partially digested and unidentifiable to species. Small Arctic Grayling relied most heavily on terrestrial infall (terrestrial life-stages of freshwater invertebrates as well as terrestrial invertebrates) during summer. Small Arctic Grayling consumed fish only at River Productivity Stations RP-184 and RP-81 (Figure 5.5-6) in side channel habitats (Figure 5.5-7).

The diet composition of large Arctic Grayling (>120 mm FL) differed significantly among seasons, but not as a function of FL, Focus Area, or habitat (MANCOVA; Table 5.5-1). Large Arctic Grayling consumed primarily freshwater prey during all seasons (Figure 5.5-5). Large Arctic Grayling relied most heavily on terrestrial infall (terrestrial life-stages of freshwater invertebrates as well as terrestrial invertebrates) during summer. A single instance of piscivory was observed for large Arctic Grayling, when a 23 mm SL prey fish (unidentifiable to species) was consumed during spring in the tributary mouth at RP-184-1 (Figures 5.5-6 and 5.5-7).

5.5.2.2. *Chinook Salmon*

The diet composition of juvenile Chinook Salmon varied among years, seasons, Focus Areas, and habitat types (MANCOVA; Table 5.5-1). Chinook Salmon did not exhibit an ontogenetic shift in overall diet composition (no effect of FL), at least within the size range of fish sampled (50-133 mm FL). Chinook Salmon consumed primarily freshwater prey during all sampling periods, with the exception of fall 2013, when they fed heavily on salmon eggs (Figure 5.5-2). Chinook Salmon relied most heavily on terrestrial infall (terrestrial life-stages of freshwater invertebrates as well as terrestrial invertebrates) during summer in both years. Chinook Salmon consumed salmon eggs only at RP-141 and RP-104, and only in tributary mouth and upland slough habitats (Figures 5.5-8 and 5.5-9). During 2014, Chinook Salmon consumed small numbers of prey fish in at RP-141 and RP-81 in side channel and upland slough habitats (Figures 5.5-8 and 5.5-9).

5.5.2.3. *Coho Salmon*

The diet composition of juvenile Coho Salmon shifted ontogenetically and differed significantly among seasons, Focus Areas, and habitat types (MANCOVA; Table 5.5-1). In 2013, Coho Salmon shifted from a diet of predominantly freshwater and terrestrial invertebrates in spring to primarily salmon eggs by fall. In 2014, Coho Salmon relied more heavily on invertebrates throughout the year, consuming no salmon eggs during summer and a reduced proportion during fall (Figures 5.5-2). Terrestrial infall (terrestrial life-stages of freshwater invertebrates as well as terrestrial invertebrates) was an important source of prey to Coho Salmon during all sampling periods. Fish also comprised a relatively large proportion of Coho Salmon diets during many sampling periods. Seven prey fish were measurable in the lab, including one 8-mm alevin and two juvenile salmonids (29 and 33 mm SL). The remaining prey fish were unidentifiable to family. Fish comprised a large proportion of the Coho Salmon diet at the RP-81 main channel site (RP-81-3), and smaller proportions at the RP-141 tributary mouth site (RP-141-1) and the RP-104 side slough site (RP-104-2) (Figures 5.5-8 and 5.5-9).

5.5.2.4. *Rainbow Trout*

Small Rainbow Trout consumed an entirely invertebrate-based diet during spring 2013 at the RP-81 tributary mouth (RP-81-2). During fall 2014, small Rainbow Trout consumed invertebrates at the RP-141 tributary mouth (RP-141-1) and the RP-81 upland slough (RP-81-1), as well as salmon eggs at the RP-104 tributary mouth (RP-104-1) (Figures 5.5-5 through 5.5-7). Too few small Rainbow Trout were sampled (n = 7 non-empty stomach content samples) to conduct a statistical analysis of their diet composition.

The diet composition of large Rainbow Trout differed significantly among seasons and Focus Areas, but not as a function of FL or habitat (MANCOVA; Table 5.5-1). Large Rainbow Trout fed nearly exclusively on invertebrates in spring, roughly equally on invertebrates, fish, and salmon eggs in summer, and nearly exclusively on salmon eggs in fall (Figures 5.5-5). Large Rainbow Trout fed most heavily on salmon eggs at the RP-141 and RP-104 tributary mouths and most heavily on fish at the RP-81 upland slough (Figures 5.5-6 and 5.5-7).

Additional information on diet composition of all focal species is available in Appendix A (Tables A5.5-1 through A5.5-10).

5.6. Characterize Organic Matter Resources (e.g., available for macroinvertebrate consumers) including Coarse Particulate Organic Matter, Fine Particulate Organic Matter, and Suspended Organic Matter in the Middle and Lower Susitna River

In 2013, both benthic (Hess, Ponar) and drift samples were collected and processed for OM contents; in 2014, only drift samples were collected and processed. Results for both years are presented here. Drift OM content in both years was collected in drift samples largely from main channel, side channel, and tributary mouth sites; upland sloughs and side sloughs were primarily low-flow habitats that were often clear pool areas with little or no organic material suspended in the water column, and were sampled with plankton tows that collected no measureable OM content. Exceptions occurred during the spring sampling events, when higher flows typically breached side slough macrohabitats, allowing water from the mainstem to flow through.

Overall summary results (range, average, and median for AFDM weights/unit) are presented for OM components within each study site for 2013 benthic OM (g/m^2) in Table 5.6-1, 2013 drift OM (mg/ft^3) in Table 5.6-2, and 2014 drift OM(mg/ft^3) in Table 5.6-3. Mean values for all OM component weights calculated for the River Productivity study sites in each seasonal event are presented for 2013 benthic OM in Table 5.6-4, 2013 drift OM in Table 5.6-5, and 2014 drift OM in Table 5.6-6. Results for mean organic matter are graphically presented in Figures 5.6-1 through 5.6-17.

In 2013, mean benthic OM was higher overall in samples collected with the petite Ponar grab sampler, in mostly off-channel sites. Upland sloughs had among the highest averaged overall total benthic OM (78.3 – 133.2 g/m^2) (Table 5.6-1). Main channels, side channels, and tributary mouths typically had larger contributions of CPOM in samples than did off-channel macrohabitat sites, which were dominated by FPOM material. Overall mean benthic OM also appears to increase moving downstream; total benthic OM averaged 7.9 g/m^2 at RP-184, increasing to 14.6 g/m^2 at RP-173, 37.4 g/m^2 at RP-141, 38.2 g/m^2 at RP-104, and 53.9 at RP-81.

Overall drift organic matter during 2013 was higher in main channel sites, with among the highest averaged overall total drift OM (4.1 – 9.4 mg/ft^3) (Table 5.6-2). Exceptions can be seen at site RP-104-2, a side slough which showed a mean total drift OM of 11.24 mg/ft^3; this was recorded for the spring event, when main channel flows were high enough to breach the side slough allowing for drift sampling (Tables 5.6-1 and 5.6-4). Also, drift OM contained a higher proportion of the CPOM component in collected samples than was seen in benthic OM, with greater or equal amount of coarse material compared to FPOM amounts.

In 2014, organic matter content collected in drift samples ranged from 0.12 mg/ft^3 at RP-173-3 (a side channel/side slough site) to 12.79 mg/ft^3 at RP-141-2 (a side channel) (Table 5.6-3). Unlike 2013, differences in overall total drift OM were not evident among the macrohabitats; instead, amounts were similar. Overall total drift OM in main channels ranged from 1.4 – 8.1 mg/ft^3; for side channels, 0.12 – 12.79 mg/ft^3. In tributary mouths, the overall total drift OM estimates ranged from 1.3 – 7.2 mg/ft^3. However, macrohabitats did differ in the amounts of CPOM and FPOM content. Both main channel and side channel sites contained a higher component of FPOM compared to CPOM amounts, whereas tributary mouths usually contained more CPOM than FPOM (Table 5.6-3).

5.6.1. RP-184 (Watana Dam)

At the Watana Dam station, estimates of the mean benthic OM (g/m^2) remained below 10 g/m^2 over the course of the sampling season in 2013, with the exception of the main channel site (RP-184-3), which peaked at 20.7 g/m^2 in the summer (Figure 5.6-1; Table 5.6-4). Summer collections at all sites showed greater benthic OM estimates, with equal contributions of CPOM and FPOM during the summer and more CPOM during the fall periods.

In 2013, mean drift OM estimates show a similar trend, remaining mostly at or below 4 mg/ft^3 at all sites during the open water season, with the exception of the main channel site (RP-184-3), which peaked at 9.6 mg/ft^3 in the summer, all FPOM (Figure 5.6-2; Table 5.6-5). Summer drift samples at this site were collected at the beginning of a storm event, which could explain the increased amount of OM.

In 2014, mean drift OM estimates peaked in the spring, exceeding 17 mg/ft^3 with the exception of one main channel site (RP-184-3), which peaked at 3.3 mg/ft^3 (Figure 5.6-3; Table 5.6-6). A majority of the drift OM was FPOM for the main and side channel sites. The tributary site (RP-184-1) recorded greater CPOM in the spring. For the remainder of the sampling season, mean drift OM estimates stayed below 5 mg/ft^3. Mean amounts of CPOM and FPOM were relatively equal in main and side channel sites during the fall sampling event, but greater amounts of CPOM were evident in samples from the tributary mouth (RP-184-1) and at the main channel site located immediately above the tributary mouth (RP-184-4) (Figure 5.6-3; Table 5.6-6).

5.6.2. RP-173 (Stephan Lake Complex)

In 2013 within the RP-173 station, mean benthic OM estimates remained steady at sites with constant flow (Hess samples from RP-173-2 and RP-173-4) or gradually declined at off-channel sites (RP-173-3 and Ponar samples at RP-173-4) over the open water period. Benthic OM was generally estimated at levels around or below 12 g/m^2 (Figure 5.6-3, Table 5.6-4). Exceptions were the small unnamed tributary site (RP-173-1), where benthic OM increased during the summer period to a high of 24 g/m^2 (Figure 5.6-3), and the side slough site (RP-173-4) sampled in slower water areas with the Ponar grab sampler, where benthic OM was 26.3 g/m^2 in the spring. Additionally, results of pre- and post-storm event sampling in the side slough site suggested that additional benthic OM was deposited in the macrohabitat due to the storm event, with an increase from 9.3 g/m^2 to 14 g/m^2 for Hess samples, and 16.2 g/m^2 to 48.8 g/m^2 for the petite Ponar grab (Table 5.6-4).

In 2013, mean drift OM estimates among RP-173 sites were highest in the main channel (RP-173-2) with peaks of 12.7 to 14.5 mg/ft^3 in the spring and summer event periods, decreasing to 0.78 mg/ft^3 in the fall (Figure 5.6-4, Table 5.6-5). Mean drift OM at the unnamed tributary mouth gradually increased from 1.8 mg/ft^3 in the spring to 3.95 mg/ft^3 in the fall.

In 2014, mean drift OM estimates among RP-173 sites were again highest in the main channel, as well as in the unnamed tributary mouth (RP-173-1). At RP-173-2, mean drift OM peaked in the spring with 4.4 mg/ft^3, decreasing in the summer to 1.35 mg/ft^3, and then to 0.56 mg/ft^3 in the fall (Figure 5.6-6; Table 5.6-6). Mean drift OM peaked at unnamed tributary mouth in the spring (2.2 mg/ft^3) and the fall (6.4 mg/ft^3). Mean drift OM collected at the side channel site (RP-173-3) and the upland slough site (RP-173-5) were 0.62 mg/ft^3 or lower, and were not measured in the fall, due to low flows and/or water levels (Table 5.6-6).

5.6.3. RP-141 (Indian River)

In 2013, mean benthic OM estimates at RP-141 (Indian River) were highest within the upland slough site (RP-141-4) for both Hess and Ponar samples collected there, exceeding 50 g/m^2, except during the fall period for the Hess-sampled benthic OM, which dropped to 22.72 g/m^2 (Figure 5.6-5, Table 5.6-4). For the side channel site (RP-141-2) benthic OM estimates was highest at 41.7 g/m^2 in the summer, dropping to 10.4 g/m^2 during the fall, which was sampled with a Ponar grab due to lack of flowing water at that time (Figure 5.6-5; Table 5.6-4).

In 2013, mean drift OM estimates were higher in the tributary mouth (RP-141-1) and main channel (RP-141-3) sites, ranging from 4.9 mg/ft^3 in the spring to 8.0 mg/ft^3 in the fall at mouth of Indian River, and near 6.0 mg/ft^3 in the spring and summer in the main channel at RP-141-3 (Figure 5.6.-6, Table 5.6-5). Mean drift OM was higher in the side channel site (RP-141-2) during the spring event period (4.8 mg/ft^3), likely due to the increased flows coming from the main channel, than in the summer and fall. Sometime during the summer of 2013, the side channel was cut off from direct flow, and became more similar to a side slough. Drift OM estimates were lower at the main channel site established upstream from the mouth of Indian River, possibly due to the site's location in a possible back-eddy caused by the inflow from the tributary into the Susitna River.

In 2014, mean drift OM estimates were higher in the side channel (RP-141-2), starting in the spring at 8 mg/ft^3 and increasing to 17.6 mg/ft^3 in the summer (Figure 5.6-9; Table 5.6-6); lower water levels in the fall prevented drift sampling, and samples were collected with plankton tows. Drift OM at the tributary mouth averaged 1.32 mg/ft^3 in 2014; the main channel site averaged 1.37 mg/ft^3 (Table 5.6-3). The main channel site located just upstream from the mouth of Indian River had an overall drift OM average of 2.14 mg/ft^3, with 4.2 mg/ft^3 in the spring (largely CPOM), declining in the summer to 1.25 mg/ft^3, and to 0.96 mg/ft^3 during the fall sampling event.

5.6.4. **RP-104 (Whiskers Slough)**

At RP-104 (Whiskers Slough) in 2013, estimates of the mean benthic OM (g/m^2) generally were higher in the spring, and decreased into the summer and fall periods. The highest benthic OM estimate was nearly 300 g/m^2 within the upland slough site (RP-104-4) during the spring event period. Benthic OM here declined to 27.3 g/m^2 in the summer, and 17.1 g/m^2 by fall (Figure 5.6-7; Table 5.6-4). Benthic OM in the side slough site (RP-104-2) collected with a Hess started at 26 g/m^2 in the spring and increased to 31.3 g/m^2 in the summer, appeared to be flushed out after a late August storm event (9.1 g/m^2), and then accumulated to 67.3 g/m^2 by fall (Table 5.6-4).

Mean drift OM estimates in 2013 show increased levels during the spring. The main channel (RP-104-3) and side slough (RP-104-2) sites showed the highest mean drift OM amounts at 12.6 mg/ft^3 and 11.2 mg/ft^3, respectively, during the spring event (Figure 5.6-8; Table 5.6-5). Once the higher spring flows receded, the side slough no longer received higher flows, and plankton tows were used for sampling. Drift OM estimates at the side channel site (RP-104-5) and the tributary mouth (RP-104-1) were lower, at 5 mg/ft^3 or less. Lower flows during the fall event also precluded drift sampling in the side channel site at that time.

In 2014, mean drift OM estimates were highest during the spring at the tributary mouth and the side channel sites, with 5.2 mg/ft^3 and 7.2 mg/ft^3, respectively (Figure 5.6-12; Table 5.6-6). Flow levels during the spring sampling event were not high enough to breach the side slough macrohabitat site (RP-104-2), so plankton tows were used throughout the 2014 sampling season at that site. Reduced flows during the summer sampling event also prevented drift nets from being used at the tributary mouth (RP-104-1), therefore no organic matter was collected at that time, as well. During the fall sampling event, however, mean drift OM at the tributary mouth had declined to 3.75 mg/ft^3 (Figure 5.6-12; Table 5.6-6). At the side channel site, summer and fall drift OM estimates were much lower (1.4 and 1.2 mg/ft^3). At the main channel site, mean drift OM estimates were fairly consistent, with an overall average over the 2014 sampling season of 1.99 mg/ft^3.

5.6.5. **RP-81 (Montana Creek)**

The 2013 benthic OM at Station RP-81 (Montana Creek) was notably greater at the upland slough site (RP-81-1), with estimates ranging from a high of 162.5 g/m^2 in the spring, declining to 20.6 g/m^2 in the fall (Figure 5.6-9; Table 5.6-4). Collections at the other sites showed benthic OM estimates of 20 g/m^2 or less.

In contrast, mean drift OM estimates in 2013 were higher in the main channel (RP-81-3) and side channel (RP-81-4 and RP-81-5) sites, especially during the spring period, ranging from 6.9 mg/ft^3 to 9.5 mg/ft^3 (Figure 5.6-10, Table 5.6-5). Drift OM estimates sharply declined into the summer and fall periods to levels at or below 2 mg/ft^3, with the exception of the side channel site, RP-81-4, during the summer, which maintained a higher drift OM of 7.5 mg/ft^3.

In 2014, peaks in mean drift OM were more varied than in 2013. Mean drift OM estimates were lower, approaching 3 mg/ft^3 during the spring and fall at the mouth of Montana Creek (RP-81-2), and during the summer sampling event at the side channel site, RP-81-4 (Figure 5.6-15; Table 5.6-6). Drift OM estimates at other sites and sampling periods recorded levels at or below 2 mg/ft^3.

5.6.6. RP-TKA (Talkeetna River)

In 2013 on the Talkeetna River, estimates of the mean benthic OM (g/m^2) showed similar trends to that seen on the Susitna River. Benthic OM estimates were higher in the upland slough site (RP-TKA-2) sampled with a petite Ponar grab, reaching highs of 171.8 g/m^2 in the spring, and 191 g/m^2 in the fall event period (Figure 5.6-11; Table 5.6-4). Benthic OM estimates in the side channel (RP-TKA-1) and side slough (RP-TKA-3) sites were generally below 15 g/m^2, with the exception of a fall increase at RP-TKA-3, to 42.2 g/m^2.

In 2013, mean drift OM estimates show a similar trend as seen at the Susitna River stations, with the side channel site (RP-TKA-1) showing higher mean drift amounts at all sites during the open water season, ranging from a high of 6 mg/ft^3 in the spring, 2.8 mg/ft^3 during the summer event period, and 4.1 mg/ft^3 in the fall (Figure 5.6-12; Table 5.6-5). Drift samples in the side slough were much lower, ranging from 0.13 mg/ft^3 in the spring to 3.8 mg/ft^3 during the fall event period, suggesting there was an increase in flow in the side slough during that time.

5.7. Estimate Benthic Macroinvertebrate Colonization Rates in the Middle Susitna River Segment under Pre-Project Baseline Conditions to Assist in Evaluating Future Post-Project Changes to Productivity in the Middle Susitna River

No field work was conducted for this objective in 2014. However, lab analysis for the 2013 data collected was completed post-ISR filing in June 2014, and results were presented in the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) filed in September 2014. In summary, colonization in the Middle Susitna River appeared to be reached at approximately six weeks, based upon density estimates in samples that were not disturbed or dewatered. Factoring in taxa richness measures, the clear sites indicated that mean taxa numbers were reached as early as four weeks. However, this could be the initial colonizing pioneer taxa, and additional time may be necessary until the community can be determined to be in equilibrium. For turbid conditions, the limited results suggest that a 6-8 week period may be sufficient for macroinvertebrate colonization.

5.8. Characterize the Pre-Project Benthic Macroinvertebrate Communities, with Regard to Species Composition and Abundance, and Algal Production in Selected Susitna River Tributaries and Lake Systems Located above Devils Canyon

Laboratory processed sample results were used to calculate an assortment of metrics for each site. For simplicity, results were presented in separate sections for tributaries and lakes, and are organized by sampling type (benthic or water column). Results for selected metrics for each tributary and lake site are presented herein, using the broader descriptive classes as discussed in Section 4.3. Mean values for all metrics calculated for the tributary and lake study sites, as well as all water quality measurements, are presented in Tables 5.8-1 through 5.8-12. Results for calculated metrics are graphically presented in Figures 5.8-1 through 5.8-27.

5.8.1. **Tributaries**

5.8.1.1. *Benthic sampling*

Hess samples collected in July 2014 from the nine selected tributaries in the Middle and Upper River segments of the Susitna River revealed a wide range of results describing the benthic communities residing in each stream. Mean density estimates among the nine tributaries ranged from a low of 1,360 individuals/m^2 at the Oshetna River site to over 132,000 individuals/m^2 at the Deadman Creek site (Figure 5.8-1; Table 5.8-1). Five of the nine tributaries revealed mean densities near or below 10,000 individuals/m^2, and an additional three sites (Watana Creek, Jay Creek and Tyone River) had mean density estimates between 20,000 and 30,000 individuals/m^2.

Mean taxa richness at the nine tributary sites ranged from 22 taxa at Oshetna River to 37.8 taxa at Tyone River (Figure 5.8-2; Table 5.8-1). All sites except Oshetna River and Deadman Creek had an average of at least 30 taxa. For total taxa richness, a tally of the composited samples at a site, Tyone River displayed 64 taxa, followed Fog Creek with 63 taxa, and Butte Creek with 61 taxa. Deadman Creek had the lowest total taxa richness, with 39 taxa. Mean EPT taxa richness estimates ranged from an average of 3.2 taxa at Deadman Creek to an average of 10.4 taxa at Fog Creek (Figure 5.8-3; Table 5.8-1). Total EPT taxa richness tallies were similar to mean EPT taxa results, with 7 total EPT taxa at Deadman Creek and 18 total EPT taxa at Fog Creek, followed closely by Devil and Butte creeks at 16 taxa (Figure 5.8-3). Taxa richness was dominated by chironomid taxa at all tributaries, ranging from an average of 10.6 taxa at Oshetna River, to 19.8 taxa at Tyone River (Table 5.8-1).

Consistent with taxa richness, the community composition of most sites was primarily composed of chironomids (Figure 5.8-4; Table 5.8-1). Mean relative abundances for chironomids ranged from 45.4 percent at Oshetna River to 84.5 percent at Deadman Creek. The Oshetna site showed the highest mean relative abundances for both mayflies (35.9 percent) and stoneflies (11.4 percent). The Oshetna site mayflies were largely composed of *Baetis bicaudatus*, *Drunella doddsii*, and a number of Heptageniidae taxa. Stoneflies were mostly of the chloroperlid *Suwallia* sp., with a small number of Capniidae taxa, and the Nemouridae taxa *Zapada*. In contrast, while the Tyone River site had a similar mean relative abundance of chironomids (49.3 percent), it also had the highest mean contributions of caddisflies (4.1 percent, mostly Hydroptilidae), Other Diptera (16 percent, mostly simuliids), and Non-insects (28.9 percent, a combination of nematodes, water mites, oligochaete worms, and snails and fingernail clams) (Figure 5.8-4; Table 5.8-1).

For the nine tributary sites, the relative abundances of functional feeding groups showed a dominance of collector-gatherers, ranging from 38.2 percent at Tyone River, to 84.6 percent at Butte Creek (Figure 5.8-5; Table 5.8-1). The mean contributor of collector-filterers was highest at Deadman Creek and Tyone River, in part due to the increased numbers of filter-feeding simuliid larvae and several filter-feeding chironomid taxa present at those two sites, both of are also located downstream from the outlet of a large lake. The Oshetna site had the highest scraper percentage, with an average of 21.2 percent, due to the presence of several mayflies with that feeding strategy (Figure 5.8-5; Table 5.8-1).

Mean benthic organic matter estimated from the Hess samples from the tributary sites ranged from 3.5 g/m^2 at Butte Creek, to 36 g/m^2 at Fog Creek (Figure 5.8-6; Table 5.8-2). Three of the nine sites, Fog Creek, Deadman Creek, and Jay Creek, had mean benthic OM amounts in excess of 20 g/m^2. At all tributary sites, CPOM exceeded or was approximately equal to the FPOM component (Figure 5.8-6; Table 5.8-2).

Estimates of mean chlorophyll-*a* collected from the surface of stones at the nine tributaries ranged from 0.14 mg/m^2 at Oshetna River, to 14.82 mg/m^2 at Deadman Creek (Figure 5.8-7; Table 5.8-3). The Tyone River site had the second highest mean chlorophyll-*a*, at 9.34 mg/m^2. Most sites had chlorophyll-*a* levels between 1 and 4 mg/m^2. Estimates of mean AFDM levels ranged from 0.1 g/m^2 at Oshetna River, to 27.7 g/m^2 at Deadman Creek, followed by 8.8 g/m^2 at Tyone River (Figure 5.8-8; Table 5.8-3). It is interesting to note that the mean AFDM amount at Deadman Creek was nearly equal to the mean benthic organic matter estimate for the site, as well. The substrate sampled at Deadman Creek displayed abundant algal growth on rocks sampled for both macroinvertebrates and algae. It may be possible that the bulk of organic matter in Deadman Creek is from the algal source.

5.8.1.2. *Drift sampling*

Drift samples collected in July 2014 from the nine selected tributaries revealed higher drift densities at sites established below lake outlets. Mean drift density was 1.12 individuals/ft^3 at Deadman Creek downstream of Deadman Lake, and nearly twice that, at 1.99 individuals/ft^3, at Tyone River downstream of Tyone Lake (Figure 5.8-9; Table 5.8-4). Lower mean drift densities, between 0.5 and 1.0 individuals/ft^3, were recorded at Fog, Watana, and Jay creeks, and below 0.5 individuals/ft^3 at Devil, Kosina, and Butte creeks, and the Oshetna River site.

Mean drift taxa richness at the nine tributary sites ranged from 14.5 taxa at Tyone River, to 49 taxa at Kosina Creek, with all sites except Tyone River exceeding a mean taxa richness of at least 30 taxa (Figure 5.8-10; Table 5.8-4). For the total number of taxa found in drift, Jay Creek was highest with 63 total taxa, followed by Kosina Creek with 60 taxa, and Fog and Watana creeks with 58 taxa. Tyone River again had the lowest number of taxa, with 24 total taxa captured in drift samples. Mean drift EPT taxa richness in the selected tributaries ranged from one taxa at Tyone River, to an average of 10.5 taxa at Kosina Creek (Figure 5.8-11; Table 5.8-4). Total EPT taxa in drift samples were similar to mean EPT taxa results, with only the one taxa at Tyone River, at a total of 14 EPT taxa captured at Kosina Creek. As was seen in benthic samples, much of the taxa richness in drift was attributed to chironomids, ranging from an average of 4 chironomid taxa at Tyone River, to an average of 27.5 at Kosina Creek (Table 5.8-4). At most sites, chironomids account for at least half of the taxa richness in drift, with the exception of Tyone River, where chironomids accounted for 29 percent of the taxa.

Similar to benthic samples, the taxonomic compositions of drift in the nine tributaries were primarily composed of chironomids, with Tyone River again an exception (Figure 5.8-12; Table 5.8-4). Mean relative abundances for chironomids ranged from 3.7 percent at Tyone River to 72.8 percent at Watana Creek. In contrast, while the Tyone River site was mostly comprised of zooplankton, with mean relative abundance of 78.6 percent (Figure 5.8-12; Table 5.8-4). Deadman Creek had the next lowest chironomid relative abundance in drift, at 48.2 percent, with a higher Other Diptera component (28.8 percent), attributed to the presence of drifting *Simulium* sp. blackfly larvae. The Oshetna site showed the highest mean relatively abundances for both mayflies (27.3 percent), largely composed of *Baetis bicaudatus*, and a number of Ephemerellidae and Heptageniidae taxa. Both Jay and Butte creeks revealed nearly one-third of their drift compositions were non-insects, largely ostracods.

Mean drift organic matter estimated from the drift samples collected from the tributary sites ranged from 0.14 mg/ft^3 at Butte Creek, to 1.16 mg/ft^3 at Oshetna River (Figure 5.8-13; Table 5.8-5). Four of the nine sites, Fog Creek, Kosina Creek, Oshetna River, and Tyone River, had mean drift OM amounts in excess of 0.5 mg/ft^3. At Fog Creek, the CPOM component comprised roughly two-thirds of the drift OM; at Deadman, Watana, and Butte creeks, FPOM contributions were higher than CPOM (Figure 5.8-13; Table 5.8-5). Drift CPOM was approximately equal to the FPOM component at the other five sites.

5.8.1.3. *Water quality*

Water quality results are presented in Table 5.8-3 and Table 5.8-6. TP levels ranged from 2.61 micrograms per liter (µg/L) at Devil Creek, to 56.72 µg/L at Oshetna River. All sites except for Oshetna River had TP levels below 10 µg/L (Table 5.8-3). SRP levels ranged from <1 µg/L (undetectable) at Butte, Kosina, and Fog creeks, to 6.18 µg/L at Jay Creek. Other sites showed SRP levels between 1.77 to 2.77 µg/L. Ammonia as nitrogen was undetectable at all tributary sites (<10 µg/L). For nitrates+nitrites, levels ranged from <10 µg/L (undetectable) at Tyone River, to 48.67 µg/L at Devil Creek. Higher nitrate+nitrite levels were also seen at Oshetna River (37.93 µg/L) and Jay Creek (36.74 µg/L). Levels of total Kjeldahl nitrogen (TKN) were undetectable (<200 mg/L) at all sites, except for Tyone River, which measured at nearly 700 mg/L. DOC levels ranged from 0.85 mg/L at Watana Creek, to 13.60 mg/L at Tyone River. Other sites showed DOC levels between 0.93 and 3.53 mg/L.

For in-situ measurements, temperatures ranged from a low of 6.2˚C at Oshetna River, to a high of 16.8˚C at Tyone River (Table 5.8-6). Oshetna River is likely lower in temperature due to its glacial source, whereas the Tyone River site was located downstream from the outfall of the shallow Lake Tyone. Deadman Creek, another tributary with lake outflow, also recorded a higher temperature of 11.5˚C. Temperatures at other sites measured between 7 and 10˚C. Specific conductance measures ranged from 52 microsiemen per centimeter (µS/cm) at Kosina Creek, to 309 µS/cm at Tyone River, with other sites not exceeding 130 µS/cm. General conductance followed the same trends. Measurements of pH ranged from 6.23 at Devil Creek, to

8.6 at Tyone River. Redox potential (ORP) ranged from 103.1 at Jay Creek, to 187.8 at Devil Creek. Dissolved oxyen (DO) levels ranged were generally high, ranging from 9.62 mg/L (at 83 percent saturation) at Watana Creek, to 13.56 mg/L at Oshetna River. Lower levels at Watana Creek could be related to the presence of a beaver pond in the off-channel at the site. Lastly, turbidity was low at most sites, with the highest levels recorded in lake-fed Tyone River (8.3 NTU, dark with tannins from the lake) and the glacially-fed Oshetna River (16.1 NTU).

5.8.2. **Lakes**

5.8.2.1. *Benthic sampling*

Petite ponar samples collected in July 2014 from the three lakes feeding the Tyone River system in the Upper Susitna River Basin revealed that benthic communities were largely determined by the depth from which they were sampled (Table 4.10-2). Lower densities were recorded at sites with greater depths (75 ft or greater). One exception was LTY-1, the shallowest site in Tyone Lake at 4.5 ft deep, with a mean benthic density of 1,119 individuals/m^2 (Table 5.8-7). Mean benthic densities from the nine sites within the three lakes ranged from 75 individuals/m^2 at LSU-1 in Susitna Lake (78 ft), to 7,550 individuals/m^2 at LTY-3 in Tyone Lake (21 ft; Figure 5.8-14; Table 5.8-7). Ponar grabs at LSU-1 were nearly devoid of organisms, netting only 7 organisms total among the five replicate grabs.

The pattern for mean taxa richness was similar to density, with sites sampled at greater depths displaying lower mean and total taxa richness values (Figure 5.8-15; Table 5.8-7). Mean taxa richness within the lake sites ranged from 1 taxa at LSU-1, to 15.2 taxa at LSU-2 in Susitna Lake (22 ft). Shallow sites displayed an average of 10 or more taxa, and a total number of taxa greater than 20, whereas deeper sites averaged less than 6 taxa, and 11 or less total taxa. For shallow sites, chironomid taxa contributed a majority to the overall taxa richness values, both mean and total (Figure 5.8-15; Table 5.8-7).

Community compositions within the nine lake sites revealed most sites were primarily composed of chironomids and non-insect taxa (Figure 5.8-16; Table 5.8-7). Mean relative abundances for chironomids ranged from 0 percent at LSU-1, to 65.7 percent at the upper site in Lake Louise (LLO-3). Similar to the trend with other metrics, sites sampled at greater depths displayed lower mean percent relative abundances of chironomids (0 – 10.2 percent), but higher contributions of non-insects (90 – 100 percent). The lower site in Susitna Lake (LSU-1) contained only a few ostracod individuals in total. Sites in shallow waters had greater contributions of chironomids (23.6 – 65 percent), with the remainder being non-insect taxa (32.2 – 68.3 percent) (Figure 5.8-16; Table 5.8-7). Non-insect taxa present at these lake sites were largely nematode worms, along with oligochaete worms, fingernail clams (Sphaeriidae), and ostracods. Some of the shallow depth sites also showed a number of *Valvata* snails.

For the nine lake sites, the relative abundances of functional feeding groups showed a dominance of collector-gatherers, ranging from 27.5 percent at LSU-2, to 80.6 percent at the middle sites in Lake Louise (LLO-2), and ultimately 100 percent at LSU-1 (Figure 5.8-17; Table 5.8-7). Collector-filterers were mostly due to larger contributions of Sphaeriidae. Scrapers can be attributed to the presence of snails, such as *Valvata*. Parasites were largely due to the larger contributions of nematode worms present in samples.

Mean benthic organic matter estimated from the Ponar samples from the lake sites ranged from 14.9 g/m^2 at the upper site in Susitna Lake (LSU-3), to 290 g/m^2 at the upper site in Lake Louise (LLO-3) (Figure 5.8-18; Table 5.8-8). At the shallow sites, mean benthic OM was greater than deep water sites, exceeding 50 g/m^2, with the exception of LTY-3, which recorded only 17.2 g/m^2. At all lake sites, benthic OM was most composed of the FPOM component (Figure 5.8-18; Table 5.8-8).

At each lake site, qualitative benthic sampling was conducted with a D-net at the nearest shoreline, generating a taxa list for the littoral zone at each location. In comparison to the Ponar samples, shoreline areas possessed a more diverse assemblage of macroinvertebrate taxa. Total taxa richness for shoreline areas ranged from 24 taxa at LSU-2 to 39 taxa at LSU-1 (Figure 5.8-18; Table 5.8-9). Shoreline EPT taxa richness, nearly non-existent in Ponar samples, ranged from 1 taxon at LTY-1 and LSU-2, to 7 taxa at LLO-2. Chironomid taxa richness along shorelines in the lakes ranged from 9 taxa at LLO-1 and LLO-3, to 17 taxa at LTY-3 and LSU-1 (Figure 5.8-18; Table 5.8-9).

Community compositions within the shorelines of the nine lake sites revealed most sites were primarily composed of chironomids and non-insect taxa, but with notable contributions from EPT taxa as well (Figure 5.8-19; Table 5.8-9). Relative abundances for chironomids ranged from 6.9 percent at LSU-2, to 72.1 percent at LTY-1. Non-insect taxa contributions ranged from 26.6 percent at LTY-1, to 91.2 percent at LSU-2. Non-insects assemblages consisted of ostracods, the gammarid *Hyalella* sp., several snail taxa, oligochaete worms, water mites (Acari), and nematode worms. The percent contribution of mayflies in shoreline communities at the nine lake sites was highest at sites within Lake Louise, ranging from 11.7 percent to 31.2 percent, attributed to the baetid *Procloeon* sp.

For the nine lake sites shorelines, the relative abundances of functional feeding groups showed a dominance of collector-gatherers, ranging from 45.7 percent at LTY-2, to 78.9 percent at LTY-1 (Figure 5.8-20; Table 5.8-9). Scraper contributions along the shorelines ranged from 1.2 percent at LSU-1, to 39 percent at LTY2, comprised of snails from families of Valvatidae, Lymnaeidae, and Planorbidae. Predator contributions along shoreline habitat ranged from 1.6 percent at LSU-2, to 18.6 percent at LLO-2.

5.8.2.2. *Plankton Tows*

Plankton tows collected in July 2014 from the three lakes feeding the Tyone River system in the Upper Susitna River Basin revealed a notable amount of zooplankton available in the water column, as compared to benthic sampling. Mean plankton tow density estimates among the nine lake sites ranged from 47,513 individuals/m^2 at the lower site in Tyone Lake (LTY-1), to 253,697 individuals/m^2 at the deepest site in Lake Louise, LLO-2 (Figure 5.8-21; Table 5.8-10). Mean dry weight biomass estimates, calculated from average body lengths of zooplankters, ranged from 149.1 mg/m^2 at LTY-1, to 553.4 mg/m^2 at LTY-2 (Figure 5.8-22; Table 5.8-10). For both density and biomass estimates, higher amounts were recorded in the middle and upper extent of Tyone Lake (LTY-1 and LTY-2) and the lower extent of Susitna Lake (LSU-1), and at the middle site in Lake Louise, LLO-2.

Mean taxa richness of zooplankton collected in the nine lake sites in July 2014 ranged from an average of 2.8 taxa at LLO-1, to an average of 5 taxa at LTY-1 (Table 5.8-10). Total taxa richness was limited to 4 to 6 taxa, due to the presence of earlier life stages of copepods, nauplii and copepodites. As such, most copepods could only be identified to order. A total of 8 cladoceran taxa were present throughout all samples, although only a maximum of 4 cladoceran taxa were found together at a site (Table 5.8-10).

The taxonomic composition of zooplankton by density revealed that a majority of zooplankton collected in July 2014 were copepods. Copepod contributions to mean density ranged from 75.1 percent at LTY-2, to 99 percent at LLO-1 (Figure 5.8-23; Table 5.8-10). Cladoceran densities were highest at sites within Tyone Lake, ranging from 11.5 percent at LTY-3, to 24.9 percent at LTY-2, with *Daphnia longiremis* being the most prominent cladoceran taxa observed. The taxonomic composition of zooplankton by weight (biomass) showed a similar trend. Copepod contributions to mean biomass ranged from 64.5 percent at LTY-2, to 97.7 percent at LLO-1 (Figure 5.8-23; Table 5.8-10). Cladoceran biomass was highest at sites within Tyone Lake, ranging from 17.4 percent at LTY-1, to 35.5 percent at LTY-2, with contributions from *Daphnia longiremis, D. ambigua,* and *Eubosmina longispina.*

5.8.2.3. *Water quality*

Water quality results are presented in Table 5.8-11 and Table 5.8-12. Depth profiles are graphically presented in Figures 5.8-24 through 5.8-27.

For measurements of light penetration in July 2014, the average Secchi depth in Tyone Lake ranged from 12.5 ft to 14.25 ft, and the calculated euphotic zone depth ranged from 16.9 ft to 22.9 ft (Table 5.8-11). In Susitna Lake, the average Secchi depth ranged from 18.6 ft to 21.5 ft, with the calculated euphotic zone depth ranging from 32.1 ft to 46.9 ft (Table 5.8-11). In Lake Louise, the average Secchi depth ranged from 24.75 ft to 27 ft, with the calculated euphotic zone depth ranging from 41.8 ft to 44.9 ft (Table 5.8-11).

Total phosphorus levels in July 2014 generally ranged from 5.3 µg/L to 11.5 µg/L, with the exception of a peak of 15.15 µg/L at LLO-2 near the bottom (129 ft). TP levels appeared to show increases near the bottom (Table 5.8-12). SRP levels generally ranged from <1 µg/L (undetectable) to 4 µg/L, with the exception of 7.90 µg/L at LLO-2 near the bottom.

In July 2014, ammonia as nitrogen was undetectable at most surface and euphotic depths (<10 µg/L), but increased substantially near the bottom of the lake sites, ranging from 11.2 µg/L near the bottom of LLO-1 (95 ft) to 138 µg/L near the bottom of LSU-1 (75 ft) (Table 5.8-12). For nitrates+nitrites, levels ranged from <10 µg/L (undetectable) at most sites and depths, but with increased levels near the lake bottom at sites with greater depths, ranging from 11.2 µg/L at LLO-1 near the bottom, to 52.9 µg/L near the bottom at LSU-1 (Table 5.8-12). Levels of TKN were ranged from 325 mg/L to 620.5 mg/L, with no discernable pattern.

DOC levels in July 2014 ranged from 7.13 mg/L to 10.4 mg/L, with no discernable pattern (Table 5.8-12). Alkalinity levels appeared to increase moving from Tyone Lake to Lake Louise. Alkalinity in Tyone Lake averaged 56.8 mg/L; in Susitna Lake, 61.8 mg/L; and in Lake Louise, 62.9 mg/L (Table 5.8-12). Chlorophyll-a levels ranged from <0.3 µg/L (undetectable) to 4.8 µg/L (measured at LLO-1 near the bottom), with no discernable pattern (Table 5.8-12).

Depth profiles in the lakes showed temperatures in July 2014 ranged from 14 – 16˚C near the lake surfaces, decreasing at about 10 – 15 ft deep (Figure 5.8-24). At deeper sites, temperatures continued to decrease until reaching a low of 5 – 8˚C at depths of 60 – 70 ft deep. PAR measurements showed a rapid decrease in light levels from the surface ambient levels, approaching the 1 percent of ambient light level around 30 – 40 ft at deeper sites, which is in general agreement with the calculated euphotic zone depths in Table 5.8-11 (Figure 5.8-24).

DO levels ranged were generally high in July 2014, ranging from 9 – 10 mg/L and higher percent saturations until reaching near the bottom, where DO levels dropped rapidly (Figure 5.8-25). At deeper sites, DO levels approached 0 mg/L (and 0 percent saturation). At LTY-1, the lower site in Tyone Lake, DO levels were supersaturated, up to nearly 104 percent. The site was located in the shallow end of Tyone Lake, with maximum depths of only 4.5 ft, with large mats of macrophytes growing in the area. Water quality measurements were taken in one of the few areas where the lake bottom was accessible. The surrounding aquatic vegetation would explain the supersaturation. The water can become supersaturated when oxygen is produced by aquatic vegetation more quickly than it can escape into the atmosphere.

Conductance measures differed among the three lakes in July 2014. Specific conductance ranged from 325 – 330 µS/cm in Tyone Lake, 315 – 320 µS/cm in Susitna Lake, and around 157 µS/cm in Lake Louise (Figure 5.8-26). At several sites, conductance values began to rapidly increase at the lake bottom. General conductance followed the same trends (Figure 5.8-26).

Measurements of pH revealed the lake waters to be fairly alkaline in July 2014, ranging between a pH of 7 and 8. Higher pH was recorded near the surface and first 10 – 20 ft, peaking around 8.2 (Figure 5.8-27). In Tyone Lake, pH levels stayed at 8.2 until decreasing at the lake bottom, with the exception of the shallow LTY-1, which maintained a pH of 8.5. In Susitna Lake, pH levels peaked at around 8.2 at depths of 10 – 20 ft, before gradually declining to near the lake bottom. Sites with greater depths (LSU-1 and LSU-3) both saw a slight increase in pH at the bottom (Figure 5.8-27). In Lake Louise, pH levels at LLO-1 peaked at around 8.2 at depths of 15 – 20 ft, before gradually declining to 7.5 at 96 ft deep. At LLO-2, pH was 8.2 at the lake surface, and gradually declined to 7.4 at the 96 ft depth (Figure 5.8-27). At LLO-3, a shallow site, pH rose to 8.2 at 16 ft deep, before decreasing to 7.4 at the bottom (17 ft). Redox potential (ORP) within the three lakes in July 2014 ranged from 300 – 390 mV (Figure 5.8-27). Most sites recorded gradual increases in ORP with increasing depths, before rapidly decreasing at the lake bottom.

6. DISCUSSION

6.1. Benthic Macroinvertebrate Communities

The remaining results from the 2013 benthic macroinvertebrate sampling efforts addressed trends in adult emergence of aquatic insects from the benthic communities, and the dynamics of the benthic macroinvertebrate community on pieces of woody debris. As was discussed in the

ISR (Section 6; AEA 2014a), collection efforts in 2013 found that the traps were prone to damage from wildlife, and were stranded on shorelines due to rapid changes in flow levels or from disturbances by boating activities. Out of 65 potential samples over the sampling season, 18 (28 percent) were lost, 20 (31 percent) were retrieved from a stranded or disturbed state, and 27 (41 percent) samples were collected intact. Due to the prolonged set times of two weeks or longer, the exact timing occurrence of a disturbance within that period was unknown, making any sample data that could be retrieved from the trap bottle qualitative, since the total sampling time was in question. The occurrences of losses and stranded or disturbed samples resulted in coverage gaps at many of the sampling sites, making it difficult to assess trends or patterns in emergence timing for the various insect taxa present. Despite these difficulties, emergence traps did collect valuable information when they were undisturbed during a sampling period.

From the data collected in 2013, emergence sampling revealed several trends. At sites above Devils Canyon, main channel habitats had higher daily emergence densities than other macrohabitats, with peaks in the latter half of July to early August. However, at Middle Reach sites below Devils Canyon (Indian River and Whiskers Slough Focus Areas), upland sloughs and tributary mouths were generally higher in daily emergence densities compared to main channels and side channels, and in the Montana Creek study station in the Lower Reach, daily emergence densities were also higher in the upland slough site compared to those recorded for main and side channel habitats. Overall emergence taxa richness during 2013 was also variable among reaches and sampling periods, again showing peaks of emergence largely in July and August.

Overall adult emergence community composition measures revealed that all sites were dominated by aquatic taxa, and were comprised mostly of chironomids, which were generally 50 percent or higher at most sites (Tables 5.1-3 to 5.1-12). The contribution of EPT taxa to community compositions appeared to be influenced by macrohabitat types, with higher relative abundances of emerging stoneflies (primarily Chloroperlidae and Perlodidae) at main channel and side channel sites, and greater contributions of caddisflies in the mouths of the named tributaries (Indian River, Tsusena Creek, Whiskers Creek, and Montana Creek). In samples that were stranded out of the water upon retrieval, higher relative abundances of terrestrial taxa were often recorded, generally marked by increased relative abundances of Hemiptera (true bugs), Hymenoptera (sawflies, wasps, bees, and ants), and Other Diptera (true flies) (Tables 5.1-3 to 5.1-12), indicating that even when onshore, the traps can capture terrestrial shoreline insects.

These results indicate that the emergence traps do function as intended when successfully deployed and left undisturbed during their deployment. The main issue appears to be that traps are left unobserved for long periods of time, during which they have increased chance of disturbance, the timing of which is unknown. To resolve the concerns with losses and stranding, modifications were proposed to redesign adult emergence traps for more successful deployments, (ISR Part C, Section 7.1.2.1; AEA 2014a). Proposed emergence trap modifications included: 1) increased floatation to prevent sinking and/or capsizing and 2) improved anchoring and deployment. In 2014, emergence traps were used in a limited capacity, collecting emergent adults for use in the stable isotope analysis study objective. As part of the "improved deployment" modification, emergence traps were deployed at selected sites for 24-48 hr durations during each sampling event. Traps were able to collect enough specimens for the needs of stable isotope analysis, and losses limited to a single trap being damaged by bears. No samples were stranded due to the short deployment time. Therefore, in addition to a physical redesign of the traps to prevent sinking, deployment methods could be altered to sample for shorter durations (24-48 hrs), but more frequently (approximately 2-week intervals) in order to provide consistent samples by minimizing losses due to unobserved disturbances or stranding.

Collection of benthic macroinvertebrates from woody debris in 2013 yielded 155 samples from 16 of the 20 study sites, an average of about 3 samples per site per sampling event. Pieces mostly were located in tributary mouths and off-channel macrohabitats. Main channel sites rarely provided suitable LWD, as most wood was located stranded around the ordinary high water mark (OHWM).

Samples collected from wood produced valuable information on the utility of the substrate to benthic macroinvertebrate communities. Results revealed that densities on wood were higher overall in larger tributary mouths and off-channel sites compared to main channel and most side channel sites. Mouths of larger named tributaries (Indian River, Montana Creek, Tsusena Creek, Whiskers Creek) had among the highest averaged densities, comparable to those seen on cobble substrates at those sites. Side channel macrohabitat sites recorded higher density estimates at RP-81 and RP-104 compared to side channels at stations farther upstream. Within other macrohabitats, overall densities on woody debris were often higher than the benthic densities recorded at the same sites.

This suggests that woody debris, when present, can act as an attractant to many macroinvertebrate taxa. Overall benthic taxa richness on woody debris during 2013 was highest in the larger tributary mouths, comprised of more than 50 percent chironomids. Many of the chironomid taxa identified were wood-boring in habit, indicating these taxa actively seek out wood to colonize, due to their particular specialization. While EPT taxa richness was relatively low on woody debris, the contribution of EPT taxa to community compositions was generally higher at sites with consistently suitable woody debris available, suggesting that wood debris may need to be more established in the water within a site to attract EPT taxa to colonize it.

The metrics calculated from the taxonomic abundance data are the first step in the data analyses planned for the benthic macroinvertebrate data collected for this study. The 2013 benthic metrics can begin to describe the benthic community structure and function. Ultimately, the data collected in 2013 and the future data collection efforts will be combined to provide the information needed for the additional statistical analyses, the results of which will be provided in the Updated Study Report.

6.2. Drift of Benthic Macroinvertebrates

Results from the drift sampling effort in 2014 showed trends similar to those seen in 2013, with some expected degree of annual variability for sites. Generally, results from both years showed noticeable differences in several metrics between sites characterized as non-flowing habitats that were sampled with plankton tows (side sloughs, upland sloughs) compared to flowing water habitats that were sampled with the drift nets, i.e., mainstem macrohabitats (main channel and side channel habitats) and tributary mouths. Mouths of the tributaries (RP-184-1, RP-141-1, RP-104-1, RP-81-2) showed higher overall drift densities as compared nearby main channel and side channel sites, suggesting their role as contributing sources of additional macroinvertebrates drifting from rich benthic communities at upstream locations. Upland sloughs and side sloughs showed among the highest overall averaged densities by volume (per cubic foot) via plankton tows in 2014, a similar trend also seen in 2013, and likely due to the inherent differences in sampling devices and the water volumes they sample (drift nets capturing flowing water versus plankton tows subsampling a non-flowing volume of water).

Overall drift taxa richness during 2014 was highest in tributary mouths and main channel habitat, followed by side channels; fewer taxa were captured in plankton tows taken in off-channel habitats (side sloughs and upland sloughs). Both the EPT taxa richness and overall chironomid taxa richness were higher in tributaries and main channel habitats than in the slough habitats.

All sites sampled in 2014 showed community compositions largely comprised of chironomids, with flowing water habitats featuring higher contributions of EPT taxa, compared to that seen in sloughs. Sites above Devils Canyon showed small relative abundances of zooplankton (0- to 13 percent), with higher averages actually seen in main and side channels (9- to 17 percent), whereas at sites below Devils Canyon, larger relative abundances of zooplankton (averages ranging from 2.5- to 34 percent) were generally limited to slow water habitats and conditions, especially at upland slough sites.

The various metrics calculated from the drift sample and plankton tow data for 2013 and 2014 provide two years of valuable baseline information on the dynamics of drifting invertebrates within the Middle and Lower Susitna River. Such results successfully highlight the differences in potential food resources available to fish in flowing-water macrohabitats compared to the slower off-channel macrohabitats, as well as longitudinal differences among stations, and seasonal and annual differences. This two year effort provides the information needed for the additional statistical analyses required to characterize drift and its availability to fish as a food resource, the results of which will be provided in the Updated Study Report.

6.3. Trophic Modeling

The bioenergetics model results indicated that feeding rate was a primary factor limiting the growth of juvenile Coho Salmon, and temperature and food quality were of secondary importance. This is consistent with general bioenergetics theory: across the range of temperatures typically observed in Alaskan streams and rivers, the growth of juvenile Chinook and Coho salmon is expected to be limited mostly by feeding rate (Beauchamp 2009). However, juvenile Chinook Salmon fed near their physiological maximum rates and were primarily limited by temperature and food quality during early summer, before becoming more food-limited during late summer. Similar results have been demonstrated in other situations when temperatures are cool and food is abundant. For example, a bioenergetics analysis and field experiment in the Chena River demonstrated that juvenile Chinook Salmon fed close to their theoretical maximum consumption rate (*P* near 1), and temperature was the primary limitation on growth (Perry 2012). In support of this model result, experimental addition of pelleted fish food to treatment reaches did not enhance the growth rate of salmon in those reaches in comparison with growth rates measured in control reaches. Likewise, heterogeneous stream temperatures in Southwest Alaskan streams caused high variability in age-0 Coho Salmon growth, and these differences were amplified by the ability of faster-growing coho to consume salmon eggs during their first growing season (Armstrong et al. 2010). Temperature has also been shown to be a primary constraint on the growth of some Arctic Grayling populations in Interior and Arctic Alaska (Deegan et al. 1999; Dion and Hughes 2004).

When abundant food resources are distributed in habitats with suboptimal temperatures for growth, juvenile salmon and other fishes have been observed to behaviorally thermoregulate to maximize their growth rates (Wurtsbaugh and Neverman 1988, Armstrong et al. 2010). This study provided some limited evidence that juvenile salmon may display this strategy in the Susitna River, but it did not appear to be widespread. Both the PIT tag study (Study 9.6) and the stable isotope analysis (Section 5.4.2) provided evidence of relatively strong site fidelity by rearing juvenile salmon. Based on an analysis of provisional PIT tag data collected within the River Productivity study area, the vast majority (75/78) of juvenile Chinook and Coho salmon tagged during 2013 and 2014 and later recaptured were found in the same habitat in which they had previously been marked. This analysis did not include PIT tags recorded by fish swimming past fixed antennas, only events when the fish were recaptured and reweighed. The pattern was consistent whether days, weeks, or months elapsed between capture events. While these results do not necessarily indicate that fish remained in the same habitat between recaptures, they can be explained most parsimoniously by site fidelity. Further, the isotopic signatures of juvenile salmon were similar to those of other salmon captured in the same macrohabitat and to the basal nutrient sources within that habitat. Based on the isotopic turnover time of fin tissue, this suggests that most fish fed in the habitat where they were captured for at least 1-2 weeks prior to capture. Both the PIT tag study and the stable isotope analysis provided evidence of occasional fish movements among macrohabitats; however, fish did not appear to move frequently.

This study documented relatively limited opportunities for fish to achieve large growth advantages through behavioral thermoregulation. Behavioral thermoregulation should be most advantageous when abundant food resources are available in a cold (or very warm) habitat that is adjacent to another habitat with more optimal temperatures. In the Susitna River, this situation could arise when salmon spawn in cold habitats like sloughs fed by hyporheic-flow. Within the broader River Productivity study area, however, salmon did not generally spawn in the coldest sites (Figure 5.4-13). In fact, the site where the most consumption of salmon eggs was documented was the relatively warm Indian River tributary mouth (Site RP-141-1). While behavioral thermoregulation was not observed during this study, most of the differences in growth rates documented in this study could be explained more simply by the temperature and food availability within each given site.

The growth rate potential analysis illustrated potential relationships between measurable habitat characteristics and fish growth, based on previously published experiments. The growth rates predicted by the model were broadly similar to the growth rates observed in this study, and the model identified certain known hotspots for juvenile salmon, such as the Indian River tributary mouth (RP-141-1) as high-growth habitats. However, this application of the growth rate potential analysis also revealed three key challenges for applying such models in large, heterogenous, glacial rivers. First, the drift foraging submodel assumed that juvenile salmon fed solely on invertebrate drift. However, the stomach content and stable isotope analysis showed that salmon eggs were a very important diet item at some sites, and the growth rate potential analysis did not take this into account. Also, many salmon were captured in slow-velocity habitats, including upland sloughs, side sloughs, and slowly flowing tributary mouths. Salmon are likely switch to search feeding in these habitats; however, this behavior is not accounted for in the standard drift foraging model framework (Hughes and Dill 1990). Novel foraging models allowing fish to switch between drift and search feeding modes may be worth investigation for future applications in the Susitna Basin (Harvey and Railsback 2013). Finally, foraging dynamics in the shallow margins of mainstem rivers are poorly understood, and most existing drift-feeding research has focused instead on small streams. The growth rate potential model generally predicted that main channel and side channel habitats would not support positive salmon growth, due largely to their high velocities. However, this study provides evidence that juvenile salmon do utilize main channel and side channel habitats in the Susitna River for feeding and rearing, and in some cases achieved faster growth in these habitats than in cooler, slowly flowing sloughs. As currently formulated, growth rate potential models based on drift foraging are most likely to be useful in tributaries to the Susitna River. To fully account for the diversity of habitats and feeding modes utilized by juvenile Chinook and Coho salmon, in the Susitna River any future development of the growth models should consider incorporation of feeding mechanism in both sloughs and mainstem habitats

6.4. Food Web Analysis via Stable Isotope Analysis and Fish Diet Analysis

6.4.1. Energy flow from algae and organic matter to freshwater invertebrates

Various trends emerged from the stable isotope analysis of lower food web components that are potentially significant in synthesizing findings from previous studies on energy flow through riverine food webs. In alignment with numerous other studies (Kline et al. 1990, France and Cattaneo 1998, Finlay 2001, Finlay 2004, Hadwen et al. 2010), algae samples were highly variable in $\delta^{13}C$ signatures compared to terrestrial OM. This overall variability appeared to be at least partially explained by macrohabitat type, where algae samples from the glacially influenced main and side channels were consistently the most ^{13}C-enriched, followed by tributary mouths, and finally by slough habitats (Figure 5.4-21). This same pattern was also evident for freshwater invertebrates (Figure 5.4-21). There are many possible interrelated environmental factors that control $\delta^{13}C$ in aquatic plants and algae, such as temperature, water velocity, partial pressure of carbon dioxide (pCO_2), and carbon source $\delta^{13}C$ (Finlay 2004). Water velocity has often been cited as a major factor contributing to isotopic variability in aquatic primary producers, predominantly by effects of boundary layer thickness on CO_2 diffusion. In this case, slow flowing water results in thicker boundary layers around algae, thereby slowing CO_2 diffusion and reducing discrimination against the heavier ^{13}C (Finlay et al. 1999, 2002). If this effect were a predominant driver of $\delta^{13}C$ patterns, algae and their primary consumers would exhibit ^{13}C-depleted tissues in faster currents relative to those in slower currents (Trudeau and Rasmussen 2003).

Throughout macrohabitats in the Susitna, however, algae and freshwater invertebrates seemed to show an opposite trend, where those in faster main and side channel habitats were more ^{13}C-enriched relative to generally slower tributary mouths, followed by sloughs with the slowest current velocities. It is possible that this pattern is explained by greater retention and availability of terrestrial OM in slow-water habitats. As this material is broken down by instream microbes, the ^{13}C-depleted CO_2 respired in the process is made available for uptake and assimilation by algae (France and Peters 1997, France and Cattaneo 1998). In habitats with higher water velocity, less organic matter is retained and available for microbial respiration, resulting in algae with relatively enriched $\delta^{13}C$ values (France and Peters 1997, France and Cattaneo 1998).

Results from linear regressions of aquatic invertebrate – source $\delta^{13}C$ showed that site-specific algae $\delta^{13}C$ predicted $\delta^{13}C$ for all aquatic invertebrate feeding groups better than did terrestrial OM $\delta^{13}C$, suggesting that primary consumers were predominantly assimilating instream sources of carbon. A number of authors (Junk et al. 1989, Sedell et al. 1989, Gaedke et al. 1996, Lewis et al. 2001) have observed that instream autotrophy is often the predominant carbon pathway in river food webs and despite the prevalence of terrestrial OM, many invertebrates rely on instream algae presumably because is more labile with a higher nitrogen content. That collector, grazer, and shredder feeding group $\delta^{13}C$ was better predicted by algae $\delta^{13}C$ in this system follows reports of feeding plasticity and a general reliance on instream autotrophy by the same groups in a number of other systems (Koslucher and Minshall 1973, Palmer et al. 1993, Miller et al. 1998, Zah et al. 2001).

6.4.2. **Energy flow to focal salmonid species**

Mixing model results suggested that freshwater invertebrate prey were the most important diet items for all salmonid target species overall (Tables 5.4-4 to 5.4-6, Figures 5.4-25 to 5.4-28). Freshwater prey were more important to juvenile salmon and Rainbow Trout diets in 2014 relative to the previous year, whereas the role of marine prey was reduced. This change was also reflected in the drastic decrease in salmon eggs found in stomach content samples in 2014. Arctic Grayling relied most heavily on freshwater and least on marine energy sources relative to other target fish species. The stomach content analysis revealed that Chinook Salmon, Coho Salmon, and Rainbow Trout exhibited an ontogenetic dietary shift to salmon eggs that occurred at approximately 55-85 mm FL.

Robust interpretation of stable isotope diet models requires diet sources to be isotopically distinct enough in order to differentiate their importance in consumer diets (Moore and Semmens 2008). Freshwater and terrestrial sources were often isotopically similar within sites, with correlations between posterior estimates of these two sources ranging between r = -0.39 to -0.97. In cases where sources were highly correlated and the model was unable to discern source contributions from isotope data, priors from stomach content data were more influential in guiding proportional contribution estimates (Moore and Semmens 2008). The uncertainty inherent in the isotope data is reflected in the relatively large credible intervals for freshwater and terrestrial source contributions (Figures 5.4-25 to 5.4-28). The stomach content data provided additional specificity in comparing the importance of freshwater and terrestrial prey, as well as the relative importance of aquatic larvae and pupae vs. terrestrial adult life-stages of freshwater invertebrates.

Taking these factors into account, comparisons of diet model results across macrohabitats (Figures 5.4-25 to 5.4-28) generally show a high degree of overlap between model estimates for fish diets among the different macrohabitat types. Both freshwater and terrestrial prey played similar roles in diets across the heterogeneous macrohabitats sampled, except where salmon eggs made up a significant proportion of diets. In 2013, salmon eggs were consumed in all macrohabitat types sampled (upland slough, tributary mouth, and side channel), however tributary mouths were the most important sites for egg consumption. In 2014, egg consumption in tributary mouths was reduced compared to the previous year, and conversely was higher in upland sloughs and the side slough site for juvenile salmon (Figures 5.4-25 and 5.4-26). No stable isotope evidence exists to suggest that any target fish species fed on salmon eggs during any sampling period in glacial-fed main channel habitats, but salmon eggs were consumed by juvenile salmon to some extent in glacial-fed side channels (Figures 5.4-25 and 5.4-26). Surveys of spawning salmon in the Middle and Lower Susitna River in 2013 and 2014 confirmed that tributary mouths were used for spawning locations, and to lesser extents, slough and side channel habitats (AEA 2014b). The use of tributary mouths by spawning salmon in 2013 parallels consumption of salmon eggs by juvenile salmon and Rainbow Trout in this macrohabitat type, and suggests that in the Susitna River, tributary mouths in particular can be important hotspots of high quality marine prey pulses to these fish species.

As expected, marine-derived food subsidies appeared to be much more important below Devils Canyon. Fish consumption of salmon eggs is likely extremely limited above this barrier due to the low densities of spawning anadromous Chinook Salmon and the absence of the primary ovivorous species, Rainbow Trout and Coho Salmon. Stomach contents of Arctic Grayling and juvenile Chinook Salmon collected above the canyon (Stations RP-173 and RP-184) did not include any salmon eggs. Below Devils Canyon, however, no consistent or discernible diet pattern was observed relating to distance from the river mouth (Figures 5.4-25 and 5.4-26). Mixing model means and credible intervals grouped by macrohabitat type and season from among all reaches generally overlapped to such an extent as to suggest that no strong upstream to downstream trend in food source contributions existed, or at least to obscure a more definitive trend (Figures 5.4-25 and 5.4-26). It is likely that the combination of seasonal and environmental drivers acting on instream production and on the input of subsidized material within individual sites of the same macrohabitat classification are unique enough to produce diet patterns that are inconsistent with a longitudinal effect (Poole 2002, Stanford et al. 2005). For example, while juvenile salmon rearing in all sampled tributary mouths in 2013 were supported by marine-derived food, the direction and magnitude of those contributions varied over time between tributary mouth sites (Figures 5.4-25 and 5.4-26). This resulting effect likely depends on a large range of possible factors such as non-overlapping spawning habitat preferences and run timing between different species of adult salmon (Wipfli and Baxter 2010; AEA 2014b).

Mixing models estimated that freshwater prey contributions remained substantial during all seasons at most sampling sites, and often either decreased in importance from spring to fall or were least important during the summer sampling period (Figures 5.4-25 to 5.4-28). Chinook Salmon diets showed a common seasonal trend where terrestrial prey were often most important to diets during the summer sampling event. A review of studies documenting consumption of terrestrial invertebrates by stream fishes reveals that temporal patterns are highly variable by year and system (Wipfli 1997; Nakano and Murakami 2001; Baxter et al. 2005; Gutierrez 2011); however, a more common pattern in higher latitude systems is an increase in the flux of terrestrial invertebrates to streams during mid-summer when terrestrial productivity can be at its highest (Chloe and Graman 1996; Wipfli 1997; Bridcut 2000). Because juvenile salmonids are opportunistic predators and are known to selectively forage for terrestrial invertebrates (Hubert and Rhodes 1989; Young et al. 1997), it is possible that a large-scale pulse of this prey subsidy during mid-summer accounts for increased contributions to these fish populations.

When juxtaposing resident fish energy source contributions, a large disparity between the two fish species is evident (Figure 5.4-28). While terrestrial contributions between Arctic Grayling and Rainbow Trout were similar across seasons, their uses of freshwater and marine sources were significantly different. While grayling relied very little on marine sources and heavily on freshwater, trout showed an opposing pattern (Figure 5.4-28). This difference in use between these species has been observed in a spawning salmon creek in the Wood River system of southwestern Alaska. Studies by Scheuerell et al. (2007) and Moore et al. (2008) both showed that while both grayling and Rainbow Trout consumed salmon eggs, trout exploited direct consumption of salmon eggs and carcasses more so than grayling, which tended to benefit more directly from increased drift of benthic invertebrates that were dislodged from nest digging by spawning female Sockeye Salmon. After increases in the availability of salmon eggs and carcass tissue in study streams, Rainbow Trout switched away from non-egg prey while grayling continued to feed on non-egg prey (Moore et al. 2008). Thus, these differences in foraging patterns between both species seem to translate across systems.

Two prior juvenile salmon diet studies were conducted during 1982 at many of the same sites in the Susitna River (ADF&G 1983; Hansen and Richards 1985), providing context for the current study. These prior studies found that juvenile Chinook Salmon and Coho Salmon consumed primarily aquatic invertebrates, with very little consumption of salmon eggs and no consumption of fish (ADF&G 1983; Hansen and Richards 1985). Direct comparisons among studies are challenging because the 1982 data were presented in terms of diet proportions by number, rather than diet proportions by mass, the metric used in the current study, which is now preferred for food web and energy flow studies (Chipps and Garvey 2007). However, the historic data consistently show that salmon eggs were not consumed by juvenile Chinook or Coho salmon with the exception of the last sampling event of the season on September 23, 1982 at Indian River, when eggs comprised 6 percent of the Chinook Salmon diet and 2 percent of the Coho Salmon diet (proportions by number; ADF&G 1983, Appendix Tables 3-C-12 and 3-C-19). The average mass of a salmon egg was 23-76 times greater than that of an average terrestrial or aquatic invertebrate food item in the current analysis; therefore, salmon eggs likely represented a large proportion (by mass) of juvenile salmon diets during late September 1982 at Indian River (site RP-141-1 in the current study). Although these historical data suggest that juvenile Chinook and Coho salmon fed heavily on salmon eggs at Indian River in late September, there is no evidence that they utilized salmon eggs during other spawning runs or at other sites within the Susitna Basin.

Overall, energy source contributions in 2014 show that freshwater energy pathways are most important in supporting juvenile salmon, Arctic Grayling, and Rainbow Trout feeding in multiple habitat types of a large section of the Middle Susitna River. While freshwater prey comprised the majority of diets, terrestrial invertebrates were also important prey items. Marine-derived prey were generally least important in diets overall but made up substantial proportions of diets in tributary mouth and slough macrohabitats when spawning salmon were present. While previous studies have observed the utilization of multiple energy pathways by stream salmonids, this study is important in demonstrating the relative importance of these pathways throughout the habitat mosaic and across seasons in river networks.

6.5. Organic Matter Resources

The methodology for estimating organic matter content in benthic and drift samples successfully produced repeatable results for samples collected in 2013 and drift samples in 2014. Results from 2013 showed that mean benthic organic matter was higher overall in samples collected with the petite Ponar grab sampler, in mostly off-channel sites. Upland sloughs had among the highest averaged overall total benthic OM. Flowing water sites (main channels, side channels, and tributary mouths) typically had larger contributions of CPOM in samples than did off-channel macrohabitat sites, which were dominated by FPOM material. A longitudinal trend was also noted, with station-wide averages of benthic OM increasing at each station/Focus Area in a downstream direction.

Drifting organic matter resources were collected in flowing water sites (main channel, side channel, and tributary mouths); upland sloughs and side sloughs were primarily low-flow habitats, often clear pool areas with little or no organic materials suspended in the water column. As these sites are largely depositional areas, most organic matter within the sloughs was likely represented by the benthic OM estimates. Therefore, drifting OM is more indicative of the transportation pathway of organic matter content through the river system.

Drift OM collected in drift samples during 2013 revealed main channels had among the highest average overall total drift OM. In 2014, differences in overall total drift OM were not evident among the flowing water macrohabitats (main channel, side channel, and tributary mouth) as they were in 2013. During both years, main channel and side channel sites contained a higher component of FPOM compared to CPOM amounts, whereas tributary mouths usually contained more CPOM than FPOM. Also, drift OM contained a higher CPOM component in collected samples than was seen in benthic OM, with greater or equal amount of coarse material compared to FPOM amounts.

The estimates for organic matter content collected over 2013 and 2014 provides a strong foundation for baseline characterization of organic matter resources that will be built upon in the next year of study. In addition, the data collected in 2013 and 2014 and in future data collection efforts will provide the information needed for the additional statistical analyses, the results of which will be provided in the Updated Study Report.

6.6. Benthic Macroinvertebrates in Tributaries and Lakes above Devils Canyon

The July 2014 survey of nine selected tributaries and three lakes in the Middle and Upper River segments of the Susitna River basin above Devils Canyon gathered a large amount of information within each site regarding the benthic macroinvertebrates, algae, organic matter, water quality and nutrients, and was successful in its goal "to provide a snapshot of the pre-Project condition of habitats in selected tributary and lake systems and the levels of productivity available to support fish populations."

Surveys of the nine selected tributaries in the Middle and Upper River segments of the Susitna River revealed healthy and productive invertebrate communities residing in three different types of streams: run-off streams, lake-influenced streams, and glacially-influenced stream. Run-off streams included Devil, Fog, Watana, Kosina, Jay and Butte creeks; these streams featured mean density estimates exceeding 5,000 individuals/m^2, with high diversity and high taxa richness. Drift densities were moderately high, but very diverse with high taxa richness. Drift compositions were largely chironomids, with some mayflies and other diptera taxa. Algal growth on substrates was low to moderate, with mean chlorophyll-*a* values ranging from 0.44 to 3.5 mg/m^2, and mean AFDM ranging from 0.3 to 1.85 g/m^2.

Lake-influenced streams included Deadman Creek, with the sampling site located approximately 1.1 miles downstream from the outlet of Deadman Lake, and Tyone River, with the site located 5.8 miles downstream from the outlet of Tyone Lake. Both streams would be considered extremely productive, but at differing levels. On the Tyone River, densities were high (21,730 individuals/m^2), along with relatively high diversity, and high taxa richness. Community compositions were dominated by chironomids, but with higher contributions of caddisflies (mostly Hydroptilidae) and non-insects than other tributaries. The site on Deadman Lake featured extremely high densities, averaging over 130,000 individuals/m^2. This estimate was largely due to one Hess sample that required less than 1 percent subsampling to obtain the 300-count, giving it an estimated 400,000 individuals/m^2. However, even if this sample is disregarded, the average of the remaining four samples was 50,000 individuals/m^2, still well above estimates from the other tributaries. Diversity and taxa richness measures were lower than most of the other tributaries, with the community comprised of nearly 85 percent chironomids, higher than the other tributaries.

Both lake-influenced sites had the highest average drift densities, between 1 and 2 individuals/ft^3, but with the lowest drift diversities and taxa richness. Drift compositions at Tyone River was primarily zooplankton, likely originating from Tyone Lake, and low-flow reach of the river in the preceding river length upstream from the site. Drift at Deadman Creek was mostly composed of filter-feeding taxa of chironomids and black fly larvae (Simuliidae, Other Diptera). Algal growth on substrates was highest at the lake-influenced sites, as evidenced by chlorophyll-*a* and AFDM results.

Oshetna River, the only glacially-influenced stream of the nine sampled, recorded the lowest mean density and lower taxa richness, but EPT taxa richness comparable to those seen in the run-off streams. Drift densities were moderately high, but very diverse with high taxa richness, especially with EPT taxa. Drift composition in the Oshetna River had the highest contributions of mayflies and stoneflies compared to the other tributaries. Algal growth on substrates was low, likely attributed to the higher turbidity from the glacial silt.

For the lakes, the July 2014 survey revealed that most invertebrate production was within the euphotic zones. As might be expected, mean benthic densities and taxa richness from petite Ponar grabs were much lower in deeper waters (profundal zone) compared to sites located in shallow water that were within euphotic zone. D-net sweeps in the littoral zone along proximal shorelines also revealed high taxa richness in those shallow areas, often including a number of EPT taxa, which were not collected at profundal sites. Most invertebrate production in the three lakes is likely attributed to zooplankton in the water column, with high mean areal densities and biomass located in the mid-to-upper extent of Tyone Lake and the lower extent of Susitna Lake, as well as within the deeper area of Lake Louise. Zooplankton was composed of mostly early-instar copepods, with a smaller percentage of cladocerans. It is important, however, to note that zooplankton compositions in lake systems change over the course of the year, and that this study intentionally provided a "snapshot in time."

Measured water quality results from the River Productivity study were compared with other measurements in the region and applicable standards to evaluate water quality conditions. The water quality results from the tributary sites were compared with data from a study in the Tanana River Basin (Moran 2007), as well as other studies summarizing the water quality in the Cook Inlet Basin (Glass et al. 2004; Brabets et al. 1999). The Tanana River Basin study collected water quality data on the mainstem and 59 tributaries of the Tanana River during water years 2004 through 2006. The Tanana River is a tributary of the Yukon River and flows laterally along the northern slope of the Alaska Range. It is the major river basin located north of the Susitna River basin. Comparisons for the tributaries are provided in Table 6.6-1.

In general, data collected at the tributary sites suggests water quality is high and productivity is low. Most tributary sites had pH values close to neutral, except for the Tyone River site which was more basic at 8.6 pH units. This value is outside the range of the water quality standard of 6.5-8.5. Kosina Creek and Devil Creek were slightly more acidic than the others with values around 6.2 pH units. DO, conductivity, and temperature measurements are typical of healthy water quality and are similar to other streams in the region. Only one temperature measurement, 16.8°C at Tyone River, exceeded the Alaska State water quality standard of 15°C for migration and rearing areas and 13°C for spawning and egg and fry incubation (Table 6.6-1). However, stream temperature varies widely depending on the season and time of day so it is reasonable to assume the temperatures in the streams will vary significantly from what is reported in Table 5.8-6.

Turbidity for the tributary sites is characteristically low (ie, < 10 NTU). Dissolved organic carbon is also low and typical of other streams in the Cook Inlet, except for the Tyone River which is on the higher side. Other nutrients measured including total phosphorus, ammonium, and nitrate-nitrite are low when compared to other measurements in the region, suggesting these tributary systems have low productivity.

Measured water quality results from the lake sites were compared with other measurements in the region, applicable standards, and lake classifications to evaluate water quality conditions. The water quality results from the lake sites were compared with data from a study of 50 lakes within the Cook Inlet Basin (ADEC 2008). Comparisons for lakes are provided in Table 6.6-2.

In-situ measurements of pH, conductivity, DO, and temperature at the lake sites varied with depth. Temperature measurements showed that the Susitna Lake (LSU) and Lake Louise (LLO) become stratified while the Tyone Lake (LTY) site was fully mixed. Water quality measurements for all three sites suggest the systems are oligotrophic, meaning they are nutrient poor, have low productivity, and high transparency. The pH measurements decreased slightly on the bottom. The lake water was fairly well oxygenated, but DO decreased to anoxic levels at the RP-LSU-1 and RP-LSU-3 sites. Under anoxic conditions, sediments can release nutrients. Nutrient concentrations and chlorophyll-*a* concentrations were low at all sites measured. Nutrients were higher in the samples collected at the bottom depths; however, this may correspond with nutrients being utilized in the photic region rather than any release from sediments. It should be noted that local residents indicated that Lake Louise had been turbid and green only a few weeks before the sampling that occurred in July.

7. CONCLUSIONS

Implementation of the River Productivity Study (Study 9.8) during 2014 included:

1. completion of the analysis for data collected in 2013, as reported the ISR, Part A, Section 5 (AEA 2014a); the *2013 Initial River Productivity Results Technical Memorandum* (R2 and UAF 2014b) filed on September 26, 2014; and this Study Implementation Report (Section 5.1);

2. conducting field collections to both support and complete the invertebrate drift objective (ISR Part A, Section 4.5; AE 2014), the trophic analysis objectives (ISR Part A, Section 4.6; AEA 2014a) and fish diet analysis objective (ISR Part A, Section 4.9; AEA 2014a) with the stated variances; and

3. collection of supplemental information to characterize the pre-Project benthic macroinvertebrate communities, with regard to species composition and abundance, and algal production in selected Susitna River tributaries and lake systems located above Devils Canyon (ISR Part C, Section 7.1.2.7.; AEA 2014a) as a proposed modification to the Study Plan.

With the combined study efforts from 2013 to 2014, the River Productivity Study has successfully collected baseline data to assist in evaluating the effects of Project-induced changes in flow and the interrelated environmental factors (temperature, substrate, water quality) upon the benthic macroinvertebrate and algal communities in the Middle and Lower Susitna River. The study efforts to date have collected detailed spatial and seasonal baseline information on benthic macroinvertebrates, periphyton, invertebrate drift, benthic and drift organic matter, trophic relationships via growth modeling and stable isotope analysis, benthic macroinvertebrate colonization dynamics, and benthic community resources in various upper basin tributaries and a major lake system.

The combination of these 2013 and 2014 study efforts, including variances (ISR Part A, Section 4; AEA 2014a) and modifications (ISR Part C, Section 7.1; AEA 2014a), and the remainder of the planned work in the next study year, which would also include these variances and the integration with other studies, will fully achieve the proposed Study Plan objectives (ISR Part A, Section 2; AEA 2014a).

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9. TABLES

Table 4.2-1. Locations and descriptions of Focus Areas selected as sampling stations for the River Productivity study in the Lower and Middle River Segments of the Susitna River in 2014. "X" indicates site established at that habitat type, "(x)" indicates no site established at that habitat type.

Focus Area ID / RivPro ID [1]	Common Name	River Productivity Study Use	Description	Geomorphic Reach	Location (PRM)		Area Length (mi)	Habitat Types Present						Additional Sampling	
					Upstream	Downstream		Main Channel	Side Channel	Tributary Mouth	Side Slough	Upland Slough	Beaver Complex	Stable Isotopes	Drift Above Tributary
FA-184/ RP-184	Watana Dam	Study Station (3 sites)	Area approximately 1.4 miles downstream of dam site	MR-1	185.7	184.7	1.0	X	X	X				X	X[3]
FA-173/ RP-173	Stephan Lake, Complex Channel	Study Station (5 sites)	Wide channel near Stephan Lake with complex of side channels	MR-2	175.4	173.6	1.8	X	X	X	X	X			X[4]
FA-141/ RP-141	Indian River	Study Station (4 sites)	Area covering Indian River and upstream channel complex	MR-6	143.4	141.8	1.6	X	X	X		X[2]	(x)	X	X[3]
FA-104/ RP-104	Whiskers Slough	Study Station (5 sites)	Whiskers Slough Complex	MR-8	106.0	104.8	1.2	X	X	X	X	X		X	X[4]
RP-81	Montana Creek Area	Study Station (4 sites)	Area nearby the mouth of Montana Creek	LR-2	82	81	1.0	X	X	X	(x)	X	(x)	X	X[3]

Notes:

1 Focus Area identification numbers (e.g., Focus Area 184) represent the truncated Project River Mile (PRM) at the downstream end of each Focus Area.
2 Upland Slough located on Cook Inlet Regional Working Group (CIRWG) lands.
3 Drift samples taken at a new location upstream of Tributary Mouth macrohabitat
4 Drift samples used from an existing adjoining site upstream of Tributary Mouth macrohabitat.

Table 4.2-2. Tributaries selected for sampling based on productivity estimates in Barrick et al. (1983).

Tributary Location	Site ID	Site Name	Location of Mouth (PRM)	Approximate Elevation (AMSL)
Upstream of Proposed Reservoir	RP-BUT-1	Butte Creek	288.0	2,980
	RP-TYO-1	Tyone River	247.3	2,369
	RP-OSH-1	Oshetna River	235.1	2,991
Proposed Reservior Inundation Zone	RP-JAY-1	Jay Creek	211.0	2,920
	RP-KOS-1	Kosina Creek	209.1	3,060
	RP-WAT-1	Watana Creek	196.9	2,991
	RP-DED-1	Deadman Creek	189.4	2,966
Below Proposed Dam, above Devils Canyon	RP-FOG-1	Fog Creek	179.3	3,125
	RP-DEV-1*	Devil Creek	164.8	1,586

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 4.3-1. Adult emergence traps deployment locations with install and removal dates, and count of number of collection visits with the number of successful samples collected in 2013.

Station	Site	Install Date	Removal Date	Number of Collection Visits	Number of Samples Collected
RP- 81 (Montana Creek)	RP-81-1	7/1/2013	10/1/2013	4	3
	RP-81-2	6/30/2013	10/1/2013	4	1
	RP-81-3	6/29/2013	10/3/2013	4	4
	RP-81-4	6/30/2013	10/3/2013	4	3
FA-104 (Whiskers Slough)	RP-104-1	6/23/2013	9/27/2013	4	4
	RP-104-2	6/19/2013	9/27/2013	4	3
	RP-104-3	6/21/2013	9/30/2013	4	4
	RP-104-4	6/23/2013	9/28/2013	4	4
	RP-104-5	6/21/2013	9/28/2013	4	2
FA-141 (Indian River)	RP-141-1	6/25/2013	9/25/2013	4	2
	RP-141-2	6/25/2013	9/26/2013	3	2
	RP-141-3	6/27/2013	9/25/2013	3	1
	RP-141-4	6/27/2013	9/26/2013	3	1
FA-173 (Stephan Lake Complex)	RP-173-1	7/11/2013	9/23/2013	2	2
	RP-173-2	7/29/2013	9/23/2013	2	2
	RP-173-3	7/11/2013	9/23/2013	2	1
	RP-173-4	7/10/2013	9/24/2013	4	3
FA-184 (Watana Dam)	RP-184-1	7/13/2013	9/22/2013	3	2
	RP-184-3	7/12/2013	9/22/2013	3	3
			Totals	**65**	**47**

Table 4.3-2. Adult emergence trap deployment locations with 2013 collection period dates, durations, estimated densities for successfully retrieved samples, and description of the trap condition upon collection.

Sampling Site	Habitat	Time Period		Duration (days)	Density (per sq m)	Density (per sq m) per day	Trap Condition
		Deployment Date	Collection Date				
RP-184-1	Tributary Mouth	7/13/2013	7/29/2013	16	413.9	25.9	Out of Water, sample retained*
		7/29/2013	8/21/2013	23	—	—	No sample collected; submerged, bottle filled with sediment/water
		8/21/2013	9/22/2013	32	102.8	3.2	Out of Water, sample retained*
RP-184-2	Side Channel	7/12/2013	7/29/2013	17	—	—	No trap installed
		7/29/2013	8/21/2013	23	—	—	No trap installed
		8/21/2013	9/22/2013	32	—	—	No trap installed
RP-184-3	Main Channel	7/12/2013	7/29/2013	17	4,066.7	239.2	Out of Water, sample retained*
		7/29/2013	8/21/2013	23	725.0	31.5	Sample collected
		8/21/2013	9/22/2013	32	188.9	5.9	Out of Water, sample retained*
RP-173-1	Tributary Mouth	7/11/2013	7/29/2013	18	466.7	25.9	Out of Water, sample retained*
		7/29/2013	8/31/2013	33	—	—	No replacement trap available
		8/31/2013	9/23/2013	23	83.3	3.6	Out of Water, sample retained*
RP-173-2	Main Channel	7/9/2013	7/29/2013	20	—	—	No trap installed
		7/29/2013	8/19/2013	21	875.0	41.7	Sample collected
		8/20/2013	9/23/2013	34	250.0	7.4	Out of Water, sample retained*
RP-173-3	Side Channel	7/11/2013	7/29/2013	18	—	—	No sample collected, damaged
		7/29/2013	8/31/2013	33	—	—	No replacement trap available
		8/31/2013	9/23/2013	23	122.2	5.3	Out of Water, sample retained*
RP-173-4	Side Slough	7/10/2013	7/28/2013	18	130.6	7.3	Sample collected
		7/28/2013	8/19/2013	22	494.4	22.5	Sample collected
		8/19/2013	8/31/2013	12	386.1	32.2	Out of Water, sample retained*
		8/31/2013	9/24/2013	24	—	—	No sample collected, damaged
RP-141-1	Tributary Mouth	6/25/2013	7/30/2013	35	4,055.6	115.9	Sample collected
		7/30/2013	8/7/2013	8	2,318.5	289.8	Sample collected
		8/7/2013	8/17/2013	10	—	—	No sample collected, Lost
		8/17/2013	9/25/2013	39	—	—	No sample collected; bottle filled with river water
RP-141-2	Side Channel	6/25/2013	7/30/2013	35	441.7	12.6	Sample collected
		7/30/2013	8/18/2013	19	647.2	34.1	Sample collected
		8/18/2013	9/26/2013	39	—	—	No sample collected; bottle filled with sediment
RP-141-3	Mult Split Main Channel	6/27/2013	7/30/2013	33	—	—	No sample collected, Lost
		7/30/2013	8/17/2013	18	183.3	10.2	Out of Water, sample retained*
		8/17/2013	9/25/2013	39	—	—	No sample collected; stranded, bottle full of sediment
RP-141-4	Upland Slough	6/27/2013	7/30/2013	33	1,772.2	53.7	Sample collected
		7/30/2013	8/18/2013	19	—	—	No sample collected, damaged
		8/18/2013	9/26/2013	39	—	—	No sample collected, damaged

* Trap was damaged and/or stranded out of water during sampling period but sample was intact; sampling duration unknown. Estimates are calculated assuming full sampling duration.

Table 4.3-2 (cont.) Adult emergence trap deployment locations with 2013 collection period dates, durations, estimated densities for successfully retrieved samples, and description of the trap condition upon collection.

Sampling Site	Habitat	Time Period		Duration (days)	Density (per sq m)	Density (per sq m) per day	Sample Condition
		Deployment Date	Collection Date				
RP-104-1	Tributary Mouth/ Side Slough	6/23/2013	8/1/2013	39	450.0	11.5	Damaged, sample retained*
		8/1/2013	8/12/2013	11	488.9	44.4	Sample collected
		8/12/2013	8/30/2013	18	683.3	38.0	Sample collected
		8/30/2013	9/27/2013	28	202.8	7.2	Sample collected
RP-104-2	Side Slough	6/19/2013	8/1/2013	43	1,286.1	29.9	Damaged, sample retained*
		8/1/2013	8/12/2013	11	41.7	3.8	Damaged, sample retained*
		8/12/2013	9/1/2013	20	—	—	No sample collected; bottle filled with sediment
		9/1/2013	9/27/2013	26	188.9	7.3	Sample collected
RP-104-3	Main Channel	6/21/2013	8/1/2013	41	47.2	1.2	Out of Water, sample retained*
		8/1/2013	8/13/2013	12	47.2	3.9	Out of Water, sample retained*
		8/13/2013	9/1/2013	19	316.7	16.7	Out of Water, sample retained*
		9/1/2013	9/30/2013	29	50.0	1.7	Out of Water, sample retained*
RP-104-4	Upland Slough	6/23/2013	8/1/2013	39	2,463.9	63.2	Sample collected
		8/1/2013	8/16/2013	15	2,548.1	169.9	Sample collected
		8/16/2013	9/1/2013	16	1,786.1	111.6	Sample collected
		9/1/2013	9/28/2013	27	86.1	3.2	Sample collected
RP-104-5	Side Channel	6/21/2013	8/1/2013	41	22.2	0.5	Sample collected
		8/1/2013	8/13/2013	12	22.2	1.9	Sample collected
		8/16/2013	9/1/2013	16	—	—	No sample collected; bottle filled with sediment
		9/1/2013	9/28/2013	27	—	—	No sample collected; bottle filled with sediment
RP-81-1	Upland Slough	7/1/2013	8/2/2013	32	1,350.0	42.2	Sample collected
		8/2/2013	8/14/2013	12	538.9	44.9	Partially Out of Water, sample retained*
		8/14/2013	9/1/2013	18	569.4	31.6	Out of Water, sample retained*
		9/1/2013	10/1/2013	30	—	—	No sample collected, damaged
RP-81-2	Tributary Mouth	6/30/2013	8/2/2013	33	—	—	No sample collected, submerged
		8/2/2013	8/15/2013	13	166.7	12.8	Sample collected
		8/15/2013	9/1/2013	17	—	—	No sample collected, Lost
		9/1/2013	10/1/2013	30	—	—	No sample collected, stranded
RP-81-3	Split Main Channel	6/29/2013	8/2/2013	34	788.9	23.2	Sample collected
		8/2/2013	8/14/2013	12	366.7	30.6	Sample collected
		8/14/2013	9/1/2013	18	169.4	9.4	Sample collected
		9/1/2013	10/3/2013	32	58.3	1.8	Out of Water, damaged, sample retained*
RP-81-4	Side Channel	6/30/2013	8/2/2013	33	411.1	12.5	Sample collected
		8/2/2013	8/15/2013	13	322.2	24.8	Sample collected
		8/15/2013	9/1/2013	17	116.7	6.9	Sample collected
		9/1/2013	10/3/2013	32	—	—	No sample collected, damaged

* Trap was damaged and/or stranded out of water during sampling period but sample was intact; sampling duration unknown. Estimates are calculated assuming full sampling duration.

Table 4.4-1. Sampling Stations and Seasonal Sampling Event dates of collection for the River Productivity study in the Lower and Middle River Segments of the Susitna River, 2014.

	Seasonal Sampling Event		
Station	**Spring 2014**	**Summer 2014**	**Fall 2014**
FA-184 (Watana Dam)	6/17 – 6/18	8/13 – 8/14	9/29 – 9/30
FA-173 (Stephan Lake Complex)	6/18 – 6/19	8/11 – 8/12	9/27 – 9/28
FA-141 (Indian River)	6/15 – 6/16	8/9 – 8/10	9/25 – 9/26
FA-104(Whiskers Slough)	6/10 – 6/12	8/4 – 8/6	9/22 – 9/24
RP-81 (Montana Creek)	6/13 – 6/14	8/7 – 8/8	9/20 – 9/21

Table 4.4-2. Benthic drift and plankton tow sample totals for 2014 sampling during three sampling events (Spr= Spring, Sum=Summer, Fall) for sampling sites in the Middle and Lower River Segments of the Susitna River, for the River Productivity Study (9.8).

Site	Macrohabitat Type	Drift Samples				Plankton Tow Samples			
		Spr	Sum	Fall	Total	Spr	Sum	Fall	Total
RP-184-1	Tributary Mouth	2	2	2	6				
RP-184-2	Side Channel	2	2	2	6				
RP-184-3	Main Channel	2	2	2	6				
RP-184-4*	Main Channel	2	2	2	6				
RP-173-1	Tributary Mouth	2	2	2	6				
RP-173-2	Main Channel	2	2	2	6				
RP-173-3*	Side Channel	2	2		4			5	5
RP-173-4	Side Slough					5	5	5	15
RP-173-5[1]	Upland Slough	2	2		4			5	5
RP-141-1	Tributary Mouth	2	2	2	6				
RP-141-2	Side Channel	2	2		4			5	5
RP-141-3	Mult Split Main Channel	2	2	2	6				
RP-141-4	Upland Slough					5	5	5	15
RP-141-5*	Main Channel	2	2	2	6				
RP-104-1	Tributary Mouth	2		2	4		5		5
RP-104-2	Side Slough					5	5	5	15
RP-104-2.1*	Side Slough (above tributary mouth)					5	5		10
RP-104-3	Main Channel	2	2	2	6				
RP-104-4	Upland Slough	2			2	5	5	5	15
RP-104-5	Side Channel	2	2	2	6				
RP-81-1	Upland Slough					5	5	5	15
RP-81-2	Tributary Mouth	2	2	2	6				
RP-81-3	Split Main Channel	2	2	2	6				
RP-81-4	Side Channel	2	2	2	6				
RP-81-5*	Side Channel	2	2	2	6				
	Totals	40	36	32	**108**	30	35	40	**105**

* Drift samples collected for above tributary comparisons.

1 Upland Slough located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 4.6-1. Itemized listing of sample components collected and analyzed in 2014 for Stable Isotope Analysis from the four sampling stations (16 sites total) in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Category	Component	Spring 2014	Summer 2014	Fall 2014	Total Number Analyzed (2014)
Endmembers	Benthic algae	48	46	48	142
	Organic matter - drift	32	32	32	96
	Organic matter - benthic	48	48	48	144
	Salmon carcass	0	4	5	9
	Salmon eggs	0	0	0	0
	Subtotal	*128*	*130*	*133*	*391*
Invertebrates	Benthic - collectors	76	77	75	228
	Benthic - grazers	26	38	19	83
	Benthic - predators	55	55	58	168
	Benthic - shredders	37	33	40	110
	Emergents	29	20	12	61
	Terrestrial	27	28	16	71
	Subtotal	*250*	*251*	*220*	*721*
Fish	Rainbow trout - juveniles	0	5	3	8
	Rainbow trout - adults	8	2	1	11
	Chinook Salmon - juveniles	39	75	64	178
	Coho Salmon - juveniles	52	42	40	134
	Arctic grayling - juveniles	24	37	24	85
	Arctic grayling - adults	6	16	7	29
	Subtotal	*129*	*177*	*139*	*445*
	2014 Totals	**507**	**558**	**492**	**1557**

Table 4.7-1. Number of fish collected for fish gut content, scales, and stable isotope tissue samples during the 2014 Spring Sampling event for each target species / age class from each sampling site in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Station	Sampling site	Habitat Type	Chinook Salmon - small	Coho Salmon - small	Rainbow Trout - small	Rainbow Trout - large	Arctic Grayling - small	Arctic Grayling - large	Totals
			2014 Spring Totals						
FA-184 (Watana Dam)	RP-184-1	Tributary Mouth	0	0	0	0	0	1	1
	RP-184-2	Side Channel	3	0	0	0	7	0	10
	RP-184-3	Main Channel	0	0	0	0	1	0	1
FA-173 (Stephan Lake Complex)	RP-173-1	Tributary Mouth	0	0	0	0	1	3	4
	RP-173-2	Main Channel	1	0	0	0	5	2	8
	RP-173-3	Side Channel	0	0	0	0	0	0	0
	RP-173-4	Side Slough	0	0	0	0	0	0	0
	RP-173-5*	Upland Slough	0	0	0	0	0	0	0
FA-141 (Indian River)	RP-141-1	Tributary Mouth	0	8	0	6	0	1	15
	RP-141-2	Side Channel	4	1	0	0	0	0	5
	RP-141-3	Mult Split Main Channel	8	0	0	0	2	3	13
	RP-141-4	Upland Slough	1	0	0	2	0	0	3
FA-104 (Whiskers Slough)	RP-104-1	Side Slough	7	9	0	0	0	0	16
	RP-104-2	Side Slough	0	6	0	0	0	0	6
	RP-104-3	Main Channel	2	0	0	0	2	0	4
	RP-104-4	Upland Slough	0	8	0	0	0	0	8
	RP-104-5	Side Channel	0	2	0	0	0	0	2
RP- 81 (Montana Creek)	RP-81-1	Upland Slough	1	8	0	0	0	0	9
	RP-81-2	Tributary Mouth	0	6	0	0	0	0	6
	RP-81-3	Split Main Channel	5	5	0	0	0	0	10
	RP-81-4	Side Channel	4	2	0	0	2	0	8
	Spring Totals		**36**	**55**	**0**	**8**	**20**	**10**	**129**

* Upland Slough located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 4.7-2. Number of fish collected for fish gut content, scales, and stable isotope tissue samples during the 2014 Summer Sampling event for each target species / age class from each sampling site in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Station	Sampling site	Habitat Type	Chinook Salmon - small	Coho Salmon - small	Rainbow Trout - small	Rainbow Trout - large	Arctic Grayling - small	Arctic Grayling - large	Totals
			2014 Summer Totals						
FA-184 (Watana Dam)	RP-184-1	Tributary Mouth	0	0	0	0	3	6	9
	RP-184-2	Side Channel	0	0	0	0	2	3	5
	RP-184-3	Main Channel	0	0	0	0	1	5	6
FA-173 (Stephan Lake Complex)	RP-173-1	Tributary Mouth	0	0	0	0	0	14	14
	RP-173-2	Main Channel	0	0	0	0	0	6	6
	RP-173-3	Side Channel	0	0	0	0	0	0	0
	RP-173-4	Side Slough	0	0	0	0	7	0	8
	RP-173-5*	Upland Slough	0	0	0	0	0	0	0
FA-141 (Indian River)	RP-141-1	Tributary Mouth	8	0	0	3	0	0	11
	RP-141-2	Side Channel	8	0	0	0	0	0	8
	RP-141-3	Mult Split Main Channel	8	0	0	0	0	0	8
	RP-141-4	Upland Slough	5	0	0	0	0	1	6
FA-104 (Whiskers Slough)	RP-104-1	Tributary Mouth	2	6	0	2	0	0	10
	RP-104-2	Side Slough	3	5	0	0	0	0	8
	RP-104-3	Main Channel	8	2	0	0	1	1	12
	RP-104-4	Upland Slough	6	8	0	0	0	0	14
	RP-104-5	Side Channel	8	5	0	0	0	1	14
RP- 81 (Montana Creek)	RP-81-1	Upland Slough	4	8	0	0	0	0	12
	RP-81-2	Tributary Mouth	7	7	0	1	0	1	16
	RP-81-3	Split Main Channel	8	0	0	0	0	0	8
	RP-81-4	Side Channel	3	0	0	0	1	0	4
	Summer Totals		**78**	**41**	**0**	**6**	**15**	**38**	**179**

* Upland Slough located on Cook Inlet Region Working Group (CIRWG) lands.

Table 4.7-3. Number of fish collected for fish gut content, scales, and stable isotope tissue samples during the 2014 Fall Sampling event for each target species / age class from each sampling site in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Station	Sampling site	Habitat Type	Chinook Salmon - small	Coho Salmon - small	Rainbow Trout - small	Rainbow Trout - large	Arctic Grayling - small	Arctic Grayling - large	Totals
			2014 Fall Totals						
FA-184 (Watana Dam)	RP-184-1	Tributary Mouth	0	0	0	0	1	5	6
	RP-184-2	Side Channel	0	0	0	0	1	0	1
	RP-184-3	Main Channel	0	0	0	0	2	0	2
FA-173 (Stephan Lake Complex)	RP-173-1	Tributary Mouth	0	0	0	0	0	0	0
	RP-173-2	Main Channel	0	0	0	0	0	2	2
	RP-173-3	Side Channel	0	0	0	0	4	0	4
	RP-173-4	Side Slough	0	0	0	0	1	0	8
	RP-173-5*	Upland Slough	0	0	0	0	0	0	0
FA-141 (Indian River)	RP-141-1	Tributary Mouth	6	1	1	1	0	0	9
	RP-141-2	Side Channel	8	0	0	0	0	0	8
	RP-141-3	Mult Split Main Channel	8	0	0	0	0	1	9
	RP-141-4	Upland Slough	3	0	0	0	0	0	3
FA-104 (Whiskers Slough)	RP-104-1	Tributary Mouth	7	9	1	0	1	0	18
	RP-104-2	Side Slough	0	10	0	0	0	0	10
	RP-104-3	Main Channel	4	0	0	0	6	3	13
	RP-104-4	Upland Slough	1	8	0	0	0	0	9
	RP-104-5	Side Channel	7	6	0	0	3	1	17
RP- 81 (Montana Creek)	RP-81-1	Upland Slough	0	13	1	0	0	0	14
	RP-81-2	Tributary Mouth	0	2	0	0	0	0	2
	RP-81-3	Split Main Channel	6	0	0	0	0	0	6
	RP-81-4	Side Channel	7	0	0	0	0	0	7
	Fall Totals		**57**	**49**	**3**	**1**	**19**	**12**	**141**

* Upland Slough located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 4.8-1. Total number of Benthic and Drift Samples with organic matter components collected for 2013 sampling during three sampling events (Spr=Spring, Sum=Summer, Fall) and Post-Storm sampling for sites in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

		Hess Samples					Ponar Grab Samples					Drift Samples			
Site	Macrohabitat Type	Spr	Sum	Fall	Post-Storm	Total	Spr	Sum	Fall	Post-Storm	Total	Spr	Sum	Fall	Total
RP-184-1	Tributary Mouth	5	5	5		15						2	2	2	6
RP-184-2	Side Channel	5	5	5		15						2	2	2	6
RP-184-3	Main Channel	5	5	5		15						2	2	2	6
RP-173-1	Tributary Mouth	5	5	5		15						2	2	2	6
RP-173-2	Main Channel	5	5	5		15						2	2	2	6
RP-173-3	Side Channel	5	5	5		15						2	2		2
RP-173-4	Side Slough	5	5	2	5	17	5	5	5	5	20				
RP-141-1	Tributary Mouth	5	5	5		15						2	2	2	6
RP-141-2	Side Channel	5	5			10			5		5	2	2	2	6
RP-141-3	Mult Split Main Channel	5	5	5		15						2	2		2
RP-141-4	Upland Slough	5	4	3		12	5	5	5		15				
RP-141-5*	Main Channel												2		2
RP-104-1	Trib Mouth/Side Slough	5	5	5		15						2	2	2	6
RP-104-2	Side Slough	5	5	2	5	17			5		5	2			2
RP-104-3	Main Channel	5	5	5		15						2	2	2	6
RP-104-4	Upland Slough						5	5	5		15	2			2
RP-104-5	Side Channel	5	5	5		15						2	2		2
RP-81-1	Upland Slough			5		5	5	5			10			2	2
RP-81-2	Tributary Mouth	5	5	5		15						2	2	2	6
RP-81-3	Split Main Channel	5	5	5		15						2	2	2	6
RP-81-4	Side Channel	5	5	5		15						2	2	2	6
RP-81-5*	Side Channel											2	2	2	6
	Totals	90	89	82	10	**271**	20	20	25	5	**70**	36	34	28	**92**

Table 4.10-1. Macroinvertebrate and algae sample totals for July 2014 sampling at nine selected tributaries in the Middle and Upper River Segments of the Susitna River for the River Productivity Study.

Tributary Location	Site ID	Site Name	Elevation (AMSL)	Date Sampled	Hess Samples	Drift Samples	Algae Samples
Upstream of Proposed Reservoir	RP-BUT-1	Butte Creek	2,980	20140716	5	2	5
	RP-TYO-1	Tyone River	2,369	20140714	5	2	5
	RP-OSH-1	Oshetna River	2,991	20140714	5	2	5
Proposed Reservior Inundation Zone	RP-JAY-1	Jay Creek	2,920	20140717	5	2	5
	RP-KOS-1	Kosina Creek	3,060	20140715	5	2	5
	RP-WAT-1	Watana Creek	2,991	20140717	5	2	5
	RP-DED-1	Deadman Creek	2,966	20140716	5	2	5
Below Proposed Dam, above Devils Canyon	RP-FOG-1	Fog Creek	3,125	20140715	5	2	5
	RP-DEV-1*	Devil Creek	1,586	20140718	5	2	5
			Totals		**45**	**18**	**45**

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 4.10-2. Benthic macroinvertebrate and plankton tow sample totals for July 2014 sampling at nine sites within three lakes located in the Upper River basin of the Susitna River for the River Productivity Study.

Site ID	Site Name	Depth (ft)	Date Sampled	Ponar Samples	Plankton Tow Samples	Shoreline Sweeps	Water Quality Grabs (at surface, euphotic, and bottom depths)
RP-LTY-1	Tyone Lake - Lower	4.5	20140722	5	5	1	1 (at 2 ft)
RP-LTY-2	Tyone Lake - Middle	16.5	20140722	5	5	1	2 (at 2 ft and 15 ft)
RP-LTY-3	Tyone Lake - Upper	21	20140722	5	5	1	2 (at 2 ft and 18 ft)
RP-LSU-1	Susitna Lake - Lower	78	20140723	5	5	1	3 (at 6, 36, and 75 ft)
RP-LSU-2	Susitna Lake - Middle	22	20140723	5	5	1	2 (at 2 ft and 20 ft)
RP-LSU-3	Susitna Lake - Upper	90	20140723	5	5	1	3 (at 6, 36, and 87 ft)
RP-LLO-1	Lake Louise - Lower	107	20140724	5	5	1	3 (at 6, 33, and 95 ft)
RP-LLO-2	Lake Louise - Middle	133	20140721	5	5	1	3 (at 6, 42, and 129 ft)
RP-LLO-3	Lake Louise - Upper	17	20140724	5	5	1	2 (at 2 ft and 16 ft)
		Totals		**45**	**45**	**9**	**21**

Table 4.10-3. Water quality sample parameters taken for July 2014 sampling at nine selected tributaries and nine lake sites in the Middle and Upper River Segments of the Susitna River for the River Productivity Study.

Analyses	Method	Sites	Container	Preservative	Standard Holding Time
Alkalinity	SM21 2320B	Lake	500-ml high-density polyethylene (HDPE)	Cool to 0-6°C	14 days
Nitrate+Nitrite	SM18 4500 NO3-F	Tributary, Lake	500-ml HDPE	Freeze	28 days
Ammonia as N	SM18 4500NH3-H	Tributary, Lake		Freeze	28 days
Soluble Reactive Phosphorous (SRP)	SM18 4500PF	Tributary, Lake		Freeze (field filter)	48 hours filtered*
Total Kjeldahl Nitrogen (TKN)	EPA 351.1	Tributary, Lake	250-ml HDPE	Freeze	28 days
Total Phosphorus (TP)	SM18 4500PF	Tributary, Lake		Freeze (field filter)	28 days
Chlorophyll-a	SM 10200H	Tributary, Lake	500-ml HDPE	Field filter, protect from light, freeze filter to -4°C	21 days
Dissolved organic carbon (DOC)	SM21 5310B	Tributary, Lake	125-ml Amber Glass	Hydrochloric acid (HCL) (pH<2) Cool to 0-6°C (field filter before preservation)	28 days

* Communication with the analytical lab indicated that freezing the SRP sample would allow for up to 28 days holding time; maximum holding time was 22 days or less.

Table 5.1-1. Values of density, taxonomic richness, and relative abundance by habitat from adult emergence trap samples collected in 2013 during the open water season for sites within the Watana Dam Focus area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Density (per sq m) per day	Taxa Richness	EPT Taxa	Mayfly (E) Taxa	Stonefly (P) Taxa	Caddisfly (T) Taxa	Percent Aquatic Taxa	Percent Terrestrial Taxa	Percent Undeter-mined
RP-184-1	Tributary Mouth	7/13/2013	7/29/2013	25.9	28	6	2	1	3	70.5	29.5	0
		7/29/2013	8/21/2013	—	—	—	—	—	—	—	—	—
		8/21/2013	9/22/2013	3.2	10	0	0	0	0	70.3	29.7	0
RP-184-2	Side Channel	7/12/2013	7/29/2013	—	—	—	—	—	—	—	—	—
		7/29/2013	8/21/2013	—	—	—	—	—	—	—	—	—
		8/21/2013	9/22/2013	—	—	—	—	—	—	—	—	—
RP-184-3	Main Channel	7/12/2013	7/29/2013	239.2	16	1	0	0	1	50.5	49.5	0
		7/29/2013	8/21/2013	31.5	28	5	1	3	1	79.3	20.7	0
		8/21/2013	9/22/2013	5.9	14	4	1	2	1	86.8	13.2	0

Table 5.1-2. Taxonomic composition metric values from adult emergence trap samples collected in 2013 during the open water season for sites within the Watana Dam Focus area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Percent Mayflies	Percent Stoneflies	Percent Caddisflies	Percent Coleo-ptera	Percent Chiro-nomids	Percent Other Diptera	Percent Hymeno-ptera	Percent Hemiptera	Percent Others
RP-184-1	Tributary Mouth	7/13/2013	7/29/2013	1.3	2.7	2.7	2.0	29.5	57.7	1.3	1.3	1.3
		7/29/2013	8/21/2013	—	—	—	—	—	—	—	—	—
		8/21/2013	9/22/2013	0.0	0.0	0.0	0.0	56.8	35.1	2.7	0.0	5.4
RP-184-2	Side Channel	7/12/2013	7/29/2013	—	—	—	—	—	—	—	—	—
		7/29/2013	8/21/2013	—	—	—	—	—	—	—	—	—
		8/21/2013	9/22/2013	—	—	—	—	—	—	—	—	—
RP-184-3	Main Channel	7/12/2013	7/29/2013	0.0	0.0	0.3	0.0	44.3	8.7	0.3	45.9	0.5
		7/29/2013	8/21/2013	0.8	44.1	1.1	2.3	29.1	11.1	3.1	3.4	5.0
		8/21/2013	9/22/2013	4.4	5.9	1.5	0.0	69.1	16.2	1.5	1.5	0.0

Table 5.1-3. Values of density, taxonomic richness, and relative abundance by habitat from adult emergence trap samples collected in 2013 during the open water season for sites within the Stephan Lake Complex Focus area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Density (per sq m) per day	Taxa Richness	EPT Taxa	Mayfly (E) Taxa	Stonefly (P) Taxa	Caddisfly (T) Taxa	Percent Aquatic Taxa	Percent Terrestrial Taxa	Percent Undeter-mined
RP-173-1	Tributary Mouth	7/11/2013	7/29/2013	25.9	21	0	0	0	0	35.7	64.3	0
		7/29/2013	8/31/2013	—	—	—	—	—	—	—	—	—
		8/31/2013	9/23/2013	3.6	3	1	1	0	0	96.7	3.3	0
RP-173-2	Main Channel	7/9/2013	7/29/2013	—	—	—	—	—	—	—	—	—
		7/29/2013	8/19/2013	41.7	19	3	1	2	0	93.0	7.0	0
		8/20/2013	9/23/2013	7.4	16	3	1	2	0	86.7	13.3	0
RP-173-3	Side Channel	7/11/2013	7/29/2013	—	—	—	—	—	—	—	—	—
		7/29/2013	8/31/2013	—	—	—	—	—	—	—	—	—
		8/31/2013	9/23/2013	5.3	6	1	1	0	0	88.6	11.4	0
RP-173-4	Side Slough	7/10/2013	7/28/2013	7.3	10	2	2	0	0	83.0	17.0	0
		7/28/2013	8/19/2013	22.5	3	1	1	0	0	93.8	6.2	0
		8/19/2013	8/31/2013	32.2	26	3	1	1	1	50.4	49.6	0
		8/31/2013	9/24/2013	—	—	—	—	—	—	—	—	—

Table 5.1-4. Taxonomic composition metric values from adult emergence trap samples collected in 2013 during the open water season for sites within the Stephan Lake Complex Focus area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Percent Mayflies	Percent Stoneflies	Percent Caddisflies	Percent Coleoptera	Percent Chironomids	Percent Other Diptera	Percent Hymeno-ptera	Percent Hemiptera	Percent Others
RP-173-1	Tributary Mouth	7/11/2013	7/29/2013	0.0	0.0	0.0	6.0	26.2	49.4	2.4	13.7	2.4
		7/29/2013	8/31/2013	—	—	—	—	—	—	—	—	—
		8/31/2013	9/23/2013	3.3	0.0	0.0	0.0	93.3	0.0	0.0	0.0	3.3
RP-173-2	Main Channel	7/9/2013	7/29/2013	—	—	—	—	—	—	—	—	—
		7/29/2013	8/19/2013	0.3	30.2	0.0	0.6	54.3	11.1	0.3	1.0	2.2
		8/20/2013	9/23/2013	5.6	21.1	0.0	1.1	51.1	15.6	1.1	0.0	4.4
RP-173-3	Side Channel	7/11/2013	7/29/2013	—	—	—	—	—	—	—	—	—
		7/29/2013	8/31/2013	—	—	—	—	—	—	—	—	—
		8/31/2013	9/23/2013	59.1	0.0	0.0	0.0	29.5	6.8	2.3	0.0	2.3
RP-173-4	Side Slough	7/10/2013	7/28/2013	4.3	0.0	0.0	0.0	72.3	10.6	0.0	2.1	10.6
		7/28/2013	8/19/2013	12.9	0.0	0.0	0.0	80.9	0.0	0.0	0.0	6.2
		8/19/2013	8/31/2013	7.2	2.2	0.7	1.4	23.0	53.2	7.9	0.7	3.6
		8/31/2013	9/24/2013	—	—	—	—	—	—	—	—	—

Table 5.1-5. Values of density, taxonomic richness, and relative abundance by habitat from adult emergence trap samples collected in 2013 during the open water season for sites within the Indian River Focus area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Density (per sq m) per day	Taxa Richness	EPT Taxa	Mayfly (E) Taxa	Stonefly (P) Taxa	Caddisfly (T) Taxa	Percent Aquatic Taxa	Percent Terrestrial Taxa	Percent Undeter-mined
RP-141-1	Tributary Mouth	6/25/2013	7/30/2013	115.9	13	3	2	0	1	97.3	2.7	0
		7/30/2013	8/7/2013	289.8	8	3	1	1	1	99.4	0.6	0
		8/7/2013	8/17/2013	—	—	—	—	—	—	—	—	—
		8/17/2013	9/25/2013	—	—	—	—	—	—	—	—	—
RP-141-2	Side Channel	6/25/2013	7/30/2013	12.6	14	3	1	2	0	93.7	6.3	0
		7/30/2013	8/18/2013	34.1	7	4	1	2	1	99.6	0.4	0
		8/18/2013	9/26/2013	—	—	—	—	—	—	—	—	—
RP-141-3	Mult Split Main Channel	6/27/2013	7/30/2013	—	—	—	—	—	—	—	—	—
		7/30/2013	8/17/2013	10.2	8	1	0	1	0	1.5	63.6	34.8
		8/17/2013	9/25/2013	—	—	—	—	—	—	—	—	—
RP-141-4	Upland Slough	6/27/2013	7/30/2013	53.7	21	1	0	0	1	86.5	13.5	0
		7/30/2013	8/18/2013	—	—	—	—	—	—	—	—	—
		8/18/2013	9/26/2013	—	—	—	—	—	—	—	—	—

Table 5.1-6. Taxonomic composition metric values from adult emergence trap samples collected in 2013 during the open water season for sites within the Indian River Focus area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Percent Mayflies	Percent Stoneflies	Percent Caddisflies	Percent Coleoptera	Percent Chironomids	Percent Other Diptera	Percent Hymeno-ptera	Percent Hemiptera	Percent Others
RP-141-1	Tributary Mouth	6/25/2013	7/30/2013	1.1	0.0	1.6	0.3	89.3	5.8	0.5	0.5	0.8
		7/30/2013	8/7/2013	0.3	0.3	1.0	0.0	50.8	47.3	0.0	0.0	0.3
		8/7/2013	8/17/2013	—	—	—	—	—	—	—	—	—
		8/17/2013	9/25/2013	—	—	—	—	—	—	—	—	—
RP-141-2	Side Channel	6/25/2013	7/30/2013	0.6	25.8	0.0	1.3	64.8	3.1	1.3	0.6	2.5
		7/30/2013	8/18/2013	1.7	27.5	0.4	0.0	68.2	1.7	0.4	0.0	0.0
		8/18/2013	9/26/2013	—	—	—	—	—	—	—	—	—
RP-141-3	Mult Split Main Channel	6/27/2013	7/30/2013	—	—	—	—	—	—	—	—	—
		7/30/2013	8/17/2013	0.0	1.5	0.0	1.5	0.0	28.8	1.5	60.6	6.1
		8/17/2013	9/25/2013	—	—	—	—	—	—	—	—	—
RP-141-4	Upland Slough	6/27/2013	7/30/2013	0.0	0.0	0.3	0.9	22.3	70.2	0.6	3.1	2.5
		7/30/2013	8/18/2013	—	—	—	—	—	—	—	—	—
		8/18/2013	9/26/2013	—	—	—	—	—	—	—	—	—

Table 5.1-7. Values of density, taxonomic richness, and relative abundance by habitat from adult emergence trap samples collected in 2013 during the open water season for sites within the Whiskers Slough Focus area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Density (per sq m) per day	Taxa Richness	EPT Taxa	Mayfly (E) Taxa	Stonefly (P) Taxa	Caddisfly (T) Taxa	Percent Aquatic Taxa	Percent Terrestrial Taxa	Percent Undeter-mined
RP-104-1	Tributary Mouth/ Side Slough	6/23/2013	8/1/2013	11.5	11	2	0	0	2	95.1	4.9	0
		8/1/2013	8/12/2013	44.4	10	1	1	0	0	97.2	2.8	0
		8/12/2013	8/30/2013	38.0	6	1	1	0	0	98.8	1.2	0
		8/30/2013	9/27/2013	7.2	10	1	0	0	1	82.2	17.8	0
RP-104-2	Side Slough	6/19/2013	8/1/2013	29.9	11	4	2	1	1	98.3	1.7	0
		8/1/2013	8/12/2013	3.8	5	0	0	0	0	93.3	6.7	0
		8/12/2013	9/1/2013	—	—	—	—	—	—	—	—	—
		9/1/2013	9/27/2013	7.3	13	2	1	0	1	51.5	48.5	0
RP-104-3	Main Channel	6/21/2013	8/1/2013	1.2	7	1	0	1	0	41.2	17.6	41.2
		8/1/2013	8/13/2013	3.9	5	1	0	1	0	94.1	5.9	0
		8/13/2013	9/1/2013	16.7	21	0	0	0	0	14.0	86.0	0
		9/1/2013	9/30/2013	1.7	10	1	0	1	0	55.6	44.4	0
RP-104-4	Upland Slough	6/23/2013	8/1/2013	63.2	12	1	1	0	0	98.5	1.5	0
		8/1/2013	8/16/2013	169.9	5	1	1	0	0	98.3	1.7	0
		8/16/2013	9/1/2013	111.6	6	0	0	0	0	98.8	1.2	0
		9/1/2013	9/28/2013	3.2	6	1	1	0	0	87.1	12.9	0
RP-104-5	Side Channel	6/21/2013	8/1/2013	0.5	2	1	1	0	0	100.0	0.0	0
		8/1/2013	8/13/2013	1.9	2	0	0	0	0	87.5	12.5	0
		8/16/2013	9/1/2013	—	—	—	—	—	—	—	—	—
		9/1/2013	9/28/2013	—	—	—	—	—	—	—	—	—

Table 5.1-8. Taxonomic composition metric values from adult emergence trap samples collected in 2013 during the open water season for sites within Whiskers Slough Focus area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Percent Mayflies	Percent Stoneflies	Percent Caddisflies	Percent Coleoptera	Percent Chironomids	Percent Other Diptera	Percent Hymeno-ptera	Percent Hemiptera	Percent Others
RP-104-1	Tributary Mouth/ Side Slough	6/23/2013	8/1/2013	0.0	0.0	3.1	0.6	90.7	2.5	0.6	0.0	2.5
		8/1/2013	8/12/2013	1.1	0.0	0.0	0.0	93.8	3.4	0.6	0.6	0.6
		8/12/2013	8/30/2013	2.8	0.0	0.0	0.0	94.3	1.6	0.0	0.4	0.8
		8/30/2013	9/27/2013	0.0	0.0	39.7	5.5	39.7	8.2	0.0	1.4	5.5
RP-104-2	Side Slough	6/19/2013	8/1/2013	0.6	2.4	0.4	0.0	94.2	0.6	0.0	1.1	0.6
		8/1/2013	8/12/2013	0.0	0.0	0.0	0.0	46.7	46.7	0.0	0.0	6.7
		8/12/2013	9/1/2013	—	—	—	—	—	—	—	—	—
		9/1/2013	9/27/2013	4.4	0.0	1.5	0.0	32.4	55.9	4.4	0.0	1.5
RP-104-3	Main Channel	6/21/2013	8/1/2013	0.0	5.9	0.0	0.0	5.9	58.8	11.8	5.9	11.8
		8/1/2013	8/13/2013	0.0	29.4	0.0	0.0	0.0	17.6	5.9	0.0	47.1
		8/13/2013	9/1/2013	0.0	0.0	0.0	0.9	7.0	82.5	7.0	0.0	2.6
		9/1/2013	9/30/2013	0.0	16.7	0.0	0.0	27.8	33.3	5.6	5.6	11.1
RP-104-4	Upland Slough	6/23/2013	8/1/2013	0.1	0.0	0.0	0.2	95.8	2.6	0.1	0.3	0.8
		8/1/2013	8/16/2013	0.3	0.0	0.0	0.0	97.7	0.3	0.0	1.2	0.6
		8/16/2013	9/1/2013	0.0	0.0	0.0	0.0	96.6	2.2	0.2	0.2	0.9
		9/1/2013	9/28/2013	6.5	0.0	0.0	0.0	64.5	19.4	0.0	0.0	9.7
RP-104-5	Side Channel	6/21/2013	8/1/2013	25.0	0.0	0.0	0.0	75.0	0.0	0.0	0.0	0.0
		8/1/2013	8/13/2013	0.0	0.0	0.0	0.0	87.5	12.5	0.0	0.0	0.0
		8/16/2013	9/1/2013	—	—	—	—	—	—	—	—	—
		9/1/2013	9/28/2013	—	—	—	—	—	—	—	—	—

Table 5.1-9. Values of density, taxonomic richness, and relative abundance by habitat from adult emergence trap samples collected in 2013 during the open water season for sites within the Montana Creek Study Area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Density (per sq m) per day	Taxa Richness	EPT Taxa	Mayfly (E) Taxa	Stonefly (P) Taxa	Caddisfly (T) Taxa	Percent Aquatic Taxa	Percent Terrestrial Taxa	Percent Undeter-mined
RP-81-1	Upland Slough	7/1/2013	8/2/2013	42.2	36	0	0	0	0	61.3	38.7	0
		8/2/2013	8/14/2013	44.9	17	0	0	0	0	86.6	13.4	0
		8/14/2013	9/1/2013	31.6	22	1	1	0	0	78.0	22.0	0
		9/1/2013	10/1/2013	—	—	—	—	—	—	—	—	—
RP-81-2	Tributary Mouth	6/30/2013	8/2/2013	—	—	—	—	—	—	—	—	—
		8/2/2013	8/15/2013	12.8	6	2	0	1	1	96.7	1.7	1.7
		8/15/2013	9/1/2013	—	—	—	—	—	—	—	—	—
		9/1/2013	10/1/2013	—	—	—	—	—	—	—	—	—
RP-81-3	Split Main Channel	6/29/2013	8/2/2013	23.2	22	4	0	3	1	93.7	6.3	0
		8/2/2013	8/14/2013	30.6	3	2	0	2	0	100.0	0.0	0
		8/14/2013	9/1/2013	9.4	10	2	0	2	0	83.6	14.8	1.6
		9/1/2013	10/3/2013	1.8	8	1	0	1	0	33.3	66.7	0
RP-81-4	Side Channel	6/30/2013	8/2/2013	12.5	17	7	2	3	2	89.9	8.8	1.4
		8/2/2013	8/15/2013	24.8	17	3	0	2	1	87.9	11.2	0.9
		8/15/2013	9/1/2013	6.9	13	4	1	2	1	73.8	26.2	0
		9/1/2013	10/3/2013	—	—	—	—	—	—	—	—	—

Table 5.1-10. Taxonomic composition metric values from adult emergence trap samples collected in 2013 during the open water season for sites within the Montana Creek Study Area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study.

Sampling Site	Habitat	Deployment Date	Collection Date	Percent Mayflies	Percent Stoneflies	Percent Caddisflies	Percent Coleoptera	Percent Chironomids	Percent Other Diptera	Percent Hymeno-ptera	Percent Hemiptera	Percent Others
RP-81-1	Upland Slough	7/1/2013	8/2/2013	0.0	0.0	0.0	2.5	28.2	64.2	2.1	3.1	0.0
		8/2/2013	8/14/2013	0.0	0.0	0.0	0.5	58.2	36.6	1.5	0.0	3.1
		8/14/2013	9/1/2013	1.5	0.0	0.0	0.5	55.6	33.7	1.0	1.0	6.8
		9/1/2013	10/1/2013	—	—	—	—	—	—	—	—	—
RP-81-2	Tributary Mouth	6/30/2013	8/2/2013	—	—	—	—	—	—	—	—	—
		8/2/2013	8/15/2013	0.0	13.3	3.3	0.0	60.0	23.3	0.0	0.0	0.0
		8/15/2013	9/1/2013	—	—	—	—	—	—	—	—	—
		9/1/2013	10/1/2013	—	—	—	—	—	—	—	—	—
RP-81-3	Split Main Channel	6/29/2013	8/2/2013	0.0	10.6	0.4	0.4	56.0	29.2	1.4	0.7	1.4
		8/2/2013	8/14/2013	0.0	8.3	0.0	0.0	91.7	0.0	0.0	0.0	0.0
		8/14/2013	9/1/2013	0.0	26.2	0.0	3.3	57.4	3.3	6.6	3.3	0.0
		9/1/2013	10/3/2013	0.0	4.8	0.0	4.8	28.6	-	33.3	19.0	9.5
RP-81-4	Side Channel	6/30/2013	8/2/2013	5.4	11.5	3.4	0.0	56.1	18.9	3.4	0.0	1.4
		8/2/2013	8/15/2013	0.0	10.3	2.6	0.9	62.1	17.2	4.3	0.0	2.6
		8/15/2013	9/1/2013	7.1	40.5	2.4	2.4	19.0	26.2	0.0	0.0	2.4
		9/1/2013	10/3/2013	—	—	—	—	—	—	—	—	—

Table 5.1-11. 2013 overall summary of LWD (Snag) metrics for sites at River Productivity stations in Middle Reach above Devils Canyon.

Station	FA-184 (Watana Dam)			FA-173 (Stephan Lake Complex)			
Site	**184-1**	**184-2**	**184-3**	**173-1**	**173-2**	**173-3**	**173-4**
Habitat	**TM**	**SC**	**MC**	**TM**	**MC**	**SC**	**SS**
Number of Reps	10	1	0	6	0	3	8
Density (Individuals/m²)							
Range	946 - 9400	140.1	—	49 - 1817	—	328 - 819	248 - 10045
Average	4822.1	140.1	—	576.9	—	588.2	2689.7
Median	4655.9	140.1	—	263.5	—	617.3	1480.0
Taxa Richness (number)							
Range	17 - 34	6	—	4 - 20	—	9 - 21	6 - 26
Average	23.8	6.0	—	10.2	—	15.3	14.6
Median	21	6	—	8	—	16	14.5
EPT Taxa (number)							
Range	3 - 8	1	—	0 - 5	—	0 - 1	0 - 2
Average	5.5	1.0	—	1.3	—	0.3	1.0
Median	5.5	1	—	0	—	0	1
Chironomid Taxa (number)							
Range	8 - 22	3	—	2 - 11	—	7 - 16	6 - 18
Average	14.4	3.0	—	6.0	—	12.0	10.9
Median	14	3	—	5	—	13	11
Diversity (H')							
Range	1.21 - 2.69	1.52	—	1.13 - 2.44	—	1.13 - 2.61	0.87 - 2.76
Average	1.99	1.52	—	1.79	—	2.07	1.78
Median	2.16	1.52	—	1.87	—	2.47	1.98
Evenness (J')							
Range	0.42 - 0.78	0.85	—	0.68 - 1	—	0.51 - 0.94	0.4 - 0.85
Average	0.63	0.85	—	0.84	—	0.76	0.67
Median	0.68	0.85	—	0.83	—	0.81	0.71
Relative Abundance Top 3 Taxa (Percent)							
Range	50.6 - 85	76.9	—	42.9 - 91.7	—	35.3 - 85	42.7 - 95.9
Average	67.7	76.9	—	65.8	—	57.7	71.5
Median	62.9	76.9	—	69.1	—	52.9	69.1
Relative Abundance EPT (Percent)							
Range	3.1 - 76	38.5	—	0 - 49.7	—	0 - 2.5	0 - 6.1
Average	22.0	38.5	—	14.1	—	0.8	1.8
Median	7.7	38.5	—	0.0	—	0.0	1.8
Relative Abundance Chironomids (Percent)							
Range	12.4 - 90.2	23.1	—	41.7 - 71.4	—	91.2 - 95	83.1 - 100
Average	53.4	23.1	—	53.4	—	93.3	90.5
Median	51.1	23.1	—	47.2	—	93.6	91.0

Table 5.1-12. 2013 overall summary of LWD (Snag) metrics for sites at River Productivity stations in Middle Reach below Devils Canyon.

Station	FA-141 (Indian River)				FA-104 (Whiskers Slough)				
Site	**141-1**	**141-2**	**141-3**	**141-4**	**104-1**	**104-2**	**104-3**	**104-4**	**104-5**
Habitat	**TM**	**SC**	**MC**	**US**	**TM**	**SS**	**MC**	**US**	**SC**
Number of Reps	13	6	0	12	12	18	0	13	7
Density (Individuals/m²)									
Range	283 - 28318	110 - 2889	—	155 - 3448	557 - 12529	6.9 - 4386	—	78 - 4394	671 - 3882
Average	7273.0	892.6	—	1432.6	3975.3	1794.8	—	1438.7	2476.7
Median	3890.7	547.2	—	1263.2	1777.9	1418.1	—	994.3	2764.4
Taxa Richness (number)									
Range	6 - 37	5 - 27	—	8 - 30	8 - 32	1 - 29	—	7 - 36	7 - 25
Average	19.2	15.2	—	16.0	22.8	17.8	—	19.8	15.6
Median	17	15	—	14.5	23	17.5	—	22	14
EPT Taxa (number)									
Range	1 - 11	1 - 5	—	0 - 6	0 - 5	0 - 4	—	0 - 6	1 - 6
Average	4.1	3.2	—	1.7	1.8	1.7	—	1.8	3.3
Median	3	3	—	1	1.5	1.5	—	1	3
Chironomid Taxa (number)									
Range	5 - 19	3 - 15	—	4 - 21	6 - 19	0 - 21	—	4 - 26	3 - 18
Average	11.3	8.5	—	10.5	15.9	13.3	—	13.2	10.9
Median	10	8	—	9.5	17	12	—	14	11
Diversity (H')									
Range	1.28 - 2.87	1.61 - 2.59	—	1.25 - 3.03	1.29 - 2.85	0 - 2.65	—	0.88 - 2.87	0.77 - 2.26
Average	2.04	2.02	—	1.99	2.26	2.00	—	2.07	1.49
Median	1.95	1.94	—	1.88	2.36	2.1	—	1.98	1.25
Relative Abundance Top 3 Taxa (Percent)									
Range	43.2 - 84.4	47.2 - 72.2	—	35.4 - 88.8	31.3 - 86.5	44.9 - 100	—	42.2 - 91.3	58.3 - 95.4
Average	66.6	61.8	—	65.0	57.0	65.6	—	63.4	81.7
Median	68.3	64.2	—	70.4	55.9	65.4	—	56.6	89.8
Relative Abundance EPT (Percent)									
Range	3.8 - 19.7	12.7 - 38.6	—	0 - 47.7	0 - 35.1	0 - 52.9	—	0 - 12.5	3.1 - 27.8
Average	9.4	24.6	—	8.2	4.9	5.8	—	3.8	12.0
Median	6.6	23.6	—	1.2	0.9	1.9	—	2.1	11.3
Relative Abundance Chironomids (Percent)									
Range	31.3 - 91.6	48.2 - 76.1	—	19 - 94.4	54.3 - 97.7	0 - 89.6	—	10.5 - 78	42.1 - 96.9
Average	69.4	62.9	—	63.2	85.7	65.1	—	49.4	79.3
Median	77.1	61.1	—	64.7	88.7	70.3	—	58.3	85.6

Table 5.1-13. 2013 overall summary of LWD (Snag) metrics for sites at River Productivity stations in Lower Reach downstream of confluence with Chulitna River.

Station	RP-81 (Montana Creek)			
Site	**81-1**	**81-2**	**81-3**	**81-4**
Habitat	**US**	**TM**	**MC**	**SC**
Number of Reps	12	15	4	15
Density (Individuals/m²)				
Range	0 - 1660.4	0 - 16002.4	21 - 213.3	23- 9624
Average	597.3	3347.3	93.7	1222.0
Median	247.1	1251.5	70.0	476.7
Taxa Richness (number)				
Range	0 - 23	0 - 31	2 - 8	4 - 29
Average	11.1	16.8	4.3	13.8
Median	10	16	3.5	12
EPT Taxa (number)				
Range	0 - 3	0 - 9	0 - 4	3 - 7
Average	0.6	3.1	1.8	4.4
Median	0	3	1.5	4
Chironomid Taxa (number)				
Range	0 - 18	0 - 18	0 - 4	0 - 19
Average	8.1	11.1	2.5	7.7
Median	6	12	3	6
Diversity (H')				
Range	0 - 2.58	0 - 2.82	0.41 - 1.58	1.32 - 2.72
Average	1.65	1.89	1.06	1.95
Median	2.14	2.06	1.13	1.82
Relative Abundance Top 3 Taxa (Percent)				
Range	0 - 100	0 - 91.2	78.8 - 100	42.1 - 87.5
Average	52.9	60.5	91.1	67.1
Median	50.0	61.5	92.9	71.4
Relative Abundance EPT (Percent)				
Range	0 - 21.4	0 - 73.6	0 - 100	15.1 - 100
Average	3.4	13.8	44.6	50.3
Median	0.0	9.4	39.2	46.1
Relative Abundance Chironomids (Percent)				
Range	0 - 87.7	0 - 89.5	0 - 100	0 - 76.2
Average	55.2	56.0	55.4	36.5
Median	79.2	65.2	60.8	39.7

Table 5.2-1. 2014 overall summary of drift and plankton metrics for sites at River Productivity stations in Middle Reach above Devils Canyon.

	Station	FA-184 (Watana Dam)				FA-173 (Stephan Lake Complex)				
	Site	184-1	184-2	184-3	184-4	173-1	173-2	173-3	173-4	173-5
Metric	Habitat	TM	SC	MC	MC/Above TM	TM	MC	SC	SS	US
Density (Individuals/ft³)	Range	0.22 - 4.27	0.03 - 2.12	0.03 - 0.86	0.138 - 1	0.09 - 1.07	0.05 - 0.65	0.29 - 13.3	0.13 - 12.6	0.4 - 137.7
	Average	1.66	0.82	0.30	0.43	0.42	0.29	2.49	3.18	43.82
	Median	1.37	0.58	0.19	0.36	0.36	0.26	0.60	1.28	31.22
Taxa Richness (number)	Range	13 - 60	23 - 39	25 - 51	18 - 46	24 - 54	36 - 57	5 - 47	2 - 18	12 - 30
	Average	35.3	30.2	36.0	35.7	38.8	42.8	20.9	7.4	20.2
	Median	33.00	30.00	35.00	37.00	40.50	39.50	12.00	5.00	21.00
EPT Taxa (number)	Range	3 - 8	2 - 8	2 - 9	0 - 7	3 - 7	4 - 7	0 - 10	0 - 1	0 - 1
	Average	5.7	4.8	5.0	4.5	5.2	5.5	2.7	0.1	0.1
	Median	5.50	4.50	4.50	5.00	5.50	5.00	1.00	0.00	0.00
Chironomid Taxa (number)	Range	4 - 34	5 - 27	10 - 24	9 - 25	9 - 25	12 - 31	2 - 16	1 - 10	8 - 17
	Average	18.2	14.2	16.2	15.3	16.8	20.3	8.2	4.7	11.8
	Median	15.50	13.00	15.50	15.50	18.00	19.00	7.00	4.00	12.00
Diversity (H')	Range	1.09 - 3.54	1.96 - 3	2.48 - 3.13	2.31 - 3.04	2.02 - 3.39	2.67 - 3.37	1.43 - 3.03	0.55 - 2.13	1.51 - 2.69
	Average	2.27	2.58	2.83	2.81	2.82	3.05	2.17	1.38	2.10
	Median	2.30	2.62	2.86	2.88	3.07	3.11	1.71	1.41	2.12
Relative Abundance Top 3 Taxa (Percent)	Range	26.7 - 85.5	29.7 - 68.6	40.4 - 54.1	37.8 - 57.7	30.1 - 71.9	27.9 - 50.3	37.5 - 79.3	60 - 100	47 - 80.7
	Average	59.0	50.5	45.4	46.0	44.6	39.3	60.6	80.7	63.6
	Median	60.07	51.41	44.03	44.68	35.74	39.95	71.43	82.26	61.59
Relative Abundance EPT (Percent)	Range	5.1 - 12.7	2.1 - 16.5	2.7 - 17.3	0 - 15.1	3.4 - 42.9	4.2 - 29.1	0 - 16.7	0 - 2.5	0 - 0.7
	Average	8.6	8.3	9.3	8.2	17.0	14.5	6.3	0.3	0.1
	Median	8.28	9.55	9.31	7.52	5.91	14.73	1.96	0.00	0.00
Relative Abundance Chironomids (Percent)	Range	11.2 - 91.5	8.7 - 84.6	15.6 - 81.6	17.8 - 85.5	20.8 - 74.3	14.4 - 82.5	47.1 - 72.5	19.4 - 100	29.4 - 97.3
	Average	58.6	52.6	49.7	49.6	53.8	47.5	57.4	60.0	62.4
	Median	72.81	64.88	50.58	45.67	60.27	48.97	57.66	50.00	61.59
Relative Abundance Zooplankton (Percent)	Range	0 - 1.8	0 - 51.7	2.7 - 40.1	0 - 36.5	0 - 5.8	0.4 - 40.1	0 - 28.6	0 - 10.8	0 - 16.8
	Average	0.7	13.4	17.4	15.4	1.2	14.2	9.3	1.6	5.2
	Median	0.31	3.01	10.19	13.26	0.31	7.28	5.88	0.00	4.35

Table 5.2-2. 2014 overall summary of drift and plankton metrics for sites at River Productivity stations in Middle Reach below Devils Canyon.

	Station	FA-141 (Indian River)					FA-104 (Whiskers Slough)					
	Site	141-1	141-2	141-3	141-4	141-5	104-1	104-2.1	104-2	104-3	104-4	104-5
Metric	Habitat	TM	SC	MC	US	MC/Above TM	TM	SS/Above TM	SS	MC	US	SC
Density (Individuals/ft^3)	Range	0.04 - 0.34	0.012 - 1.96	0.006 - 0.26	0.374 - 9.11	0.069 - 0.43	0.102 - 6.24	0.062 - 3.58	0.08 - 10.48	0.03 - 0.21	0.21 - 121.8	0.01 - 0.48
	Average	0.17	0.67	0.10	2.39	0.20	2.21	1.14	2.05	0.08	15.83	0.15
	Median	0.15	0.44	0.08	2.06	0.15	0.71	0.59	0.84	0.05	1.31	0.11
Taxa Richness (number)	Range	41 - 55	1 - 40	18 - 42	4 - 18	30 - 38	4 - 37	1 - 12	1 - 19	20 - 35	2 - 40	11 - 26
	Average	48.8	15.0	33.2	9.3	33.2	19.4	5.6	6.7	27.7	12.1	19.8
	Median	49.50	10.00	38.50	10.00	33.00	15.00	5.00	5.00	26.50	8.00	20.50
EPT Taxa (number)	Range	4 - 11	0 - 6	0 - 7	0 - 1	3 - 8	0 - 7	0 - 2	0 - 1	0 - 6	0 - 3	0 - 5
	Average	7.7	1.6	4.5	0.3	5.2	2.4	0.3	0.1	3.8	0.6	2.7
	Median	8.50	1.00	5.50	0.00	5.00	1.00	0.00	0.00	5.00	0.00	3.00
Chironomid Taxa (number)	Range	17 - 35	1 - 16	12 - 19	1 - 12	11 - 20	0 - 18	0 - 6	0 - 9	8 - 25	0 - 23	5 - 13
	Average	23.7	8.0	15.3	5.1	15.5	9.7	2.4	3.1	14.2	6.8	9.7
	Median	23.00	6.00	15.00	5.00	14.50	8.00	2.00	2.00	13.50	4.00	10.00
Diversity (H')	Range	3.01 - 3.3	0 - 3.2	2.68 - 3.02	1.13 - 2.45	2.33 - 3.07	1.32 - 3	0 - 2.27	0 - 2.12	1.81 - 3.13	0.56 - 3.26	2.27 - 2.79
	Average	3.15	2.06	2.84	1.81	2.61	2.17	1.20	1.42	2.52	1.76	2.53
	Median	3.13	2.24	2.85	1.69	2.52	2.10	1.39	1.45	2.71	1.75	2.59
Relative Abundance Top 3 Taxa (Percent)	Range	35.7 - 39.2	34.2 - 100	32.1 - 50.8	37.9 - 96.3	32.2 - 65	40 - 87.5	50 - 100	60.2 - 100	34.4 - 74	29 - 100	38.2 - 57.6
	Average	37.8	55.6	42.3	66.0	53.3	61.8	81.5	79.4	53.0	69.0	49.7
	Median	38.50	45.93	41.35	67.44	59.16	63.10	80.56	75.00	46.26	71.43	51.18
Relative Abundance EPT (Percent)	Range	8.7 - 40.5	0 - 16.9	0 - 16.7	0 - 33.3	8.1 - 13	0 - 36.8	0 - 11.1	0 - 1	0 - 15.2	0 - 28.6	0 - 36.4
	Average	21.5	5.2	9.1	2.9	9.6	9.5	1.4	0.1	8.2	3.9	13.4
	Median	13.64	4.17	8.11	0.00	8.39	5.23	0.00	0.00	9.34	0.00	7.95
Relative Abundance Chironomids (Percent)	Range	23.1 - 76.9	56.4 - 100	30.2 - 75.8	16 - 71.4	34.9 - 81.5	0 - 49.3	0 - 100	0 - 87.5	53.2 - 83.1	0 - 77.9	39.4 - 64.7
	Average	55.3	69.8	57.8	44.4	63.3	35.6	32.8	43.0	66.5	41.7	54.1
	Median	66.19	66.67	59.76	45.32	73.55	41.83	26.39	39.58	64.93	45.96	55.40
Relative Abundance Zooplankton (Percent)	Range	0 - 6.4	0 - 33.3	0 - 25.9	0 - 33.3	0 - 17.6	0 - 62.5	0 - 33.3	0 - 40.8	0 - 7.8	0 - 28.6	0 - 10.9
	Average	2.5	10.2	8.6	9.3	5.9	26.4	10.1	14.4	4.7	5.6	6.1
	Median	1.58	4.17	3.66	7.32	0.58	22.03	2.44	12.50	4.83	1.55	6.52

Table 5.2-3. 2014 overall summary of drift and plankton metrics for sites at River Productivity stations in Lower Reach downstream of confluence with Chulitna River.

	Station	RP-81 (Montana Creek)				
	Site	81-1	81-2	81-3	81-4	81-5
Metric	Habitat	US	TM	MC	SC	SC/Above TM
Density (Individuals/ft^3)	Range	0 - 52.83	0.13 - 0.97	0.05 - 0.19	0.001 - 0.04	0.011 - 0.15
	Average	16.26	0.33	0.11	0.02	0.08
	Median	13.97	0.21	0.10	0.03	0.09
Taxa Richness (number)	Range	0 - 19	31 - 49	30 - 56	4 - 32	22 - 36
	Average	8.2	40.7	43.0	19.3	30.0
	Median	7.00	42.50	44.00	20.50	31.50
EPT Taxa (number)	Range	0 - 1	4 - 11	3 - 8	1 - 6	2 - 5
	Average	0.1	7.8	5.3	3.5	3.7
	Median	0.00	8.00	5.00	4.00	4.00
Chironomid Taxa (number)	Range	0 - 9	12 - 25	15 - 19	2 - 14	10 - 17
	Average	4.1	18.3	17.5	9.8	14.0
	Median	4.00	18.50	18.00	12.00	14.00
Diversity (H')	Range	0 - 2.3	2.33 - 3.15	2.45 - 3.27	1.37 - 3.17	1.53 - 3.09
	Average	1.11	2.81	2.83	2.48	2.47
	Median	1.56	2.95	2.70	2.51	2.79
Relative Abundance Top 3 Taxa (Percent)	Range	0 - 100	29.1 - 58.4	34 - 57	29.4 - 80	31.4 - 79
	Average	75.5	44.5	48.7	49.5	52.4
	Median	77.11	44.30	54.99	44.19	44.29
Relative Abundance EPT (Percent)	Range	0 - 2.1	2.9 - 14.4	7.8 - 51.5	8.7 - 27.4	3.6 - 33.3
	Average	0.2	8.4	23.8	16.4	19.6
	Median	0.00	7.86	11.42	15.93	22.75
Relative Abundance Chironomids (Percent)	Range	0 - 100	56 - 84.8	21.1 - 44	46.7 - 62.3	22.5 - 60
	Average	41.3	71.1	36.2	54.7	38.2
	Median	48.51	72.14	41.89	55.38	36.05
Relative Abundance Zooplankton (Percent)	Range	0 - 98.7	0.4 - 10.4	0 - 9.3	0 - 6.7	1.5 - 22.4
	Average	33.7	4.2	3.6	2.5	7.6
	Median	3.23	4.34	3.12	1.93	5.64

Table 5.4-1. Summary of water temperature patterns across years and macrohabitat types. All metrics calculated from daily mean temperatures at each station.

Year	Habitat	Water temperature (°C)			
		Mean	Standard Deviation (SD)	Maximum	Minimum
2013	Main channel	10.7495	2.79168	16.8819	1.63667
2013	Side channel	9.67468	2.69146	17.2902	4.445
2013	Side slough	7.73464	3.45712	14.575	3.40771
2013	Trib mouth	10.2155	2.79093	15.8727	-0.014375
2013	Upland slough	9.45116	3.0383	15.9369	0.276667
2014	Main channel	10.1632	1.82555	13.8952	2.03036
2014	Side channel	9.24361	2.23946	14.0573	1.99793
2014	Side slough	6.44367	1.81087	12.7231	3.53593
2014	Trib mouth	8.93124	2.24914	15.0177	2.38571
2014	Upland slough	9.115	2.09717	14.1442	3.659

Table 5.4-2. Bioenergetics model results showing the growth, proportion of maximum consumption (P), growth efficiency of juvenile Chinook (SCK) and Coho (SCO) salmon. Consumption rates were estimated from observed growth between the spring and summer (Spr-Sum) sampling events and between the summer and fall events (Sum-Fal). Model inputs were pooled for combinations of main channel (MC), side channel (SC), side slough (SS), tributary mouth (TM), and upland slough (US) macrohabitats based on a statistical analysis of growth patterns. Growth of age-0 Coho Salmon did not differ among SC, SS, TM, and US habitats, so inputs were pooled across these habitat types (All).

Species	Age	Year	Interval	Habitats	Initial weight (g)	Final weight (g)	*P*, Pro-portion of maximum consum-ption	Growth efficiency (%)	Mean mass-specific consum-ption rate (g/g/d)	Mean mass-specific growth rate (g/g/d)
Chinook	0	2013	Spr-Sum	SS, TM, US	0.80	6.48	0.91	31%	31%	3.48%
Chinook	0	2013	Sum-Fal	SS, TM, US	6.48	7.20	0.52	15%	14%	0.31%
Chinook	0	2014	Spr-Sum	MC, SC	0.60	4.09	0.97	26%	24%	3.31%
Chinook	0	2014	Spr-Sum	SS, TM, US	0.60	2.89	1.12	23%	17%	2.72%
Chinook	0	2014	Sum-Fal	MC, SC	4.09	4.54	0.54	6%	17%	0.22%
Chinook	0	2014	Sum-Fal	SS, TM, US	2.89	3.36	0.55	9%	11%	0.32%
Coho	0	2013	Spr-Sum	SC, SS, TM, US	0.80	2.76	0.29	31%	11%	2.08%
Coho	0	2013	Sum-Fal	SC, SS, TM, US	2.76	3.36	0.18	23%	8%	0.57%
Coho	0	2014	Spr-Sum	SC, SS, TM, US	0.60	2.57	0.40	27%	13%	2.52%
Coho	0	2014	Sum-Fal	SC, SS, TM, US	2.57	2.71	0.17	4%	8%	0.12%
Coho	1	2013	Spr-Sum	SC, TM	4.88	9.27	0.26	27%	28%	1.08%
Coho	1	2013	Spr-Sum	SS, US	4.97	7.13	0.26	14%	25%	0.61%
Coho	1	2013	Sum-Fal	SS, US	7.13	8.32	0.25	19%	19%	0.45%
Coho	1	2014	Spr-Sum	SC, TM	4.53	9.20	0.38	20%	40%	1.23%
Coho	1	2014	Spr-Sum	SS, US	5.97	6.81	0.23	7%	20%	0.23%
Coho	1	2014	Sum-Fal	SS, US	6.81	6.30	0.13	-11%	10%	-0.17%

Table 5.4-3. Growth rate potential model results showing physical parameters and drift invertebrate biomass density measured at each sampling event, as well as simulated daily ration, growth rate potential, and proportion of maximum consumption (*P*) of age-1 Coho Salmon under the observed conditions. Habitat types abbreviated as main channel (MC), side channel (SC), side slough (SS), tributary mouth (TM). Bold text indicates sites with positive growth rate potential values.

Site	Habitat	Year	Season	Tempera-ture (ºC)	Drift Invert. Biomass Density (mg dry / m² / sec)	Velocity (m/s)	Turbidity (NTU)	Daily Ration (g wet)	Growth rate potential (g / g / day)	P
RP-184-1	TM	2013	Spring	11.3	0.51	0.51	0.59	0.00	-1.5%	0.00
RP-184-1	TM	2013	Summer	7.9	0.28	0.46	34	0.00	-1.1%	0.00
RP-184-1	**TM**	**2014**	**Spring**	**6.3**	**5.91**	**0.38**	**1.04**	**9.41**	**2.2%**	**1.00**
RP-184-1	**TM**	**2014**	**Fall**	**3.6**	**2.52**	**0.35**	**1.54**	**4.48**	**0.7%**	**1.00**
RP-184-2	**SC**	**2014**	**Spring**	**9.3**	**2.34**	**0.30**	**45.9**	**1.51**	**3.8%**	**1.00**
RP-184-2	SC	2014	Summer	10.5	0.13	0.42	59.7	0.00	-1.4%	0.00
RP-184-3	MC	2014	Spring	9.4	0.31	0.52	35.1	0.00	-1.3%	0.00
RP-184-3	MC	2014	Summer	11.0	0.32	0.45	61.1	0.00	-1.4%	0.00
RP-184-3	MC	2014	Fall	6.6	0.59	0.48	9.58	0.00	-1.0%	0.00
RP-173-1	**TM**	**2013**	**Spring**	**10.5**	**0.18**	**0.32**	**7.9**	**0.42**	**1.5%**	**0.47**
RP-173-1	TM	2014	Spring	6.9	0.71	0.69	3.53	0.00	-1.0%	0.00
RP-173-1	TM	2014	Summer	8.9	0.25	0.87	1.27	0.00	-1.2%	0.00
RP-173-1	TM	2014	Fall	3.5	2.57	0.98	2	0.00	-0.8%	0.00
RP-173-2	MC	2013	Spring	13.0	0.38	0.52	19	0.00	-1.7%	0.00
RP-173-2	MC	2013	Summer	8.5	0.54	0.69	68.2	0.00	-1.2%	0.00
RP-173-3	**SC**	**2013**	**Spring**	**6.3**	**0.15**	**0.30**	**1.07**	**1.04**	**2.3%**	**1.00**
RP-173-3	**SC**	**2014**	**Spring**	**6.3**	**0.85**	**0.32**	**0.59**	**6.34**	**2.2%**	**1.00**
RP-173-3	SC	2014	Summer	7.7	1.04	0.50	3.09	0.00	-1.1%	0.00
RP-141-1	TM	2013	Spring	9.3	2.88	0.90	0.02	0.00	-1.2%	0.00
RP-141-1	TM	2013	Summer	8.8	0.85	0.75	0.95	0.00	-1.2%	0.00
RP-141-1	**TM**	**2013**	**Fall**	**7.4**	**1.14**	**0.34**	**0.69**	**3.50**	**2.9%**	**1.00**
RP-141-1	**TM**	**2014**	**Spring**	**8.0**	**0.43**	**0.35**	**0.63**	**2.08**	**3.3%**	**1.00**
RP-141-1	**TM**	**2014**	**Summer**	**9.6**	**0.63**	**0.40**	**2.32**	**0.20**	**0.1%**	**0.24**
RP-141-1	TM	2014	Fall	6.1	0.67	0.59	5.26	0.00	-0.9%	0.00
RP-141-2	SC	2013	Spring	11.8	0.42	0.38	99	0.02	-1.4%	0.02
RP-141-2	SC	2013	Summer	8.4	0.03	0.30	16	0.03	-0.9%	0.05
RP-141-3	MC	2013	Spring	12.0	0.03	0.52	106	0.00	-1.6%	0.00
RP-141-3	MC	2013	Summer	9.4	0.19	0.61	24	0.00	-1.3%	0.00
RP-141-3	MC	2014	Spring	9.8	0.01	0.32	21.7	0.01	-1.2%	0.01
RP-141-3	MC	2014	Summer	11.7	0.21	0.43	47	0.00	-1.5%	0.00
RP-141-3	MC	2014	Fall	5.3	0.27	0.49	13.3	0.00	-0.9%	0.00

Table 5.4-3 (cont.). Growth rate potential model results showing physical parameters and drift invertebrate biomass density measured at each sampling event, as well as simulated daily ration, growth rate potential, and proportion of maximum consumption (*P*) of age-1 Coho Salmon under the observed conditions. Habitat types abbreviated as main channel (MC), side channel (SC), side slough (SS), tributary mouth (TM). Bold text indicates sites with positive growth rate potential values.

Site	Habitat	Year	Season	Tempera-ture (ºC)	Drift Invert. Biomass Density (mg dry / m² / sec)	Velocity (m/s)	Turbidity (NTU)	Daily Ration (g wet)	Growth rate potential (g / g / day)	P
RP-104-2	SS	2013	Spring	12.5	0.70	0.46	46	0.00	-1.6%	0.00
RP-104-3	MC	2013	Spring	14.4	0.24	0.69	115	0.00	-2.0%	0.00
RP-104-3	MC	2013	Summer	9.6	0.12	0.37	600	0.01	-1.2%	0.01
RP-104-3	MC	2014	Summer	12.4	0.12	0.32	45.7	0.05	-1.2%	0.06
RP-104-3	MC	2014	Fall	6.8	0.26	0.46	27.1	0.00	-1.0%	0.00
RP-104-5	SC	2013	Spring	14.4	0.24	0.43	111	0.00	-1.9%	0.00
RP-104-5	**SC**	**2014**	**Spring**	**10.2**	**0.46**	**0.32**	**15.7**	**0.67**	**3.0%**	**0.77**
RP-104-5	SC	2014	Fall	7.8	0.20	0.30	46.5	0.07	-0.6%	0.11
RP-81-2	TM	2013	Spring	11.3	0.60	0.69	0.41	0.00	-1.5%	0.00
RP-81-2	TM	2013	Fall	6.5	0.09	0.62	1.18	0.00	-1.0%	0.00
RP-81-2	TM	2014	Summer	13.0	0.38	0.59	1.52	0.00	-1.7%	0.00
RP-81-2	**TM**	**2014**	**Fall**	**9.5**	**0.49**	**0.30**	**2.96**	**1.31**	**3.8%**	**1.00**
RP-81-3	MC	2013	Summer	9.5	0.11	0.35	66	0.02	-1.1%	0.02
RP-81-3	MC	2014	Spring	10.5	0.13	0.44	35.1	0.00	-1.4%	0.00
RP-81-3	MC	2014	Fall	7.8	0.55	0.40	16	0.03	-0.9%	0.04
RP-81-4	SC	2013	Summer	9.6	0.45	0.79	85	0.00	-1.3%	0.00
RP-81-4	SC	2014	Spring	9.7	0.06	0.47	49	0.00	-1.3%	0.00
RP-81-4	SC	2014	Summer	10.4	0.16	0.34	35	0.07	-0.9%	0.08

Table 5.4-4. Results of MixSIAR Bayesian stable isotope diet models performed for juvenile Chinook and Coho salmon, and Arctic Grayling and the potential freshwater, marine, and terrestrial prey categories for all study sites with sufficient sample size (n > 2) in the Spring 2014 sampling event.

Season	Sampling Site	Macrohabitat type	Consumer species (n)	Mean % contribution (2.5%, 97.5% CI)		
				Freshwater	Marine	Terrestrial
Spring	184-3	Side channel	SCK (3)	70.0 (37.1, 94.8)	12.6 (0.5, 40.8)	17.4 (0.7, 48.6)
			GRA (7)	78.5 (61.6, 93.0)	6.3 (0.4, 14.9)	15.2 (2.9, 31.0)
	RP-141-1	Tributary mouth	SCO (5)	61.3 (39.3, 80.9)	17.6 (4.9, 30.1)	21.1 (5.3, 41.6)
	RP-141-2	Side channel	SCK (4)	57.7 (24.3, 86.8)	10.1 (0.4, 32.5)	32.2 (6.6, 67.6)
	RP-141-3	Main channel	SCK (8)	73.1 (48.1, 92.8)	10.1 (0.7, 21.7)	16.8 (1.9, 40.6)
			GRA (3)	63.4 (29.7, 90.7)	13.1 (0.9, 29.8)	23.6 (2.1, 54.8)
	RP-104-1	Tributary mouth	SCK (6)	58.1 (43.6, 73.8)	17.0 (6.8, 26.1)	24.8 (11.7, 39.7)
			SCO (10)	61.3 (48.3, 75.5)	14.3 (6.1, 22.3)	24.4 (12.7, 37.3)
	RP-104-2	Side slough	SCO (5)	57.3 (33.9, 79.4)	15.3 (1.8, 29.6)	27.4 (7.0, 55.4)
	RP-104-4	Upland slough	SCO (4)	68.6 (51.9, 83.9)	23.0 (8.6, 33.6)	8.4 (0.5, 24.7)
	RP-104-5	Side channel	SCO (3)	57.9 (14.8, 91.5)	21.6 (0.9, 63.8)	20.5 (0.6, 62.1)
	RP-81-1	Upland slough	SCO (6)	66.7 (42.8, 92.9)	19.1 (0.6, 40.7)	14.2 (0.7, 38.8)
	RP-81-2	Tributary mouth	SCO (4)	69.7 (37.5, 93.2)	14.3 (0.9, 37.9)	16.0 (1.1, 45.4)
	RP-81-3	Main channel	SCK (3)	64.0 (27.0, 93.1)	12.9 (0.3, 43.6)	23.2 (1.6, 60.0)
			SCO (6)	64.9 (33.8, 90.0)	10.1 (0.4, 30.2)	25.0 (4.1, 56.1)
	RP-81-4	Side channel	SCK (5)	62.8 (32.9, 89.7)	13.2 (0.5, 32.4)	24.0 (3.1, 56.1)

Table 5.4-5. Results of MixSIAR Bayesian stable isotope diet models performed for juvenile Chinook and Coho salmon, and Arctic Grayling and the potential freshwater, marine, and terrestrial prey categories for all study sites with sufficient sample size (n > 2) in the Summer 2014 sampling event.

Season	Sampling Site	Macrohabitat type	Consumer species (n)	Mean % contribution (2.5%, 97.5% CI)		
				Freshwater	Marine	Terrestrial
Summer	RP-184-1	Tributary mouth	GRA (6)	67.5 (30.4, 93.6)	5.9 (0.1, 22.8)	26.6 (2.5, 62.8)
	RP-184-2	Main channel	GRA (6)	56.3 (29.3, 80.6)	9.5 (0.8, 19.8)	34.2 (11.9, 62.4)
	RP-184-3	Side channel	GRA (5)	72.7 (42.3, 94.3)	9.3 (0.5, 26.5)	17.9 (1.5, 47.1)
	RP-141-1	Tributary mouth	SCK (7)	62.9 (39.4, 87.7)	12.0 (4.0, 20.5)	25.1 (3.9, 46.9)
	RP-141-2	Side channel	SCK (8)	53.2 (30.9, 79.7)	7.8 (0.5, 17.3)	39.0 (13.3, 63.9)
	RP-141-3	Main channel	SCK (8)	43.8 (24.0, 64.0)	14.7 (4.1, 24.2)	41.5 (21.3, 65.1)
	RP-141-4	Upland slough	SCK (5)	61.6 (38.8, 83.2)	26.6 (5.3, 41.6)	11.8 (0.5, 35.9)
	RP-104-1	Tributary mouth	SCO (6)	53.4 (34.9, 73.5)	6.0 (0.2, 16.9)	40.6 (19.5, 61.3)
	RP-104-3	Main channel	SCK (10)	65.6 (46.4, 82.9)	8.4 (1.0, 17.4)	26.0 (8.1, 46.9)
	RP-104-4	Upland slough	SCO (8)	67.7 (47.1, 88.8)	3.9 (0.1, 12.6)	28.4 (7.5, 50.2)
			SCK (5)	75.9 (53.4, 95.5)	3.5 (0.1, 12.7)	20.6 (1.5, 44.0)
	RP-104-5	Side channel	SCO (4)	71.1 (39.1, 95.4)	16.5 (0.6, 39.2)	12.4 (0.3, 42.2)
			SCK (8)	50.1 (25.5, 73.8)	5.8 (0.3, 13.9)	44.1 (20.9, 68.9)
	RP-81-1	Upland slough	SCO (8)	58.3 (35.5, 86.6)	16.0 (1.0, 33.4)	25.6 (4.4, 51.0)
			SCK (4)	45.6 (15.7, 83.0)	17.9 (0.4, 44.2)	36.5 (7.5, 69.2)
	RP-81-2	Tributary mouth	SCO (6)	68.0 (42.9, 90.5)	8.9 (0.6, 20.2)	23.1 (4.5, 47.9)
			SCK (6)	54.3 (26.7, 87.0)	7.1 (0.3, 19.3)	38.6 (7.3, 66.8)
	RP-81-3	Main channel	SCK (8)	64.2 (40.7, 84.3)	5.4 (0.3, 14.1)	30.3 (11.8, 54.8)
	RP-81-4	Side channel	SCK (3)	52.1 (17.3, 85.6)	12.4 (0.3, 45.4)	35.5 (6.4, 72.3)

Table 5.4-6. Results of MixSIAR Bayesian stable isotope diet models performed for juvenile Chinook and Coho salmon, and Arctic Grayling and the potential freshwater, marine, and terrestrial prey categories for all study sites with sufficient sample size (n > 2) in the Fall 2014 sampling event.

Season	Sampling Site	Macrohabitat type	Consumer species (n)	Mean % contribution (2.5%, 97.5% CI)		
				Freshwater	Marine	Terrestrial
Fall	RP-184-1	Tributary mouth	GRA (6)	46.2 (19.2, 74.7)	6.3 (0.2, 21.3)	47.5 (17.5, 76.2)
	RP-141-1	Tributary mouth	SCK (7)	59.4 (40.5, 77.4)	31.3 (18.4, 42.2)	9.2 (0.3, 26.9)
	RP-141-2	Side channel	SCK (8)	74.4 (44.0, 96.0)	4.4 (0.1, 18.1)	21.2 (1.5, 53.9)
	RP-141-3	Main channel	SCK (8)	74.5 (47.5, 94.6)	7.0 (0.2, 18.3)	18.5 (1.5, 45.7)
	RP-141-4	Upland slough	SCK (3)	34.4 (5.7, 72.8)	38.6 (8.5, 76.7)	27.0 (2.8, 66.1)
	RP-104-1	Tributary mouth	SCO (8)	64.5 (43.1, 87.3)	6.7 (0.3, 18.6)	28.8 (6.5, 52.7)
			SCK (8)	69.6 (45.5, 90.2)	5.8 (0.2, 16.9)	24.7 (4.4, 51.2)
	RP-104-2	Side slough	SCO (8)	51.1 (3.0, 70.2)	23.5 (10.2, 40.3)	25.4 (6.1, 51.2)
	RP-104-3	Main channel	SCK (4)	66.7 (36,0, 92.1)	13.5 (1.0, 30.6)	19.8 (1.9, 48.5)
	RP-104-4	Upland slough	SCO (8)	69.5 (48.2, 90.3)	9.3 (1.4, 18.6)	21.2 (3.3, 42.7)
	RP-104-5	Side channel	SCO (4)	55.8 (20.1, 88.1)	12.2 (0.4, 33.5)	31.9 (6.4, 64.1)
			SCK (8)	53.3 (26.9, 80.7)	11.7 (0.7, 23.5)	35.0 (12.8, 57.9)
	RP-81-1	Upland slough	SCO (12)	45.3 (28.5, 64.9)	24.4 (11.9, 36.1)	30.2 (13.4, 48.8)
	RP-81-3	Main channel	SCK (3)	61.2 (23.0, 91.0)	17.8 (1.9, 40.6)	21.0 (0.9, 57.1)
	RP-81-4	Side channel	SCK (8)	40.0 (8.3, 78.5)	8.2 (0.1, 36.9)	51.7 (16.6, 85.3)

Table 5.5-1. MANCOVA models testing for ontogenetic, temporal, and spatial differences in diet composition. Degrees of freedom (df) are listed for both hypothesis (hyp) and error terms. Type-II *p*-values are reported.

Factor	Levels	Hyp df	Error df	Wilk's lambda	*F*	*P*
Arctic grayling (small; ≤ 120 mm FL)						
Fork length (covariate)	50-120 mm	4	38	0.878	1.325	0.2784
Season	Spring, Summer, Fall	8	76	0.525	3.609	0.0013
Focus Area	RP-184, RP-173, RP-104, RP-81	12	101	0.492	2.587	0.0049
Habitat	MC, SC, SS, TM	12	101	0.734	1.044	0.4154
Arctic grayling (large; > 120 mm FL)						
Fork length (covariate)	124-394 mm	4	46	0.954	0.555	0.6963
Season	Spring, Summer, Fall	8	92	0.612	3.206	0.0030
Focus Area	RP-184, RP-173, RP-141, RP-104, RP-81	16	141	0.612	1.540	0.0937
Habitat	MC, SC, TM	8	92	0.736	1.904	0.0686
Chinook Salmon						
Fork length (covariate)	50-133 mm	5	181	0.995	0.181	0.9696
Year	2013, 2014	5	181	0.930	2.734	0.0208
Season	Spring, Summer, Fall	10	362	0.745	5.736	<0.0001
Focus Area	RP-184, RP-173, RP-141, RP-104, RP-81	20	601	0.841	1.612	0.0448
Habitat	MC, SC, SS, TM, US	20	601	0.823	1.816	0.0163
Coho salmon						
Fork length (covariate)	48-165 mm	5	233	0.795	11.996	<0.0001
Year	2013, 2014	5	233	0.895	5.494	<0.0001
Season	Spring, Summer, Fall	10	466	0.751	7.179	<0.0001
Focus Area	RP-141, RP-104, RP-81	10	466	0.851	3.906	<0.0001
Habitat	MC, SC, SS, TM, US	20	774	0.769	3.189	<0.0001
Rainbow trout (large; > 120 mm FL)*						
Fork length (covariate)	121-490 mm	5	30	0.865	0.933	0.4737
Season	Spring, Summer, Fall	10	60	0.363	3.952	0.0004
Focus Area	RP-141, RP-104, RP-81	10	60	0.345	4.212	0.0002
Habitat	SS, TM, US	10	60	0.645	1.470	0.1731

*Note. Small rainbow trout (≤ 120 mm fork length) were not captured in sufficient numbers for statistical analysis (n = 7 non-empty stomachs).

Table 5.6-1. Overall summary of benthic organic matter components collected for 2013 sampling over three sampling events (Spring, Summer, Fall) and Post-Storm sampling for sites in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Site	Macro-habitat	Sampling Device	Benthic CPOM (g/m²)			Benthic FPOM (g/m²)			Total Benthic OM (g/m²)		
			Range	Average	Median	Range	Average	Median	Range	Average	Median
RP-184	All		0 - 15.8	3.2	1.7	0 - 14	4.7	3.0	0.7 - 26.5	7.9	6.6
RP-184-1	TM	Hess	0 - 13.1	2.4	0.9	0.2 - 8.7	3.1	2.7	0.7 - 16.5	5.6	5.1
RP-184-2	SC	Hess	0 - 15.8	3	1.4	0 - 12.6	4.2	3.0	1.7 - 17.2	7.2	6.8
RP-184-3	MC	Hess	0 - 14.2	4.2	2.7	0.3 - 14	6.6	7.9	1.8 - 26.5	10.8	7.9
RP-173	All		0 - 53	5.4	0.0	0 - 76.2	9.2	5.3	0 - 100.3	14.6	10.3
RP-173-1	TM	Hess	0 - 28	8.9	8.5	0.5 - 24.5	7.3	6.5	3 - 38.4	16.2	13.9
RP-173-2	MC	Hess	0 - 21.7	6.4	5.1	0.2 - 19.5	5.7	3.1	5.3 - 22.9	12.1	10.5
RP-173-3	SC	Hess	0 - 8.2	1.7	0.0	0.5 - 14.9	4.5	3.2	2 - 14.9	6.2	5.2
RP-173-4	SS	Hess & P. Ponar	0 - 53	5	0.0	0 - 76.2	13.4	7.0	0 - 100.3	18.4	12.3
RP-141	All		0 - 236.5	16.1	0.0	0.2 - 161.9	21.4	6.8	0.9 - 357.4	37.4	10.8
RP-141-1	TM	Hess	0 - 24.8	4	0.0	0.2 - 12.7	4.6	3.8	1 - 27.8	8.6	7.0
RP-141-2	SC	Hess & P. Ponar	0 - 120.9	12.7	0.0	1.9 - 73.3	13.3	6.2	1.9 - 150.7	25.9	13.1
RP-141-3	MC	Hess	0 - 2	0.3	0.0	0.4 - 12.8	3.7	1.6	0.9 - 12.8	4.1	1.8
RP-141-4	US	Hess & P. Ponar	0 - 236.5	33.4	2.6	1.2 - 161.9	44.9	37.2	4.1 - 357.4	78.3	52.1
RP-104	All		0 - 111.9	8.4	0.0	0 - 680.3	29.8	7.4	0.8 - 680.3	38.2	13.3
RP-104-1	TM/SS	Hess	0 - 24.3	4.4	0.0	1.3 - 56.6	13.1	6.8	3.6 - 56.6	17.5	13.9
RP-104-2	SS	Hess & P. Ponar	0 - 76.2	14.9	0.0	3 - 71	19.2	13.5	3.5 - 136.1	34.1	21.7
RP-104-3	MC	Hess	0 - 111.9	12.2	2.4	0.3 - 32.6	8.6	2.6	2.1 - 117.5	20.8	10.0
RP-104-4	US	P. Ponar	0 - 29.8	6.8	0.0	0.8 - 680.3	106.6	10.2	0.8 - 680.3	113.3	31.6
RP-104-5	SC	Hess	0 - 4	0.8	0.0	0 - 21	6.5	3.4	1.1 - 21	7.3	4.6
RP-81	All		0 - 58	8.5	3.8	0.2 - 275.6	23.8	6.4	1.5 - 275.6	32.3	15.6
RP-81-1	US	Hess & P. Ponar	0 - 58	14.2	14.1	5.8 - 275.6	74.1	46.9	22.7 - 275.6	88.2	60.3
RP-81-2	TM	Hess	0 - 32.9	10	4.0	0.7 - 25.9	8.7	5.4	5.4 - 46.4	18.7	16.8
RP-81-3	MC	Hess	0 - 24.9	7	4.6	0.4 - 40.1	7.7	1.7	3 - 40.1	14.8	15.0
RP-81-4	SC	Hess	0 - 9.9	2.8	1.8	0.2 - 13.4	4.8	4.3	1.5 - 14	7.6	7.2
RP-TKA	All		0 - 434.9	20.7	0.0	0.5 - 503.8	33.2	7.2	1 - 618.7	53.9	15.1
RP-TKA-1	SC	Hess	0 - 27	4.1	0.0	0.5 - 15.3	4.6	3.7	1 - 28.9	8.6	5.5
RP-TKA-2	US	P. Ponar	0 - 434.9	45.7	12.5	5.9 - 503.8	87.5	50.8	7.2 - 618.7	133.2	83.5
RP-TKA-3	SS	Hess	0 - 99	12.4	0.0	1.4 - 20.9	7.4	5.5	1.7 - 101.8	19.9	13.4

Table 5.6-2. Overall summary of drift (seston) organic matter components collected for 2013 sampling over three sampling events (Spring, Summer, Fall) and Post-Storm sampling for sites in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Site	Macrohabitat	Seston CPOM (mg/ft^3)			Seston FPOM (mg/ft^3)			Total Seston OM (mg/ft^3)		
		Range	Average	Median	Range	Average	Median	Range	Average	Median
RP-184	All	0 - 3.5	1.34	1.42	0 - 16.4	1.83	0.83	0.08 - 16.4	3.18	2.99
RP-184-1	TM	0 - 3.5	1.56	1.68	0 - 2	0.51	0.11	0.08 - 3.7	2.07	2.44
RP-184-2	SC	0 - 3	1.27	1.06	0.4 - 1.6	0.98	0.95	0.81 - 4.6	2.25	1.58
RP-184-3*	MC	0 - 2.4	1.2	1.36	0.55 - 16.4	4	1.71	1.36 - 16.4	5.20	3.16
RP-173	All	0 - 14.9	2.99	0.37	0.07 - 12.8	1.69	0.31	0.11 - 27.7	4.68	1.31
RP-173-1	TM	0 - 4	1.86	1.88	0.07 - 5.3	1.15	0.29	0.15 - 5.3	3.01	3.56
RP-173-2*	MC	0 - 14.9	6.12	4.11	0.32 - 12.8	3.23	1.16	0.61 - 27.7	9.35	5.02
RP-173-3	SC	0 - 0	0	0.00	0.11 - 0.2	0.18	0.18	0.11 - 0.2	0.18	0.18
RP-173-4	SS	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK
RP-141	All	0 - 8.3	2.26	1.08	0.11 - 6.1	1.57	1.13	0.38 - 9.8	3.83	4.07
RP-141-1	TM	0 - 8.3	2.65	1.08	0.54 - 6.1	2.2	1.15	1.52 - 9.8	4.85	4.89
RP-141-2	SC	0.33 - 3.7	2.01	2.01	0.24 - 1.2	0.73	0.73	0.57 - 4.8	2.74	2.80
RP-141-3	MC	0 - 6.1	2.7	2.81	0.81 - 4.7	1.98	1.46	1.28 - 8.8	4.68	4.75
RP-141-4	US	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK
RP-141-5*	MC, Above TM	0.21 - 0.3	0.26	0.26	0.11 - 0.2	0.14	0.14	0.38 - 0.4	0.4	0.40
RP-104	All	0 - 13.9	3.46	2.44	0 - 6.2	1.66	1.57	0 - 16	5.12	4.50
RP-104-1	TM/SS	0 - 7.5	1.59	0.00	0 - 0.1	0.07	0.08	0 - 7.6	1.66	0.09
RP-104-2*	SS	4.81 - 13.9	9.38	9.38	1.73 - 2	1.87	1.87	6.53 - 16	11.24	11.24
RP-104-3	MC	0 - 8.3	3.82	3.68	0.48 - 6.2	3.07	3.07	0.69 - 13.2	6.88	6.92
RP-104-4	US	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK
RP-104-5	SC	1.08 - 4.4	2.78	2.79	1.05 - 2.6	1.83	1.85	2.13 - 6.4	4.61	4.94
RP-81	All	0 - 9.5	1.95	1.05	0.02 - 6.1	1.51	0.69	0.19 - 12.9	3.46	1.40
RP-81-1	US	0.15 - 0.2	0.18	0.18	0.03 - 0	0.04	0.04	0.19 - 0.2	0.21	0.21
RP-81-2	TM	0 - 1	0.46	0.42	0.33 - 0.7	0.46	0.38	0.68 - 1.3	0.92	0.83
RP-81-3	MC	0.25 - 9.5	2.58	1.14	0.27 - 3.4	1.49	0.75	0.52 - 12.9	4.08	1.88
RP-81-4	SC	0.17 - 6	2.91	3.27	0.02 - 6.1	2.66	2.90	0.19 - 12.1	5.57	6.53
RP-81-5*	SC, Above TM	0.39 - 5.5	1.93	1.25	0.12 - 4.7	1.57	1.06	0.85 - 10.3	3.5	2.49
RP-TKA	All	0 - 5.2	1.65	1.15	0.05 - 4.5	1.26	0.58	0.05 - 7.6	2.90	2.59
RP-TKA-1	SC	0 - 4.4	2.01	2.20	0.71 - 4.5	2.27	1.67	1.1 - 7.6	4.28	4.40
RP-TKA-2	US	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK	_PK
RP-TKA-3	SS	0 - 5.2	1.29	0.21	0.05 - 0.5	0.24	0.22	0.05 - 5.5	1.53	0.65

Table 5.6-3. Overall summary of drift (seston) organic matter components collected for 2014 sampling over three sampling events (Spring, Summer, Fall) and Post-Storm sampling for sites in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Site	Macrohabitat	Seston CPOM (mg/ft^3)			Seston FPOM (mg/ft^3)			Total Seston OM (mg/ft^3)		
		Range	Average	Median	Range	Average	Median	Range	Average	Median
RP-184	All	0.05 - 23.7	3.09	0.83	0.06 - 31	3.35	0.92	0.11 - 42.3	6.44	2.13
RP-184-1	TM	0.05 - 23.7	5.16	1.55	0.06 - 10.7	2.04	0.19	0.11 - 34.4	7.2	2.13
RP-184-2	SC	0.32 - 11.3	2.29	0.51	0.49 - 31	5.77	0.81	1.01 - 42.3	8.06	1.30
RP-184-3	MC	0.36 - 1.8	0.84	0.62	0.41 - 3.6	1.6	1.39	0.92 - 5.4	2.43	2.03
RP-184-4	MC, Above TM	0.85 - 9.3	4.07	3.86	0.46 - 17.7	3.99	1.18	1.75 - 27	8.07	4.86
RP-173	All	0.02 - 7.1	1.12	0.23	0.02 - 2.7	0.49	0.19	0.04 - 7.4	1.61	0.61
RP-173-1	TM	0.05 - 7.1	2.62	1.68	0.12 - 0.6	0.3	0.27	0.17 - 7.4	2.92	2.16
RP-173-2	MC	0.15 - 3.1	0.85	0.39	0.3 - 2.7	1.24	1.04	0.46 - 5.9	2.09	1.35
RP-173-3	SC	0.02 - 0.1	0.06	0.07	0.02 - 0.1	0.05	0.04	0.04 - 0.2	0.12	0.11
RP-173-4	SS	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK
RP-173-5*	US	0.13 - 0.5	0.3	0.28	0.03 - 0.2	0.1	0.10	0.17 - 0.7	0.4	0.38
RP-141	All	0.08 - 9.2	1.51	0.61	0.16 - 23	2.13	0.54	0.25 - 32.2	3.64	1.35
RP-141-1	TM	0.2 - 1.6	0.95	0.98	0.19 - 0.6	0.37	0.32	0.47 - 2.1	1.32	1.35
RP-141-2	SC	0.08 - 9.2	4.26	3.90	0.16 - 23	8.53	5.47	0.25 - 32.2	12.79	9.37
RP-141-3	MC	0.19 - 0.7	0.44	0.52	0.22 - 2.1	0.93	0.50	0.43 - 2.8	1.37	0.95
RP-141-4	US	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK
RP-141-5	MC, Above TM	0.23 - 4.5	1.32	0.46	0.42 - 1.4	0.82	0.63	0.66 - 6	2.14	1.40
RP-104	All	0.06 - 4.1	1.35	0.93	0.18 - 4.9	1.51	1.17	0.63 - 8	2.87	2.10
RP-104-1	TM/SS	1.63 - 4.1	3.18	3.49	0.53 - 2.9	1.29	0.88	2.35 - 6.1	4.47	4.72
RP-104-2	SS	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK
RP-104-3	MC	0.3 - 0.9	0.71	0.75	0.83 - 1.8	1.27	1.26	1.13 - 2.5	1.99	2.10
RP-104-4	US	0.95 - 1	0.98	0.98	0.18 - 0.2	0.19	0.19	1.14 - 1.2	1.17	1.17
RP-104-5	SC	0.06 - 3.2	0.9	0.28	0.5 - 4.9	2.34	1.43	0.63 - 8	3.24	1.68
RP-81	All	0.1 - 2.1	0.76	0.55	0.06 - 2.6	0.76	0.43	0.28 - 4.3	1.52	1.08
RP-81-1	US	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK	–PK
RP-81-2	TM	0.15 - 2.1	0.9	0.67	0.22 - 2.6	1.11	0.86	0.38 - 4.3	2.01	1.53
RP-81-3	MC	0.27 - 2.1	1.01	0.95	0.23 - 0.8	0.37	0.28	0.71 - 2.4	1.39	1.23
RP-81-4	SC	0.1 - 1.1	0.46	0.34	0.1 - 2.4	0.87	0.43	0.28 - 3.5	1.32	0.77
RP-81-5	SC, Above TM	0.23 - 1.8	0.66	0.47	0.06 - 1.7	0.71	0.71	0.29 - 2.8	1.37	1.08

* Upland Slough located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.6-4. Summary of mean values of benthic organic matter components collected for 2013 sampling over three sampling events (Spring, Summer, Fall) and Post-Storm sampling for sites in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

			Spring			Summer			Post Storm			Fall		
Site	Macro-habitat	Sampling Device	Benthic CPOM (g/m^2)	Benthic FPOM (g/m^2)	Total Benthic OM (g/m^2)	Benthic CPOM (g/m^2)	Benthic FPOM (g/m^2)	Total Benthic OM (g/m^2)	Benthic CPOM (g/m^2)	Benthic FPOM (g/m^2)	Total Benthic OM (g/m^2)	Benthic CPOM (g/m^2)	Benthic FPOM (g/m^2)	Total Benthic OM (g/m^2)
RP-184-1	TM	Hess	–	–	5.49	4.88	3.58	8.46	–	–	–	2.37	0.39	2.76
RP-184-2	SC	Hess	–	–	6.69	3.82	5.15	8.97	–	–	–	5.23	0.78	6.01
RP-184-3	MC	Hess	–	–	8.18	9.74	10.98	20.72	–	–	–	2.97	0.67	3.64
RP-173-1	TM	Hess	–	–	12.56	15.92	8.13	24.05	–	–	–	10.70	1.15	11.85
RP-173-2	MC	Hess	–	–	12.34	9.03	4.01	13.03	–	–	–	10.14	0.69	10.83
RP-173-3	SC	Hess	–	–	9.37	2.10	3.09	5.19	–	–	–	2.97	0.99	3.97
RP-173-4	SS	Hess	–	–	9.35	5.46	3.82	9.28	7.17	6.85	14.02	8.69	1.68	10.37
RP-173-4	SS	P. Ponar	–	–	26.33	0.89	15.31	16.20	14.51	34.31	48.82	5.62	2.66	8.27
RP-141-1	TM	Hess	–	–	6.89	8.21	5.56	13.77	–	–	–	3.86	1.37	5.23
RP-141-2	SC	Hess	–	–	25.72	30.41	11.32	41.73	–	–	–	–	–	–
RP-141-2	SC	P. Ponar	–	–	–	–	–	–	–	–	–	7.58	2.78	10.36
RP-141-3	MC	Hess	–	–	8.80	0.00	1.76	1.76	–	–	–	1.00	0.64	1.64
RP-141-4	US	Hess	–	–	55.93	78.04	45.44	123.47	–	–	–	19.86	2.86	22.72
RP-141-4	US	P. Ponar	–	–	53.97	55.19	40.88	96.07	–	–	–	50.73	53.81	104.54
RP-104-1	TM/SS	Hess	–	–	25.17	0.55	10.75	11.30	–	–	–	12.73	3.38	16.11
RP-104-2	SS	Hess	–	–	26.02	19.26	12.02	31.28	1.96	7.13	9.08	31.96	35.38	67.34
RP-104-2	SS	P. Ponar	–	–	–	–	–	–	–	–	–	31.17	9.87	41.05
RP-104-3	MC	Hess	–	–	21.47	30.79	3.86	34.66	–	–	–	5.92	0.46	6.38
RP-104-4	US	P. Ponar	–	–	295.61	6.54	20.80	27.34	–	–	–	13.83	3.25	17.08
RP-104-5	SC	Hess	–	–	13.60	0.63	5.62	6.25	–	–	–	1.71	0.35	2.06
RP-81-1	US	Hess	–	–	–	–	–	–	–	–	–	24.47	10.54	35.00
RP-81-1	US	P. Ponar	–	–	162.49	18.05	49.17	67.23	–	–	–	–	–	–
RP-81-2	TM	Hess	–	–	17.05	11.21	7.14	18.35	–	–	–	18.72	1.86	20.58
RP-81-3	MC	Hess	–	–	20.63	4.41	1.58	5.99	–	–	–	16.71	0.96	17.68
RP-81-4	SC	Hess	–	–	9.30	4.26	3.97	8.23	–	–	–	4.13	1.05	5.18
RP-TKA-1	SC	Hess	–	–	9.26	0.00	3.14	3.14	–	–	–	12.16	1.35	13.51
RP-TKA-2	US	P. Ponar	–	–	171.79	19.20	17.75	36.95	–	–	–	118.02	72.99	191.00
RP-TKA-3	SS	Hess	–	–	12.11	2.08	3.28	5.36	–	–	–	35.22	6.94	42.16

Table 5.6-5. Summary of mean values of drift (seston) organic matter components collected for 2013 sampling over three sampling events (Spring, Summer, Fall) and Post-Storm sampling for sites in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Site	Macrohabitat	Spring			Summer			Fall		
		Drift CPOM (mg/ft³)	Drift FPOM (mg/ft³)	Total Drift OM (mg/ft³)	Drift CPOM (mg/ft³)	Drift FPOM (mg/ft³)	Total Drift OM (mg/ft³)	Drift CPOM (mg/ft³)	Drift FPOM (mg/ft³)	Total Drift OM (mg/ft³)
RP-184-1	TM	0.00	0.08	0.08	2.11	1.38	3.48	2.58	0.07	2.66
RP-184-2	SC	2.74	1.35	4.09	0.00	1.11	1.11	1.06	0.49	1.55
RP-184-3*	MC	1.58	0.70	2.27	0.00	9.60	9.60	2.02	1.71	3.74
RP-173-1	TM	1.70	0.12	1.82	0.23	3.04	3.26	3.66	0.29	3.95
RP-173-2*	MC	10.49	2.24	12.72	7.47	7.07	14.54	0.40	0.37	0.78
RP-173-3	SC	0.00	0.18	0.18	0.00	0.18	0.18	–[PK]	–[PK]	–[PK]
RP-173-4	SS	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-141-1	TM	0.00	4.89	4.89	1.08	0.55	1.63	6.87	1.15	8.02
RP-141-2	SC	3.64	1.15	4.79	0.38	0.31	0.69	–[PK]	–[PK]	–[PK]
RP-141-3	MC	4.76	1.38	6.14	3.11	3.50	6.61	0.24	1.06	1.30
RP-141-4	US	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-141-5*	MC, Above TM	–	–	–	0.26	0.14	0.40	–	–	–
RP-104-1	TM/SS	0.00	0.05	0.05	0.00	0.06	0.06	4.77	0.09	4.86
RP-104-2*	SS	9.38	1.87	11.24	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-104-3	MC	7.67	4.96	12.64	3.68	3.25	6.92	0.10	0.99	1.10
RP-104-4	US	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-104-5	SC	2.79	2.32	5.11	2.76	1.35	4.11	–[PK]	–[PK]	–[PK]
RP-81-1	US	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	0.18	0.04	0.21
RP-81-2	TM	0.16	0.54	0.70	–	–	–	0.76	0.38	1.13
RP-81-3	MC	6.27	3.25	9.52	1.14	0.74	1.88	0.35	0.48	0.83
RP-81-4	SC	4.71	4.30	9.01	3.81	3.64	7.46	0.21	0.03	0.24
RP-81-5*	SC, Above TM	3.45	3.43	6.88	1.23	1.06	2.29	1.10	0.22	1.33
RP-TKA-1	SC	2.68	3.30	5.98	0.00	2.79	2.79	3.34	0.73	4.07
RP-TKA-2	US	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-TKA-3	SS	0.07	0.06	0.13	0.20	0.45	0.65	3.59	0.22	3.81

Table 5.6-6. Summary of mean values of drift (seston) organic matter components collected for 2014 sampling over three sampling events (Spring, Summer, Fall) and Post-Storm sampling for sites in the Middle and Lower River Segments of the Susitna River for the River Productivity Study.

Site	Macrohabitat	Spring			Summer			Fall		
		Drift CPOM (mg/ft^3)	Drift FPOM (mg/ft^3)	Total Drift OM (mg/ft^3)	Drift CPOM (mg/ft^3)	Drift FPOM (mg/ft^3)	Total Drift OM (mg/ft^3)	Drift CPOM (mg/ft^3)	Drift FPOM (mg/ft^3)	Total Drift OM (mg/ft^3)
RP-184-1	TM	12.24	5.83	18.07	0.07	0.09	0.16	3.16	0.19	3.36
RP-184-2	SC	5.85	15.99	21.84	0.38	0.81	1.19	0.65	0.50	1.15
RP-184-3	MC	1.07	2.25	3.32	0.93	1.87	2.81	0.50	0.67	1.17
RP-184-4	MC, Above TM	6.90	10.29	17.19	0.98	1.18	2.15	4.35	0.51	4.86
RP-173-1	TM	1.68	0.48	2.16	0.09	0.14	0.22	6.10	0.28	6.38
RP-173-2	MC	2.02	2.36	4.37	0.32	1.04	1.35	0.23	0.33	0.56
RP-173-3	SC	0.10	0.08	0.18	0.03	0.03	0.05	–[PK]	–[PK]	–[PK]
RP-173-4	SS	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-173-5*	US	0.47	0.16	0.62	0.13	0.04	0.17	–[PK]	–[PK]	–[PK]
RP-141-1	TM	1.08	0.56	1.64	0.30	0.32	0.63	1.47	0.21	1.68
RP-141-2	SC	3.49	4.50	8.00	5.03	12.55	17.58	–[PK]	–[PK]	–[PK]
RP-141-3	MC	0.20	0.36	0.56	0.67	1.96	2.63	0.44	0.47	0.91
RP-141-4	US	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-141-5	MC, Above TM	3.23	0.98	4.21	0.39	0.86	1.25	0.33	0.63	0.96
RP-104-1	TM/SS	3.49	1.70	5.20	–[PK]	–[PK]	–[PK]	2.88	0.88	3.75
RP-104-2	SS	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-104-3	MC	0.89	1.27	2.16	0.79	1.48	2.27	0.46	1.07	1.54
RP-104-4	US	0.98	0.19	1.17	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-104-5	SC	2.35	4.84	7.19	0.28	1.08	1.35	0.07	1.10	1.17
RP-81-1	US	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]	–[PK]
RP-81-2	TM	1.15	1.62	2.77	0.16	0.23	0.39	1.40	1.47	2.87
RP-81-3	MC	1.11	0.28	1.38	0.29	0.59	0.87	1.65	0.25	1.90
RP-81-4	SC	0.34	0.43	0.77	0.89	1.97	2.86	0.14	0.19	0.34
RP-81-5	SC, Above TM	0.45	0.07	0.51	0.38	1.28	1.66	1.14	0.79	1.93

* Upland Slough located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.8-1. Mean metric values (n=5) from Hess samples collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

Tributary Name		Devil Creek*	Fog Creek	Deadman Creek	Watana Creek	Kosina Creek	Jay Creek	Oshetna River	Tyone River	Butte Creek
Site ID		**RP-DEV-1**	**RP-FOG-1**	**RP-DED-1**	**RP-WAT-1**	**RP-KOS-1**	**RP-JAY-1**	**RP-OSH-1**	**RP-TYO-1**	**RP-BUT-1**
Density (#/sq m)		8,428.52	9,519.66	132,347.55	28,273.53	5,176.73	20,364.24	1,360.47	21,730.36	7,266.15
Taxa Richness	Mean (Total)	33.2 (55)	35.8 (63)	22.6 (39)	33.6 (58)	31.8 (55)	32.2 (59)	22 (45)	37.8 (64)	34.4 (61)
EPT Taxa	Mean (Total)	8.8 (16)	10.4 (18)	3.2 (7)	8 (14)	8 (13)	6.4 (11)	6.6 (10)	6 (13)	9 (16)
Mayfly (E) Taxa	Mean (Total)	4.8 (7)	5 (8)	2 (3)	4.6 (7)	5.2 (7)	4.4 (7)	4.8 (7)	2.4 (5)	5.6 (9)
Stonefly (P) Taxa	Mean (Total)	2.8 (7)	4.6 (7)	0.8 (3)	2.8 (5)	1.8 (3)	1.2 (2)	1.8 (3)	0.6 (1)	2.6 (5)
Caddisfly (T) Taxa	Mean (Total)	1.2 (2)	0.8 (3)	0.4 (1)	0.6 (2)	1 (3)	0.8 (2)	0 (0)	3 (7)	0.8 (2)
Chironomid Taxa	Mean (Total)	16.2 (25)	17.6 (30)	14 (20)	16.6 (28)	16.8 (29)	16.2 (29)	10.6 (23)	19.8 (32)	17 (27)
Diversity (H')		2.83	2.94	2.17	2.80	2.57	2.72	2.56	2.80	2.88
Evenness (J')		0.81	0.82	0.70	0.80	0.75	0.79	0.84	0.77	0.82
Community Compositions										
Percent Mayflies		12.75	13.45	3.29	15.32	17.52	12.64	35.86	1.66	13.68
Percent Stoneflies		5.60	9.48	0.31	5.78	1.37	3.53	11.39	0.26	2.01
Percent Caddisflies		0.70	0.45	0.13	0.25	0.84	0.38	0	4.06	0.32
Percent Chironomids		64.28	61.32	84.47	65.57	61.69	61.64	45.39	49.26	72.40
Percent Other Diptera		1.40	4.40	9.29	4.68	9.02	5.20	3.56	15.91	7.20
Percent Other Insects		0	0	0	0	0	0	0.16	0	0
Percent Non-insects		15.28	10.91	2.51	8.40	9.57	16.60	3.65	28.85	4.38
EPT:Chironomid Ratio		0.23	0.28	0.04	0.25	0.26	0.22	0.51	0.12	0.18
Percent Top Taxa		18.56	17.54	32.23	25.41	26.59	22.12	21.35	22.42	16.94
Percent Top 3 Taxa		42.16	38.21	62.18	44.94	52.46	46.90	48.02	46.15	39.08
Functional Feeding Groups (FFGs)										
Percent Collector-Gatherers		79.37	75.04	62.23	75.57	71.96	81.46	56.87	38.23	84.60
Percent Collector-Filterers		1.40	3.32	16.56	2.68	9.26	1.04	1.92	21.73	6.43
Percent Scrapers		9.56	3.17	0.00	12.41	9.16	7.55	21.18	6.17	3.83
Percent Shredders		3.62	7.04	0.38	5.04	0.71	3.79	6.40	6.86	0.97
Percent Predators		4.82	4.78	3.59	3.93	3.50	5.12	13.15	12.74	3.91
Percent Parasites		1.03	3.47	0.18	0.31	3.82	0	0.38	8.91	0.20
Percent Other FFGs		0.19	3.17	17.06	0.06	1.59	1.04	0.10	5.37	0.07

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.8-2. Summary of benthic organic matter components collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

Site	Site ID	Sampling Device	Benthic CPOM (g/m²)			Benthic FPOM (g/m²)			Total Benthic OM (g/m²)		
			Range	Average	Median	Range	Average	Median	Range	Average	Median
Butte Creek	RP-BUT-1	Hess	0.57 - 3.7	1.91	0.97	0.44 - 2.6	1.57	1.55	1 - 6.3	3.48	2.71
Tyone River	RP-TYO-1	Hess	5.93 - 10.8	8.24	7.29	4.02 - 16.3	9.39	8.70	9.95 - 23.6	17.63	19.26
Oshetna River	RP-OSH-1	Hess	3.5 - 27.3	10.84	5.66	1.31 - 10.5	5.7	5.71	5.31 - 33	16.54	16.08
Jay Creek	RP-JAY-1	Hess	6.57 - 41.1	16.69	8.28	3.75 - 32.3	10.47	5.21	11.78 - 73.3	27.16	14.53
Kosina Creek	RP-KOS-1	Hess	1.04 - 11.6	5.23	3.05	0.2 - 3.1	1.31	0.66	1.24 - 14.7	6.54	3.83
Watana Creek	RP-WAT-1	Hess	1.35 - 23.1	8.68	7.20	1.13 - 28.3	10.84	2.93	2.47 - 42.6	19.52	9.53
Deadman Creek	RP-DED-1	Hess	2.88 - 73.8	26	18.57	2.14 - 9.2	4.84	2.96	9.8 - 83	30.84	21.50
Fog Creek	RP-FOG-1	Hess	11.63 - 65.7	27.28	20.95	1.56 - 18.2	8.7	7.31	13.19 - 83.9	35.98	27.83
Devil Creek*	RP-DEV-1*	Hess	1.97 - 18.6	8.33	5.79	1.16 - 5.7	2.71	1.75	3.72 - 20.1	11.03	11.17

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.8-3. Nutrient levels measured from water quality grab samples, and mean chlorophyll-*a*, pheophytin, and Ash Free Dry Mass (AFDM) values (n=5) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

Tributary Name	Site ID	Total Phosphorus (TP) (µg/L)	Soluble Reactive Phosphorus (SRP) (µg/L)	Ammonia as N (µg/L)	Nitrate + Nitrite (NO3+NO2) (µg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)	Dissolved Organic Carbon (DOC) (mg/L)	Mean Chlorophyll-a (mg/m²)	Mean Pheophytin (mg/m²)	Mean AFDM (g/m²)
Butte Creek	RP-BUT-1	2.9	<1	<10	19.8	<200	1.9	1.04	0.12	0.31
Tyone River	RP-TYO-1	9.8	2.0	<10	<10	691	13.6	9.34	5.25	8.84
Oshetna River	RP-OSH-1	56.7	2.4	<10	37.9	<200	1.0	0.14	0.04	0.10
Jay Creek	RP-JAY-1	8.5	6.2	<10	36.7	<200	3.5	3.95	0.50	1.65
Kosina Creek	RP-KOS-1	2.8	<1	<10	26.5	<200	1.2	0.44	0.46	0.40
Watana Creek	RP-WAT-1	4.5	2.4	<10	30.0	<200	0.9	1.44	0.03	0.59
Deadman Creek	RP-DED-1	6.2	2.8	<10	11.2	<200	2.1	14.82	6.50	27.69
Fog Creek	RP-FOG-1	7.5	<1	<10	22.6	<200	1.0	3.51	6.40	1.85
Devil Creek*	RP-DEV-1*	2.6	1.8	<10	48.7	<200	0.9	2.81	1.98	0.90

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.8-4. Mean metric values (n=2) from drift net samples collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

Tributary Name	Devil Creek*	Fog Creek	Deadman Creek	Watana Creek	Kosina Creek	Jay Creek	Oshetna River	Tyone River	Butte Creek
Site ID	**RP-DEV-1**	**RP-FOG-1**	**RP-DED-1**	**RP-WAT-1**	**RP-KOS-1**	**RP-JAY-1**	**RP-OSH-1**	**RP-TYO-1**	**RP-BUT-1**
Density (#/cu. ft)	0.219	0.716	1.108	0.524	0.123	0.599	0.214	1.987	0.345
Taxa Richness Mean (Total)	37.5 (44)	45 (58)	34.5 (44)	46 (58)	49 (60)	48.5 (63)	40 (52)	14.5 (24)	36.5 (49)
EPT Taxa Mean (Total)	7 (8)	7 (10)	4 (4)	7.5 (9)	10.5 (14)	5.5 (7)	9 (10)	1 (1)	4.5 (6)
Mayfly (E) Taxa Mean (Total)	5.5 (6)	4 (6)	3 (3)	4.5 (5)	8 (9)	3.5 (5)	5.5 (6)	0 (0)	3.5 (5)
Stonefly (P) Taxa Mean (Total)	1 (1)	1.5 (2)	0 (0)	1.5 (2)	1.5 (3)	1 (1)	2 (2)	0 (0)	1 (1)
Caddisfly (T) Taxa Mean(Total)	0.5 (1)	1.5 (2)	1 (1)	1.5 (2)	1 (2)	1 (1)	1.5 (2)	1 (1)	0 (0)
Chironomid Taxa Mean (Total)	23 (26)	21.5 (25)	20 (24)	24.5 (31)	27.5 (33)	23 (28)	19.5 (26)	4 (7)	22.5 (31)
Zooplankton Taxa Mean (Total)	3 (4)	5 (8)	5.5 (8)	6.5 (8)	6 (7)	7.5 (10)	3.5 (5)	4 (8)	5 (6)
Non-insect Taxa Mean (Total)	0 (0)	2 (3)	0.5 (1)	1.5 (2)	0 (0)	3 (3)	2 (2)	3.5 (5)	1.5 (2)
Diversity (H')	3.01	3.02	2.79	3.19	3.46	3.11	2.83	1.60	2.64
Evenness (J')	0.83	0.79	0.79	0.83	0.89	0.80	0.77	0.60	0.73
Community Compositions									
Percent Mayflies	12.89	13.99	9.94	4.39	13.95	2.73	27.32	0.00	6.55
Percent Stoneflies	0.43	0.76	0.00	1.57	0.48	2.13	1.51	0.00	0.30
Percent Caddisflies	0.15	0.55	0.28	0.47	0.48	0.43	0.59	3.80	0.00
Percent Chironomids	70.88	67.55	48.15	72.82	65.53	55.52	63.43	3.72	51.40
Percent Other Diptera	9.20	8.73	28.77	1.82	12.80	2.89	3.35	10.51	6.10
Percent Other Insects	1.13	2.24	0.88	0.78	0.31	1.64	0.92	0.32	0.15
Percent Zooplankton	0.00	2.08	1.34	5.03	0.00	3.61	1.08	78.60	1.04
Percent Non-insects	5.31	4.11	10.65	13.12	6.44	31.06	1.81	3.06	34.46
EPT:Chironomid Ratio	0.16	0.18	0.18	0.08	0.18	0.09	0.32	0.48	0.12
Percent Top Taxa	27.50	25.73	28.49	11.37	12.11	21.81	23.07	42.35	32.79
Percent Top 3 Taxa	39.52	46.47	50.15	31.84	27.72	43.67	54.86	86.70	54.43

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.8-5. Summary of drift (seston) organic matter components collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

Site	Site ID	Sampling Device	Benthic CPOM (mg/ft³)			Benthic FPOM (mg/ft³)			Total Benthic OM (mg/ft³)		
			Range	Average	Median	Range	Average	Median	Range	Average	Median
Butte Creek	RP-BUT-1	Drift Net	0.03 - 0.1	0.05	0.05	0.07 - 0.1	0.09	0.09	0.1 - 0.2	0.14	0.14
Tyone River	RP-TYO-1	Drift Net	0.01 - 0.5	0.27	0.27	0.15 - 0.5	0.3	0.30	0.16 - 1	0.57	0.57
Oshetna River	RP-OSH-1	Drift Net	0.32 - 0.8	0.55	0.55	0.39 - 0.8	0.61	0.61	0.7 - 1.6	1.16	1.16
Jay Creek	RP-JAY-1	Drift Net	0.15 - 0.3	0.22	0.22	0.12 - 0.2	0.17	0.17	0.36 - 0.4	0.38	0.38
Kosina Creek	RP-KOS-1	Drift Net	0.31 - 0.6	0.48	0.48	0.34 - 0.6	0.47	0.47	0.91 - 1	0.95	0.95
Watana Creek	RP-WAT-1	Drift Net	0.08 - 0.1	0.11	0.11	0.2 - 0.3	0.22	0.22	0.33 - 0.3	0.33	0.33
Deadman Creek	RP-DED-1	Drift Net	0.08 - 0.1	0.08	0.08	0.08 - 0.1	0.11	0.11	0.17 - 0.2	0.19	0.19
Fog Creek	RP-FOG-1	Drift Net	0.36 - 0.9	0.65	0.65	0.31 - 0.5	0.41	0.41	0.67 - 1.4	1.05	1.05
Devil Creek*	RP-DEV-1*	Drift Net	0.05 - 0.1	0.08	0.08	0.05 - 0.1	0.05	0.05	0.1 - 0.2	0.13	0.13

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.8-6. In-situ water quality measurements collected in July 2014 at sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

Tributary Name	Site ID	Temperature (°C)	Specific Conductance (µS/cm)	General Conductance (µS)	pH	Dissolved Oxygen, DO (mg/L)	Percent Dissolved Oxygen	Redox Potential, ORP (mv)	Turbidity (NTU)
Butte Creek	RP-BUT-1	7.1	130	86	6.9	12.7	104.9	173.1	0.2
Tyone River	RP-TYO-1	16.8	309	260	8.6	11.7	120.6	137.9	8.3
Oshetna River	RP-OSH-1	6.2	128	82	6.5	13.6	109.7	159	16.1
Jay Creek	RP-JAY-1	8.2	118	80	7.1	11.3	95.5	103.1	0.6
Kosina Creek	RP-KOS-1	7.4	52	35	6.3	11.9	100	137.1	0.4
Watana Creek	RP-WAT-1	8.8	76	52	6.5	9.6	82.8	137	0.4
Deadman Creek	RP-DED-1	11.5	95	70	7.4	10.7	98.2	157.7	3.6
Fog Creek	RP-FOG-1	8.1	92	62	7.4	12.3	103.5	125.2	1.3
Devil Creek*	RP-DEV-1*	9.5	64	45	6.2	10.6	92.7	187.8	0

* Site located on Cook Inlet Regional Working Group (CIRWG) lands.

Table 5.8-7. Mean metric values (n=5) from petite Ponar grab samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

Lake Name		Tyone Lake (RP-LTY)			Susitna Lake (RP-LSU)			Lake Louise (RP-LLO)		
Site ID		**RP-LTY-1**	**RP-LTY-2**	**RP-LTY-3**	**RP-LSU-1**	**RP-LSU-2**	**RP-LSU-3**	**RP-LLO-1**	**RP-LLO-2**	**RP-LLO-3**
Depth (ft)		4.5	16.5	21	78	22	90	107	133	17
Density (#/sq m)		1,119.45	4,055.84	7,550.52	75.35	6,096.68	667.36	930.00	1,102.22	1,455.28
Taxa Richness	Mean (Total)	10.2 (24)	12.2 (25)	13.2 (21)	1 (1)	15.2 (26)	4.8 (8)	4 (6)	5.8 (11)	13.2 (30)
EPT Taxa	Mean (Total)	2 (3)	0	0	0	0.2 (1)	0	0	0	0.2 (1)
Mayfly (E) Taxa	Mean (Total)	0.8 (1)	0	0	0	0	0	0	0	0
Stonefly (P) Taxa	Mean (Total)	0	0	0	0	0	0	0	0	0
Caddisfly (T) Taxa	Mean (Total)	0.6 (2)	0	0	0	0.2 (1)	0	0	0	0.2 (1)
Chironomid Taxa	Mean (Total)	4.4 (12)	7.8 (17)	7.2 (12)	0	9 (17)	1.2 (3)	1 (2)	2.2 (7)	8 (17)
Diversity (H')		1.91	2.00	1.99	0	1.93	1.36	1.12	1.33	2.27
Evenness (J')		0.92	0.88	0.77	0	0.72	0.88	0.83	0.76	0.94
Community Compositions										
Percent Mayflies		8.56	0	0	0	0	0	0	0	0
Percent Stoneflies		0.00	0	0	0	0	0	0	0	0
Percent Caddisflies		1.93	0	0	0	0.16	0	0	0	0.44
Percent Chironomids		41.52	49.18	31.68	0	23.60	8.54	5.68	10.15	65.71
Percent Other Diptera		0	0	0	0	0	0	0	0	1.64
Percent Other Insects		0	0	0	0	0	0	0	0	0
Percent Non-insects		47.99	50.82	68.32	100.00	76.24	91.46	94.32	89.85	32.20
EPT:Chironomid Ratio		0.18	0	0	0	0.01	0	0	0	0.01
Percent Top Taxa		33.58	32.75	36.65	100.00	45.28	41.62	50.23	48.76	27.78
Percent Top 3 Taxa		65.59	67.75	65.48	100.00	69.33	84.16	93.58	86.86	59.62
Functional Feeding Groups (FFGs)										
Percent Collector-Gatherers		63.06	47.34	43.71	100.00	27.51	34.46	45.67	80.58	37.49
Percent Collector-Filterers		10.48	6.15	4.96	0	9.45	22.68	27.16	6.78	28.69
Percent Scrapers		0.62	6.07	7.19	0	10.89	0	0.77	1.60	1.76
Percent Shredders		0.31	1.35	0.42	0	1.10	0	0	0	3.38
Percent Predators		9.22	9.81	6.70	0	4.21	4.89	4.91	2.31	23.36
Percent Parasites		14.38	29.28	37.02	0	46.77	37.97	21.49	8.72	4.46
Percent Other FFGs		1.93	0	0	0	0.07	0	0	0	0.85

Table 5.8-8. Summary of benthic organic matter components from petite Ponar samples (n=5) collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

Site	Site ID	Sampling Device	Benthic CPOM (g/m²)			Benthic FPOM (g/m²)			Total Benthic OM (g/m²)		
			Range	Average	Median	Range	Average	Median	Range	Average	Median
Tyone Lake	RP-LTY	P. Ponar	0.08 - 107.2	29.9	17.52	9 - 116.7	56.79	43.92	10.1 - 208.8	86.69	83.17
Tyone Lake - Lower	RP-LTY-1	P. Ponar	45.2 - 107.2	68.29	57.26	43.9 - 101.6	75.69	68.89	101.2 - 208.8	143.98	115.82
Tyone Lake - Middle	RP-LTY-2	P. Ponar	0.08 - 46.9	20.09	17.52	40.9 - 116.7	78.85	83.10	55.8 - 163.6	98.94	83.17
Tyone Lake - Upper	RP-LTY-3	P. Ponar	0.71 - 2.5	1.32	1.10	9 - 26.8	15.83	11.32	10.1 - 29.3	17.15	12.59
Susitna Lake	RP-LSU	P. Ponar	0.09 - 9.3	2.72	1.42	10.63 - 90.8	33.89	28.59	11.16 - 99.9	36.61	31.87
Susitna Lake - Lower	RP-LSU-1	P. Ponar	0.43 - 2.4	1.42	1.42	11.63 - 50.8	28.41	32.08	14.01 - 52.2	29.82	33.98
Susitna Lake - Middle	RP-LSU-2	P. Ponar	3.28 - 9.3	6.46	6.03	28.59 - 90.8	58.68	44.78	31.87 - 99.9	65.14	49.51
Susitna Lake - Upper	RP-LSU-3	P. Ponar	0.09 - 0.5	0.27	0.24	10.63 - 18.9	14.6	13.22	11.16 - 19.2	14.87	13.30
Lake Louise	RP-LLO	P. Ponar	0 - 45.6	11.41	0.80	4.26 - 389.2	101.41	30.91	4.41 - 424.8	112.82	30.91
Lake Louise - Lower	RP-LLO-1	P. Ponar	0.13 - 1.2	0.67	0.80	4.26 - 27.4	15.09	14.25	4.41 - 28.2	15.76	15.31
Lake Louise - Middle	RP-LLO-2	P. Ponar	0 - 0.8	0.17	0.00	25.62 - 39.4	32.87	30.91	25.67 - 40.2	33.04	30.91
Lake Louise - Upper	RP-LLO-3	P. Ponar	15.5 - 45.6	33.39	35.61	174.4 - 389.2	256.27	197.63	189.9 - 424.8	289.65	240.25

Table 5.8-9. Metric values from qualitative shoreline benthic D-net sweep samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

Lake Name	Tyone Lake (RP-LTY)			Susitna Lake (RP-LSU)			Lake Louise (RP-LLO)		
Site ID	**RP-LTY-1**	**RP-LTY-2**	**RP-LTY-3**	**RP-LSU-1**	**RP-LSU-2**	**RP-LSU-3**	**RP-LLO-1**	**RP-LLO-2**	**RP-LLO-3**
Taxa Richness	30	34	37	39	24	33	26	32	32
EPT Taxa	1	4	5	3	1	5	3	7	4
Mayfly (E) Taxa	1	2	2	1	0	1	1	1	1
Stonefly (P) Taxa	0	0	1	2	0	1	1	3	1
Caddisfly (T) Taxa	0	2	2	0	1	3	1	3	2
Chironomid Taxa	15	13	17	17	10	13	9	13	9
Diversity (H')	1.90	2.66	2.86	2.93	1.84	2.80	2.54	2.59	2.41
Evenness (J')	0.56	0.76	0.79	0.80	0.58	0.80	0.78	0.75	0.70
Community Compositions									
Percent Mayflies	0.66	1.62	3.96	6.10	0.00	7.07	11.65	31.21	29.01
Percent Stoneflies	0.00	0.00	3.96	11.89	0.00	0.32	0.32	3.50	4.14
Percent Caddisflies	0.00	0.65	0.99	0.00	0.33	3.54	0.32	2.55	0.55
Percent Chironomids	72.09	18.51	17.49	28.35	6.89	18.97	42.72	29.94	10.22
Percent Other Diptera	0.00	0.32	0.99	2.13	0.66	1.29	0.32	0.96	1.10
Percent Beetles	0.33	0.00	0.66	1.83	0.98	0.64	3.56	4.46	0.83
Percent Non-insects	26.58	78.57	71.62	49.39	91.15	58.84	41.10	27.39	53.87
EPT:Chironomid Ratio	0.01	0.11	0.34	0.39	0.05	0.37	0.22	0.55	0.77
Percent Top Taxa	57.74	22.40	26.43	25.91	49.18	13.50	17.15	31.21	29.01
Percent Top 3 Taxa	69.42	50.16	41.28	40.69	69.18	35.69	43.69	49.36	59.94
Functional Feeding Groups (FFGs)									
Percent Collector-Gatherers	78.91	45.70	66.27	67.53	74.75	57.56	54.37	67.52	59.39
Percent Collector-Filterers	0.66	4.35	1.65	1.83	0.66	0.64	0.97	0.00	2.49
Percent Scrapers	8.64	38.96	4.62	1.22	19.67	19.94	15.86	6.37	25.14
Percent Shredders	5.04	3.76	5.94	13.13	1.97	5.14	12.62	3.18	5.52
Percent Predators	6.09	4.96	18.55	9.16	1.64	14.47	10.03	18.47	5.25
Percent Parasites	0.66	2.27	2.97	4.27	0.98	1.29	6.15	3.82	1.93
Percent Other FFGs	0.00	0.00	0.00	2.87	0.33	0.96	0.00	0.64	0.28

Table 5.8-10. Mean metric values (n=5) from plankton tow samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. Density and biomass estimates are areal (per m^2) as opposed to by volume.

Lake Name	Tyone Lake (RP-LTY)			Susitna Lake (RP-LSU)			Lake Louise (RP-LLO)		
Site ID	RP-LTY-1	RP-LTY-2	RP-LTY-3	RP-LSU-1	RP-LSU-2	RP-LSU-3	RP-LLO-1	RP-LLO-2	RP-LLO-3
Density (#/m^2)	47,513.0	185,087.0	215,180.2	192,272.8	127,312.6	93,342.1	21,576.2	253,697.4	75,365.1
Biomass (mg/m^2)	149.11	553.37	487.32	481.49	311.30	214.18	243.11	498.81	202.41
Taxa Richness Mean (Total)	5 (6)	4.6 (5)	4.8 (5)	4 (4)	4.4 (5)	4.4 (6)	2.8 (4)	3.6 (6)	4.2 (5)
Cladocera Taxa Mean (Total)	3 (4)	2.6 (3)	2.8 (3)	2 (2)	2.4 (3)	2.4 (4)	0.8 (2)	1.6 (4)	2.2 (3)
Copepod Taxa Mean (Total)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)
Community Compositions by Density (percent)									
Eubosmina longispina	1.91	0.74	3.57	1.51	1.23	1.98	0.87	1.93	1.33
Daphnia longiremis	9.95	18.11	5.91	3.13	2.49	0.96	0.18	0.10	5.45
Daphnia ambigua	2.64	6.05	1.97	0.00	0.55	0.29	0.00	0.00	0.41
Other Cladocera	0.26	0.00	0.00	0.00	0.00	0.12	0.00	0.26	0.00
Copepoda - nauplii	17.63	33.30	44.67	27.48	45.49	33.93	26.33	28.88	6.90
Copepoda - Calanoida	26.50	17.29	16.27	17.93	28.21	14.28	9.10	14.64	40.42
Copepoda - Cyclopoida	41.10	24.52	27.62	49.95	22.02	48.44	63.52	54.18	45.49
Community Compositions by Weight (percent)									
Eubosmina longispina	1.61	1.33	6.88	3.38	2.35	4.43	2.02	3.86	2.69
Daphnia longiremis	11.93	24.65	9.30	9.55	3.63	3.90	0.27	0.52	11.52
Daphnia ambigua	3.63	9.51	4.21	0.00	0.97	1.32	0.00	0.00	0.45
Other Cladocera	0.22	0.00	0.00	0.00	0.00	1.28	0.00	1.56	0.00
Copepoda - nauplii	5.16	10.46	17.39	9.86	16.79	13.44	11.83	13.06	2.27
Copepoda - Calanoida	42.71	32.88	30.80	30.76	54.33	28.29	21.02	21.87	43.32
Copepoda - Cyclopoida	34.74	21.16	31.43	46.44	21.92	47.34	64.87	59.13	39.76

Table 5.8-11. Mean Secchi depths, light extinction coefficients, and calculated euphotic zone depths for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study in July 2014.

Site	Site ID	WaterDepth (ft)	Average Secchi Depth (ft)	Light Extinction Coefficient	Calculated Euphotic Zone Depth (ft)
Tyone Lake - Lower	RP-LTY-1	4.5	Visible to bottom	0.2731	16.9
Tyone Lake - Middle	RP-LTY-2	16.5	12.5	0.2291	20.1
Tyone Lake - Upper	RP-LTY-3	21	14.25	0.2011	22.9
Susitna Lake - Lower	RP-LSU-1	78	18.55	0.1054	43.7
Susitna Lake - Middle	RP-LSU-2	22	18.75	0.1436	32.1
Susitna Lake - Upper	RP-LSU-3	90	21.5	0.0982	46.9
Lake Louise - Lower	RP-LLO-1	107	27	0.1069	43.1
Lake Louise - Middle	RP-LLO-2	133	24.75	0.1025	44.9
Lake Louise - Upper	RP-LLO-3	17	Visible to bottom	0.1101	41.8

Table 5.8-12. Nutrient and chlorophyll-*a* levels measured from water quality grab samples collected near surface, near euphotic depth, and near-bottom in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

Site ID	Replicate	Water Grab Depth (ft)	Total Phosphorus (TP) (µg/L)	Soluble Reactive Phosphorus (SRP) (µg/L)	Ammonia as N (µg/L)	Nitrate + Nitrite (NO3+NO2) (µg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)	Dissolved Organic Carbon (DOC) (mg/L)	Alkalinity (mg/L)	Mean Chlorophyll-a (µg/L)	Mean Pheophytin (µg/L)
RP-LTY-1	1	2	7.2	1.4	<10	<10	434.9	10.4	54.6	2.1	<0.3
RP-LTY-2	1	2	6.5	1.2	<10	<10	398.7	9.7	56.4	1.6	<0.3
RP-LTY-2	2	15	11.5	1.9	11.5	<10	519.3	10.2	56.3	1.1	1.9
RP-LTY-3	1	2	7.1	<1	<10	<10	400.4	8.9	58.2	2.0	0.8
RP-LTY-3	2	18	9.3	2.0	52.5	<10	437.8	9.5	58.6	2.7	0.3
RP-LSU-1	1	6	6.7	<1	<10	<10	429.1	7.9	60.5	2.7	<0.3
RP-LSU-1	2	36	4.6	<1	<10	<10	330.0	7.7	61.5	3.7	<0.3
RP-LSU-1	3	75	11.2	1.3	138.0	52.9	475.1	7.5	67.1	<0.3	2.4
RP-LSU-2	1	2	6.1	1.3	<10	<10	455.4	8.5	60.0	1.1	1.2
RP-LSU-2	2	20	5.9	<1	<10	<10	378.6	9.1	60.8	<0.3	4.5
RP-LSU-3	1	6	5.4	1.2	<10	<10	409.8	7.9	60.5	1.1	2.7
RP-LSU-3	2	36	5.3	1.5	10.5	<10	361.3	7.6	61.7	<0.3	9.3
RP-LSU-3	3	87	5.5	<1	21.7	16.5	426.7	7.4	62.0	1.1	3.4
PR-LLO-1	1	6	6.3	<1	<10	<10	353.0	8.2	62.5	2.1	4.2
PR-LLO-1	2	33	7.0	1.9	<10	<10	620.5	7.5	62.9	1.1	3.8
PR-LLO-1	3	95	9.8	3.7	11.2	11.2	374.5	7.1	63.3	4.8	<0.3
RP-LLO-2	1	6	6.1	2.9	<10	<10	325.0	7.5	62.4	<0.3	<0.3
RP-LLO-2	2	42	8.1	2.7	<10	<10	350.6	7.4	63.0	1.1	<0.3
RP-LLO-2	3	129	15.1	7.9	15.7	12.5	381.0	8.3	63.9	1.6	<0.3
PR-LLO-3	1	2	6.0	1.0	<10	<10	362.1	7.5	62.8	2.1	<0.3
PR-LLO-3	2	16	6.3	1.8	<10	<10	345.6	7.7	62.1	<0.3	<0.3

Table 6.6-1: Comparison of river site water quality with Alaska standards and other typical measurements in the region.

Parameter	Alaska State Water Quality Standard	Range of Values for 9 Tributary Study Sites	Comparison		
			Average	Range	Source
Temperature (ºC)	<15ºC for migration routes/spawning areas; <13ºC for Spawning areas/Incubation	6.2-16.8	–	4-20	Davis and Davis 2008
DO (mg/L)	<5 mg/L	9.6-13.6	–	–	–
pH	>6.5, <8.5	6.3-8.6	7.9	6.7-8.8	Tanana Basin Study (Moran, 2007)
Specific Conductivity (µS/cm)	–	52-309	228.6	12-1323	Tanana Basin Study (Moran 2007)
Total Phosphorus (µg/L)	<100[1]	2.7-57	–	50-150	Cook Inlet Studies,(Brabets et al. 1999)
Ammonium (µg/L)	NA	<10	240	150-340	Tanana Basin Study (Moran 2007)
Nitrate-Nitrite (µg/L)	10,000	<10-49	100	10-1000	Cook Inlet Studies (Glass et al. 2004)
Dissolved Organic Carbon (mg/L)	NA	0.85-13.6	4.3	0.3-4.3; 0.5-18	Tanana Basin Study (Moran 2007); Cook Inlet Studies (Glass et al. 2004)
Turbidity (NTU)	May not exceed 25 NTU above natural conditions	0.2-8.3	–	–	–

Table 6.6-2. Comparison of lake site water quality with other lakes in the region.

Parameter	Typical Oligotrophic Lake Values[1]	Range of Values for 9 Lake Study Sites	Cook Inlet Basin Lake Survey[2]	
			Average	Range
Temperature (ºC)		5.3-16.2	10.8	4.2-18.9
DO (mg/L)		0.11-10.5	8.4	1.1-12
pH		6.9-8.5	7.6	3.8-10.2
Conductivity (µS/cm)		155.7-765.4	89	7.5-670
Secchi (meters)	>8-4	3.7-8.2	3.7	0.6-8.5
Total Phosphorus (µg/L)	0-12	<2-15.2	24.1	10-32.3
Ammonia-N (µg/L)		<10 - 138	10.2	1.4-51
Nitrate-Nitrite (µg/L)		<10 - 53	44.8	0.8-476
TOC, Dissolved (mg/L)		7.1-10.4	5.3	0.5-19.5
Alkalinity (mg/L)		54.6-67.1	44	11-105
Chlorophyll A (µg/L)	0-2.6	<0.3-4.8	6.6	0.18-13.1

[1] Carlson and Simpson 1996.
[2] ADEC 2008.

10. FIGURES

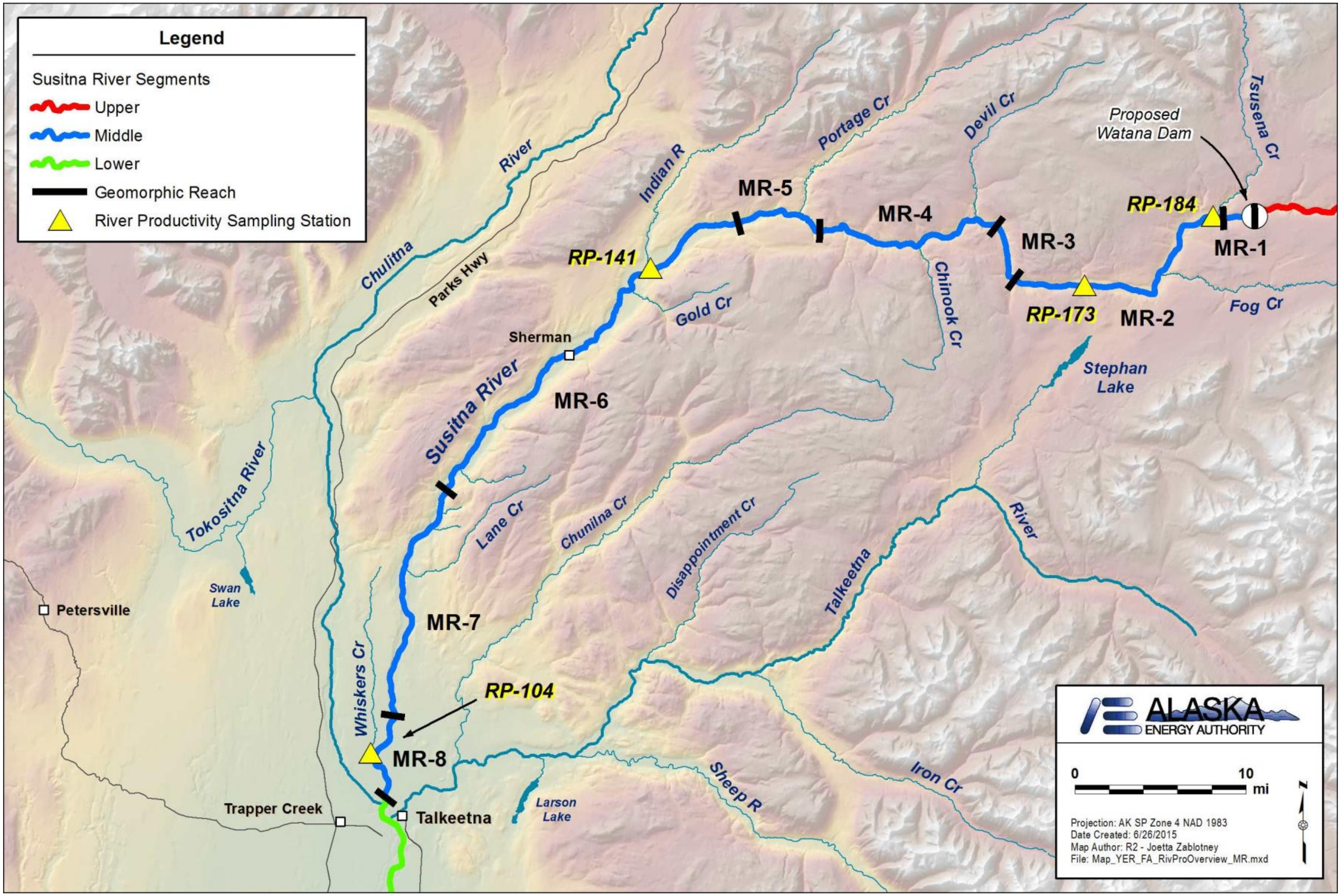


Figure 3-1. Middle Susitna River Segment, with the four River Productivity sampling stations /Instream Flow Focus Areas selected for the River Productivity Study, plus the sampling station for reference sites on the Talkeetna River.

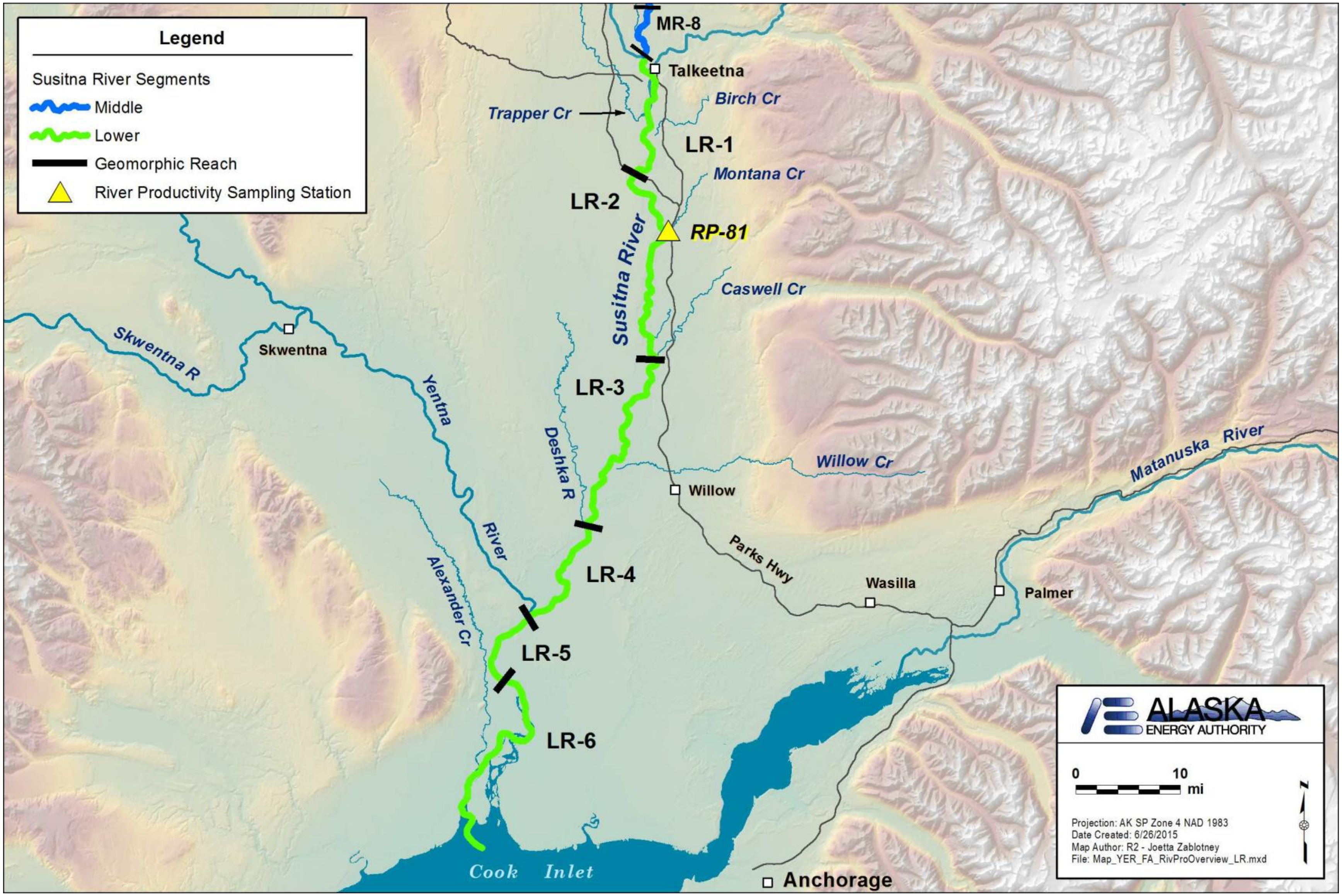


Figure 3-2. Lower Susitna River Segment, with Montana Creek area River Productivity sampling station selected for the River Productivity Study.

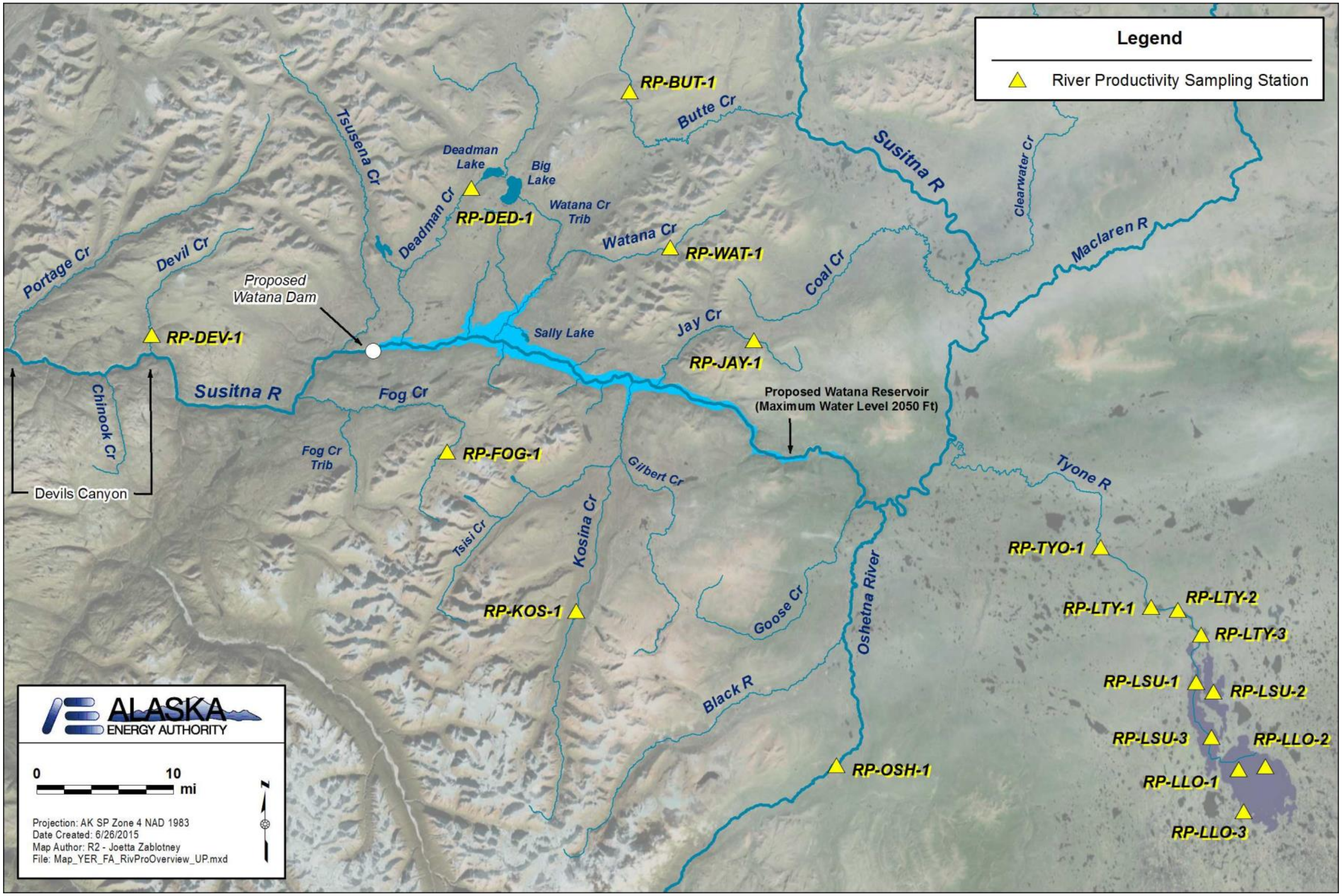


Figure 3-3. Tributary sites and lake sites above Devils Canyon in the Middle and Upper Segments, selected for the 2014 River Productivity Study.

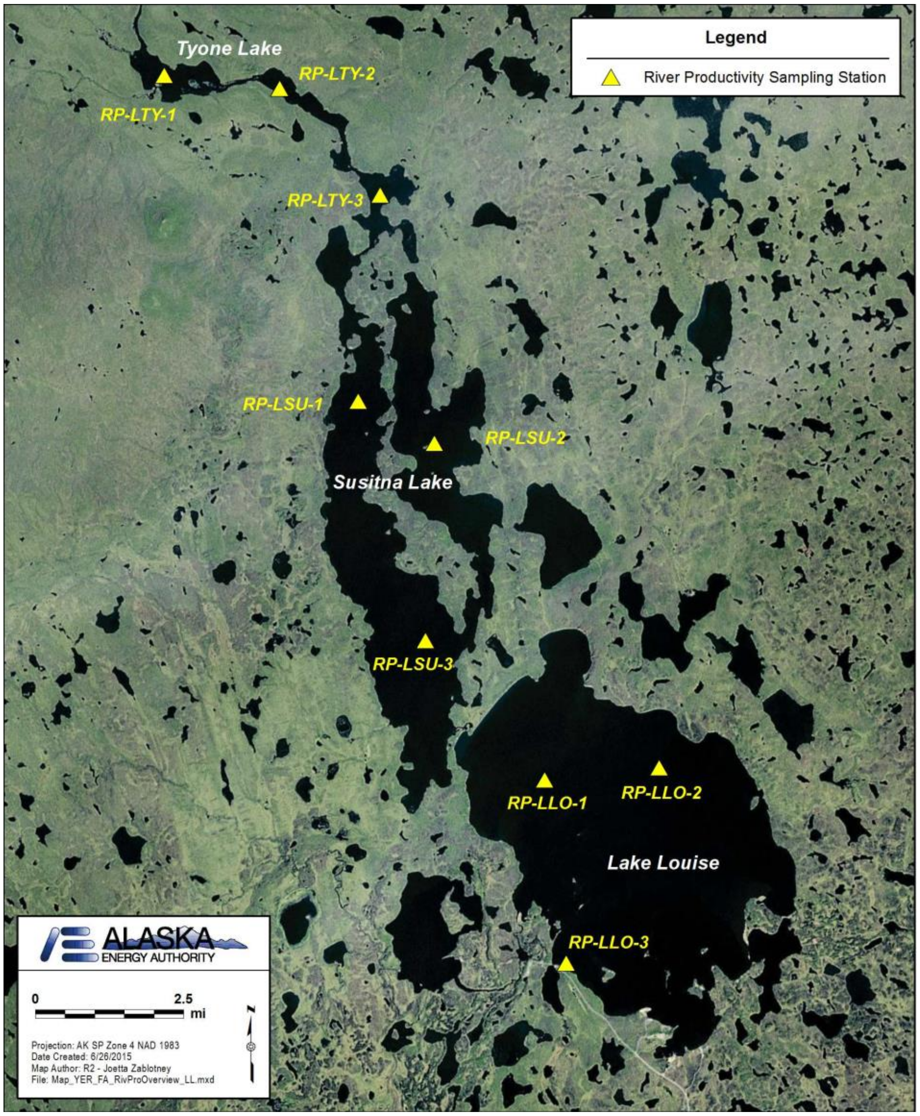


Figure 3-4. Lake sites above Devils Canyon in the Middle and Upper Segments, selected for the 2014 River Productivity Study.

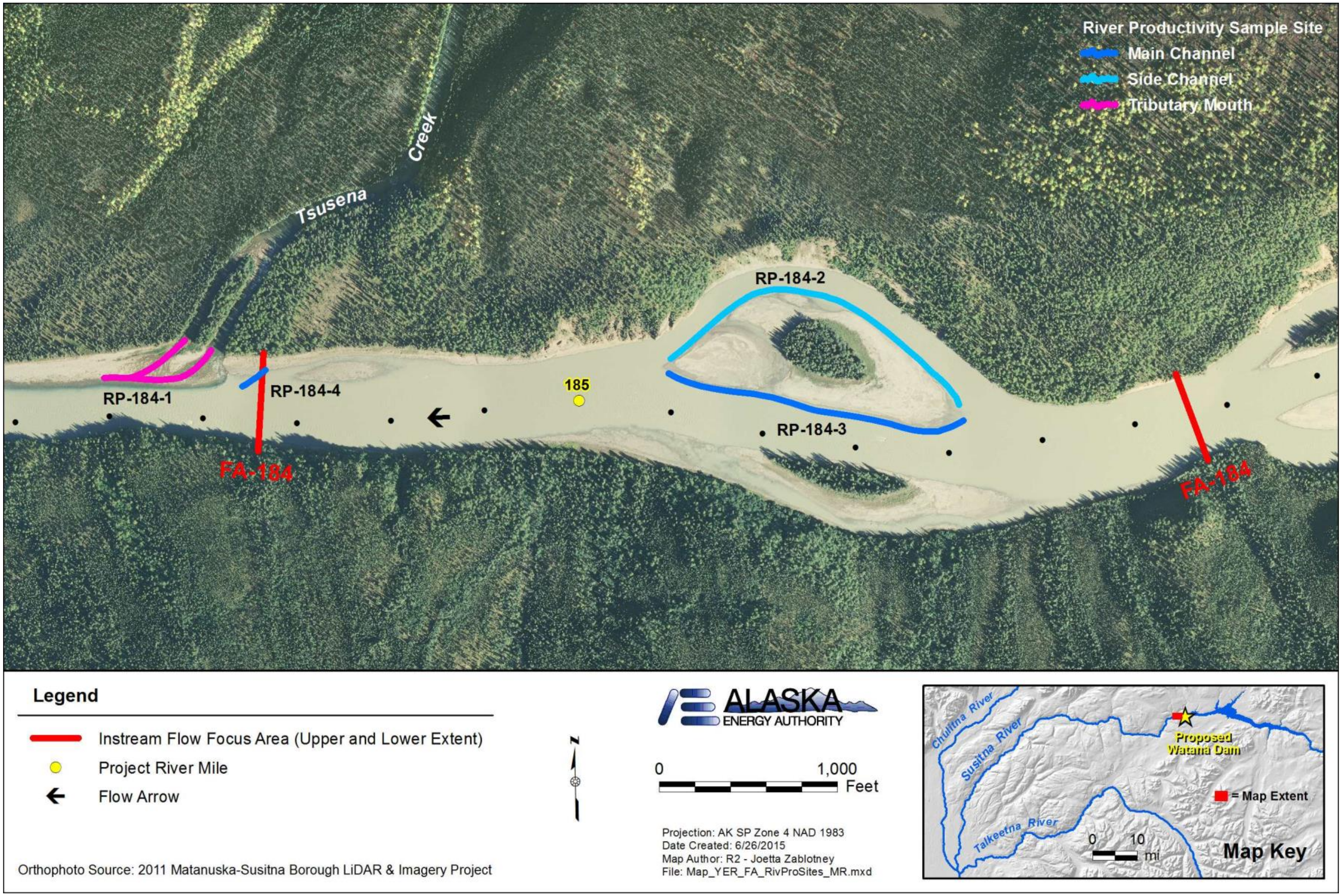


Figure 4.2-1. Focus Area 184 (Watana Dam), and the three River Productivity sampling sites.

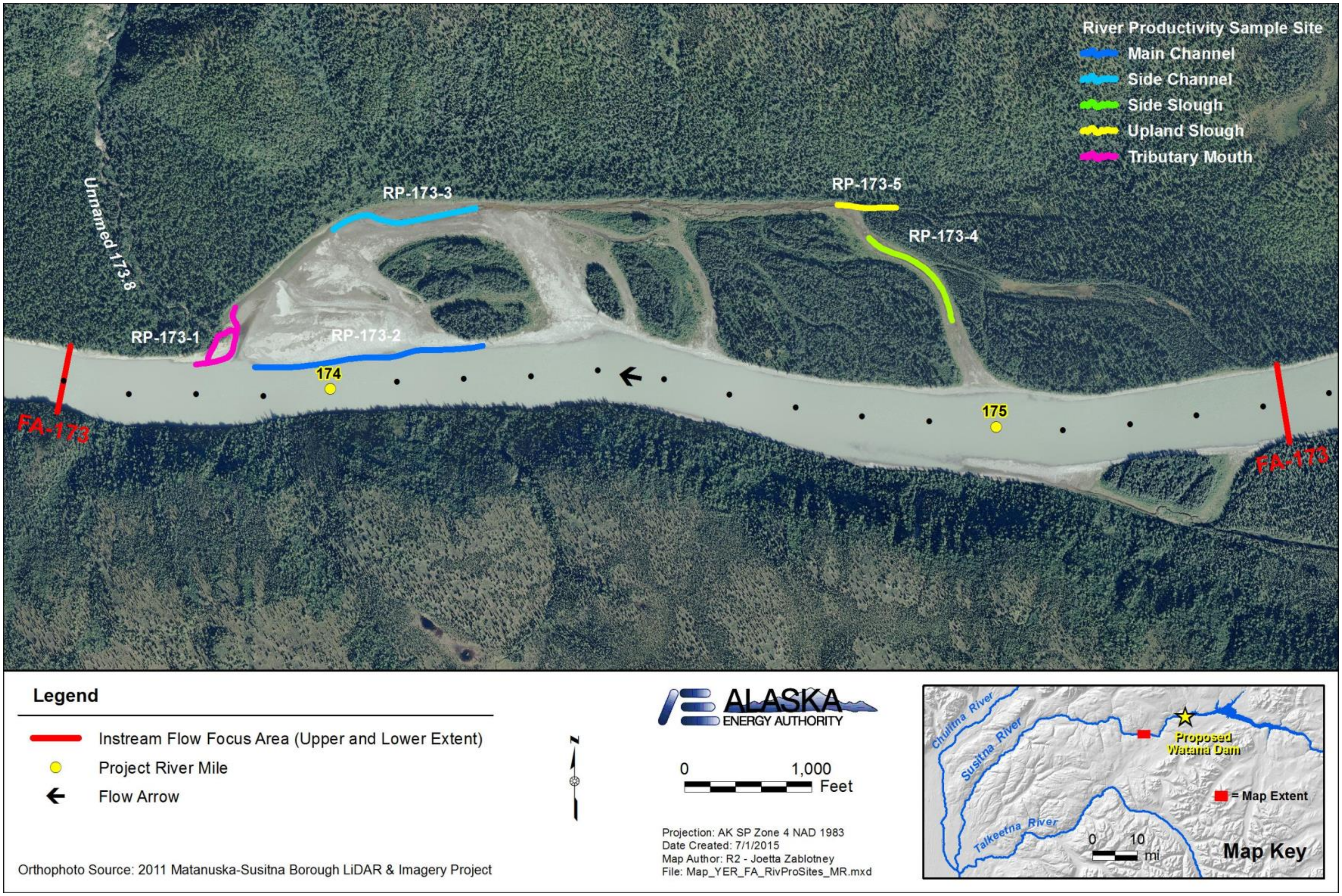


Figure 4.2-2. Focus Area FA-173 (Stephan Lake Complex), and the four River Productivity sampling sites. Site RP-173-3, originally identified as a side channel, has been reclassified as a side slough by the Aquatic Habitat Study (Study 9.9) in 2014.

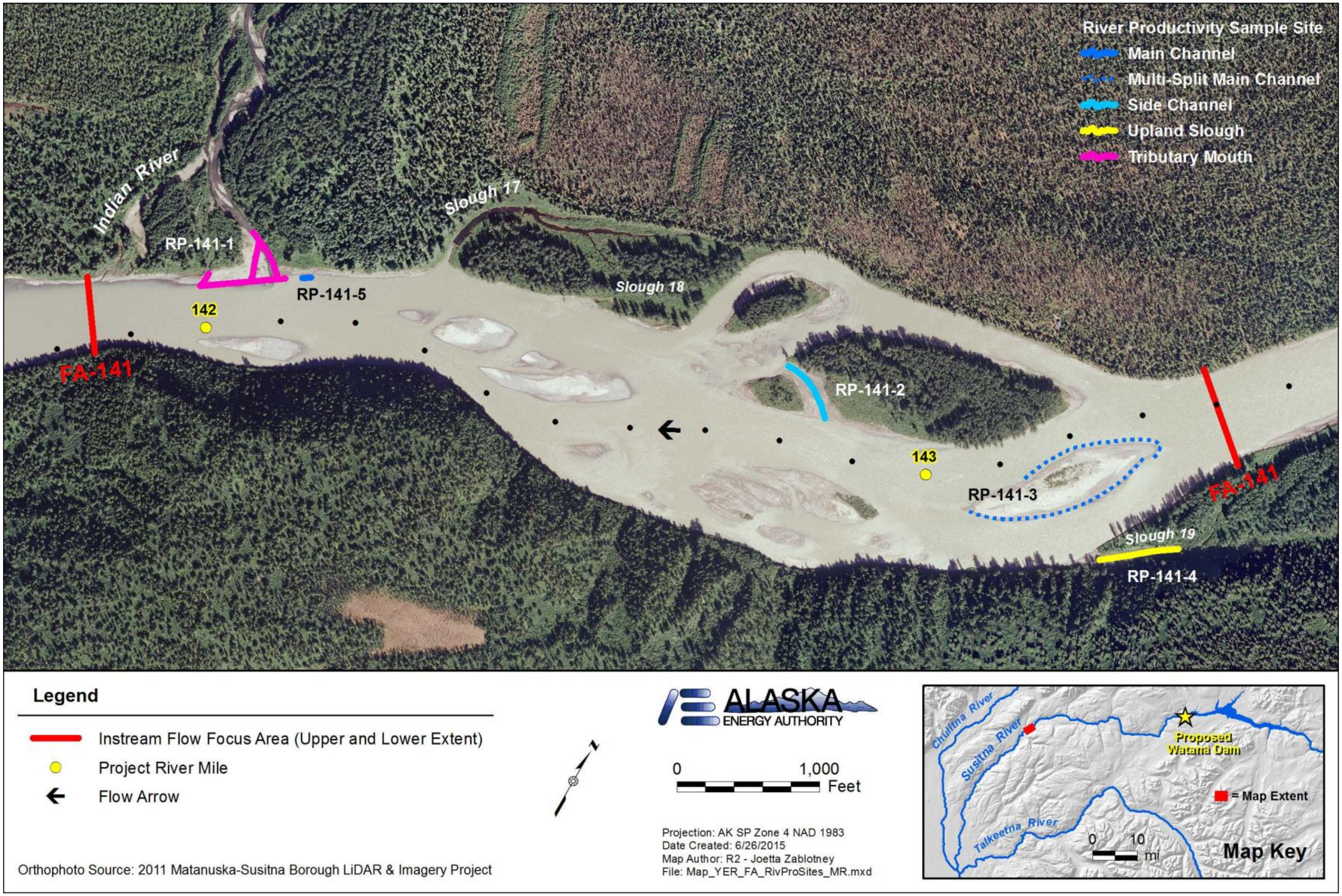


Figure 4.2-3. Focus Area FA-141 (Indian River), and the four River Productivity sampling sites.

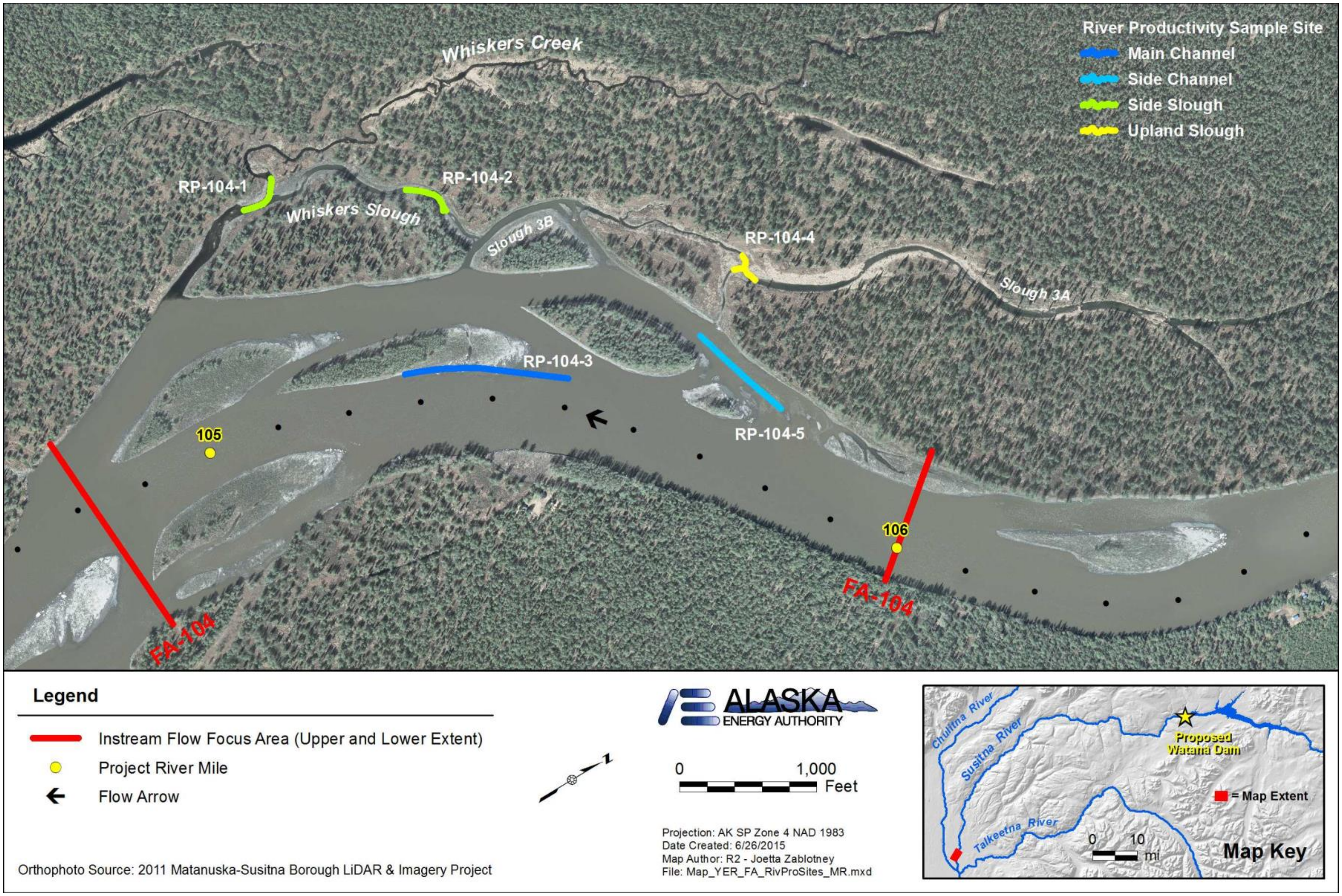


Figure 4.2-4. Focus Area FA-104 (Whiskers Slough), and the five River Productivity sampling sites.

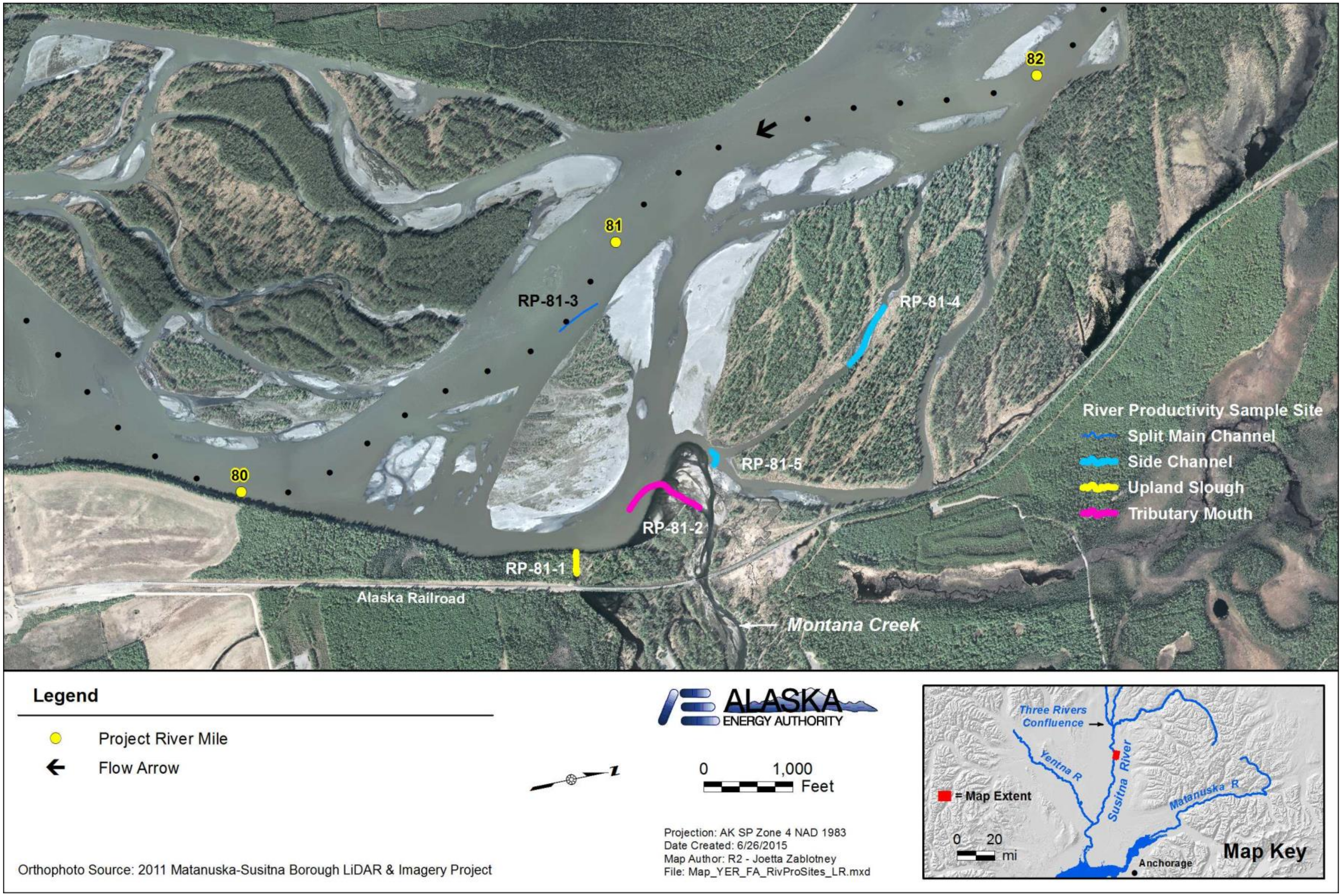


Figure 4.2-5. Station RP-81 (Montana Creek), and the four River Productivity sampling sites.

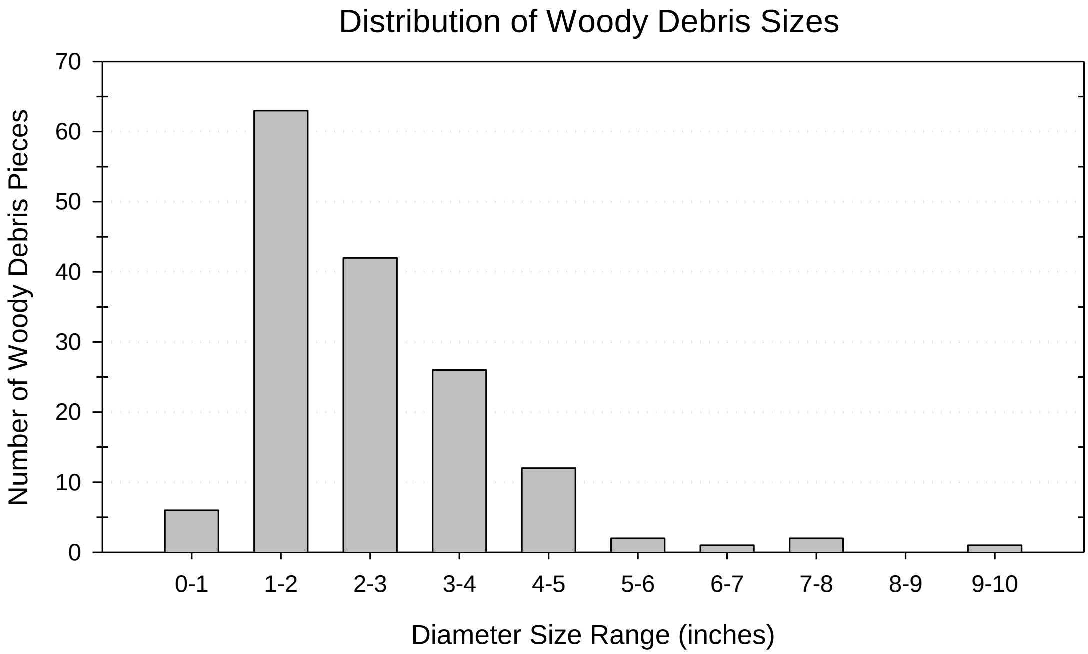


Figure 4.3-1. Size distribution of the 155 snag pieces collected in 2013 during the open water season within the all sites the Susitna River for the River Productivity Study.

Figure 4.6-1. Sampling equipment used to collect benthic macroinvertebrates in streams and rivers Top left: Hess stream sampler. Top right: drift nets. Bottom left: floating aquatic insect emergence trap. Bottom right: D-net kick sampler.

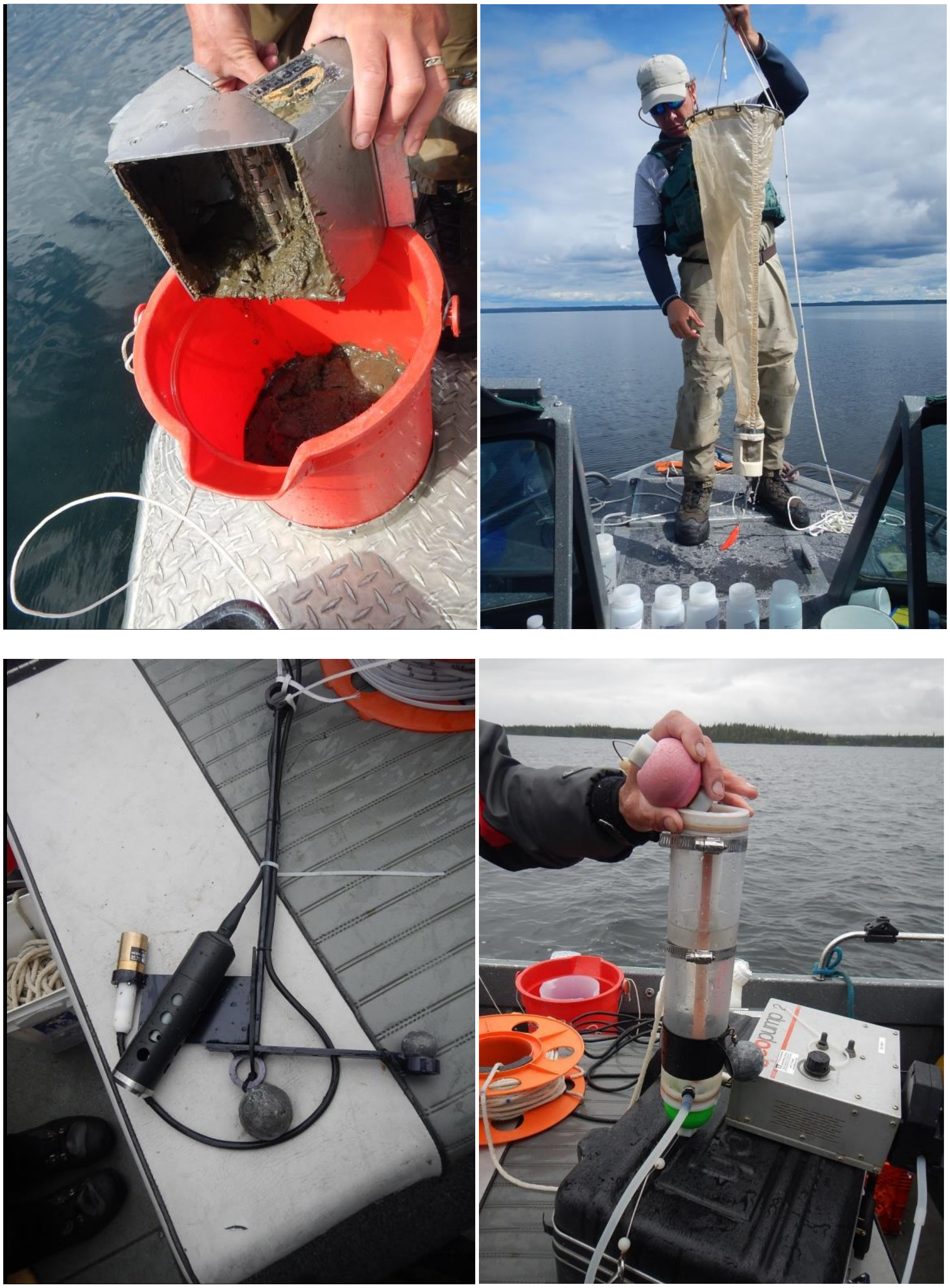


Figure 4.10-1. Sampling equipment used to collect invertebrates and water quality samples from lakes. Top left: Petite Ponar grab sampler. Top right: plankton net. Bottom left: PAR meter and *in situ* YSI multiprobe water quality meter. Bottom right: Van Dorn vertical water sampler.

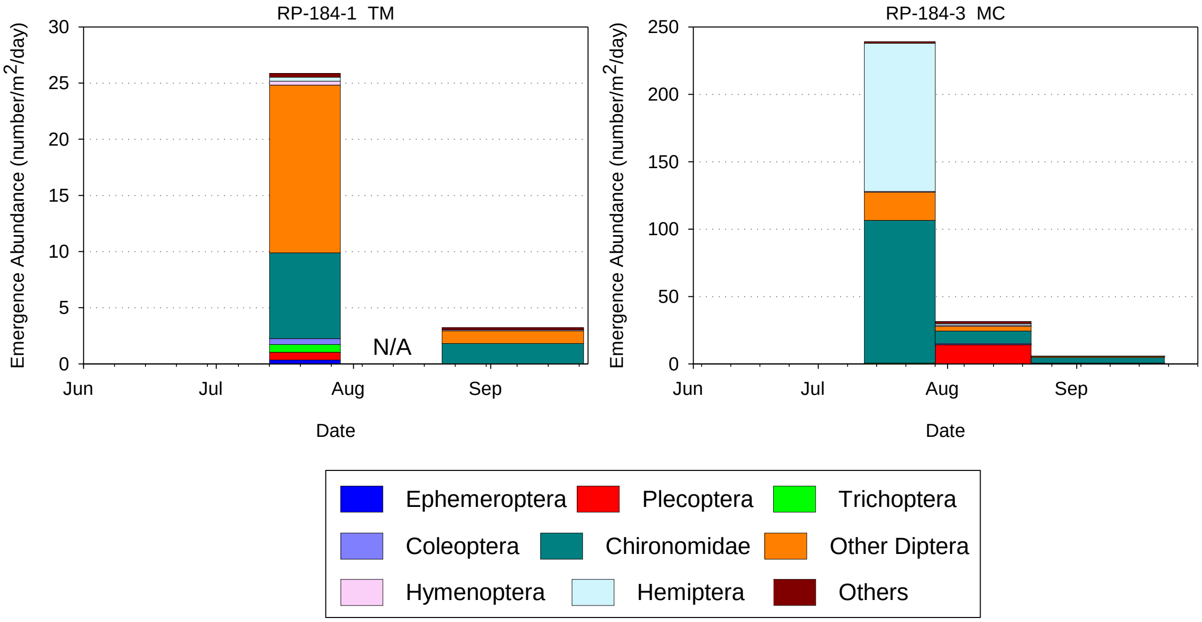


Figure 5.1-1. Mean emergence trap density estimates (n=1) collected in 2013 during the open water season within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Bar width indicates the length of period deployment for the emergence trap. "N/A" indicates no sample was collected during that time period.

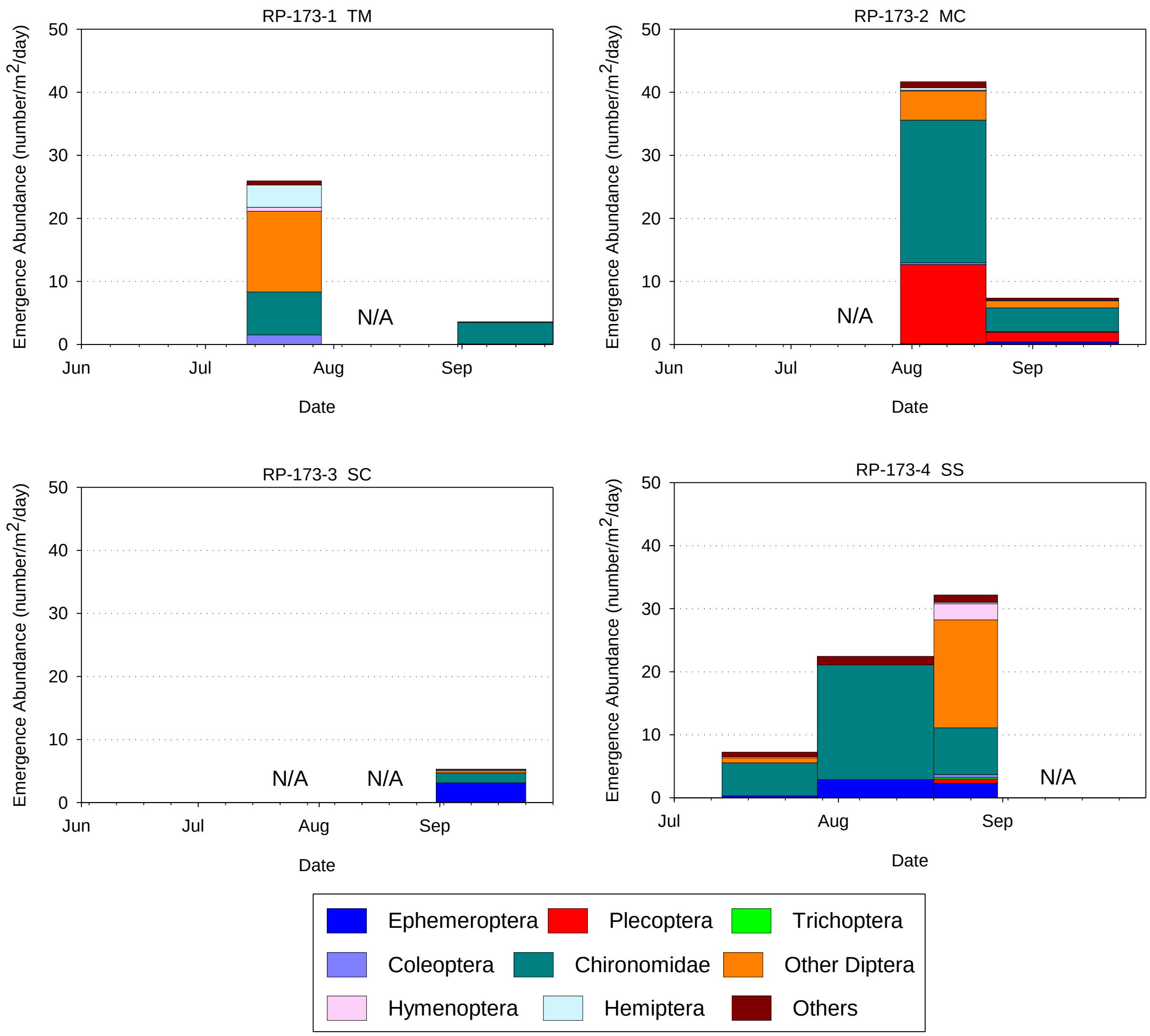


Figure 5.1-2. Mean emergence trap density estimates (n=1) collected in 2013 during the open water season within the Stephan Lake complex Focus Area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study. Bar width indicates the length of period deployment for the emergence trap. "N/A" indicates no sample was collected during that time period.

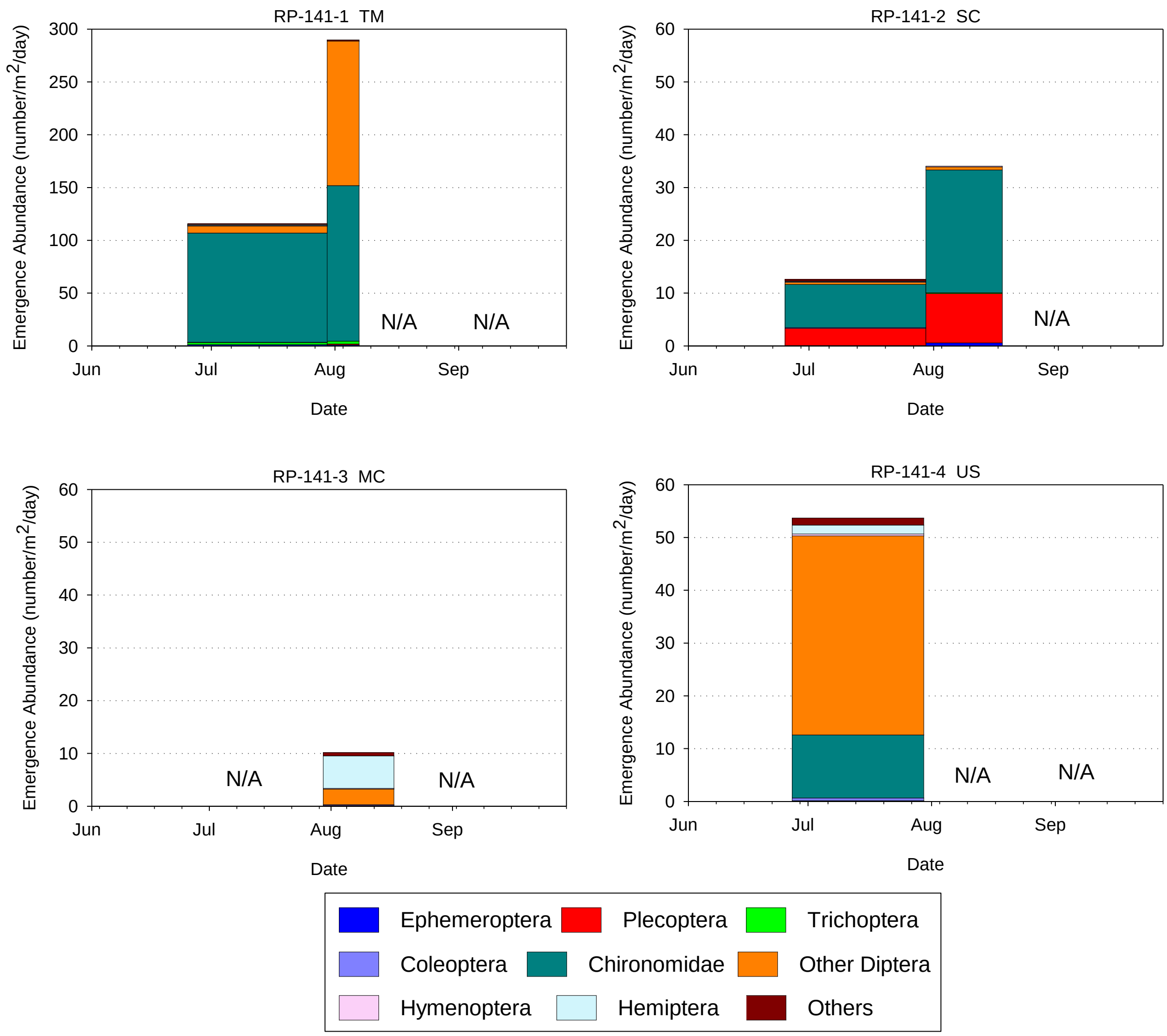


Figure 5.1-3. Mean emergence trap density estimates (n=1) collected in 2013 during the open water season within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Bar width indicates the length of period deployment for the emergence trap. "N/A" indicates no sample was collected during that time period.

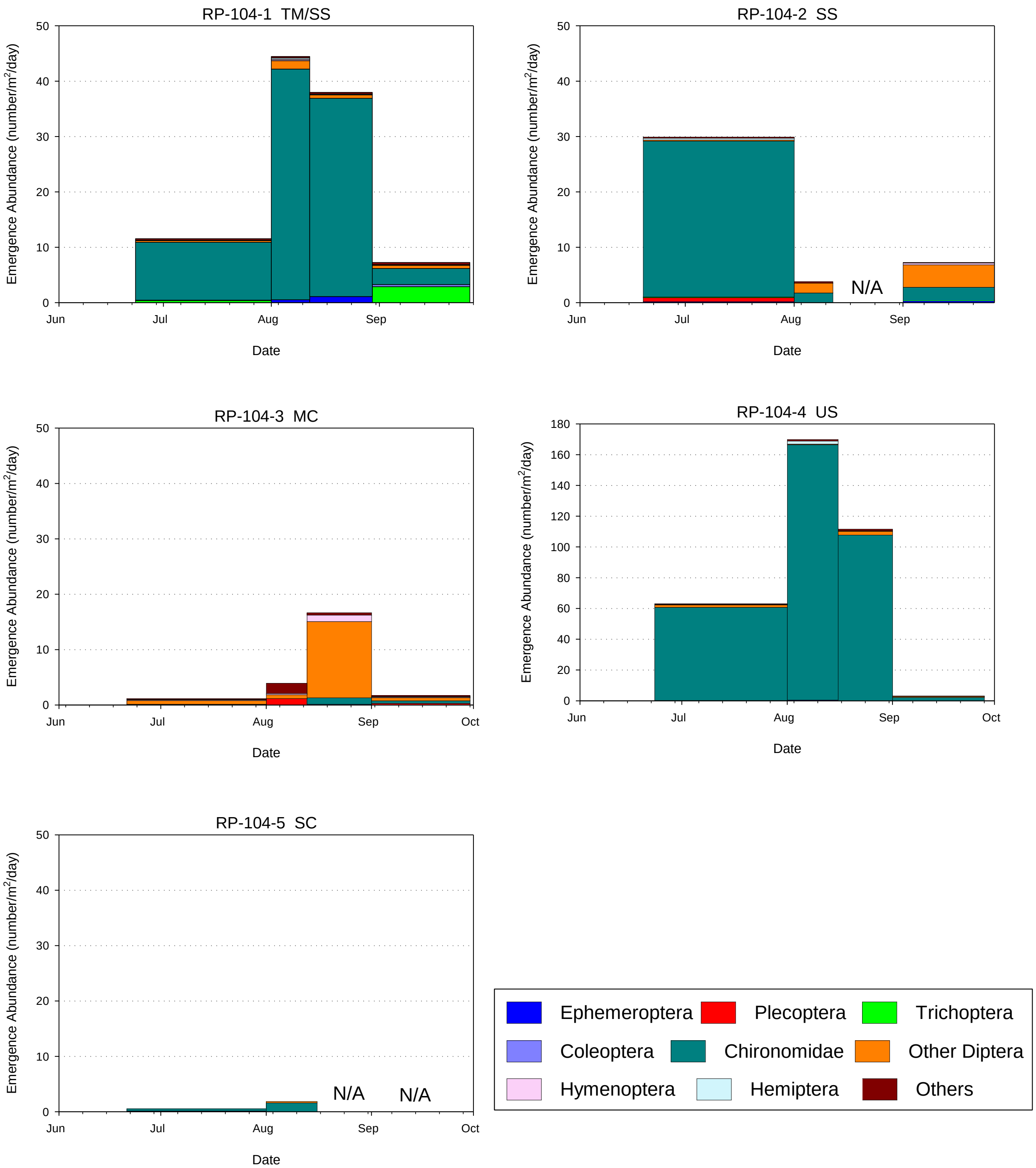


Figure 5.1-4. Mean emergence trap density estimates (n=1) collected in 2013 during the open water season within the Whiskers Slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Bar width indicates the length of period deployment for the emergence trap. "N/A" indicates no sample was collected during that time period.

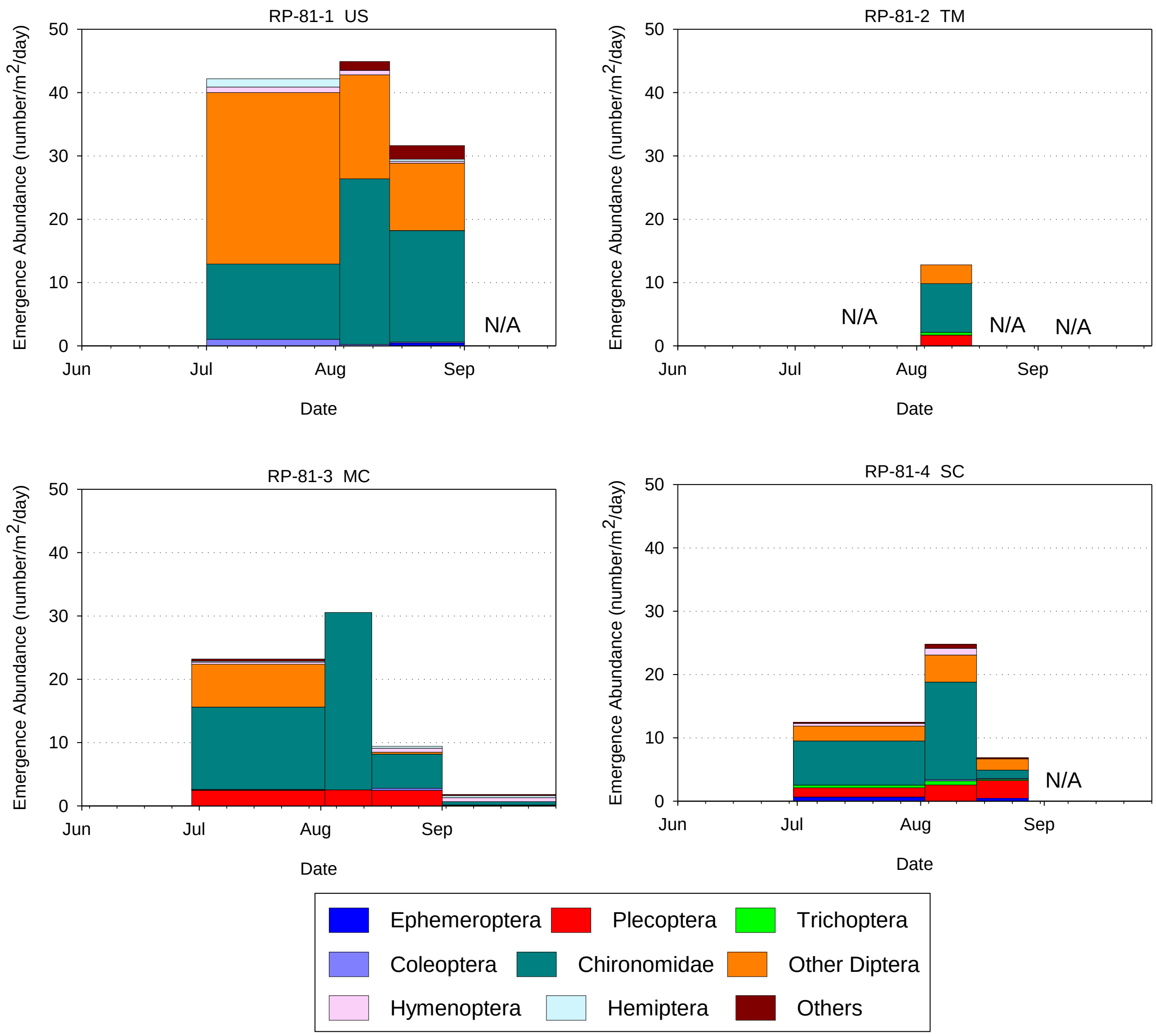


Figure 5.1-5. Mean emergence trap density estimates (n=1) collected in 2013 during the open water season within the Montana Creek study area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study. Bar width indicates the length of period deployment for the emergence trap. "N/A" indicates no sample was collected during that time period.

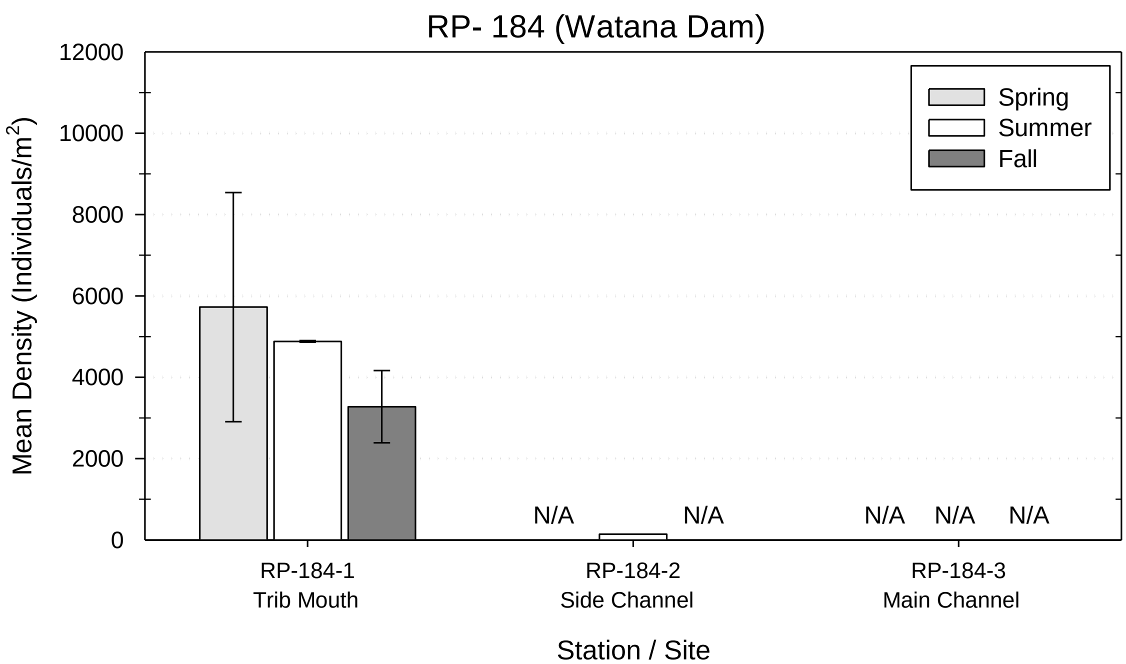


Figure 5.1-6. Mean density estimates collected from woody debris in 2013 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

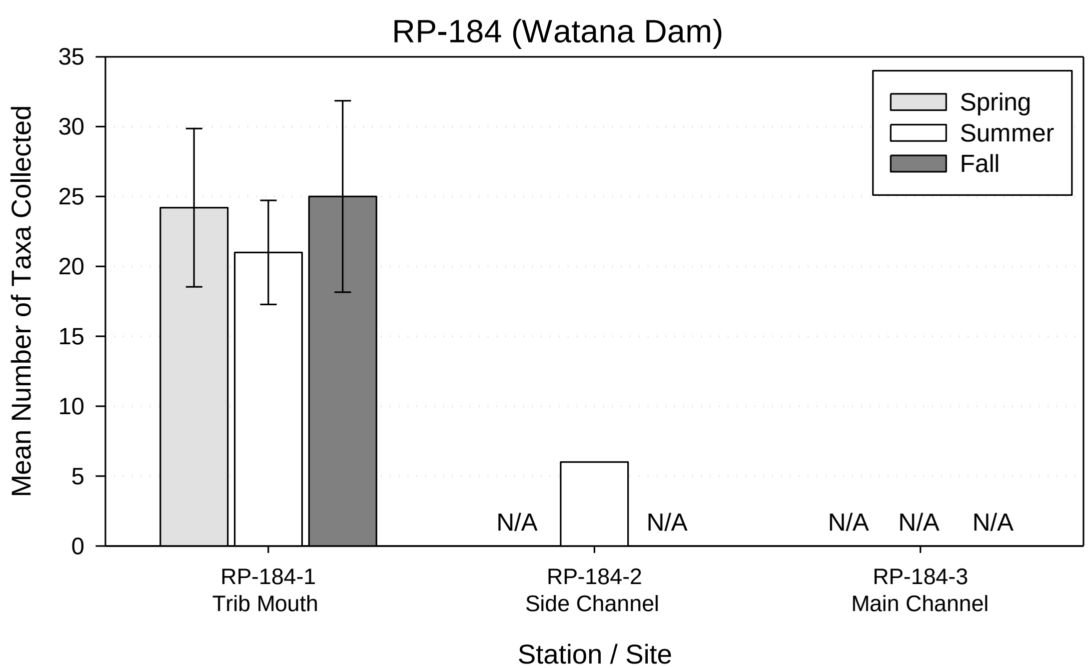


Figure 5.1-7. Mean taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

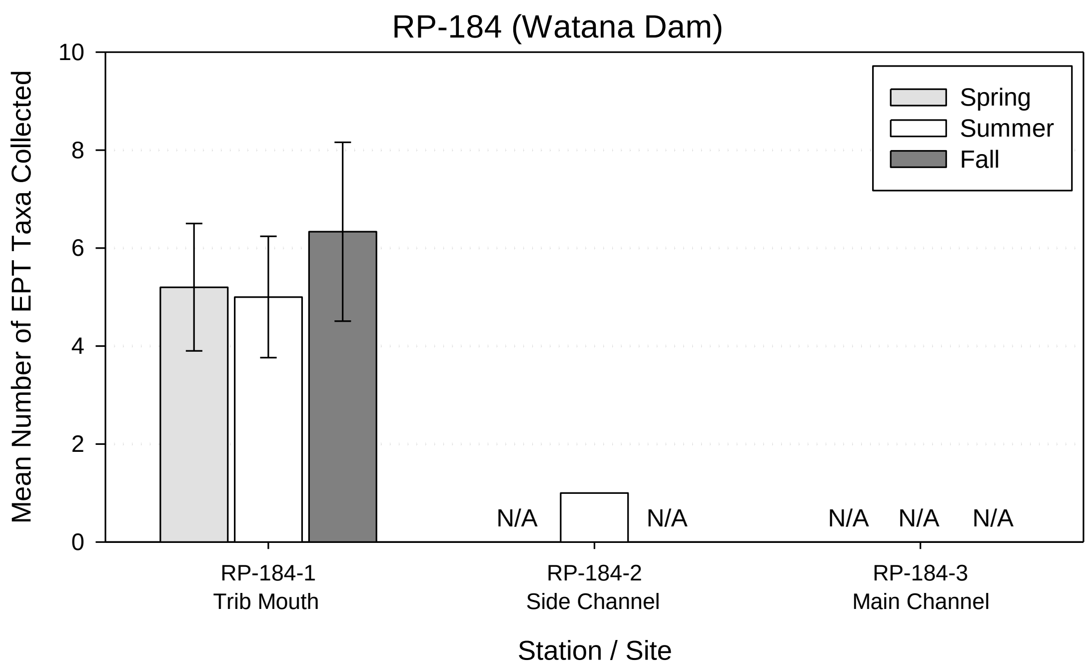


Figure 5.1-8. Mean EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

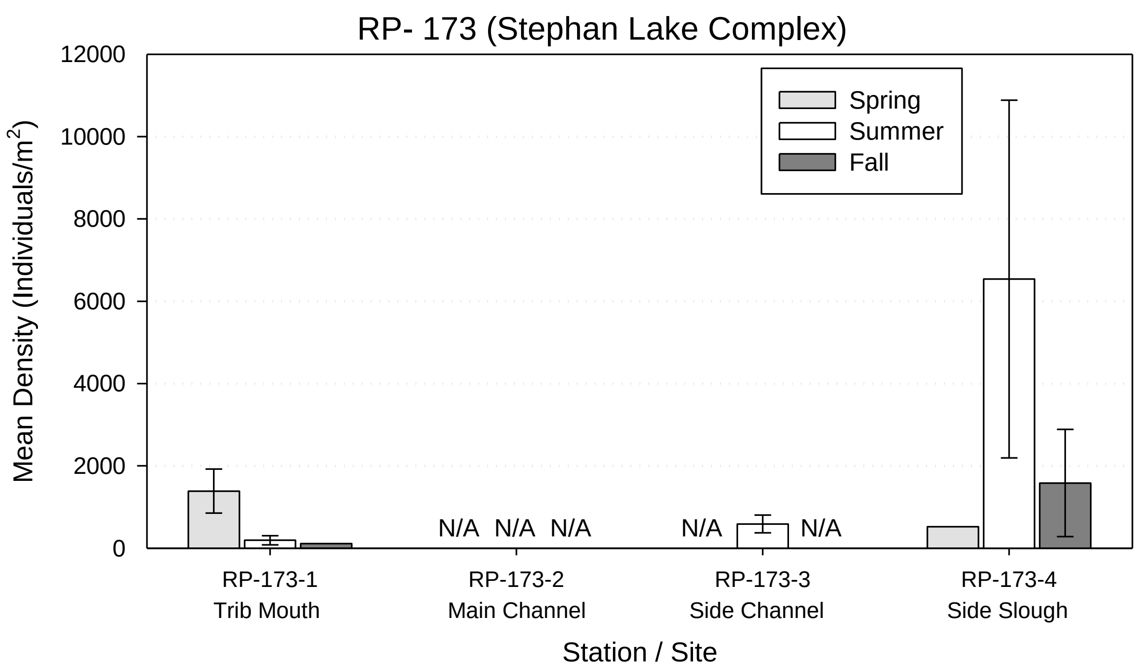


Figure 5.1-9. Mean density estimates collected from woody debris in 2013 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

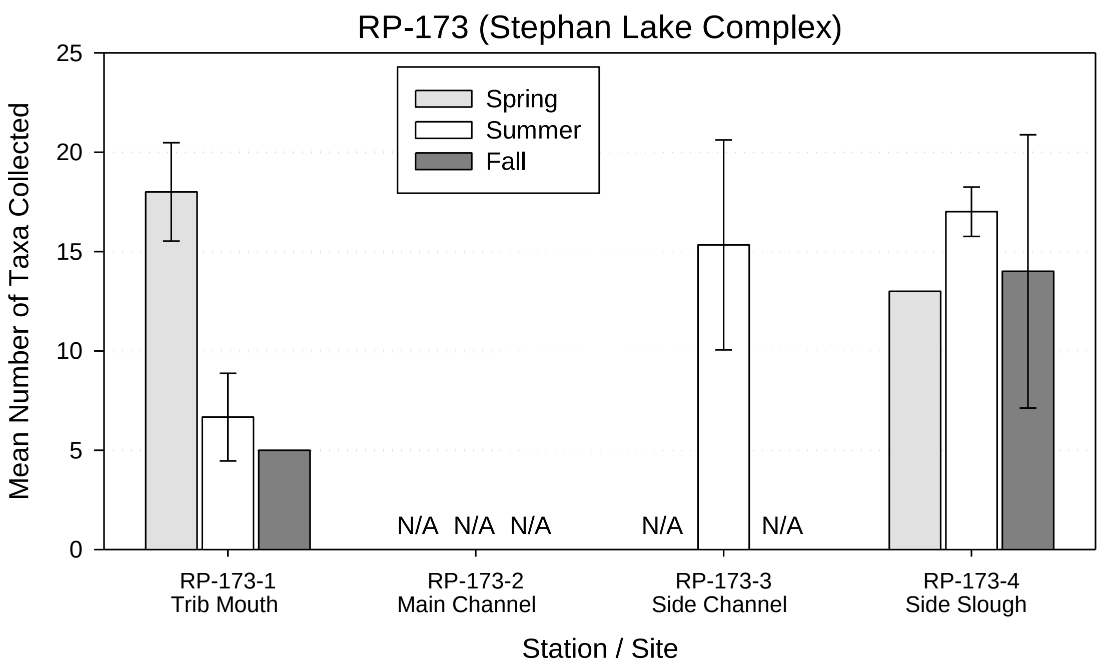


Figure 5.1-10. Mean taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

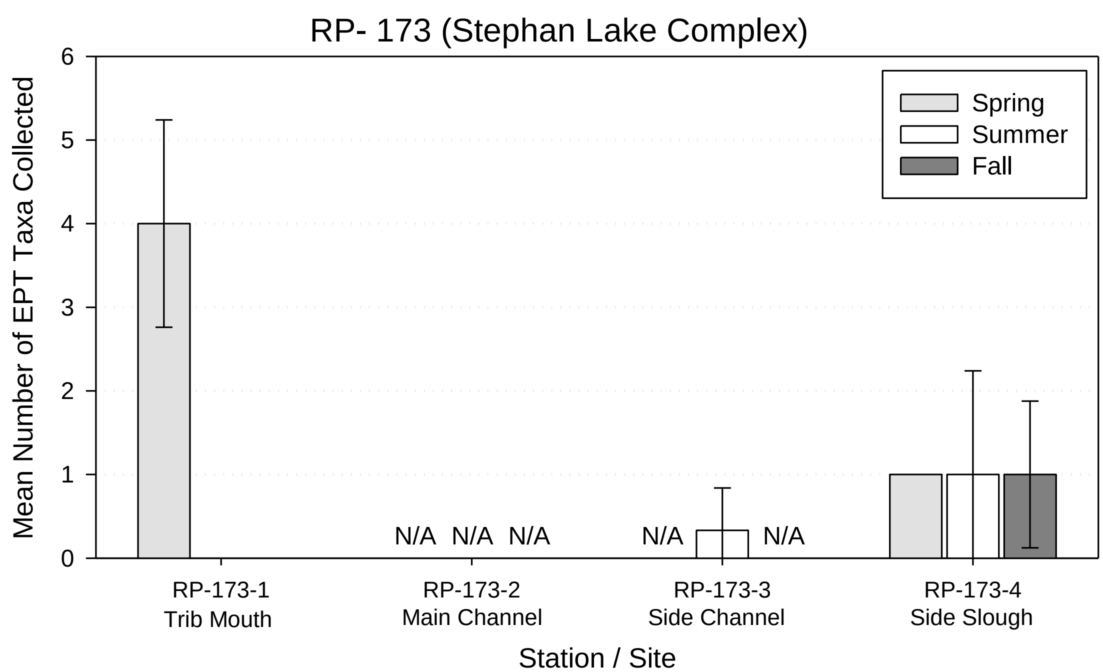


Figure 5.1-11. Mean EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

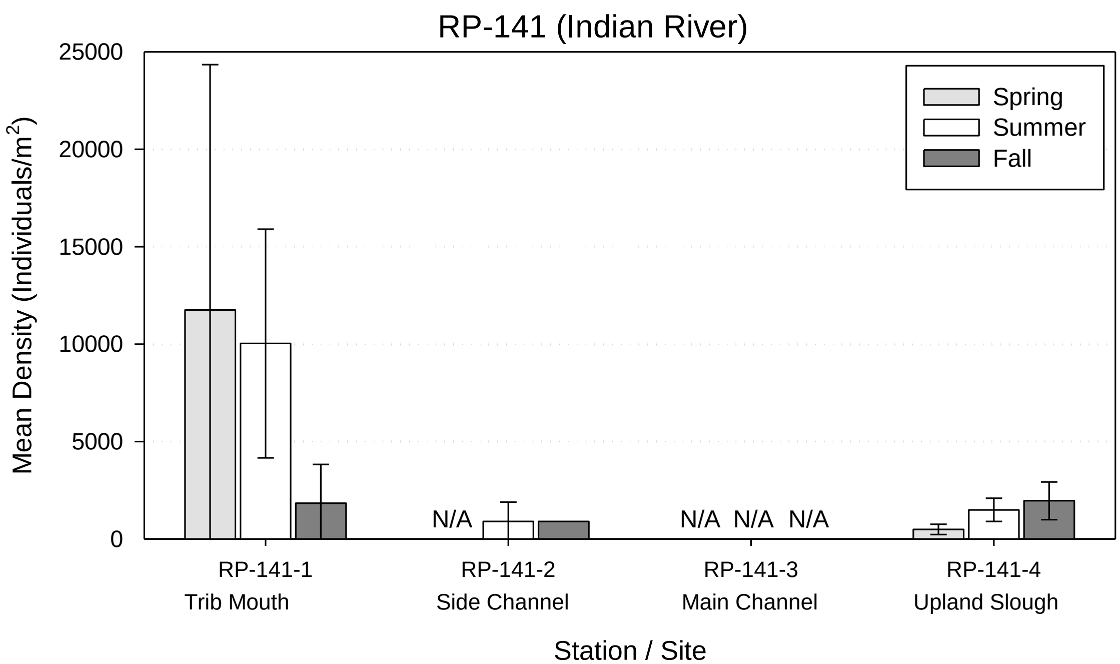


Figure 5.1-12. Mean density estimates collected from woody debris in 2013 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

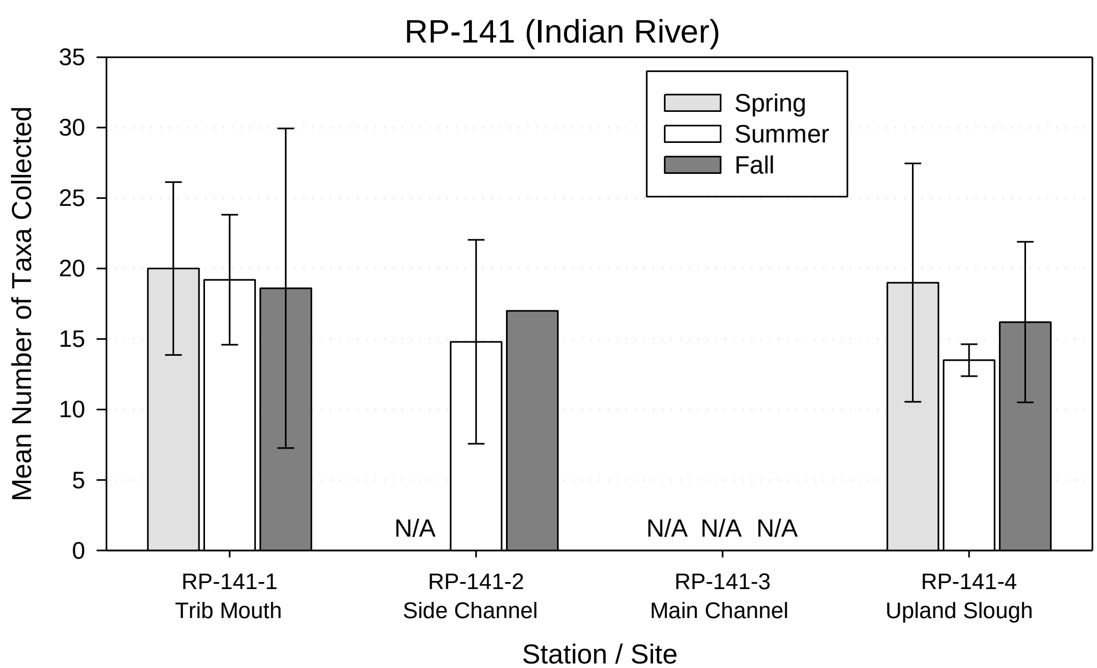


Figure 5.1-13. Mean taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

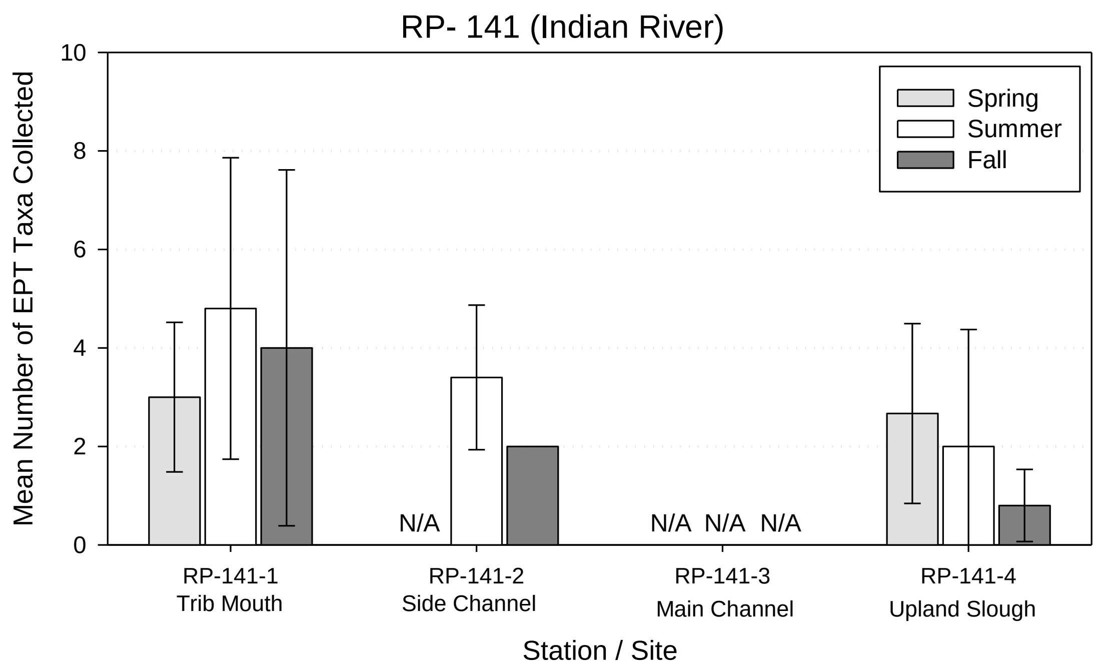


Figure 5.1-14. Mean EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

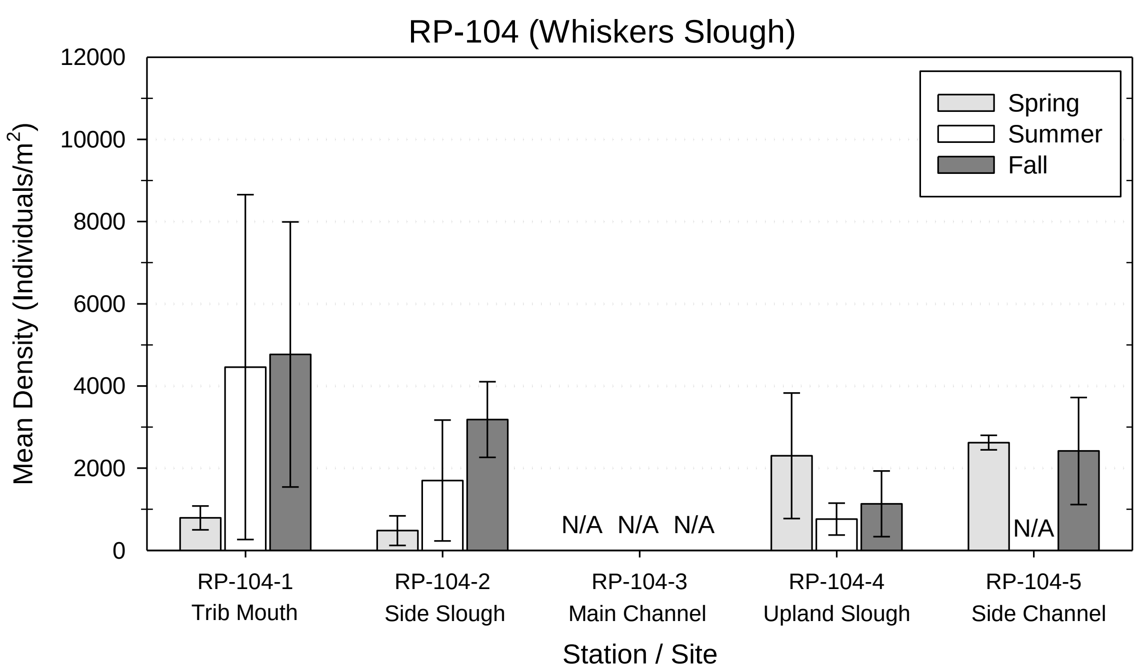


Figure 5.1-15. Mean density estimates collected from woody debris in 2013 during three sampling events for sites within the Whiskers Slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

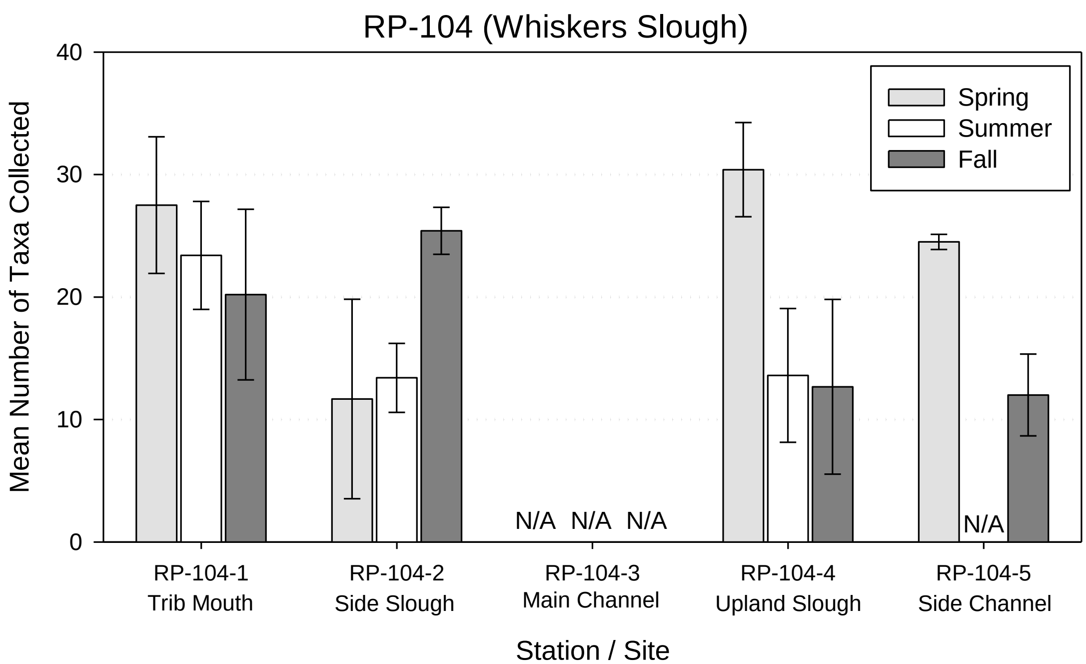


Figure 5.1-16. Mean taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Whiskers Slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

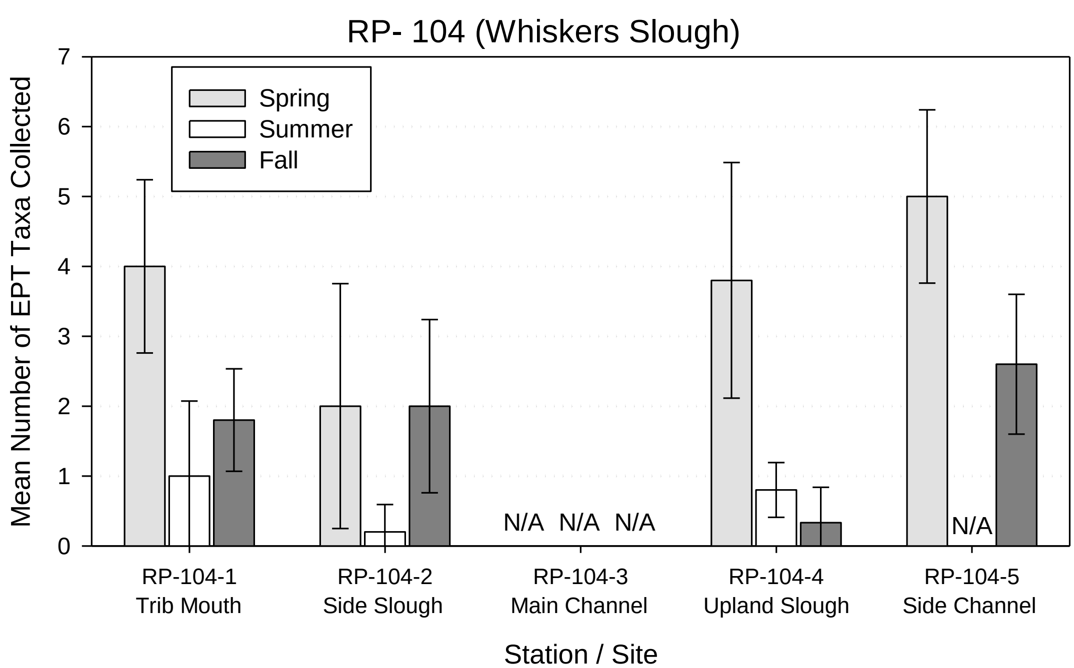


Figure 5.1-17. Mean EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Whiskers slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected.

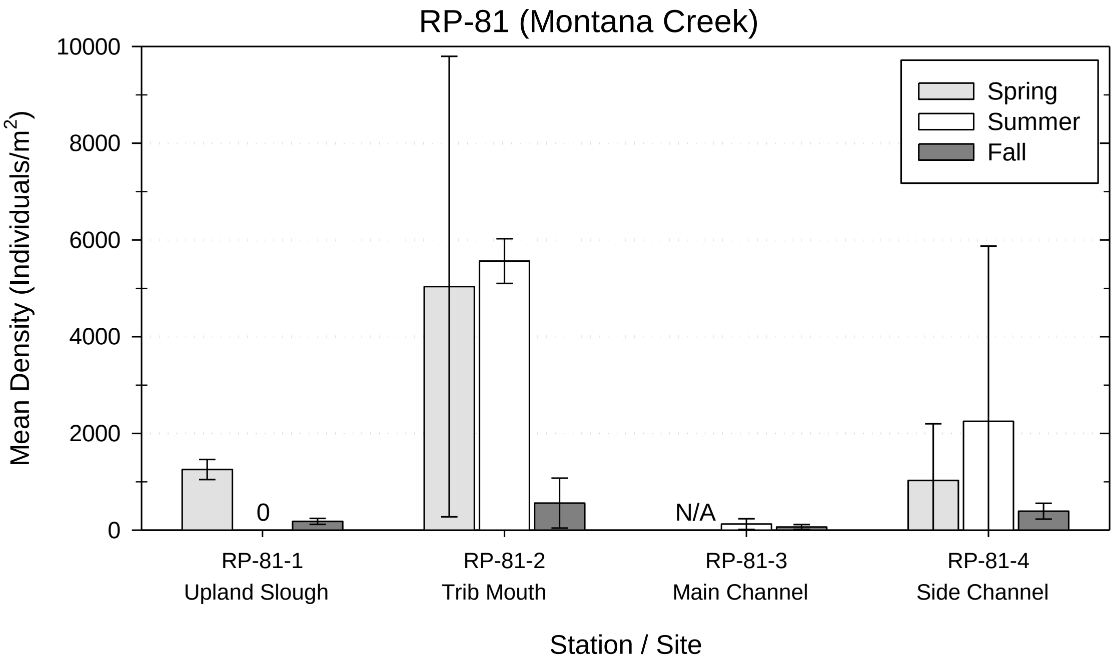


Figure 5.1-18. Mean density estimates collected from woody debris in 2013 during three sampling events for sites within the Montana Creek Study Area (RP-81 in the Lower River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected. "0" indicates zero organisms were collected on collected woody debris.

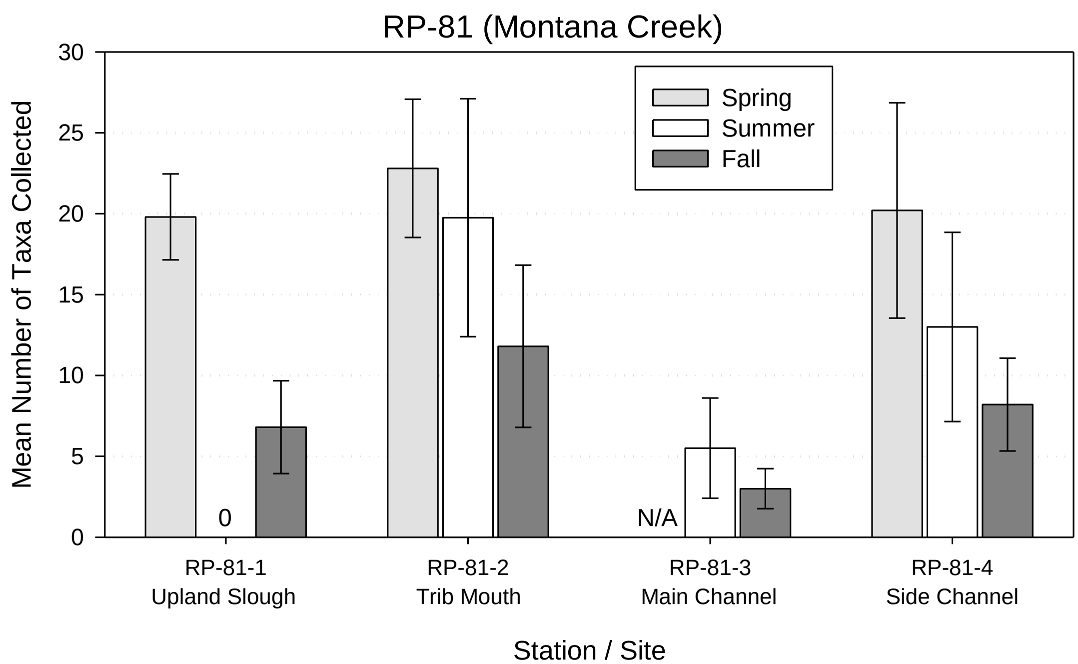


Figure 5.1-19. Mean taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Montana Creek Study Area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected. "0" indicates zero organisms were collected on collected woody debris.

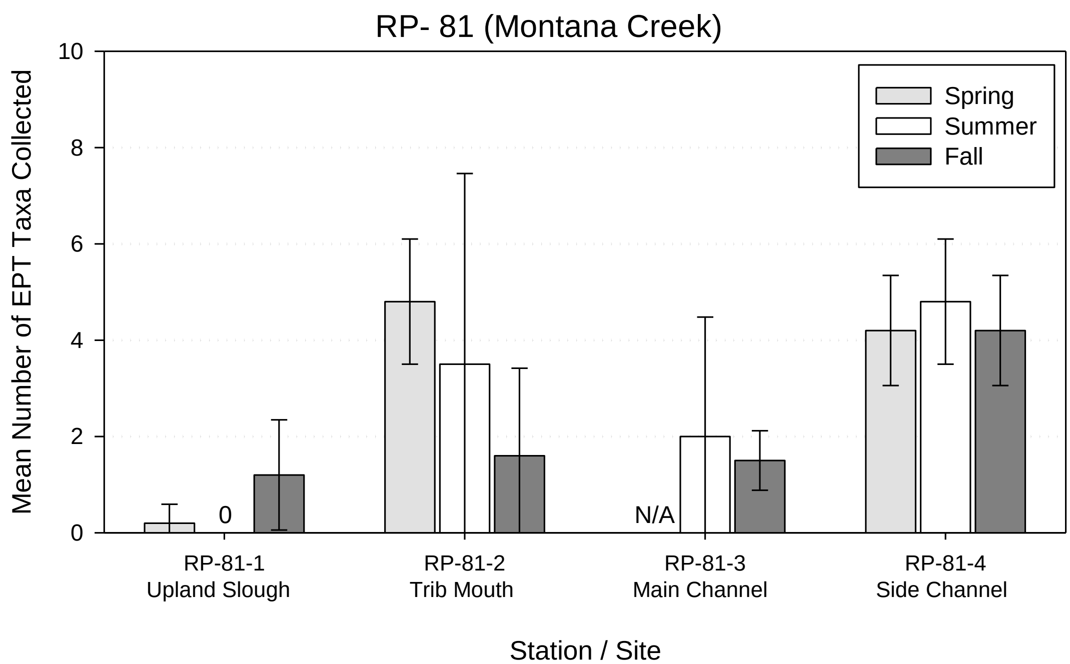


Figure 5.1-20. Mean EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness estimates collected from woody debris in 2013 during three sampling events for sites within the Montana Creek Study Area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "N/A" indicates no sample was collected. "0" indicates zero organisms were collected on collected woody debris.

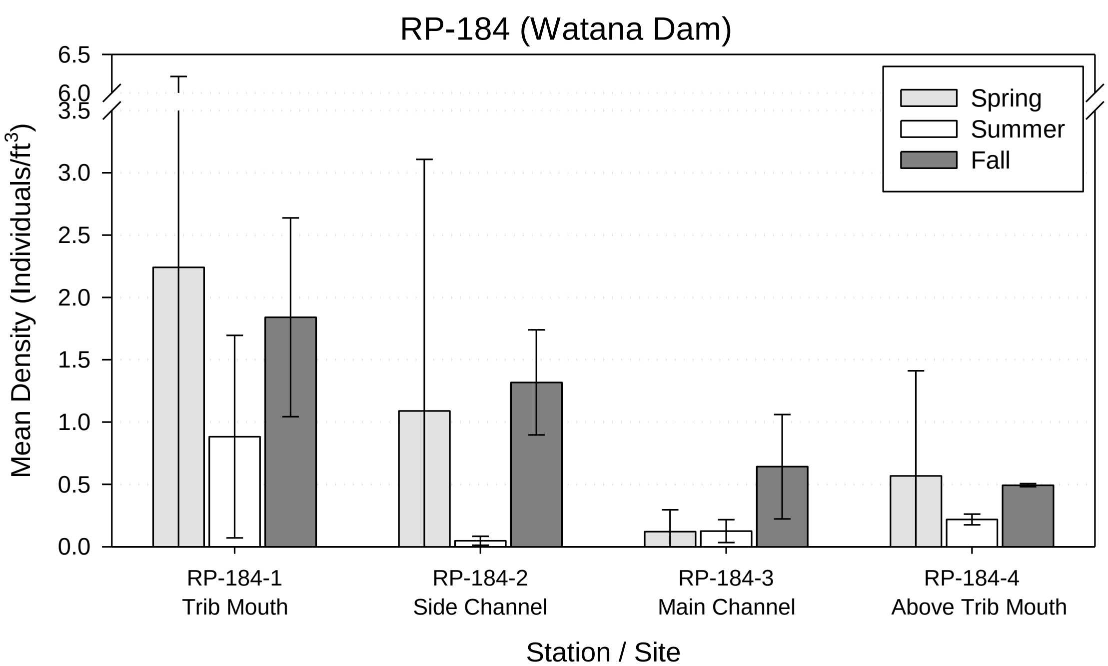


Figure 5.2-1. Mean drift density estimates from drift samples (n=2) collected in 2014 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

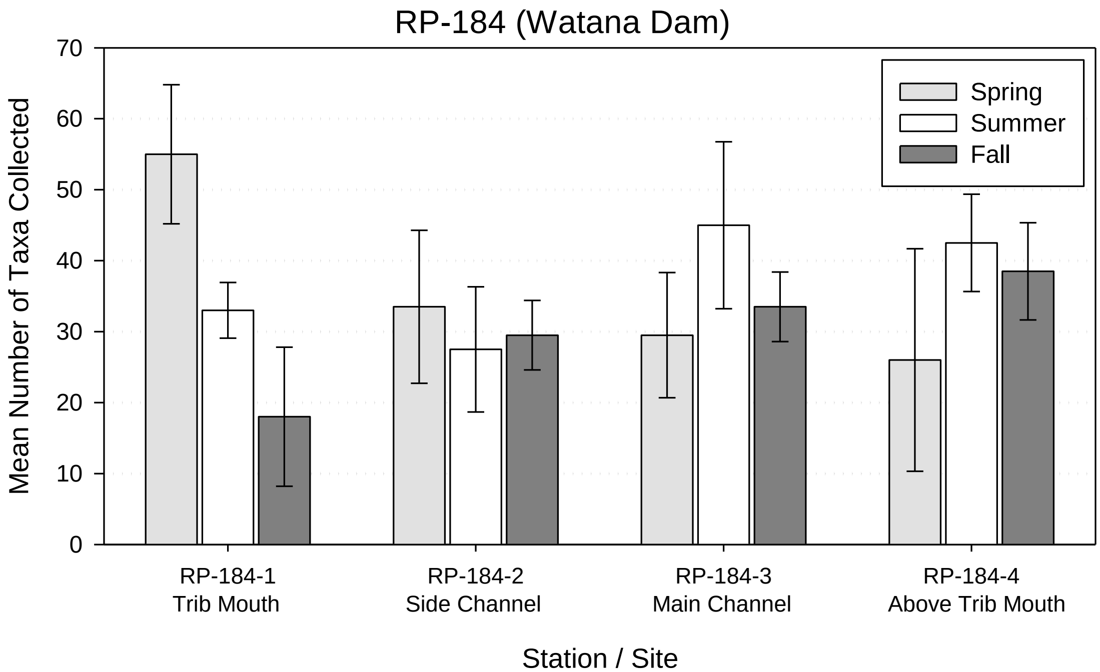


Figure 5.2-2. Mean drift taxa richness estimates from drift samples (n=2) collected in 2014 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

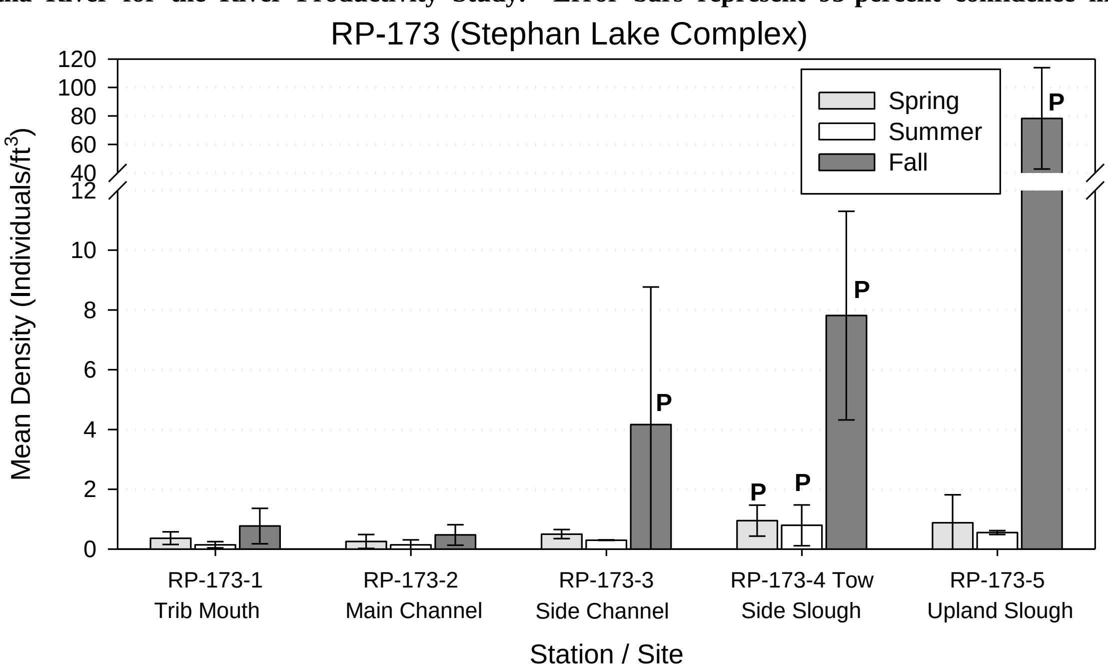


Figure 5.2-3. Mean drift density estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows.

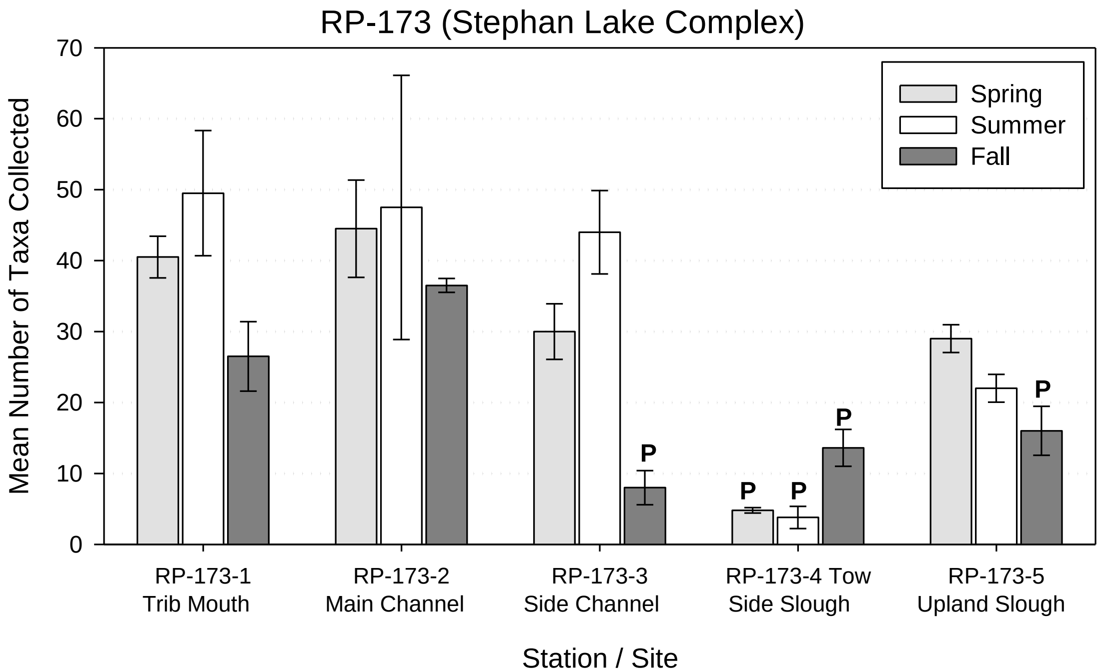


Figure 5.2-4. Mean drift taxa richness estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows.

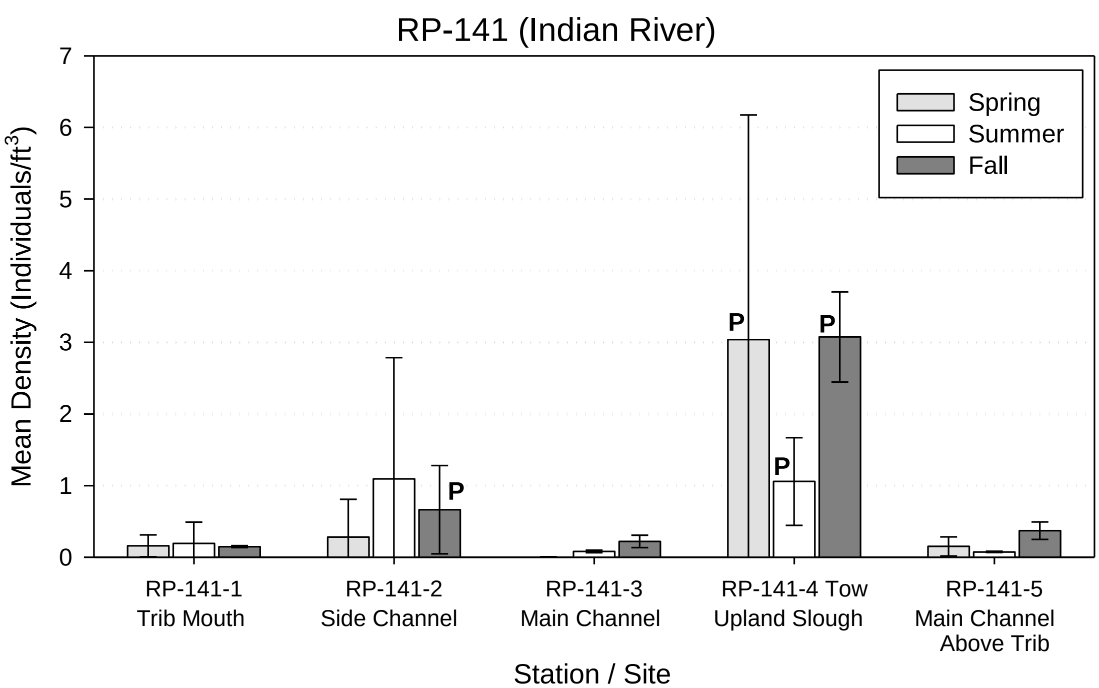


Figure 5.2-5. Mean drift density estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River

Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows.

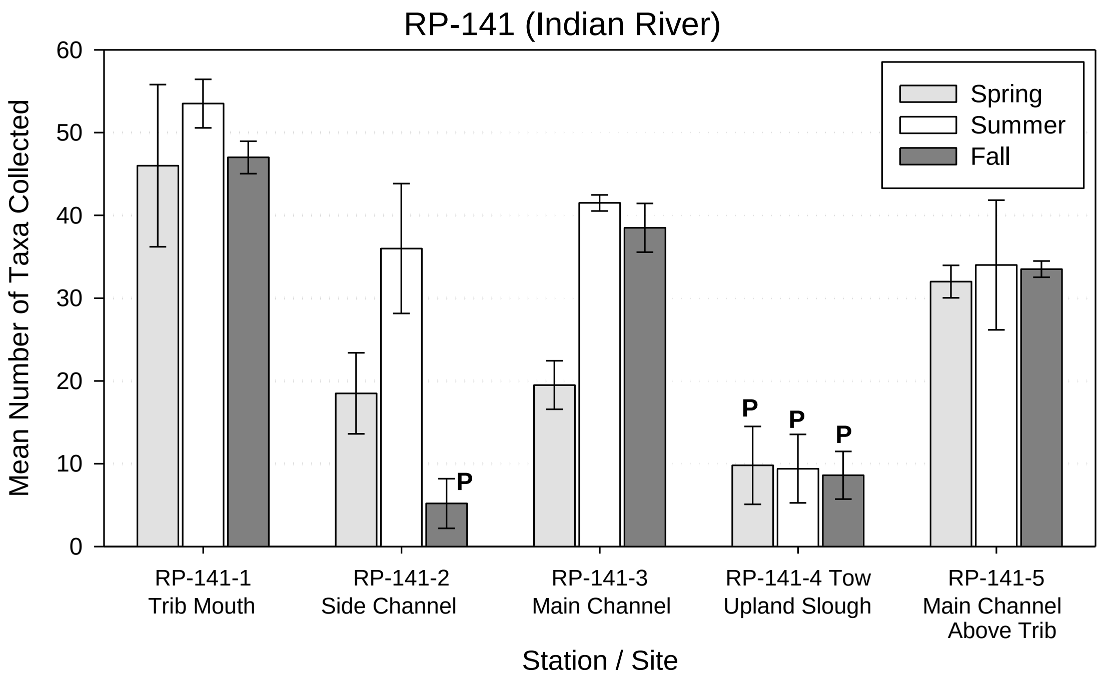


Figure 5.2-6. Mean drift taxa richness estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows.

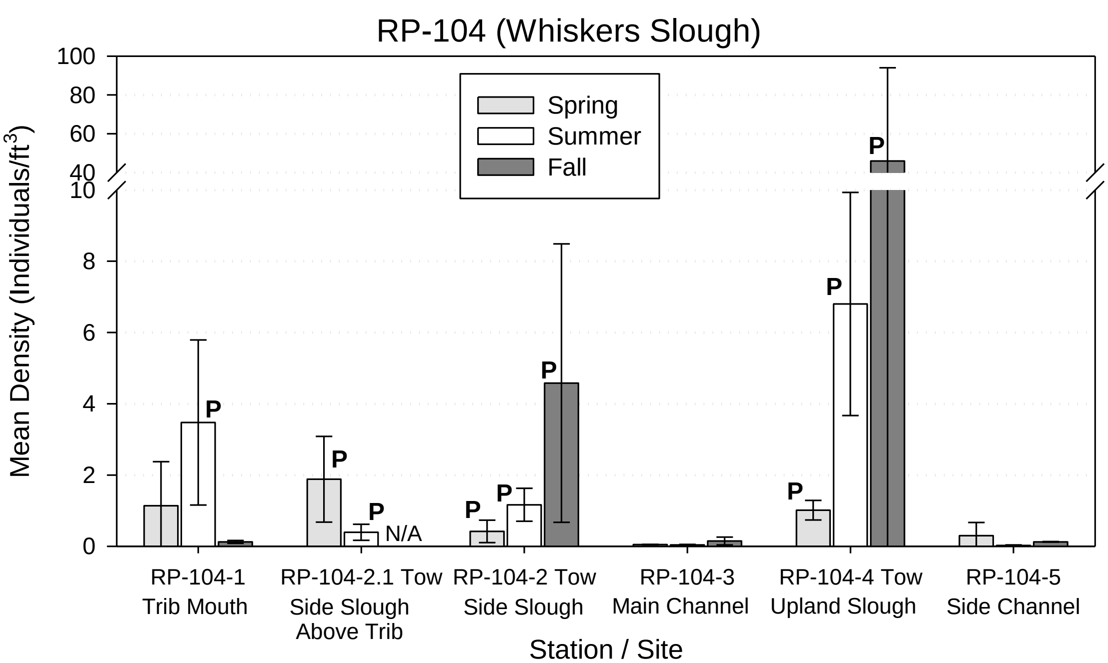


Figure 5.2-7. Mean drift density estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Whiskers Slough Focus Area (FA-104) in the Middle River

Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows. "N/A" - no samples were collected.

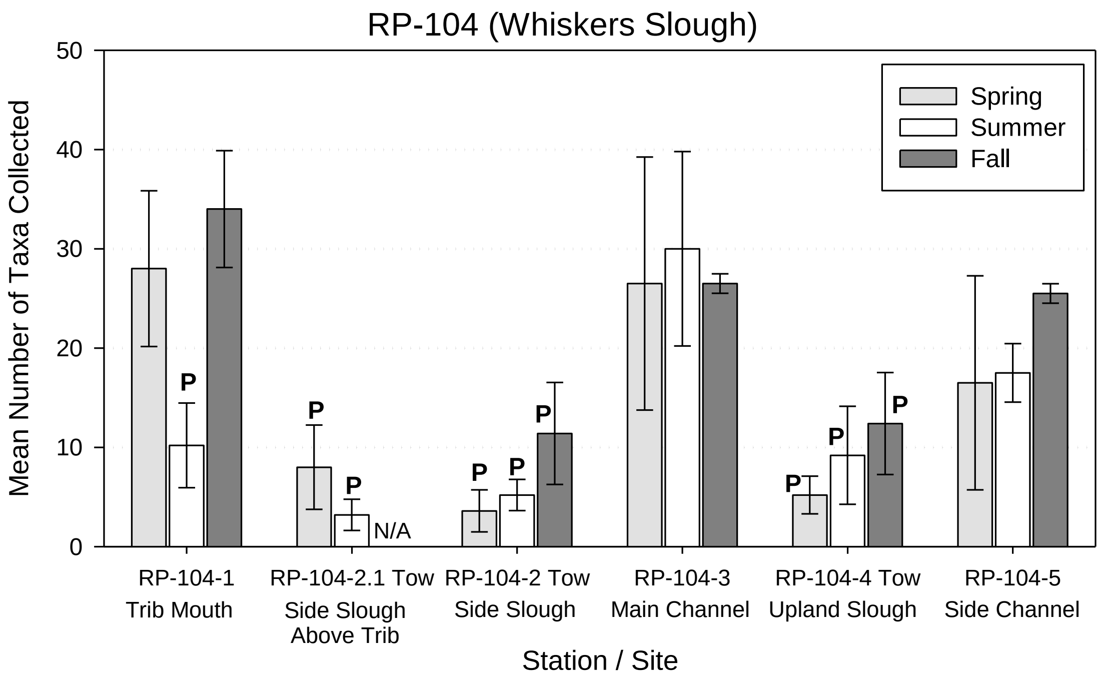


Figure 5.2-8. Mean drift taxa richness estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Whiskers Slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows. "N/A" - no samples were collected.

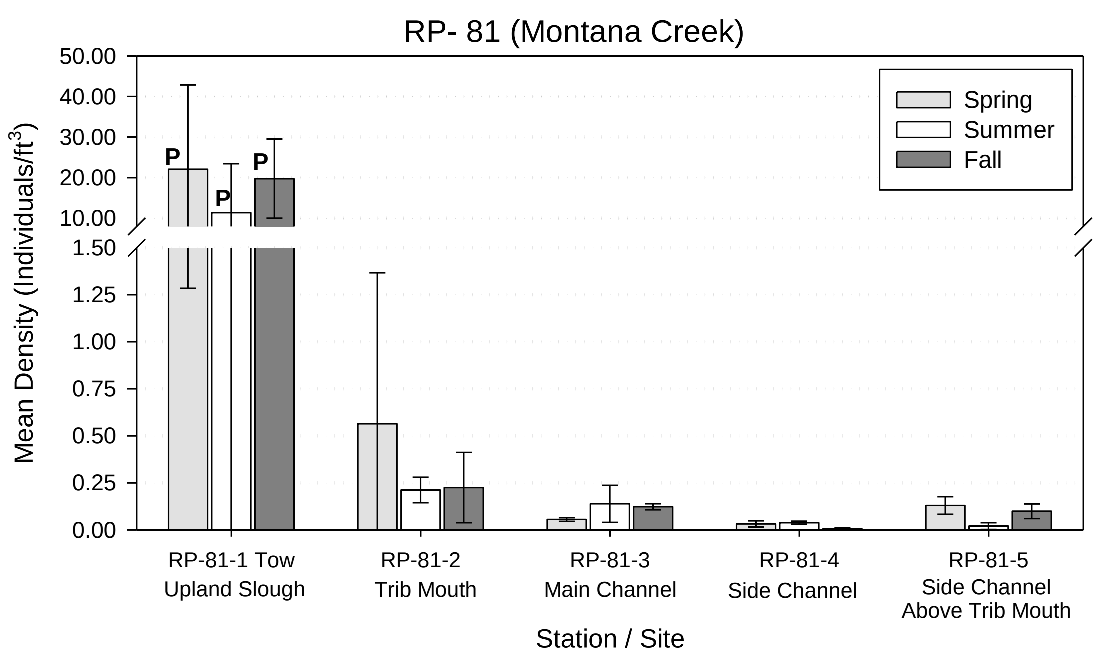


Figure 5.2-9. Mean drift density estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Montana Creek area (RP-81) in the Lower River Segment of

the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows.

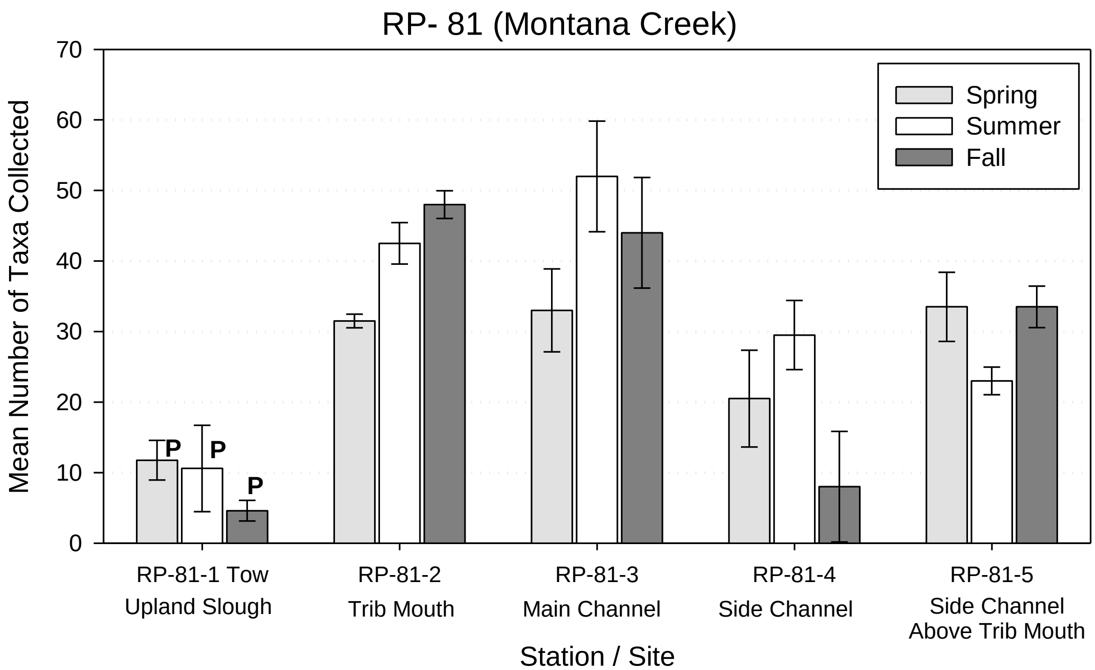


Figure 5.2-10. Mean drift taxa richness estimates from drift samples (n=2) and plankton tows (n=5) collected in 2014 during three sampling events for sites within the Montana Creek area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. Bars marked with a "P" are plankton tows.

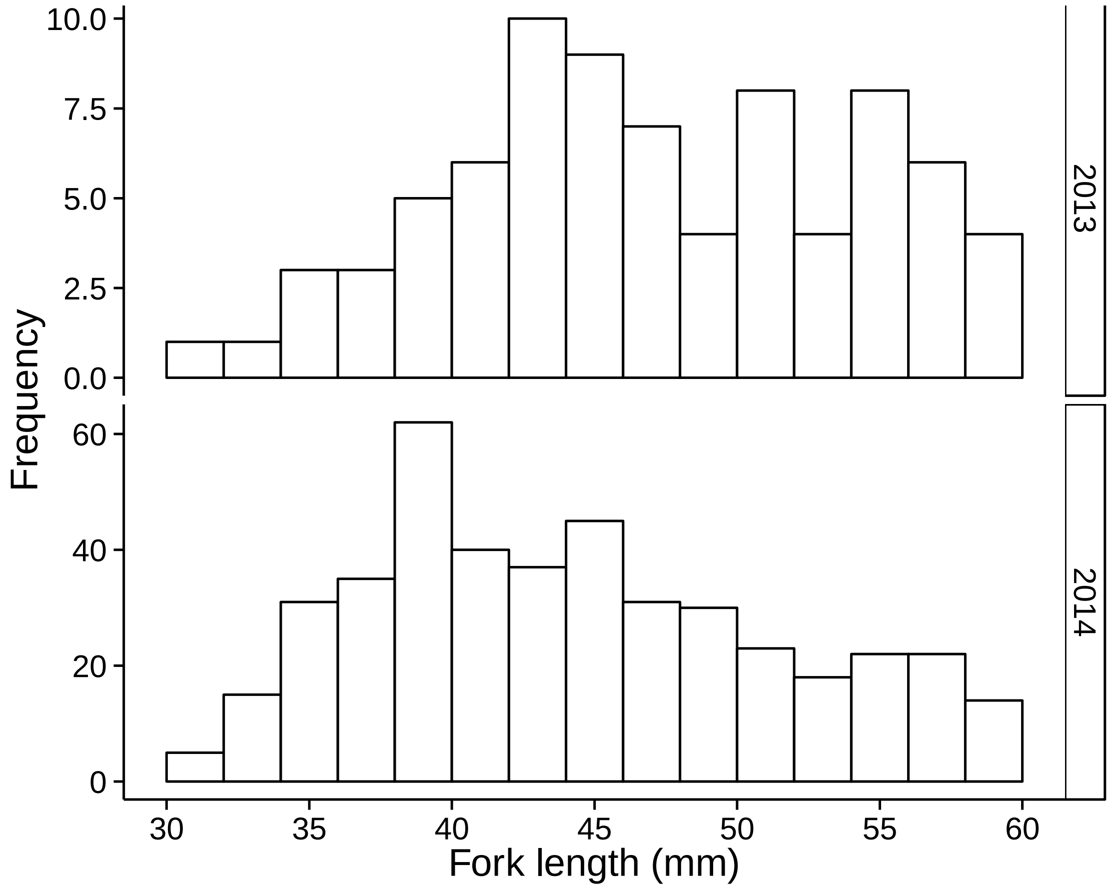


Figure 5.4-1. Length-frequency distributions of Chinook Salmon and Coho Salmon sampled during June 2013 and June 2014 in the study area of the River Productivity Study by the Fish Distribution and Abundance in the Middle and Lower River Study. Distributions are truncated at 60 mm fork length to show size structure of age-0 fish.

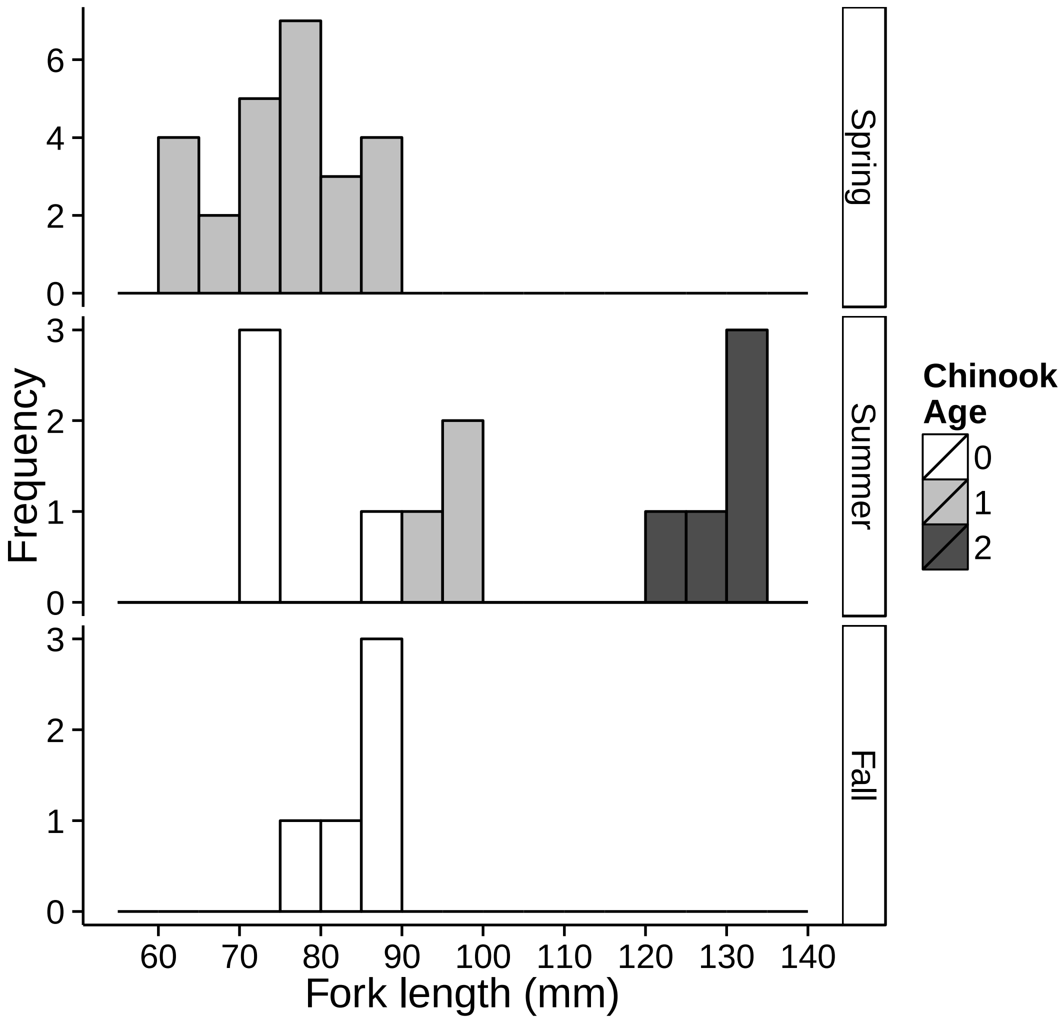


Figure 5.4-2. Seasonal length-at-age relationship of Chinook Salmon collected during 2013 and aged from scales.

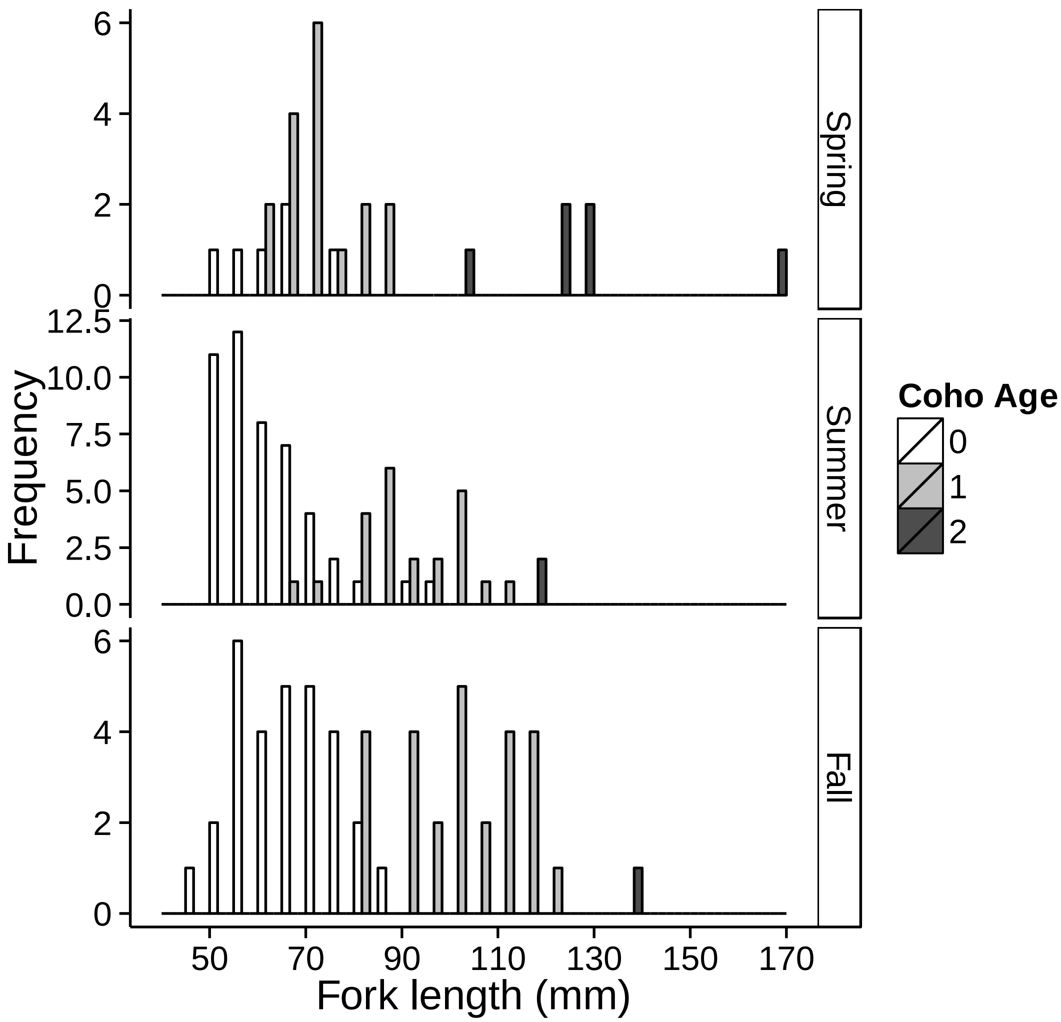


Figure 5.4-3. Seasonal length-at-age relationship of Coho Salmon collected during 2013 and aged from scales.

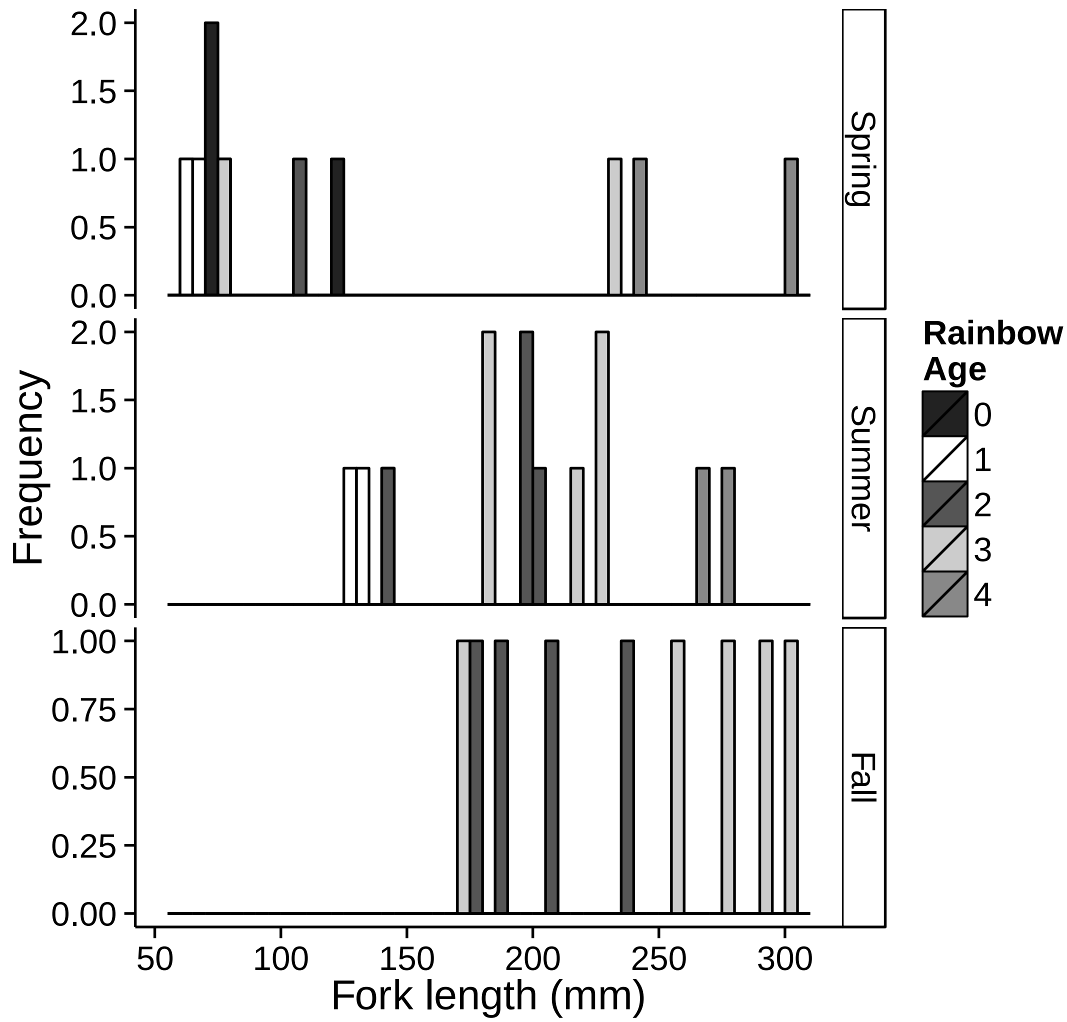


Figure 5.4-4. Seasonal length-at-age relationship of Rainbow Trout collected during 2013 and aged from scales.

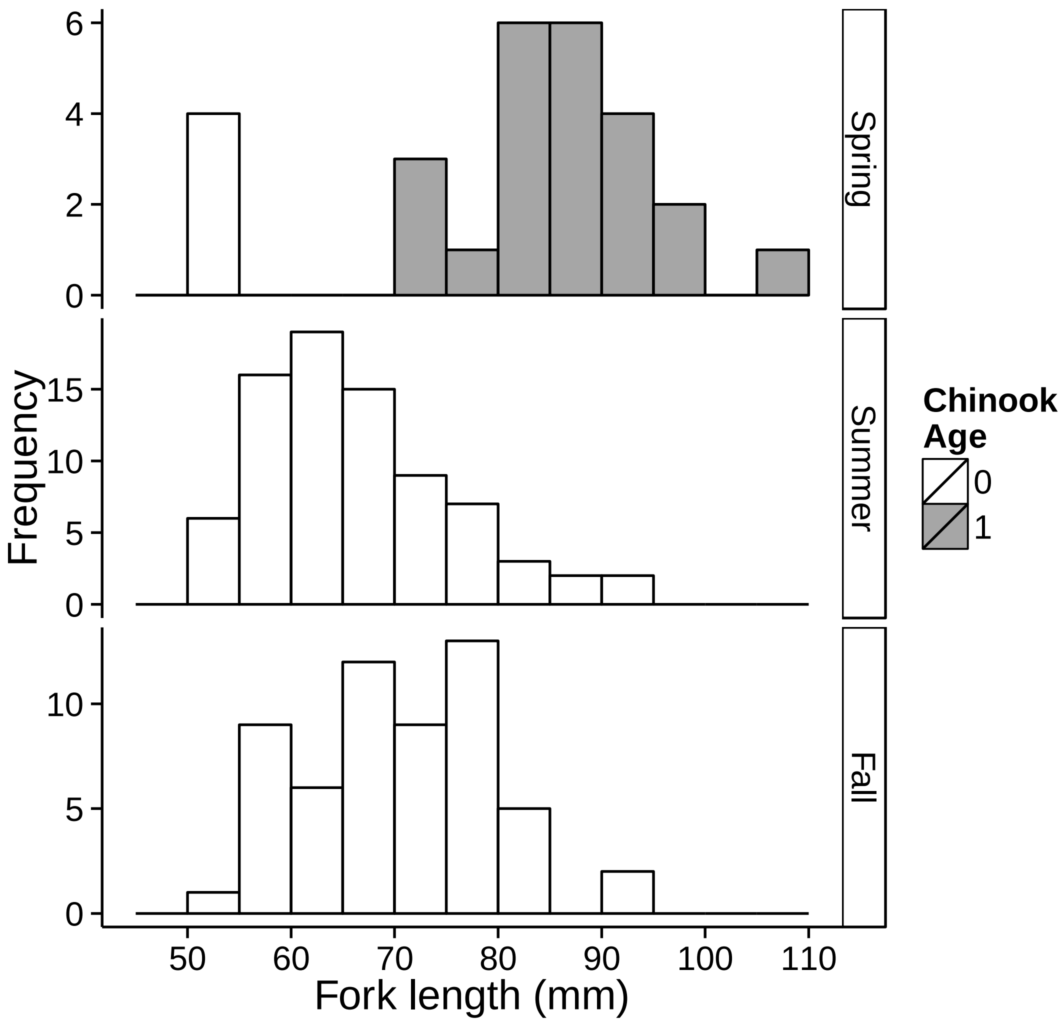


Figure 5.4-5. Seasonal length-at-age relationship of Chinook Salmon aged from scales during 2014.

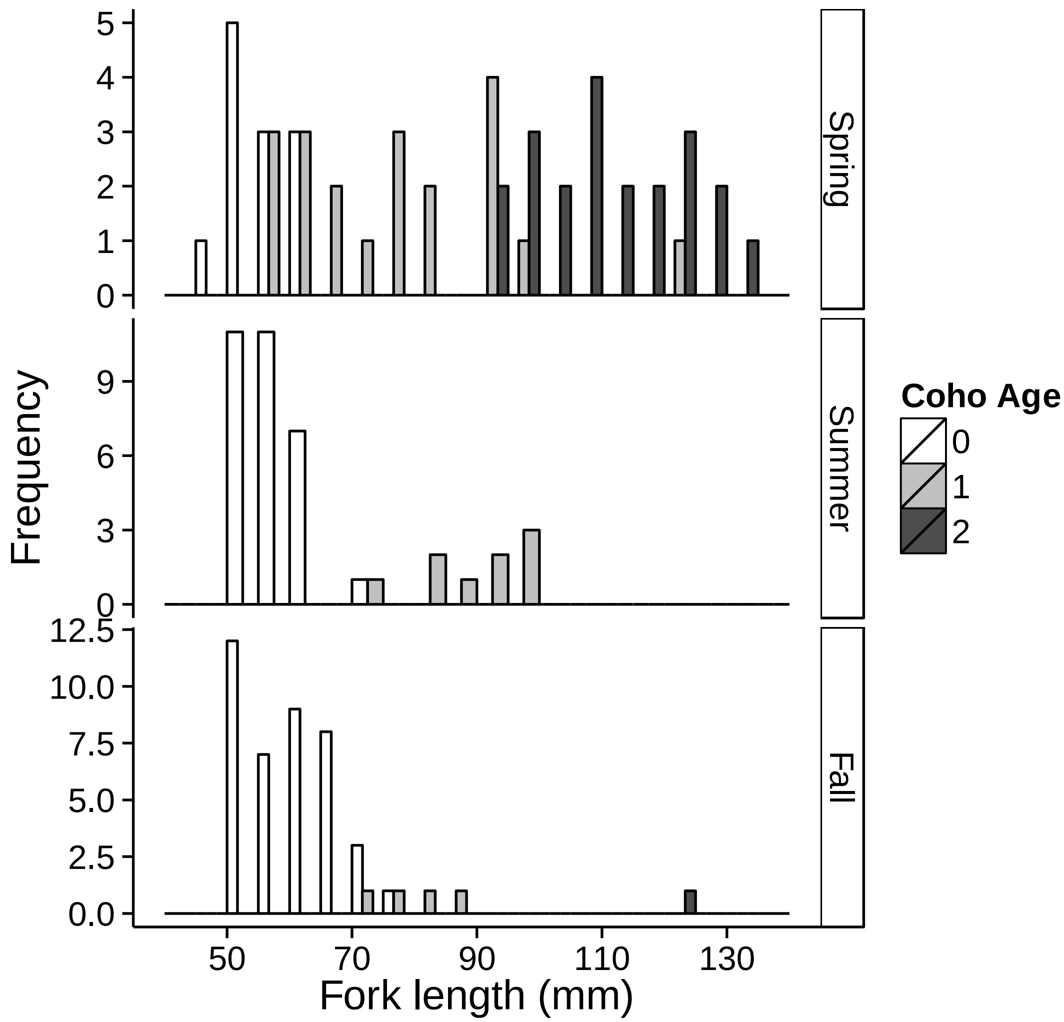


Figure 5.4-6. Seasonal length-at-age relationship of Coho Salmon aged from scales during 2014.

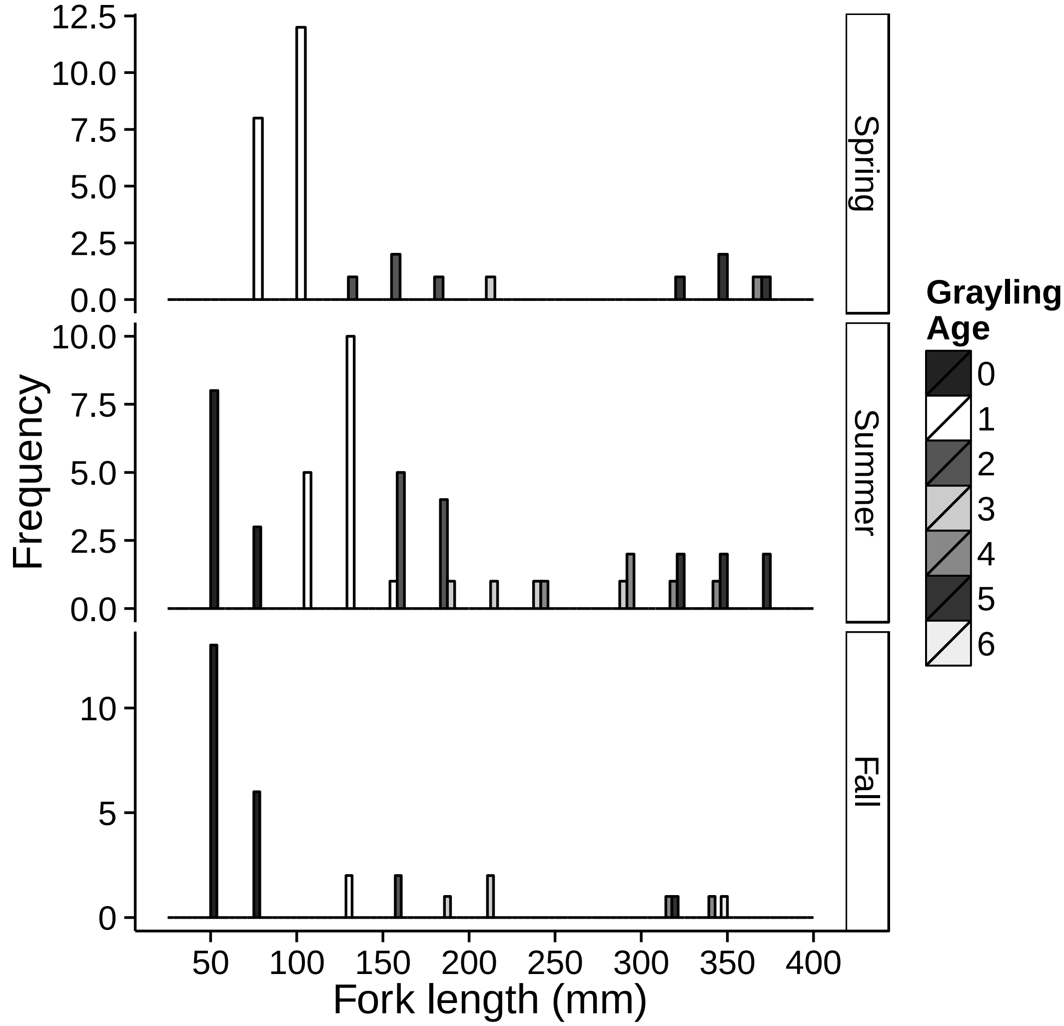


Figure 5.4-7. Seasonal length-at-age relationship of Arctic Grayling aged from scales during 2014.

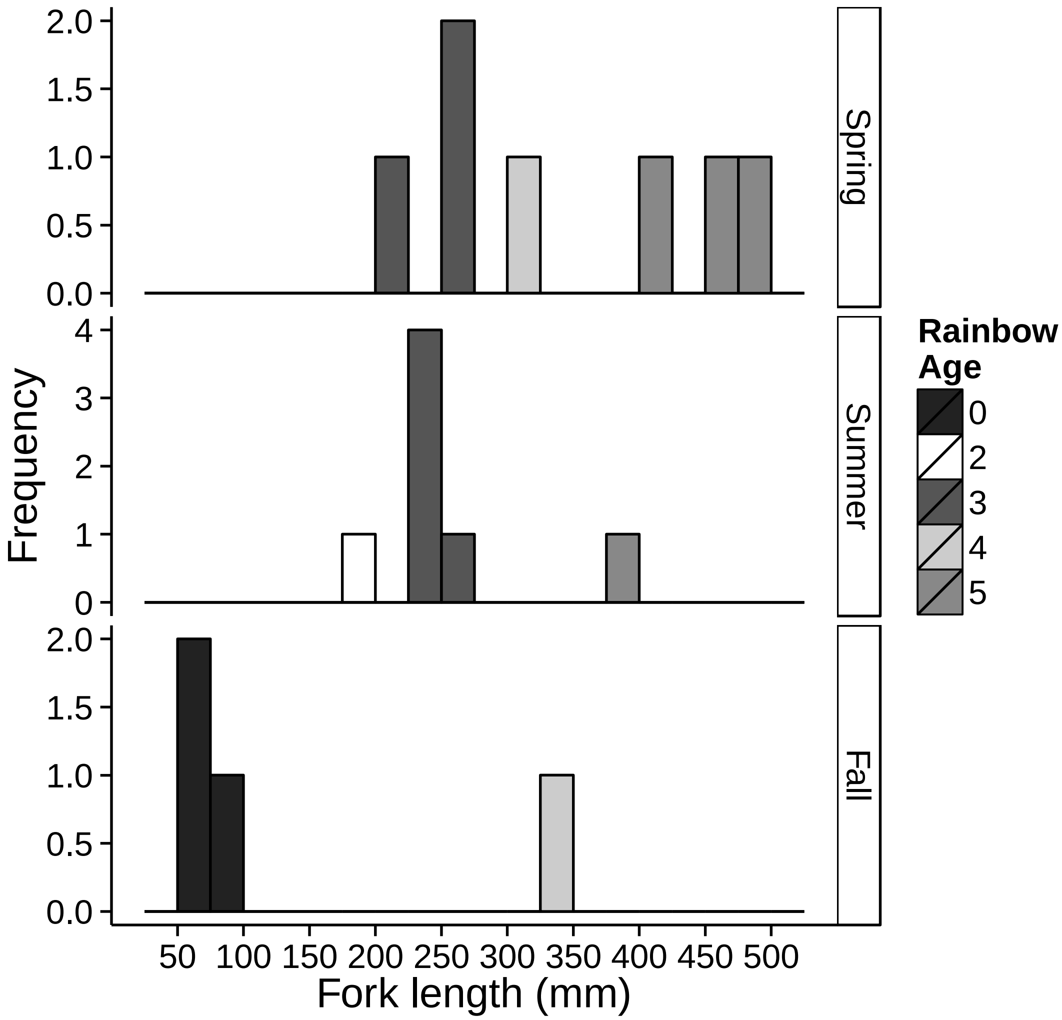


Figure 5.4-8. Seasonal length-at-age relationship of Rainbow Trout aged from scales during 2014.

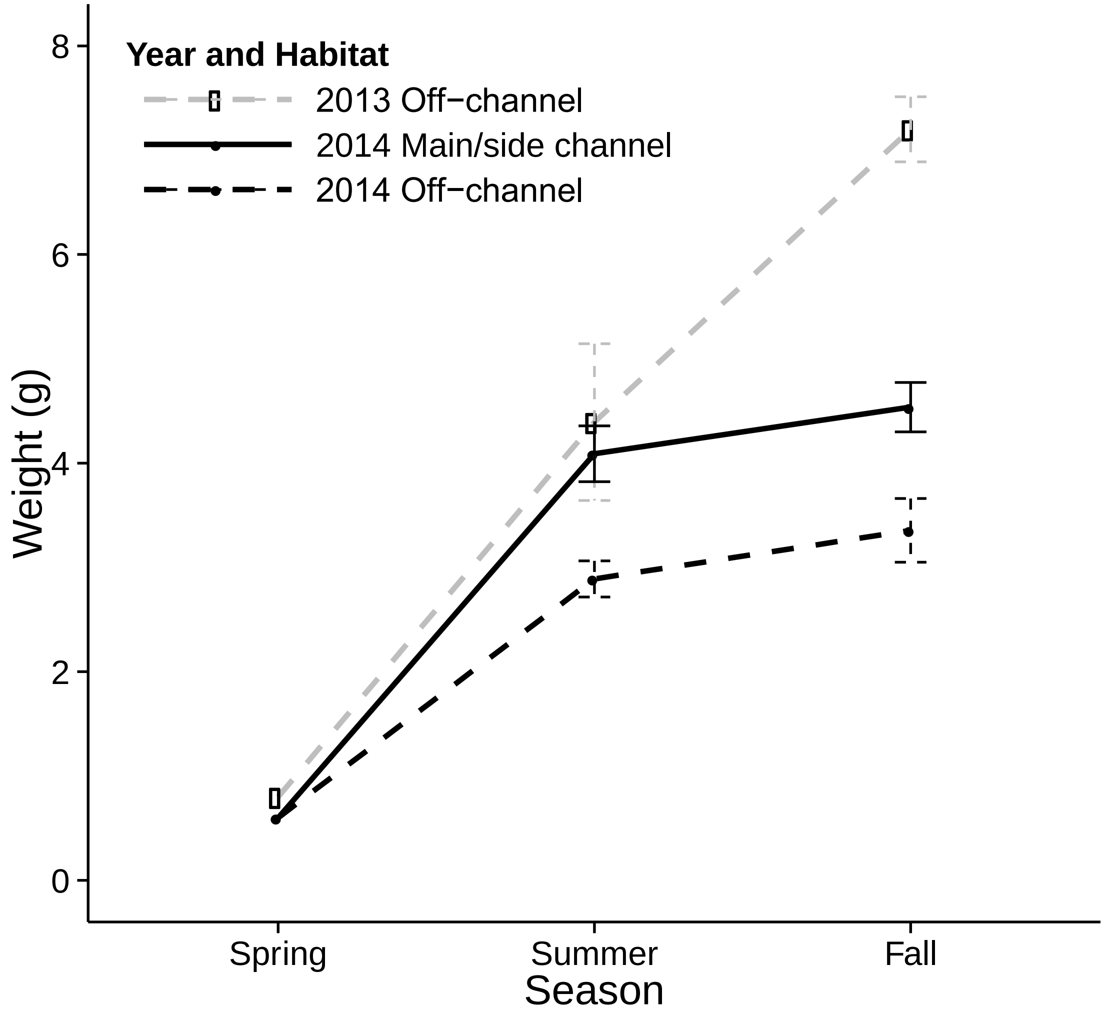


Figure 5.4-9. Seasonal mean weights of age-0 Chinook Salmon sampled in main channel and side channel habitats (main/side channel) and side sloughs, tributary mouths, and upland slough habitats (off-channel) during 2013 and 2014. Symbols represent means ± 1 SE. The mean weight of age-0 Chinook Salmon during spring of each year was estimated from length-frequency distributions and a length-weight relationship, and these values are reported for all habitats combined, without error.

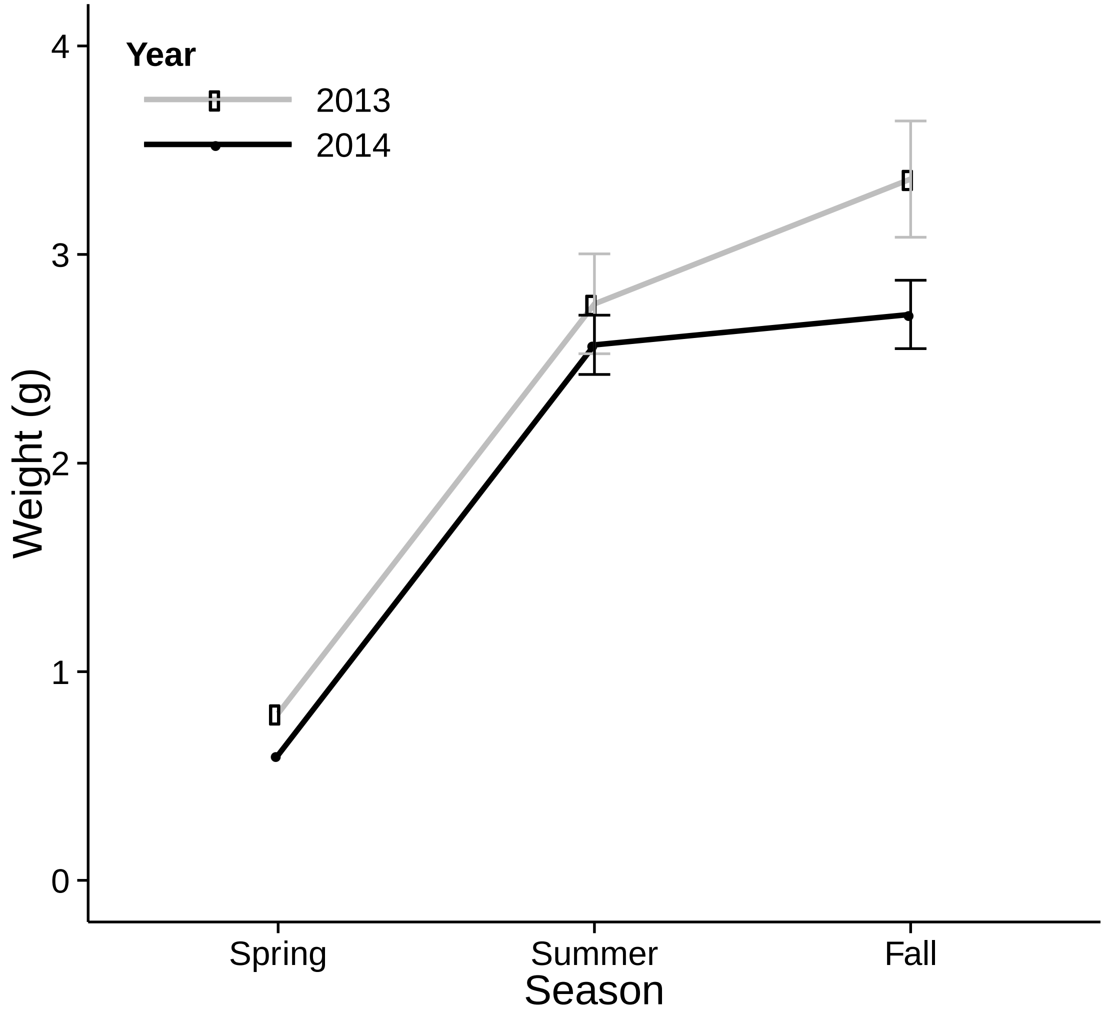


Figure 5.4-10. Seasonal mean weights of age-0 Coho Salmon sampled in all habitats (side channel, side slough, tributary mouth, and upland slough) during 2013 and 2014. Symbols represent means ± 1 SE. The mean weight of age-0 Coho Salmon during spring of each year was estimated from length-frequency distributions and a length-weight relationship, and these values are reported without error.

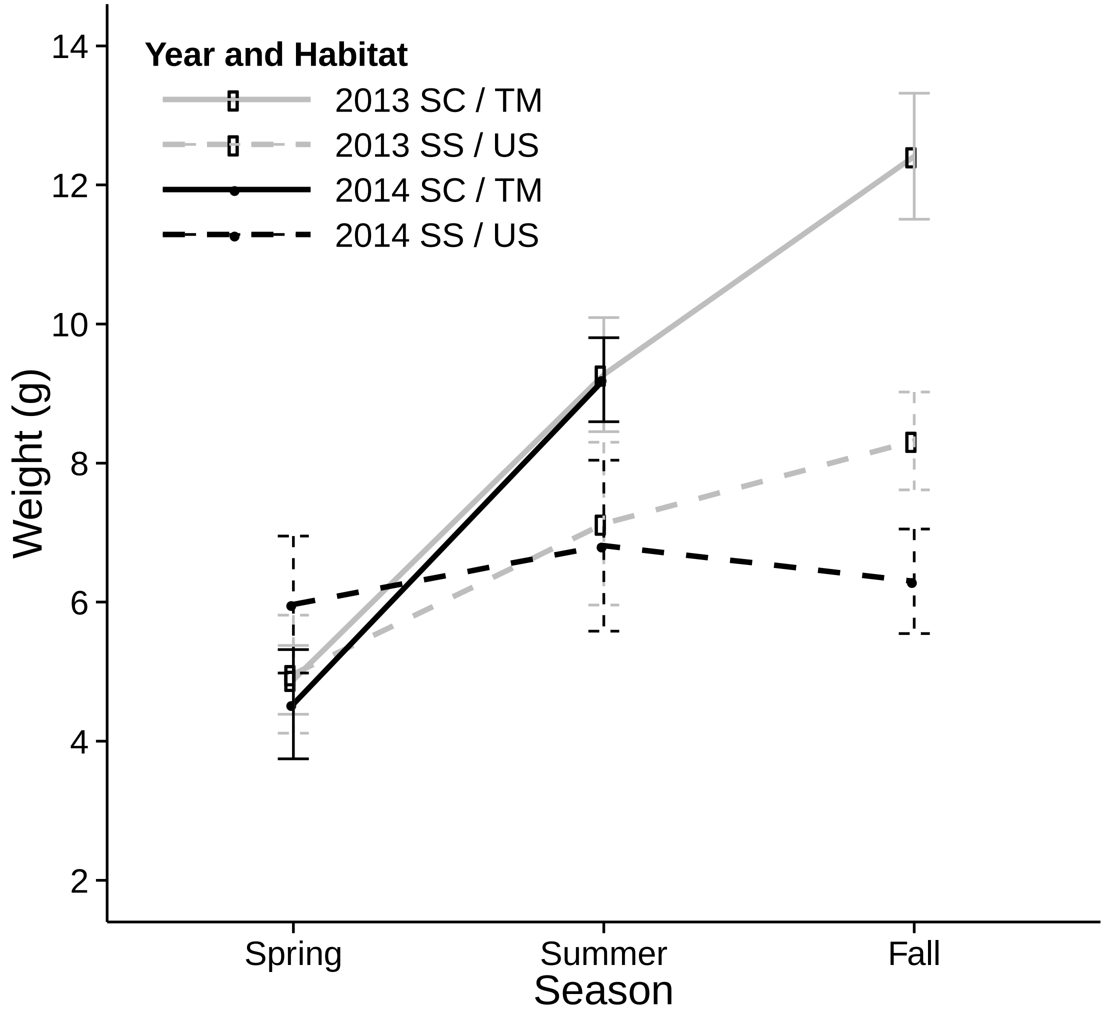


Figure 5.4-11. Seasonal mean weights of age-1 Coho Salmon sampled in side channel and tributary mouth habitats (SC / TM) and side sloughs and upland slough habitats (SS / US) during 2013 and 2014. Symbols represent means ± 1 SE.

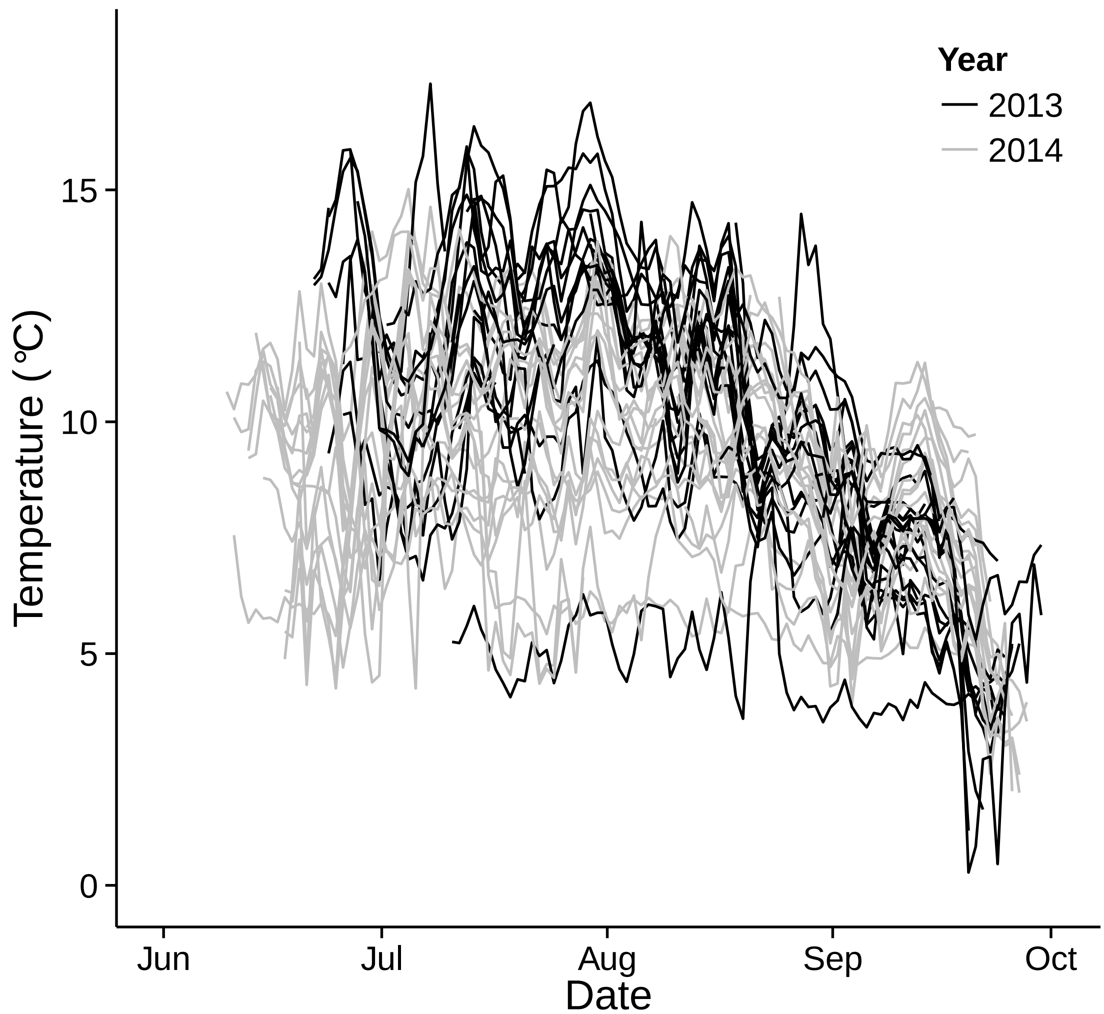
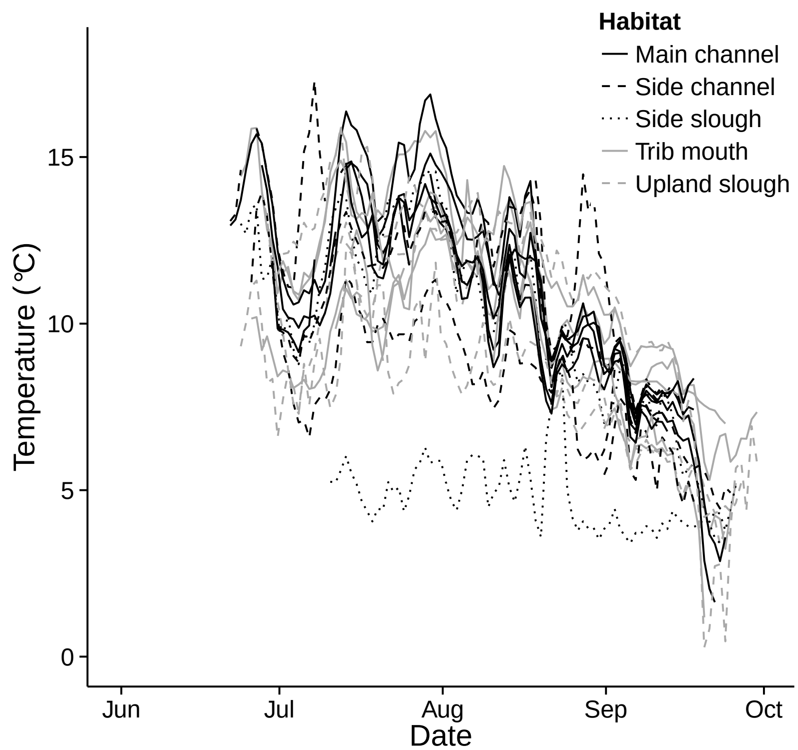


Figure 5.4-12. Daily mean stream temperatures recorded at all study sites during 2013 and 2014.



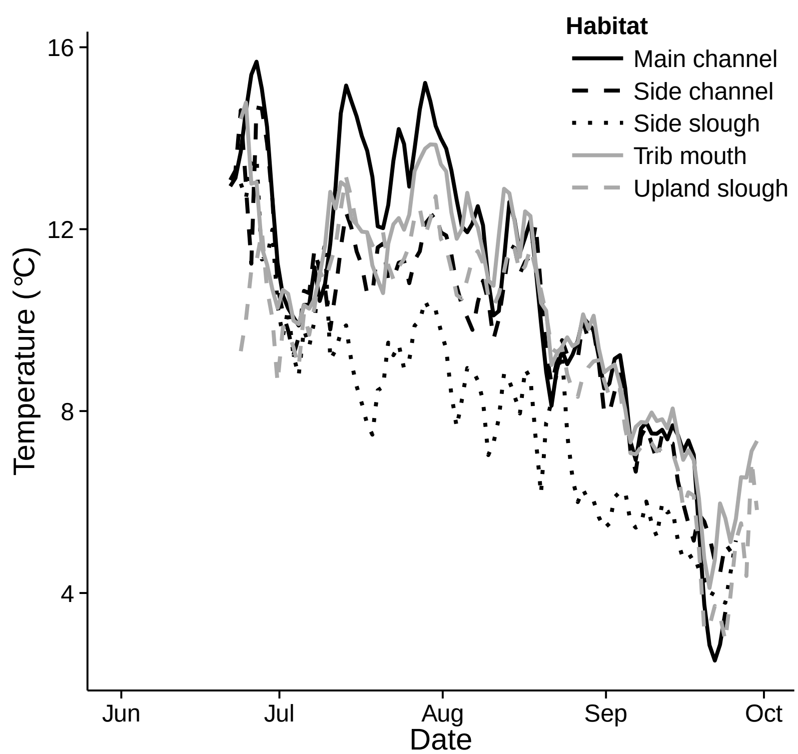
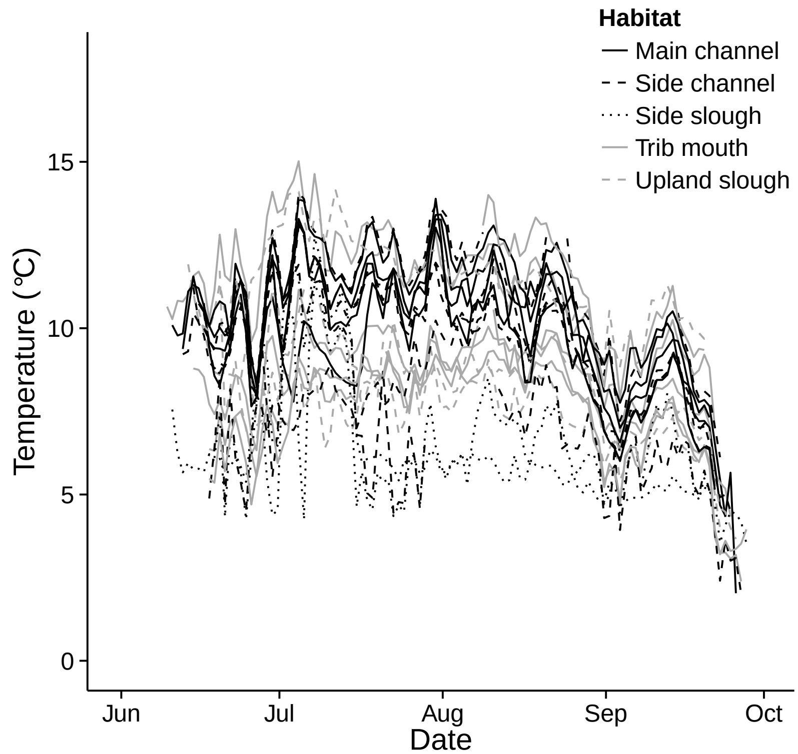


Figure 5.4-13. Daily mean stream temperatures recorded at each site in 2013, displayed by macrohabitat type (top panel); daily stream temperatures averaged across all sites within each habitat type (bottom panel).



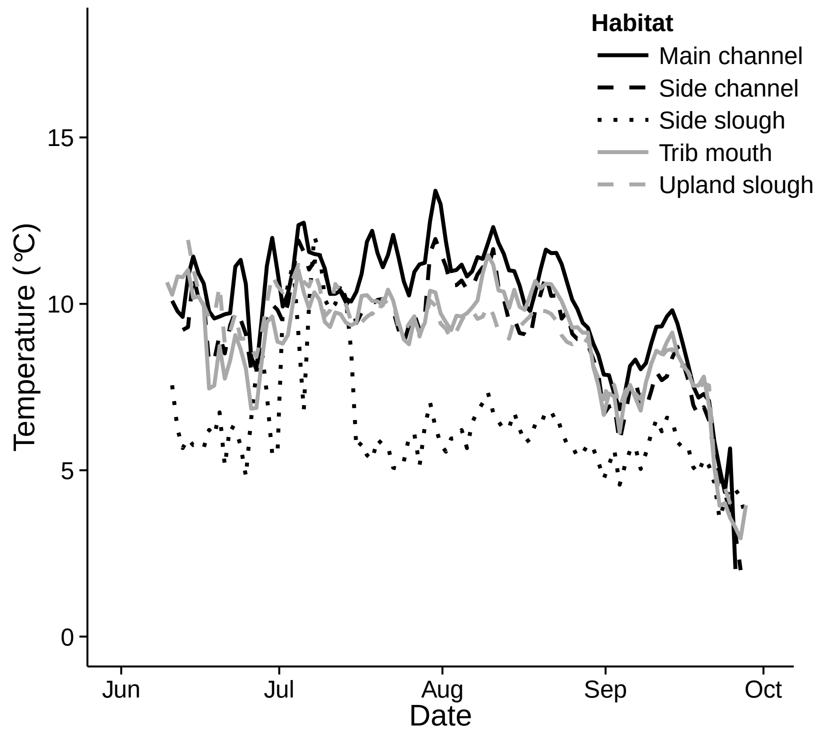


Figure 5.4-14. Daily mean stream temperatures recorded at each site in 2014, displayed by macrohabitat type (top panel); daily stream temperatures averaged across all sites within each macrohabitat type (bottom panel).

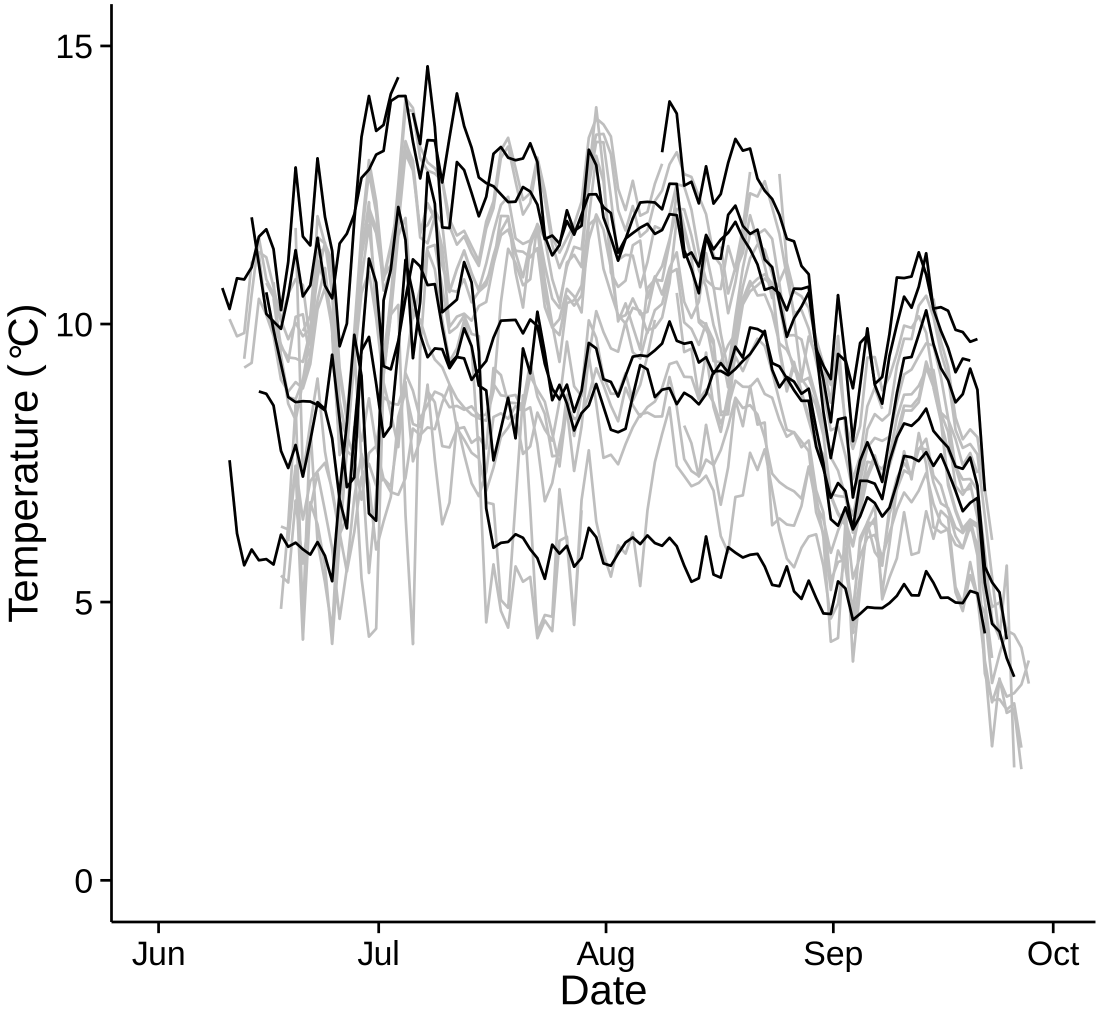


Figure 5.4-15. Daily mean stream temperatures recorded at each site in 2014 (gray); sites where the stomach contents of juvenile salmon contained salmon eggs are plotted in black.

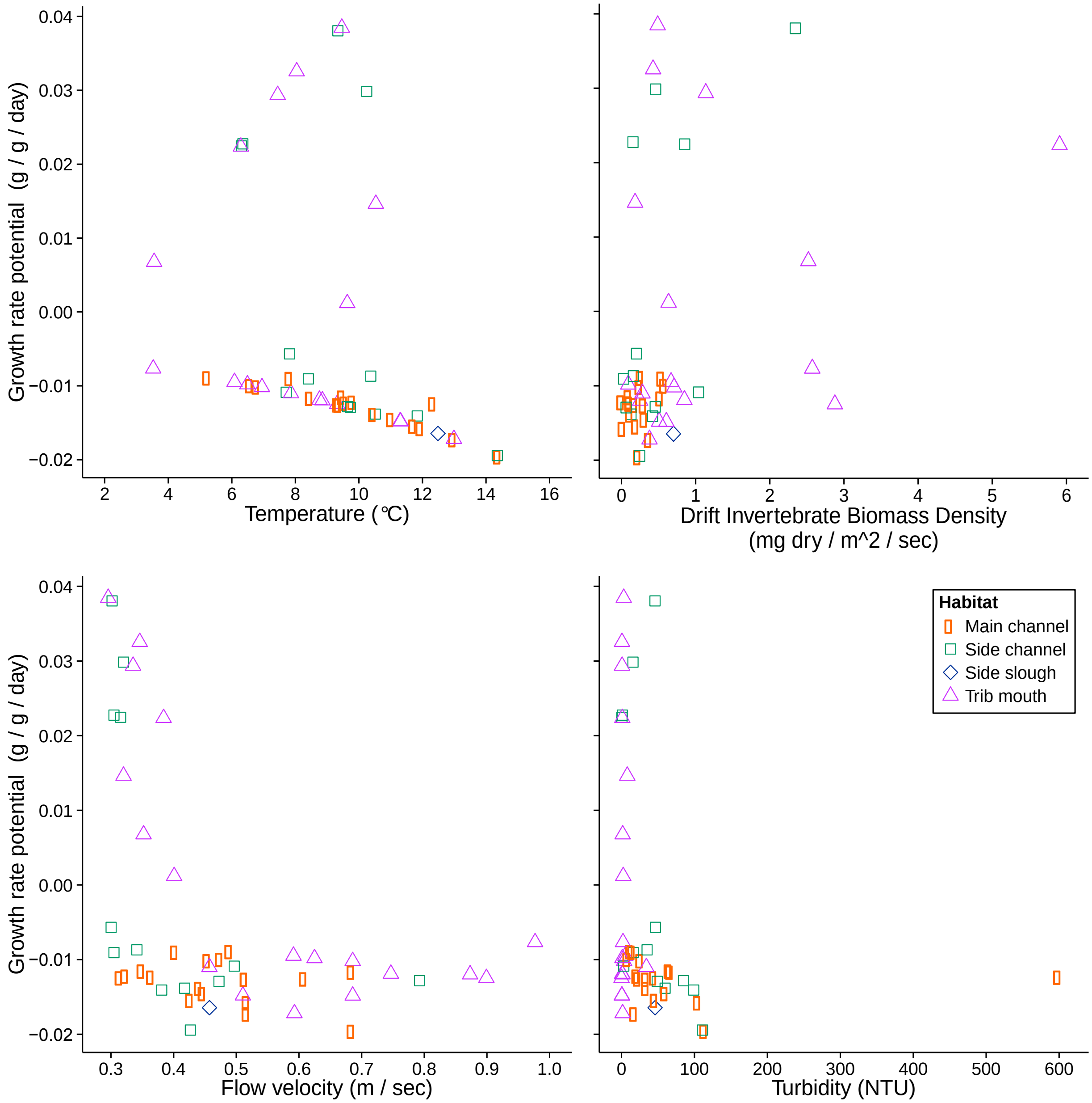


Figure 5.4-16. Associations between temperature, drift invertebrate biomass density, flow velocity, turbidity and model-estimated growth rate potential of drift feeding age-1 Coho Salmon.

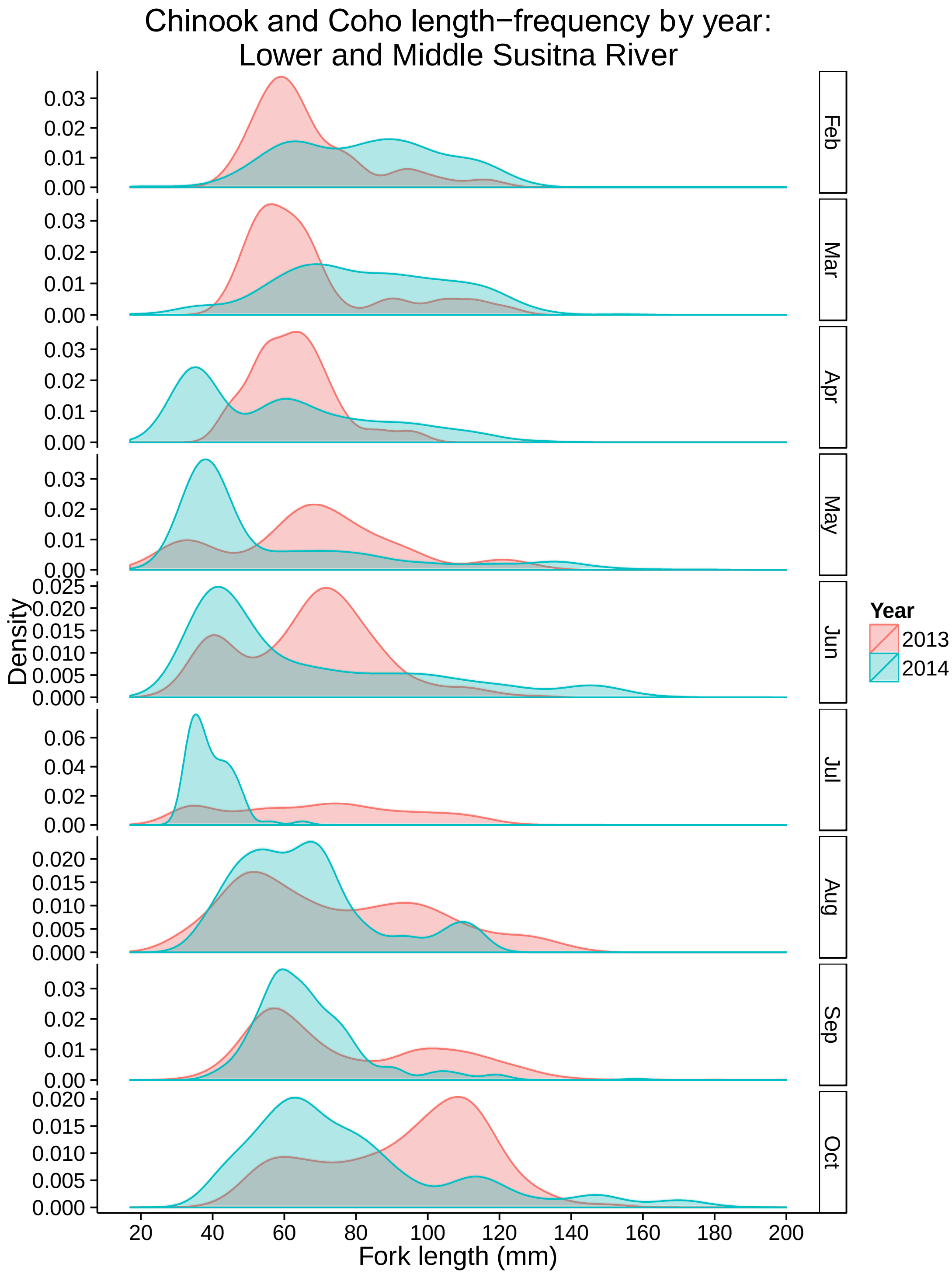


Figure 5.4-17. Monthly length frequency distributions of Chinook Salmon and Coho Salmon sampled in the Middle and Lower Susitna River during 2013 and 2014.

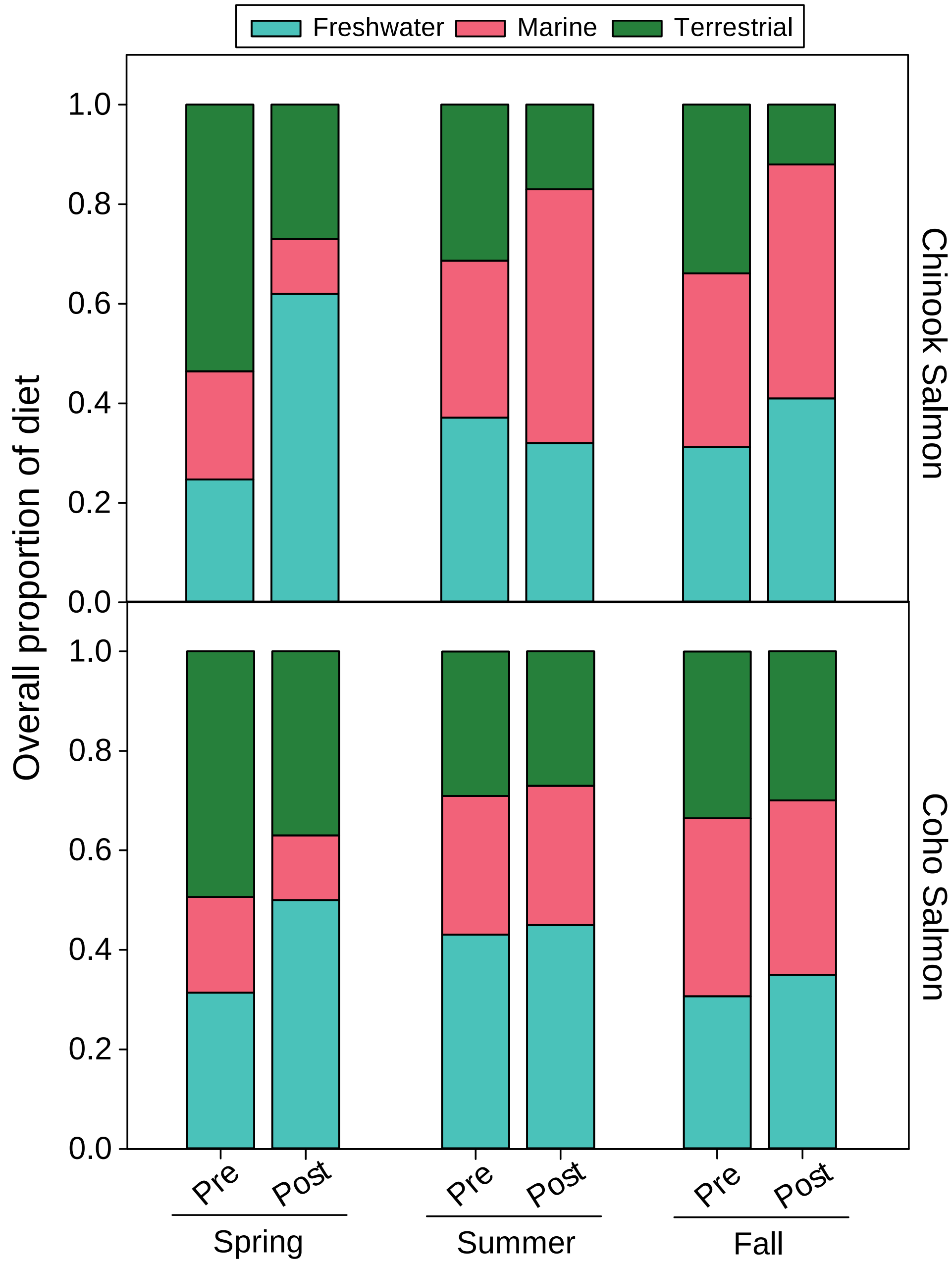


Figure 5.4-18. Comparisons of the mean dietary proportions of juvenile Chinook and Coho salmon across sampling periods in 2013, as determined by Bayesian stable isotope mixing models before genetic analysis of juvenile salmon tissues (Pre) and after the incorporation of species reassignments and informative priors from stomach contents (Post).

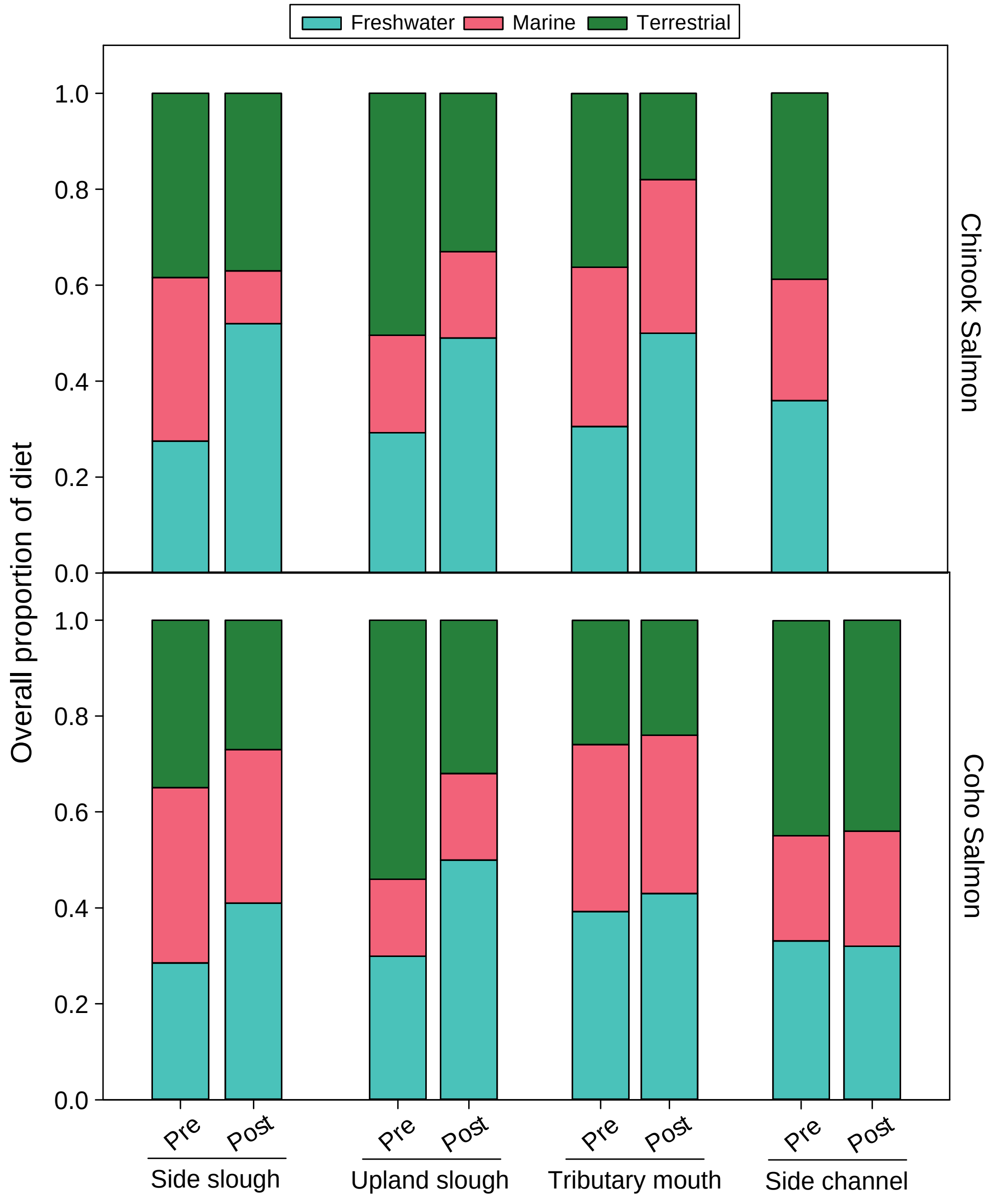


Figure 5.4-19. Comparisons of the mean dietary proportions of juvenile Chinook and Coho salmon across macrohabitats in 2013, as determined by Bayesian stable isotope mixing models before genetic analysis of juvenile salmon tissues (Pre) and after the incorporation of species reassignments and informative priors from stomach contents (Post).

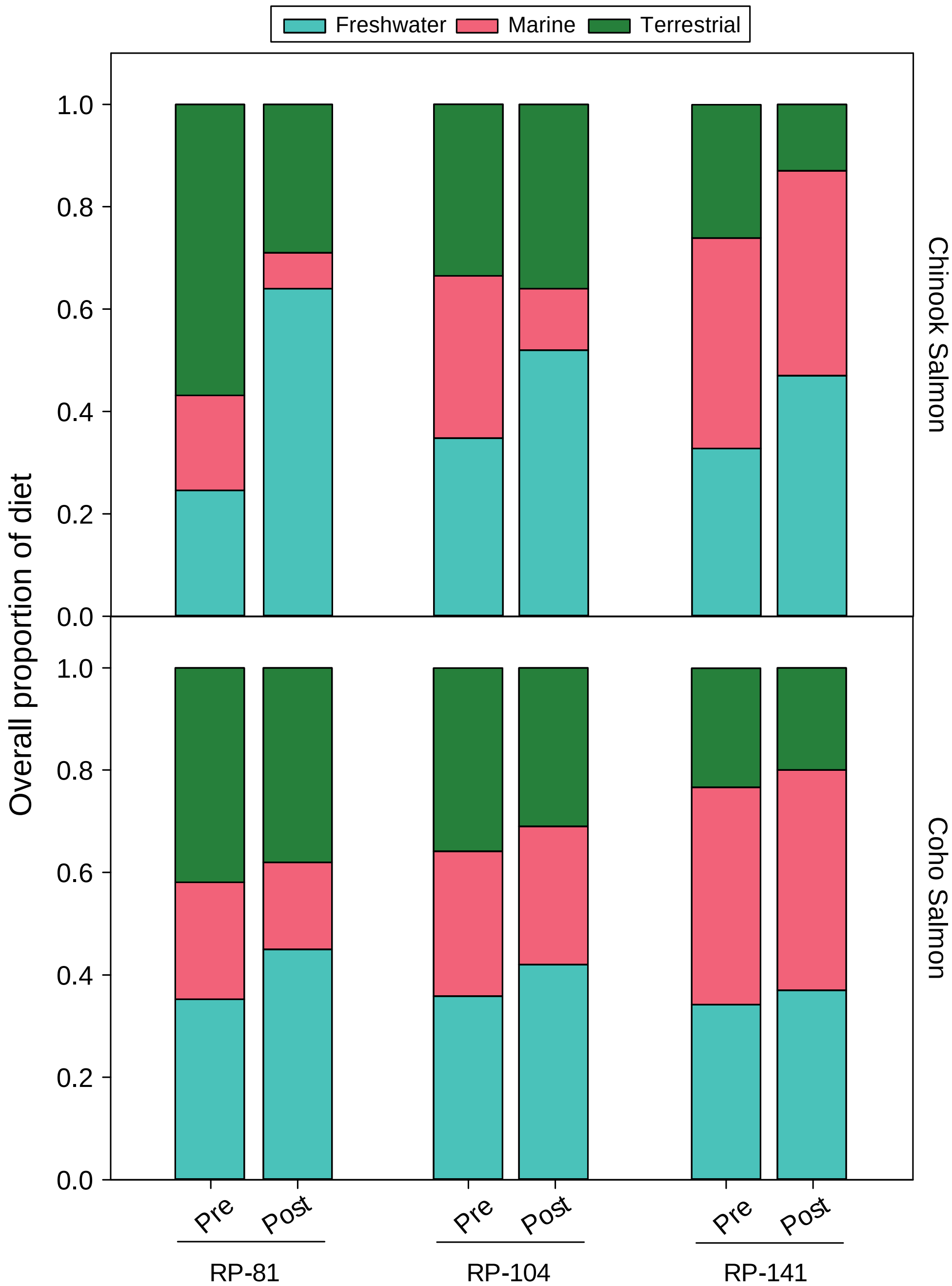


Figure 5.4-20. Comparisons of the mean dietary proportions of juvenile Chinook and Coho salmon across RP Focus Areas in 2013, as determined by Bayesian stable isotope mixing models before genetic analysis of juvenile salmon tissues (Pre) and after the incorporation of species reassignments and informative priors from stomach contents (Post).

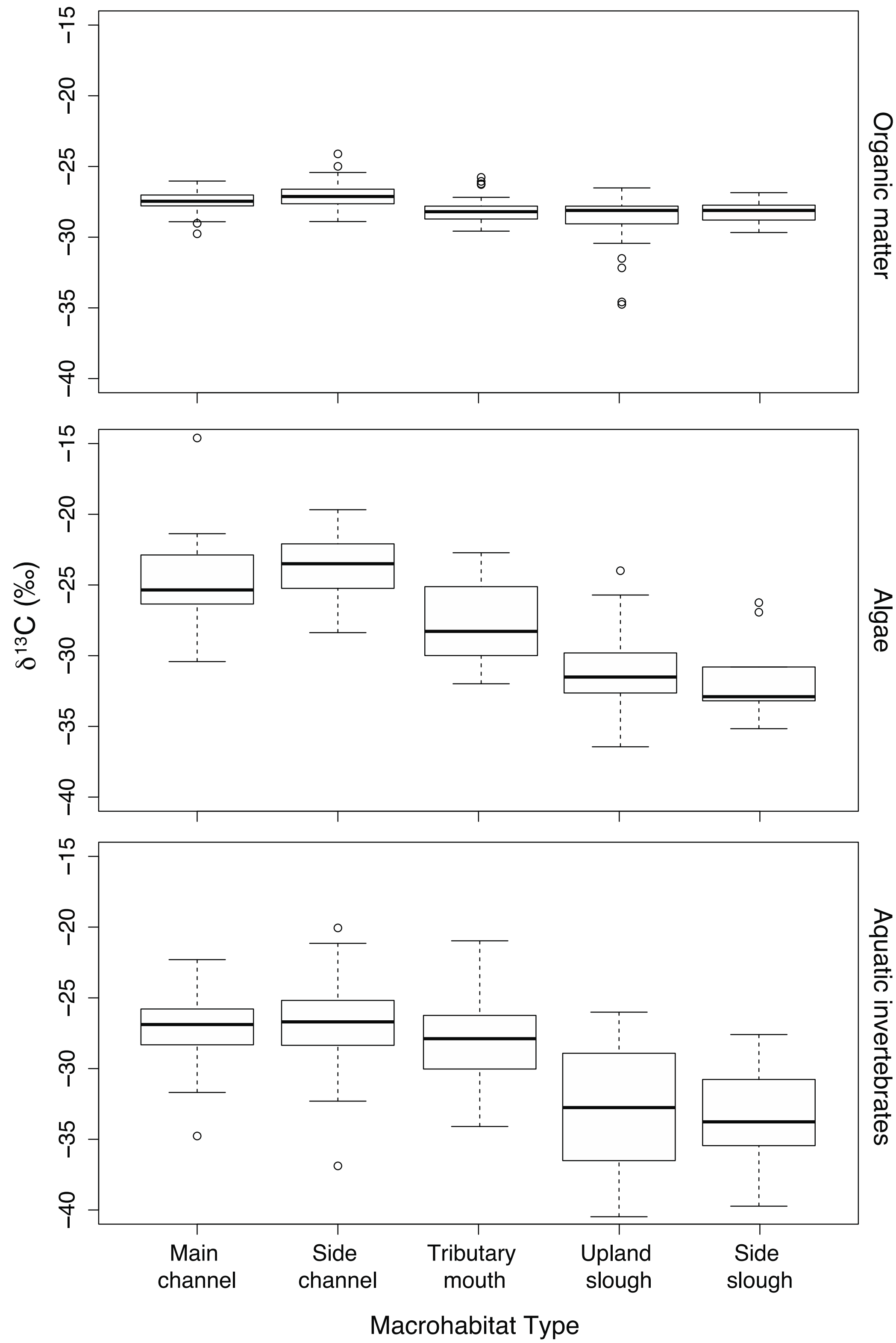


Figure 5.4-21. Median $\delta^{13}C$ values (with 2.5, 25, 75, 97.5% ranges; open circles represent values outside the distribution) for organic matter, algae, and aquatic invertebrates pooled by macrohabitat type.

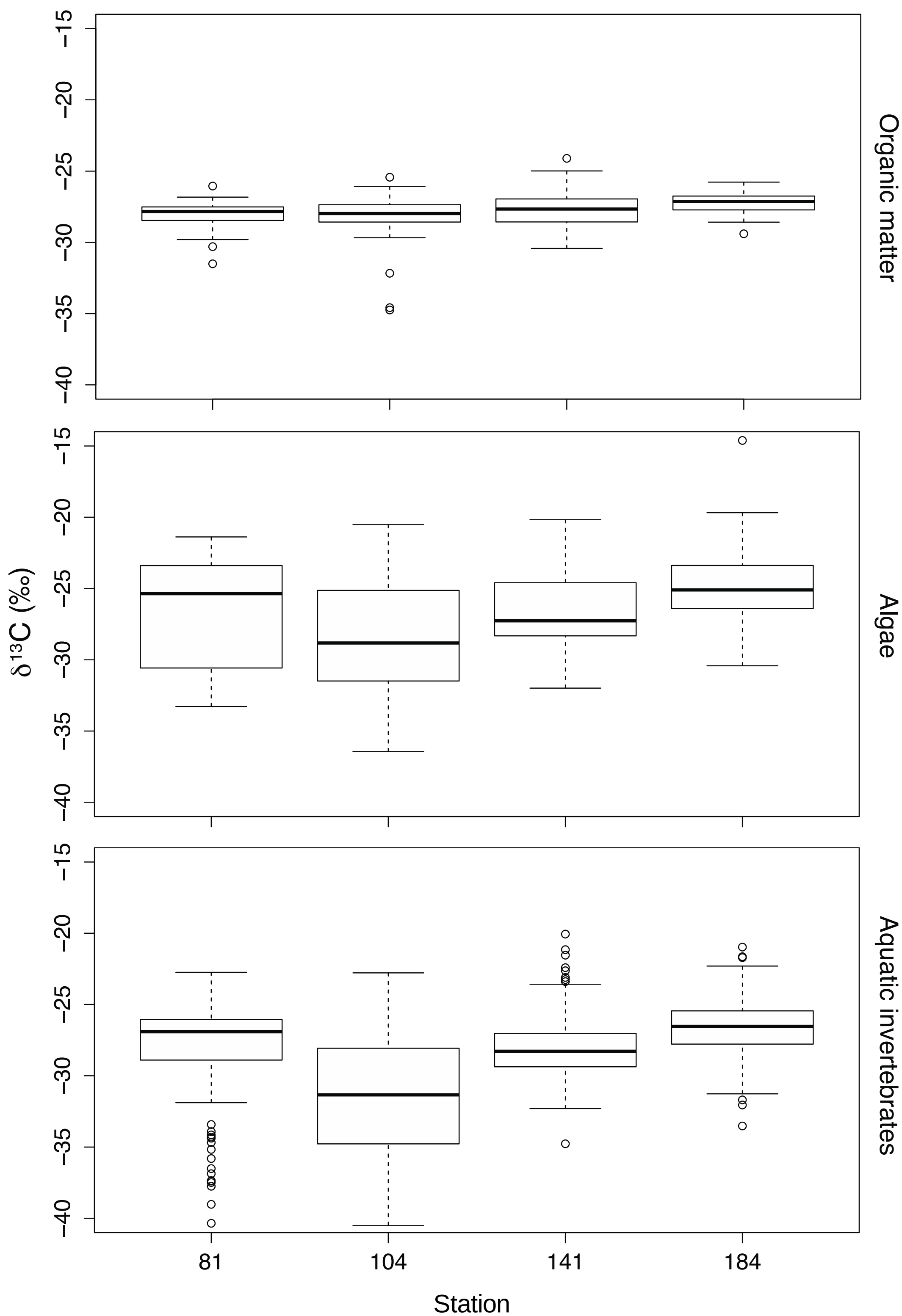


Figure 5.4-22. Median δ13C values (with 2.5, 25, 75, 97.5% ranges; open circles represent values outside the distribution) for organic matter, algae, and aquatic invertebrates pooled by reach (Focus Area).

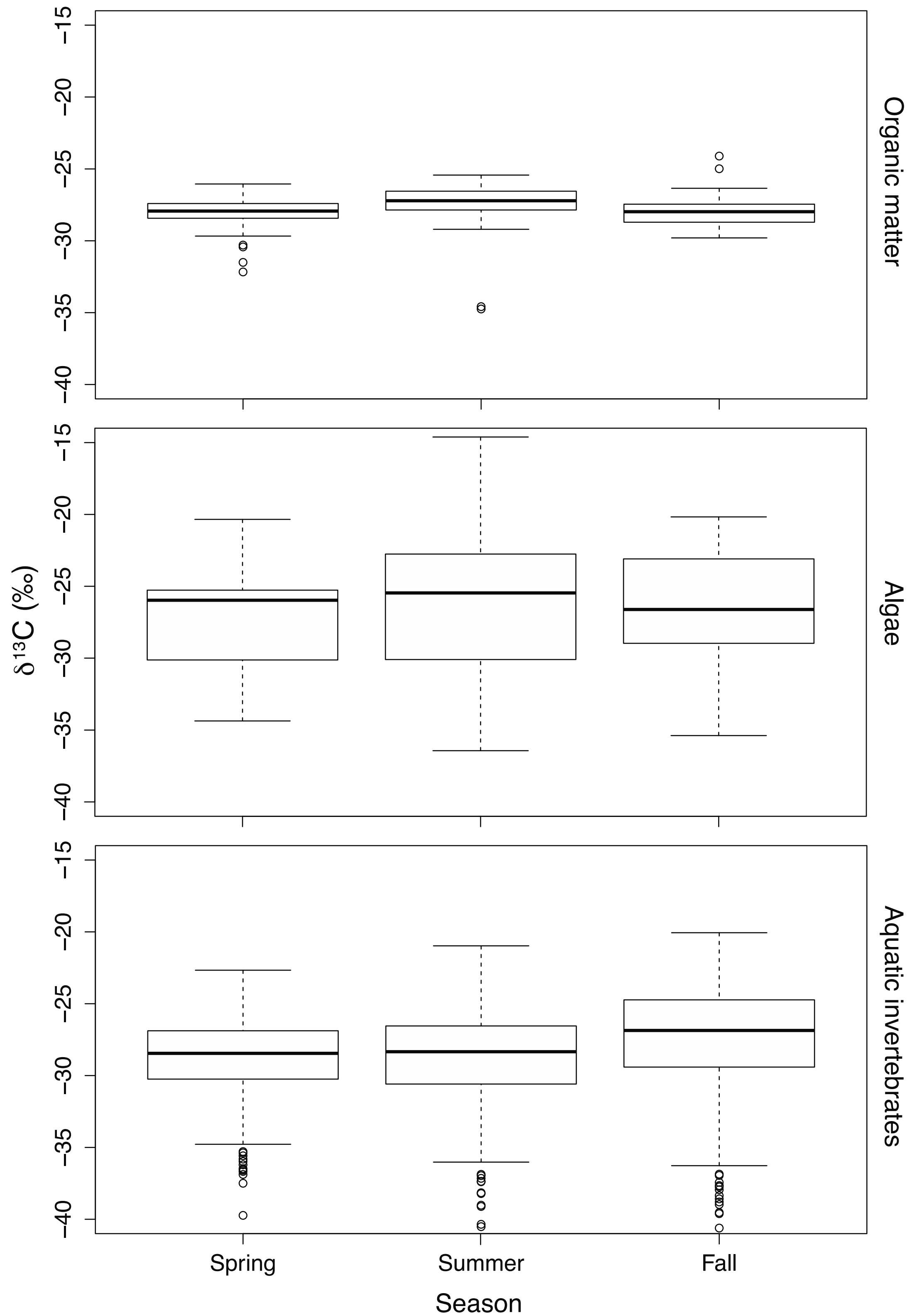


Figure 5.4-23. Median $\delta^{13}C$ values (with 2.5, 25, 75, 97.5% ranges; open circles represent values outside the distribution) for organic matter, algae, and aquatic invertebrates pooled by season.

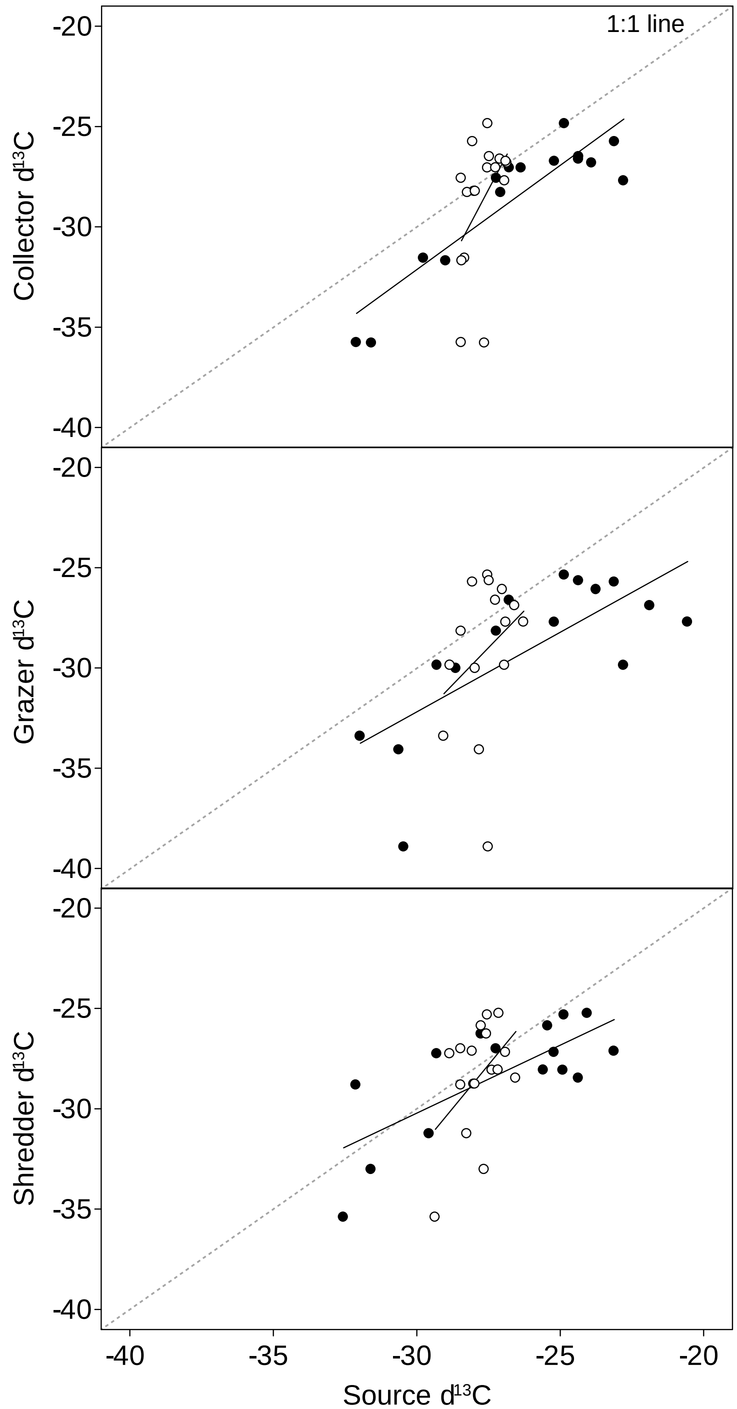


Figure 5.4-24. Linear regressions of aquatic invertebrate consumer group $\delta^{13}C$ against potential food source (periphyton [filled circles] and terrestrial organic matter [open circles]) $\delta^{13}C$ for 2014. Each data point represents site-specific mean invertebrate $\delta^{13}C$ vs. site-specific mean source $\delta^{13}C$ for all seasons combined.

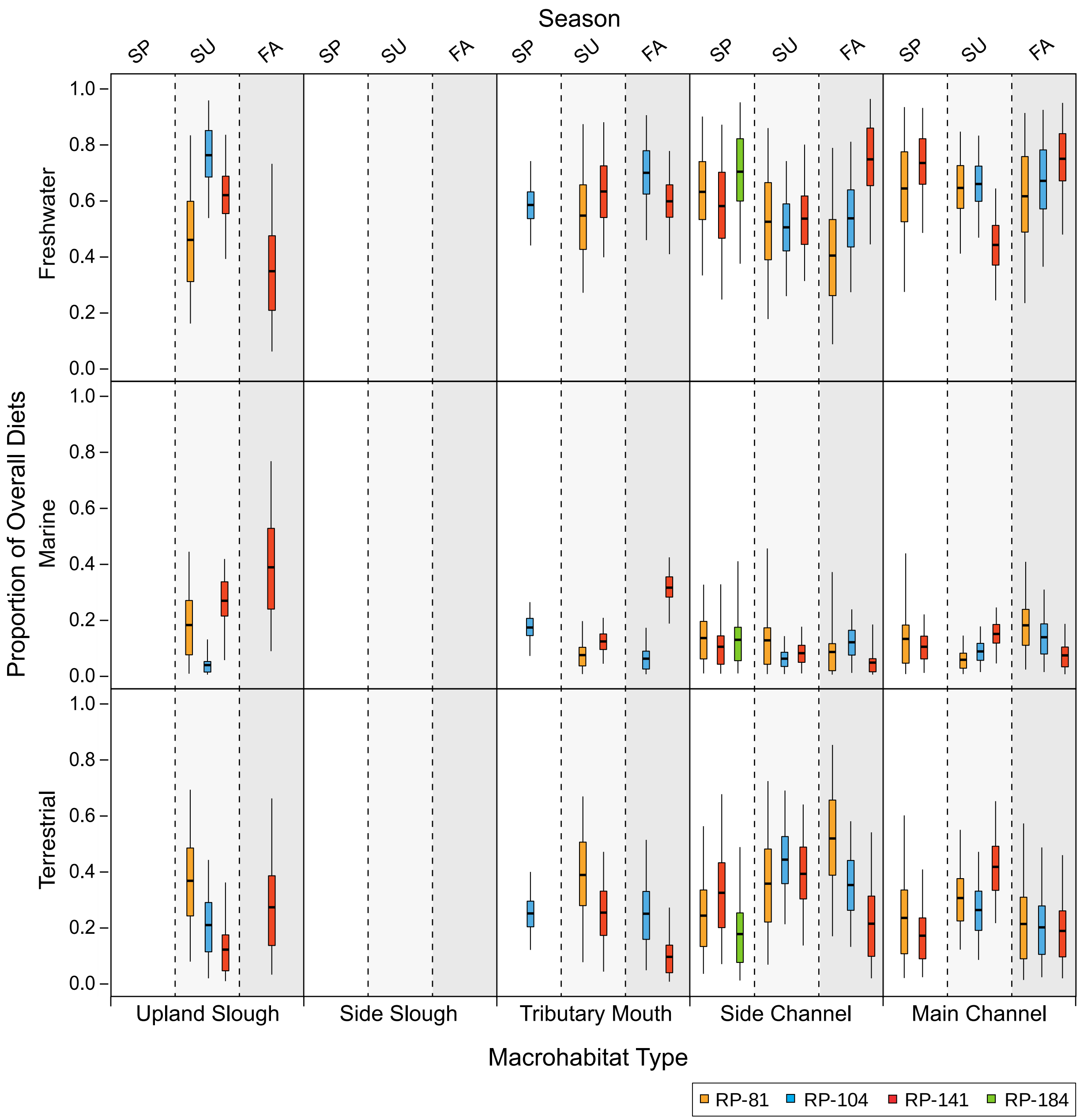


Figure 5.4-25. Diet composition of juvenile Chinook Salmon in 2014, as estimated with MixSIAR Bayesian mixing models. Box plots show the mean proportional contribution (with 2.5, 25, 75, and 97.5 credibility intervals) of each prey category to the diet. Contributions of all diet sources from a single sampling event are stacked vertically across panels. Model results are grouped so that all spatial and temporal dietary trends addressed in this study may be discerned: first by macrohabitat as indicated by labels at the bottom of the plot, then by season as indicated by panel color and labels at the top of the plot (SP = spring, SU = summer, FA = fall), and lastly by increasing distance from the river mouth as indicated by box color (see legend).

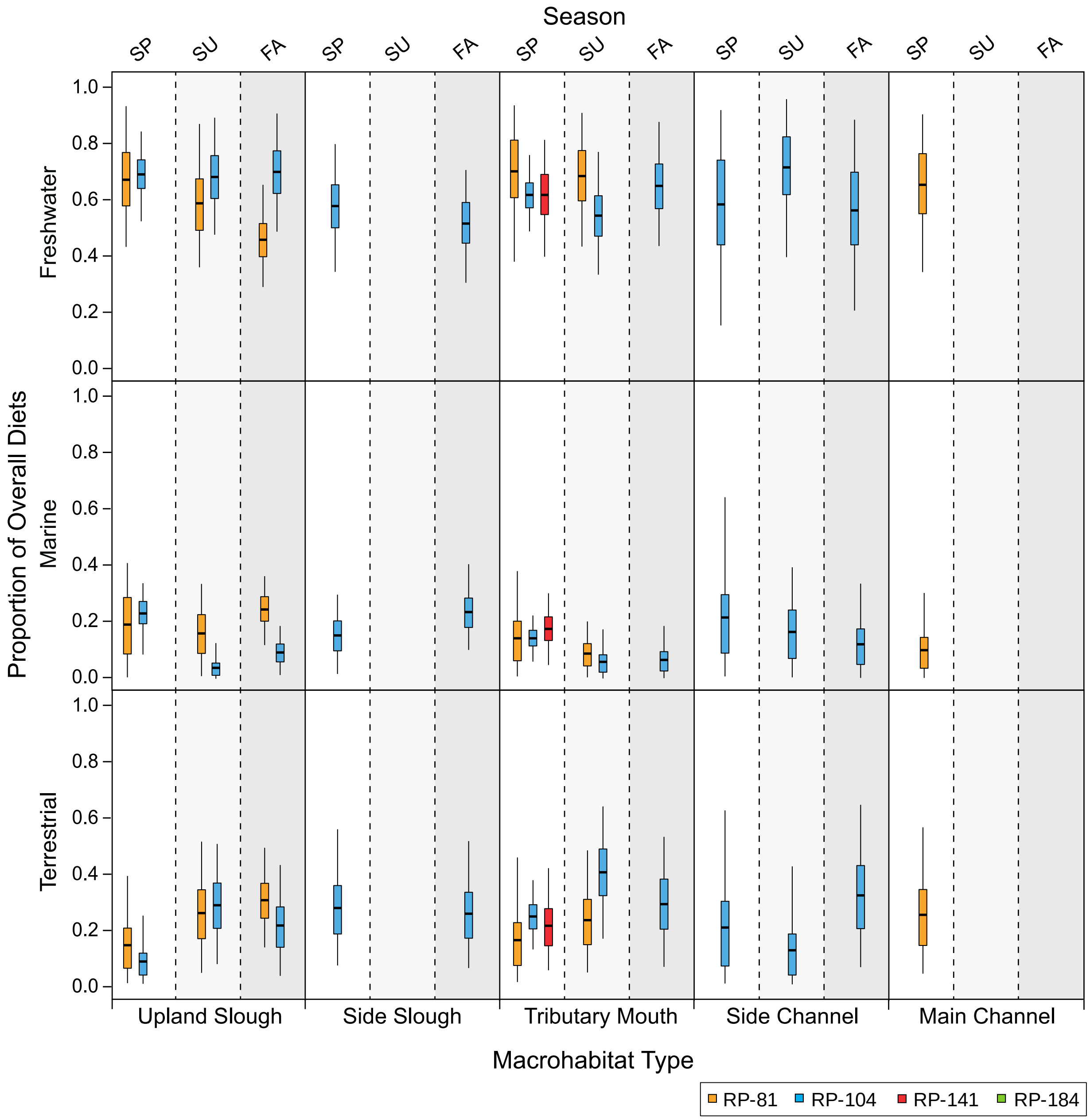


Figure 5.4-26. Diet composition of juvenile Coho Salmon in 2014, as estimated with MixSIAR Bayesian mixing models. Box plots show the mean proportional contribution (with 2.5, 25, 75, and 97.5 credibility intervals) of each prey category to the diet. Contributions of all diet sources from a single sampling event are stacked vertically across panels. Model results are grouped so that all spatial and temporal dietary trends addressed in this study may be discerned: first by macrohabitat as indicated by labels at the bottom of the plot, then by season as indicated by panel color and labels at the top of the plot (SP = spring, SU = summer, FA = fall), and lastly by increasing distance from the river mouth as indicated by box color (see legend).

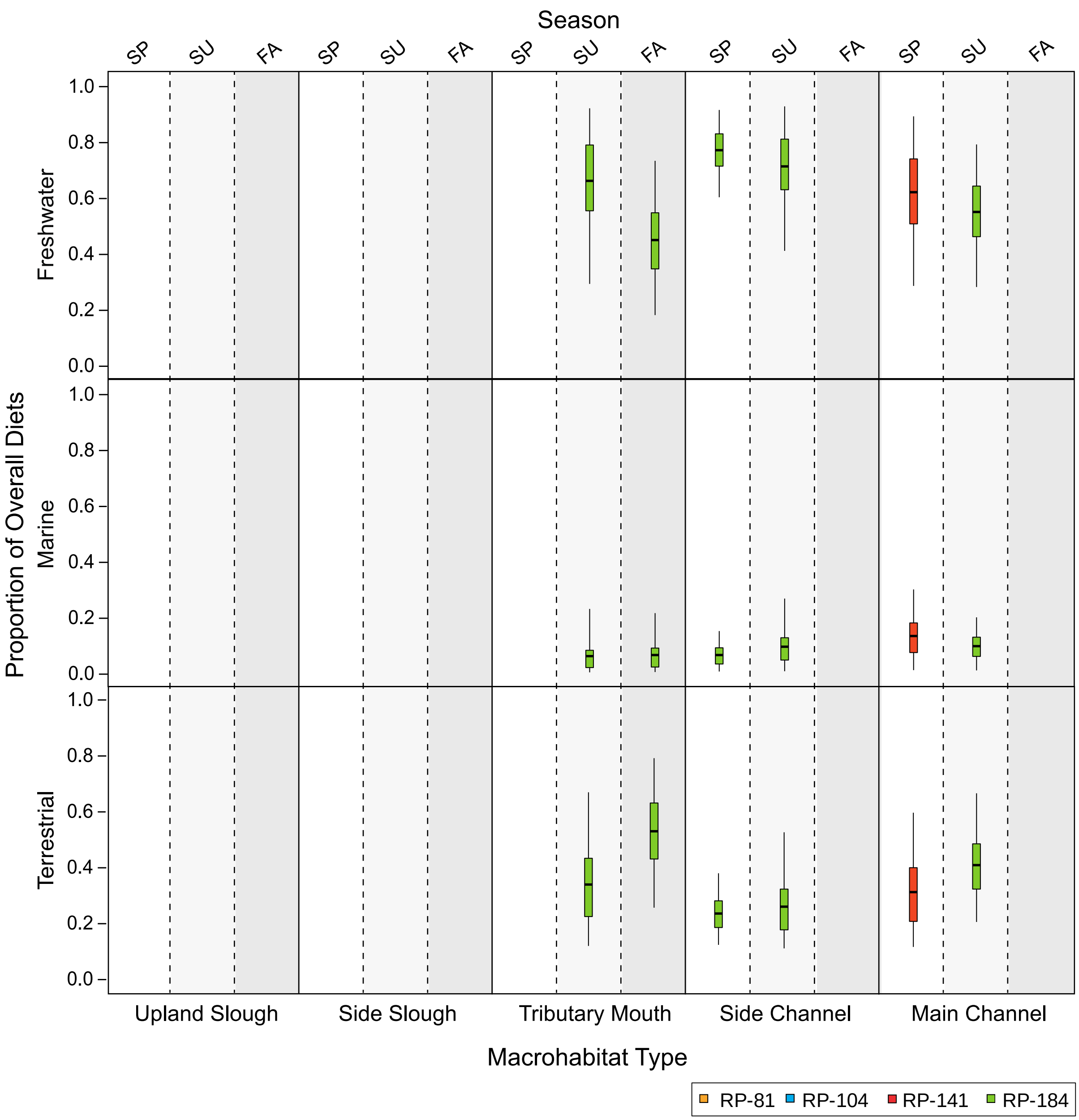


Figure 5.4-27. Diet composition of Arctic Grayling in 2014, as estimated with MixSIAR Bayesian mixing models. Box plots show the mean proportional contribution (with 2.5, 25, 75, and 97.5 credibility intervals) of each prey category to the diet. Contributions of all diet sources from a single sampling event are stacked vertically across panels. Model results are grouped so that all spatial and temporal dietary trends addressed in this study may be discerned: first by macrohabitat as indicated by labels at the bottom of the plot, then by season as indicated by panel color and labels at the top of the plot (SP = spring, SU = summer, FA = fall), and lastly by increasing distance from the river mouth as indicated by box color (see legend).

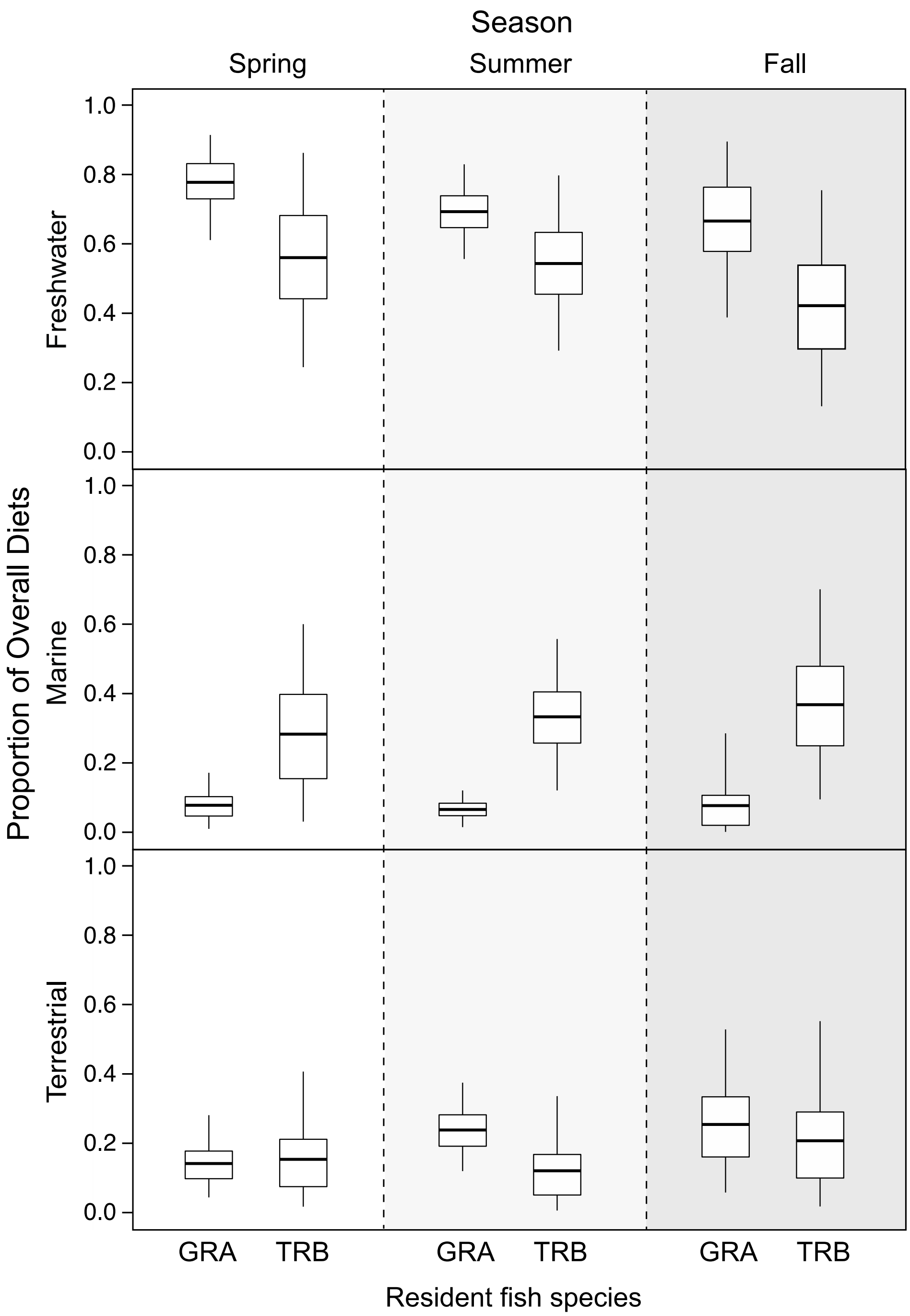


Figure 5.4-28. Diet composition of resident salmonids (GRA: Arctic Grayling; TRB: Rainbow Trout) in 2014, as estimated with MixSIAR Bayesian mixing models. Boxplots show the mean proportional contribution (with 2.5, 25, 75, and 97.5 credibility intervals) of each prey category to the diet. Contributions of all diet sources from a single sampling event are stacked vertically across panels. Model results are grouped by season.

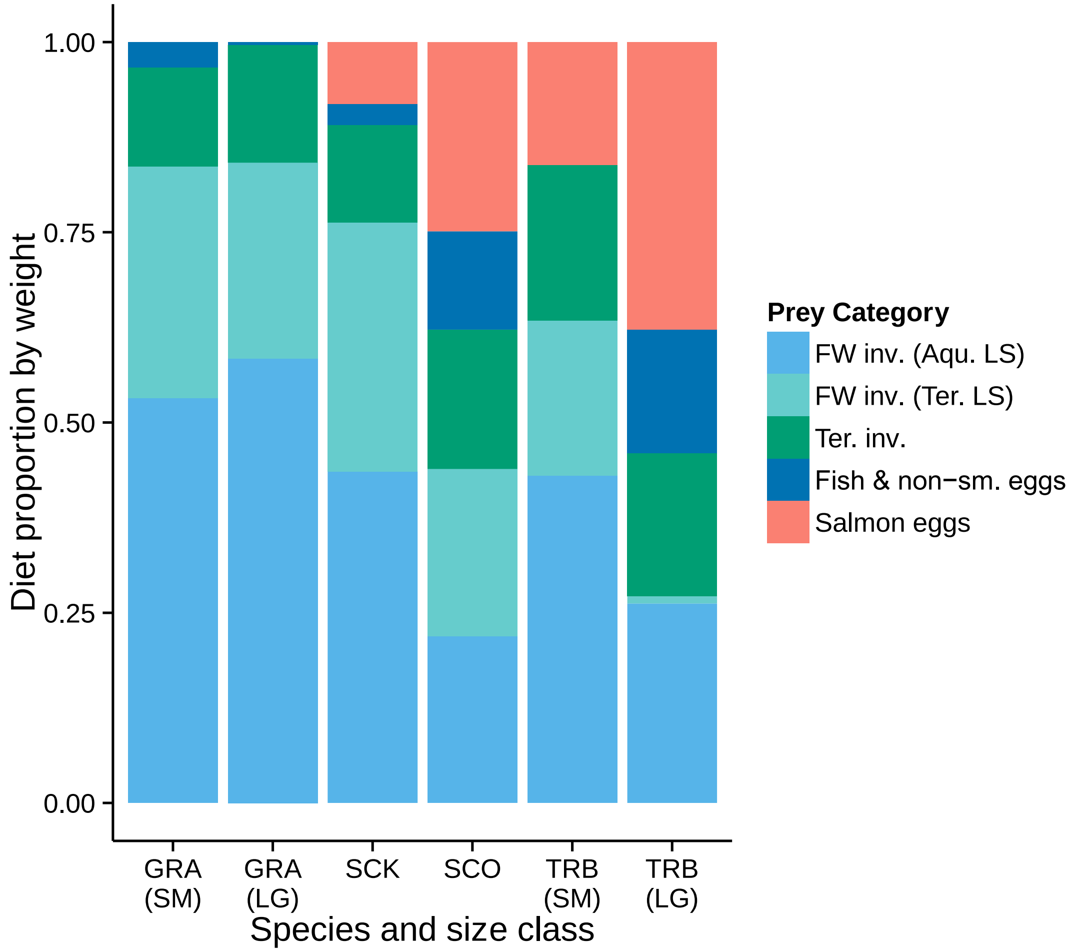


Figure 5.5-1. Overall diet composition of two size classes of Arctic Grayling (GRA), juvenile Chinook Salmon (SCK), juvenile Coho Salmon (SCO), and two size classes of Rainbow Trout (TRB) sampled during 2013 and 2014 in the Susitna River. Size classes were defined as small (SM; ≤ 120 mm fork length [FL]) and large (LG; > 120 mm FL). Diet proportions (by dry mass) were determined by stomach content analysis. Prey items were categorized as aquatic life-stages of freshwater invertebrates (FW inv. [Aqu LS]), terrestrial life-stages of freshwater invertebrates (FW inv. [Ter LS]), terrestrial invertebrates (Ter. inv.), fish and non-salmonid fish eggs (Fish & non-sm. eggs), or salmon eggs.

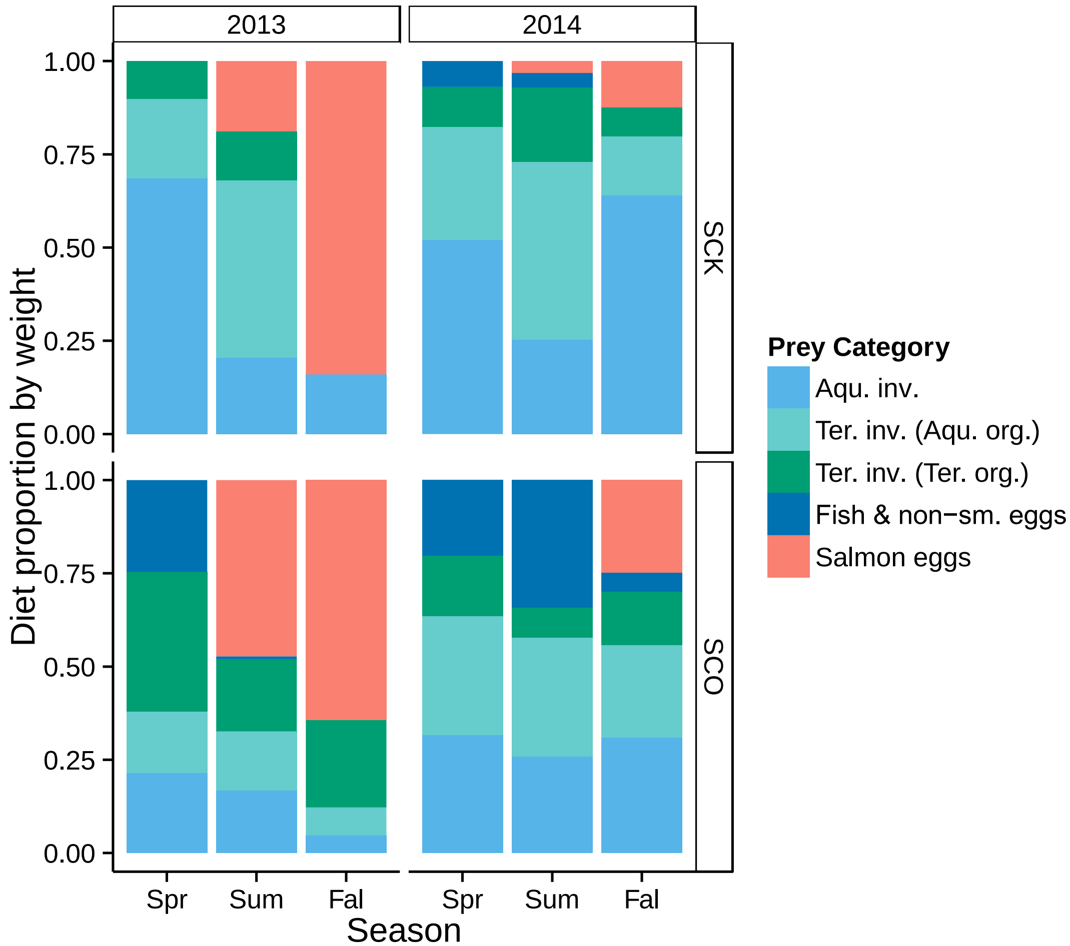


Figure 5.5-2. Annual and seasonal patterns of diet composition of juvenile Chinook Salmon (SCK) and juvenile Coho Salmon (SCO) sampled during 2013 and 2014 in the Susitna River. Diet proportions (by dry mass) were determined by stomach content analysis. Seasons are abbreviated as spring (Spr), summer (Sum), and fall (Fal). Prey items were categorized as aquatic life-stages of freshwater invertebrates (FW inv. [Aqu LS]), terrestrial life-stages of freshwater invertebrates (FW inv. [Ter LS]), terrestrial invertebrates (Ter. inv.), fish and non-salmonid fish eggs (Fish & non-sm. eggs), or salmon eggs.

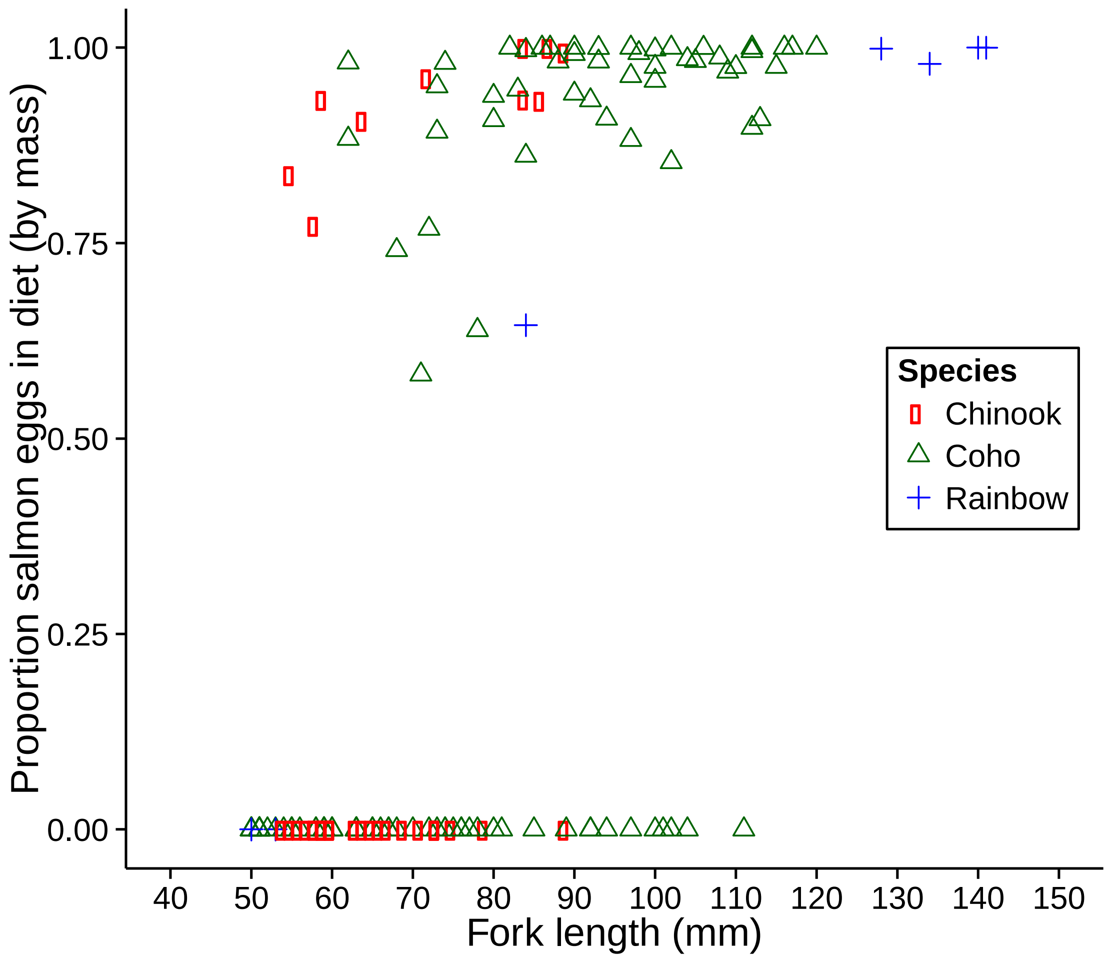


Figure 5.5-3. Proportion (by dry mass) of salmon eggs in the stomach contents of individual Chinook Salmon, Coho Salmon, and Rainbow Trout sampled by gastric lavage, as a function of fork length. Figure is truncated at 150 mm fork length to show detail at smaller lengths. Only fish captured during sampling events when salmon eggs were available for consumption are shown. These sampling events were determined by the presence of salmon eggs in the stomach contents of at least one sampled fish.

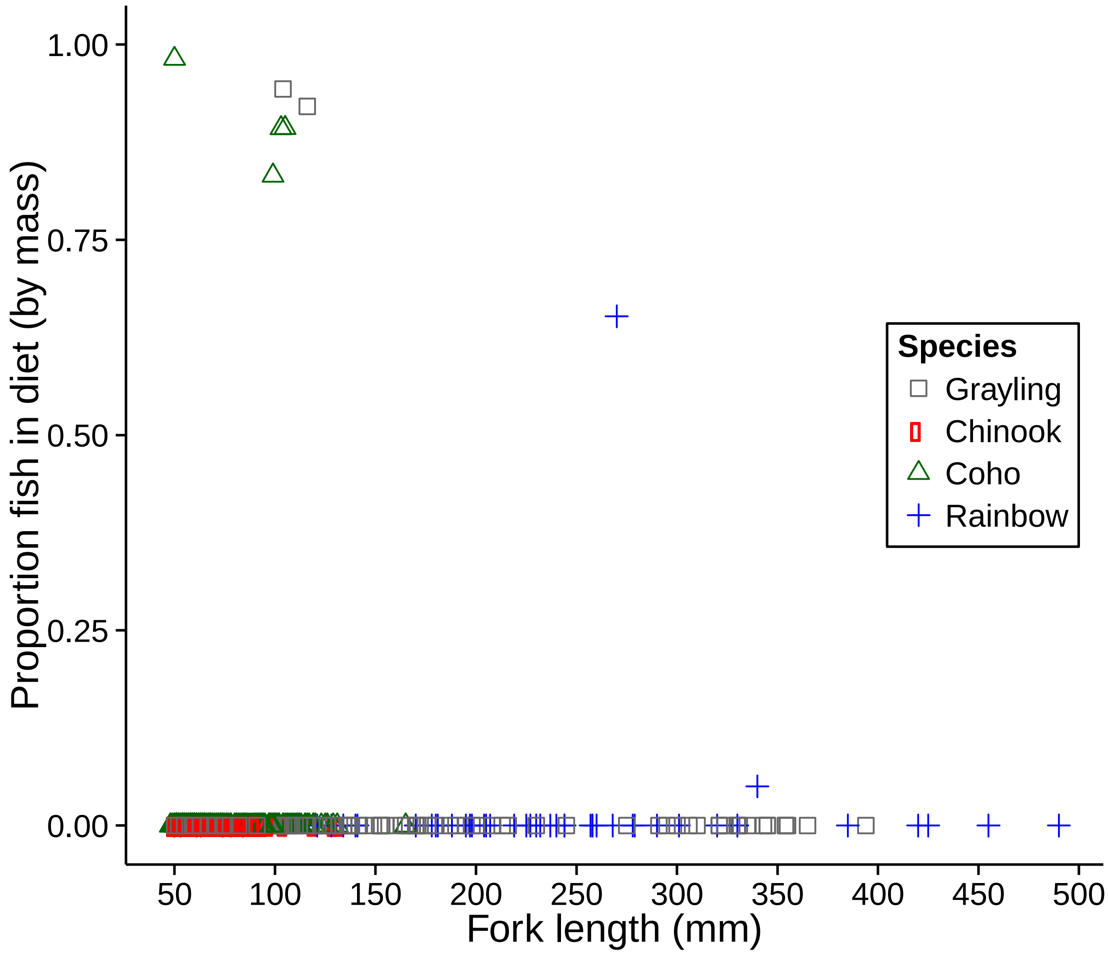


Figure 5.5-4. Proportion (by dry mass) of fish in the stomach contents of individual Arctic Grayling, Chinook Salmon, Coho Salmon, and Rainbow Trout sampled by gastric lavage, as a function of fork length.

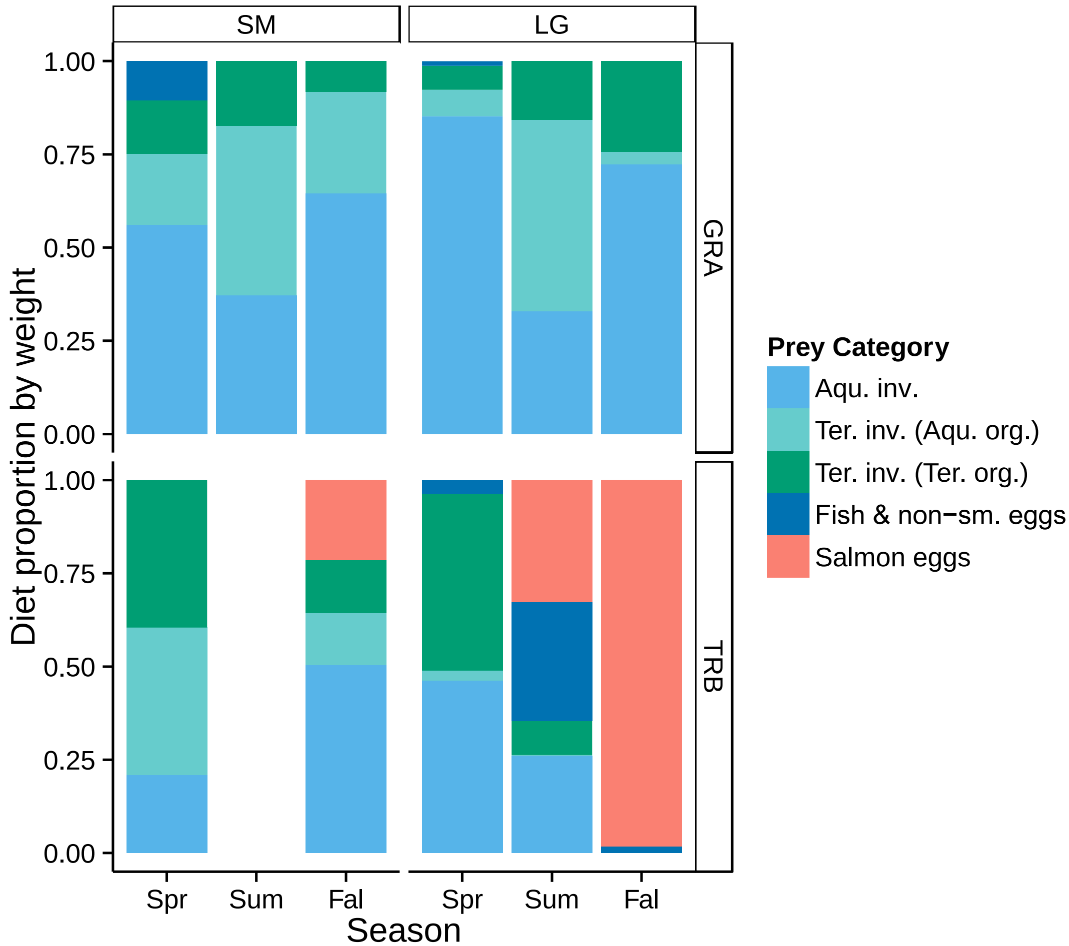


Figure 5.5-5. Seasonal diet composition of two size classes of Arctic Grayling (GRA) sampled during 2014 and two size classes of Rainbow Trout (TRB) sampled during 2013 and 2014 in the Susitna River. Size classes were defined as small (SM; ≤ 120 mm fork length [FL]) and large (LG; > 120 mm FL). Diet proportions (by dry mass) were determined by stomach content analysis. Prey items were categorized as aquatic life-stages of freshwater invertebrates (FW inv. [Aqu LS]), terrestrial life-stages of freshwater invertebrates (FW inv. [Ter LS]), terrestrial invertebrates (Ter. inv.), fish and non-salmonid fish eggs (Fish & non-sm. eggs), or salmon eggs.

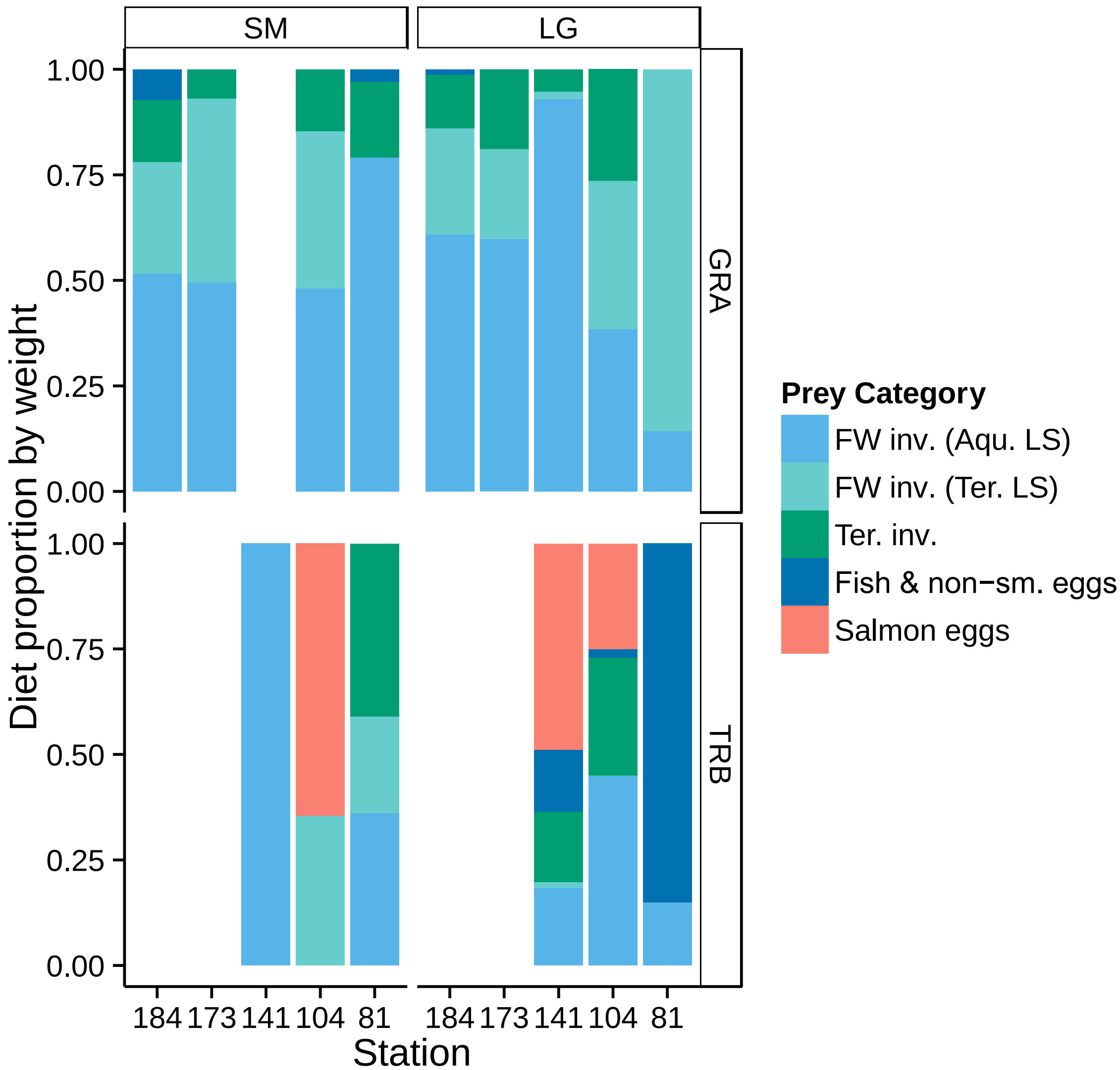


Figure 5.5-6. Large-scale spatial patterns of diet composition of two size classes of Arctic Grayling (GRA) sampled during 2014 and two size classes of Rainbow Trout (TRB) sampled during 2013 and 2014 in the Susitna River. Fish were sampled in five study stations (RP-184, RP-173, RP-141, RP-104, and RP-81), which were abbreviated in the x-axis labels by project river mile. Size classes were defined as small (SM; ≤ 120 mm fork length [FL]) and large (LG; > 120 mm FL). Diet proportions (by dry mass) were determined by stomach content analysis. Prey items were categorized as aquatic life-stages of freshwater invertebrates (FW inv. [Aqu LS]), terrestrial life-stages of freshwater invertebrates (FW inv. [Ter LS]), terrestrial invertebrates (Ter. inv.), fish and non-salmonid fish eggs (Fish & non-sm. eggs), or salmon eggs.

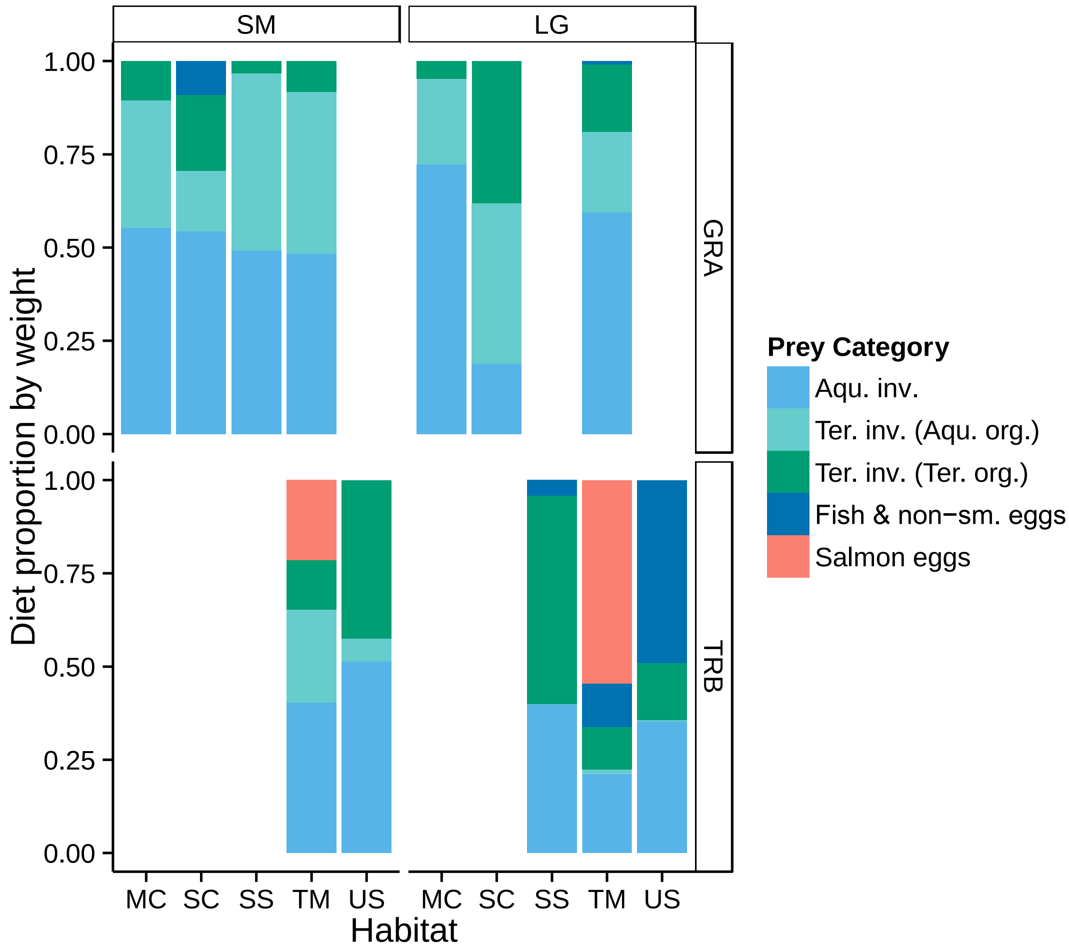


Figure 5.5-7. Habitat-based patterns of diet composition of two size classes of Arctic Grayling (GRA) sampled during 2014 and two size classes of Rainbow Trout (TRB) sampled during 2013 and 2014 in the Susitna River. Fish were sampled in five macrohabitat types: main channel (MC), side channel (SC), side slough (SS), tributary mouth (TM), and upland slough (US). Size classes were defined as small (SM; ≤ 120 mm fork length [FL]) and large (LG; > 120 mm FL). Diet proportions (by dry mass) were determined by stomach content analysis. Prey items were categorized as aquatic life-stages of freshwater invertebrates (FW inv. [Aqu LS]), terrestrial life-stages of freshwater invertebrates (FW inv. [Ter LS]), terrestrial invertebrates (Ter. inv.), fish and non-salmonid fish eggs (Fish & non-sm. eggs), or salmon eggs.

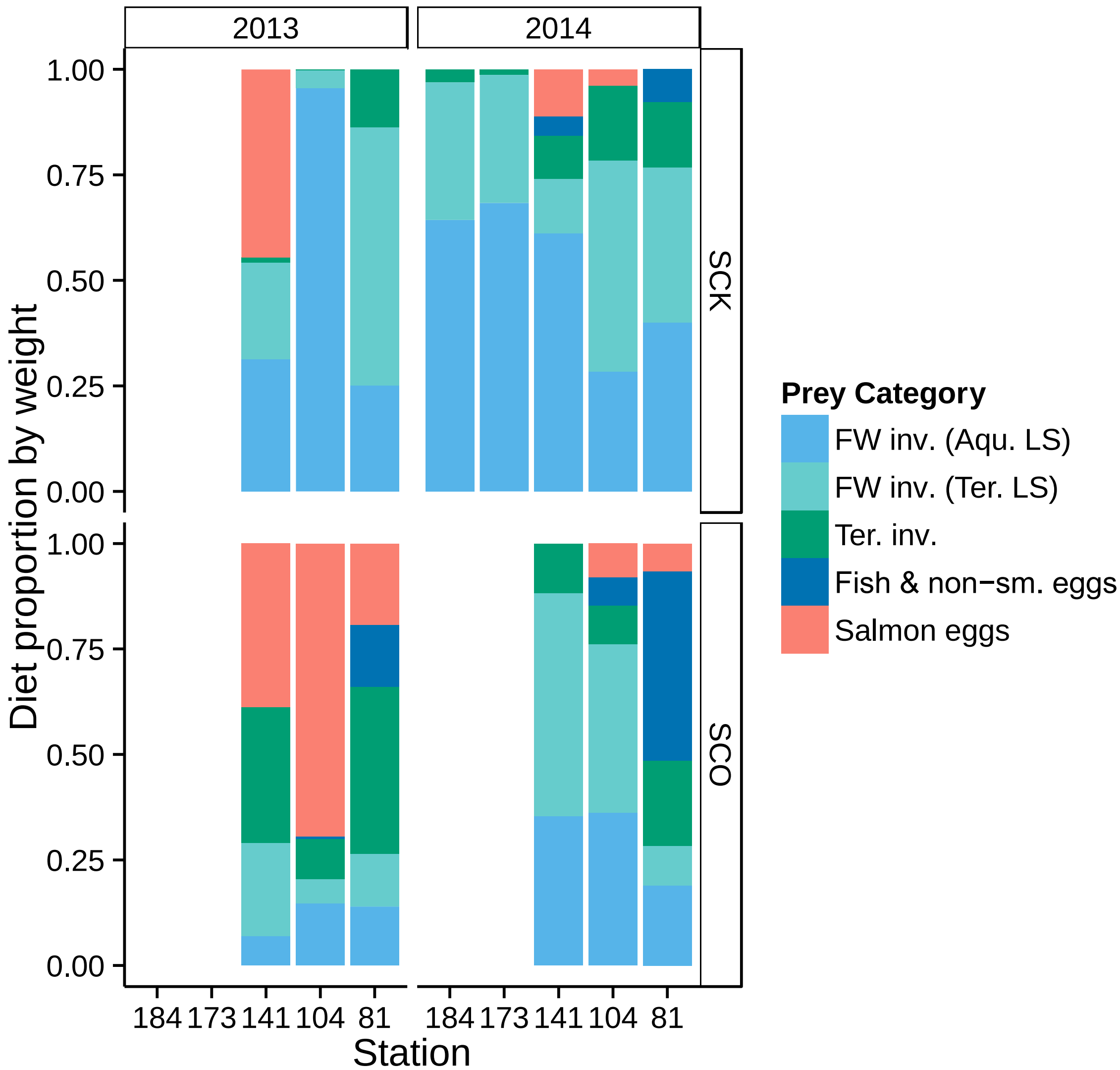


Figure 5.5-8. Large-scale spatial patterns of diet composition of juvenile Chinook Salmon (SCK) and juvenile Coho Salmon (SCO) sampled during 2013 and 2014 in the Susitna River. Fish were sampled in five study stations (RP-184, RP-173, RP-141, RP-104, and RP-81), which were abbreviated in the x-axis labels by project river mile. Size classes were defined as small (SM; ≤ 120 mm fork length [FL]) and large (LG; > 120 mm FL). Diet proportions (by dry mass) were determined by stomach content analysis. Prey items were categorized as aquatic life-stages of freshwater invertebrates (FW inv. [Aqu LS]), terrestrial life-stages of freshwater invertebrates (FW inv. [Ter LS]), terrestrial invertebrates (Ter. inv.), fish and non-salmonid fish eggs (Fish & non-sm. eggs), or salmon eggs.

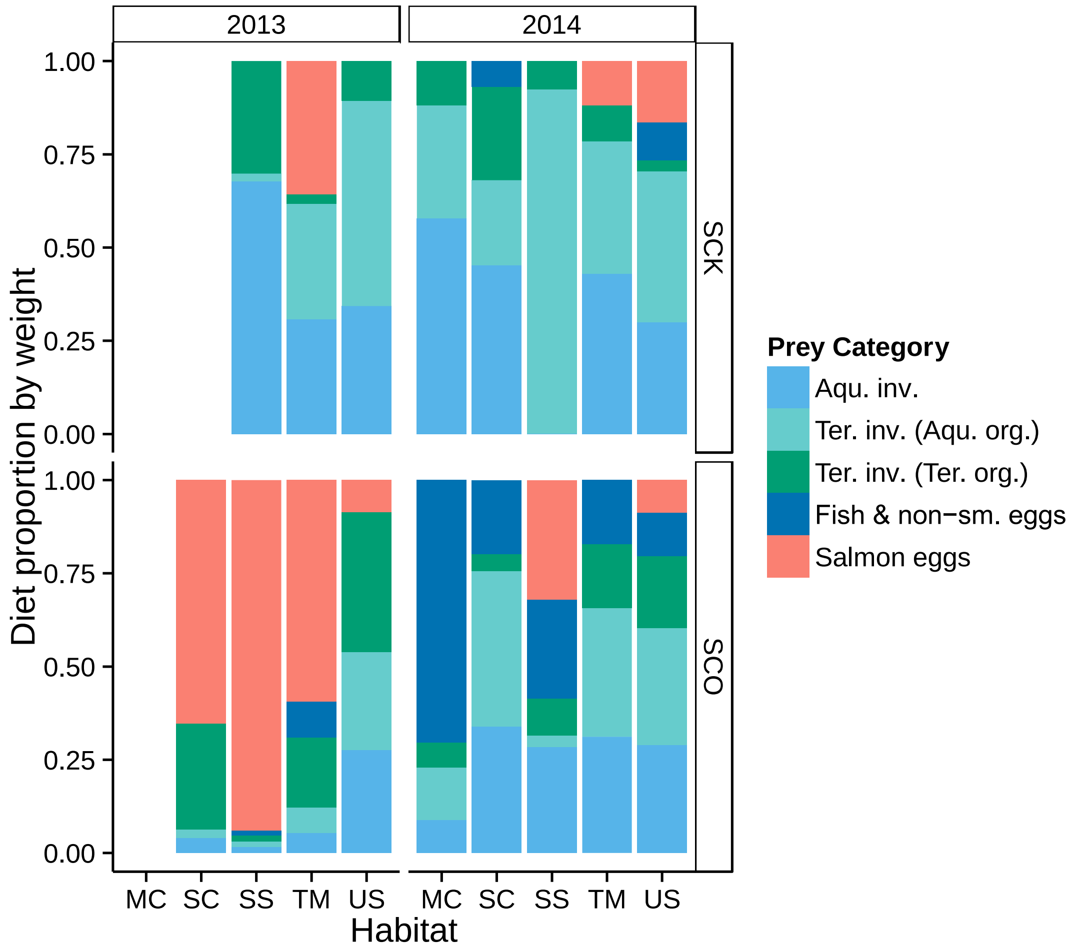


Figure 5.5-9. Habitat-based patterns of diet composition of juvenile Chinook Salmon (SCK) and juvenile Coho Salmon (SCO) sampled during 2013 and 2014 in the Susitna River. Fish were sampled in five macrohabitat types: main channel (MC), side channel (SC), side slough (SS), tributary mouth (TM), and upland slough (US). Size classes were defined as small (SM; ≤ 120 mm fork length [FL]) and large (LG; > 120 mm FL). Diet proportions (by dry mass) were determined by stomach content analysis. Prey items were categorized as aquatic life-stages of freshwater invertebrates (FW inv. [Aqu LS]), terrestrial life-stages of freshwater invertebrates (FW inv. [Ter LS]), terrestrial invertebrates (Ter. inv.), fish and non-salmonid fish eggs (Fish & non-sm. eggs), or salmon eggs.

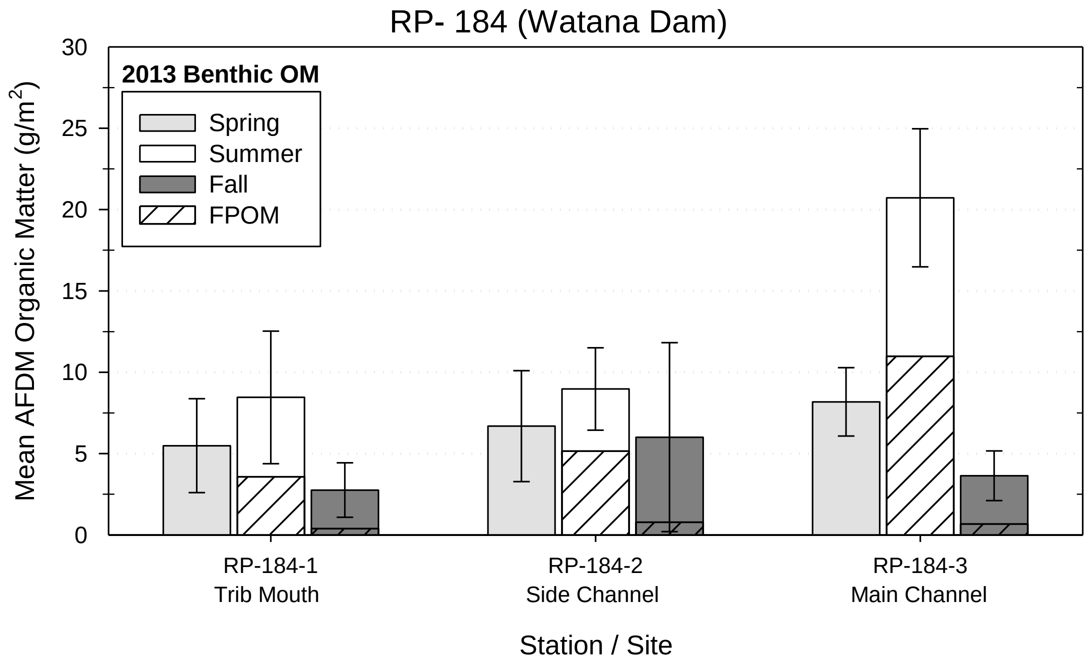


Figure 5.6-1. Mean benthic organic matter estimates (g/m^2) from Hess samples collected in 2013 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

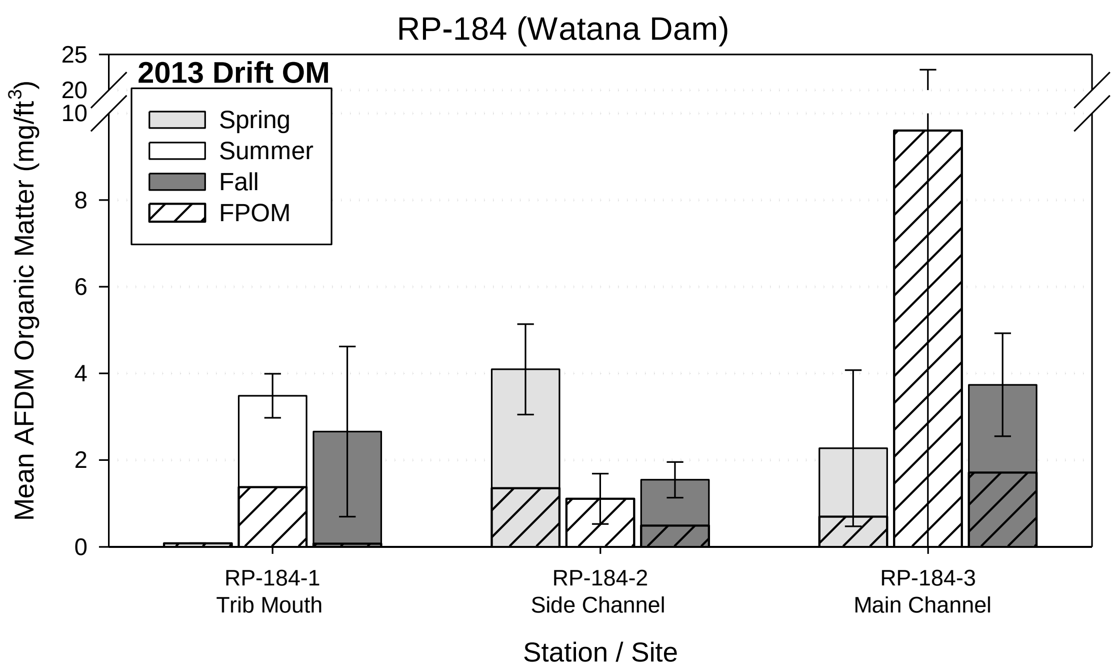


Figure 5.6-2. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2013 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

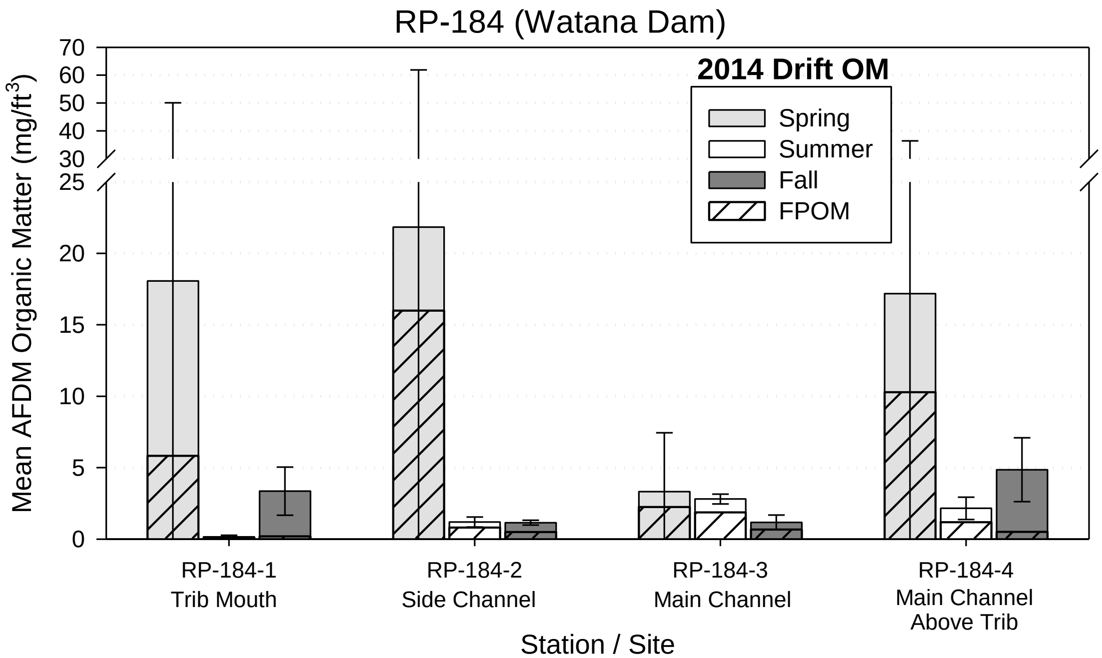


Figure 5.6-3. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2014 during three sampling events for sites within the Watana Dam Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

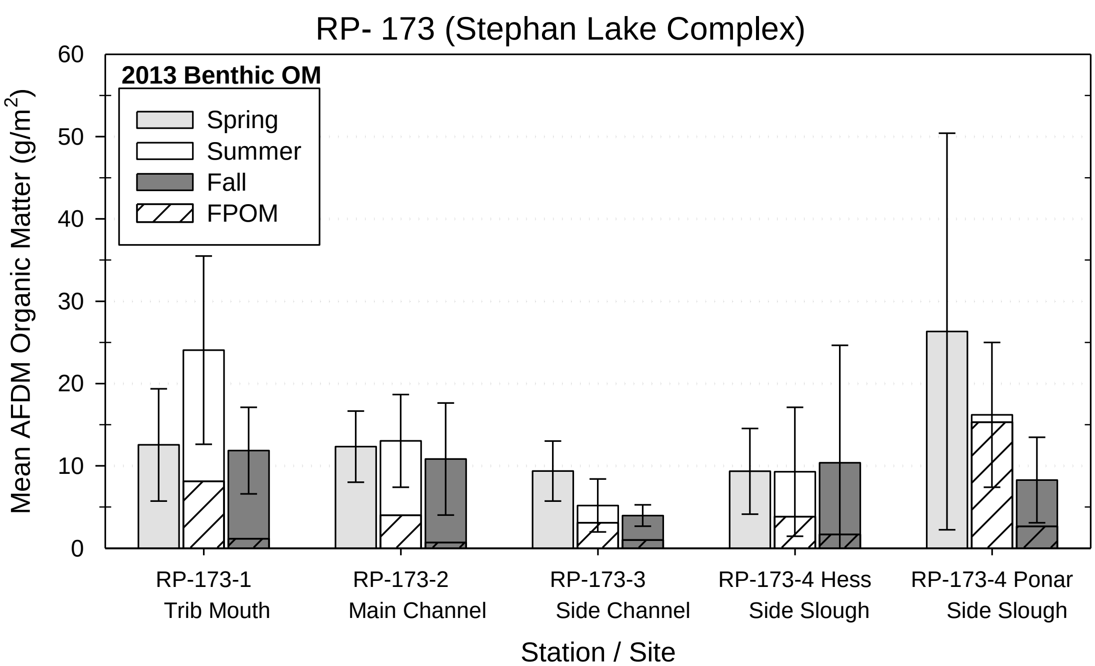


Figure 5.6-4. Mean benthic organic matter estimates (g/m^2) from Hess and petite Ponar grab samples collected in 2013 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-173) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent

95-percent confidence intervals.

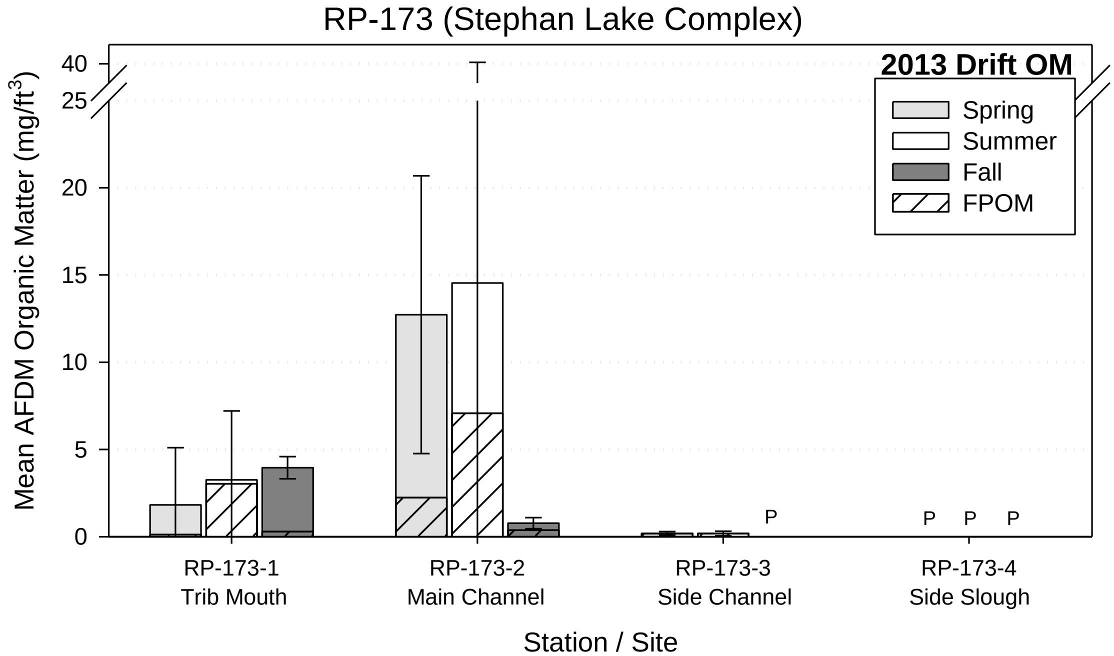


Figure 5.6-5. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2013 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected.

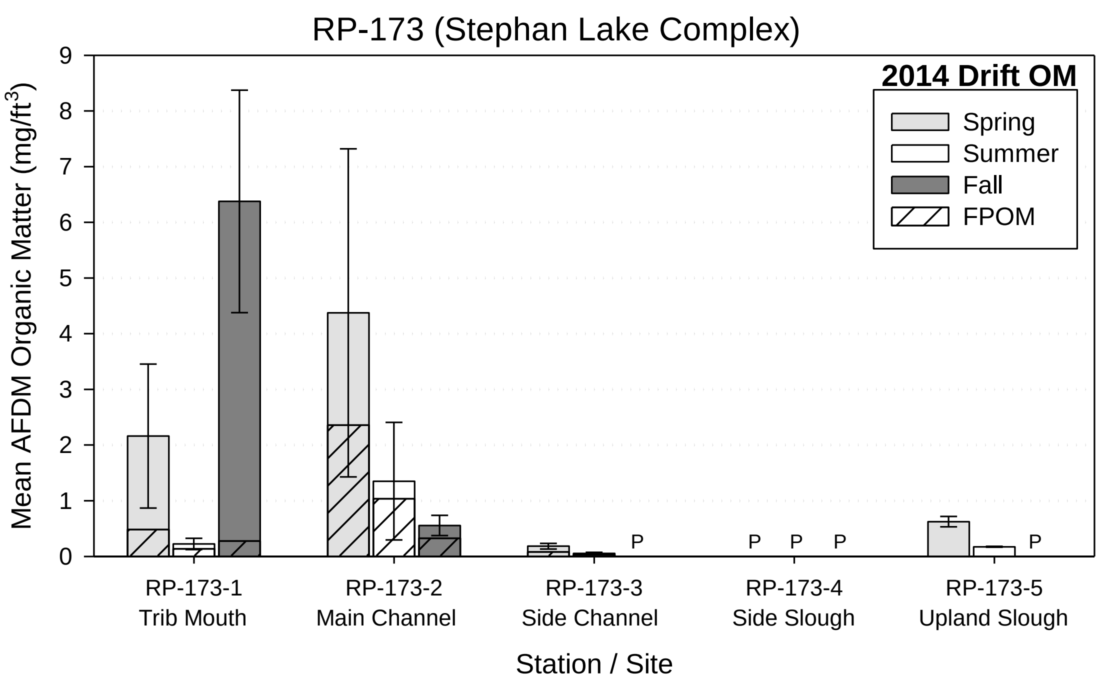


Figure 5.6-6. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2014 during three sampling events for sites within the Stephan Lake Complex Focus Area (FA-184) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected.

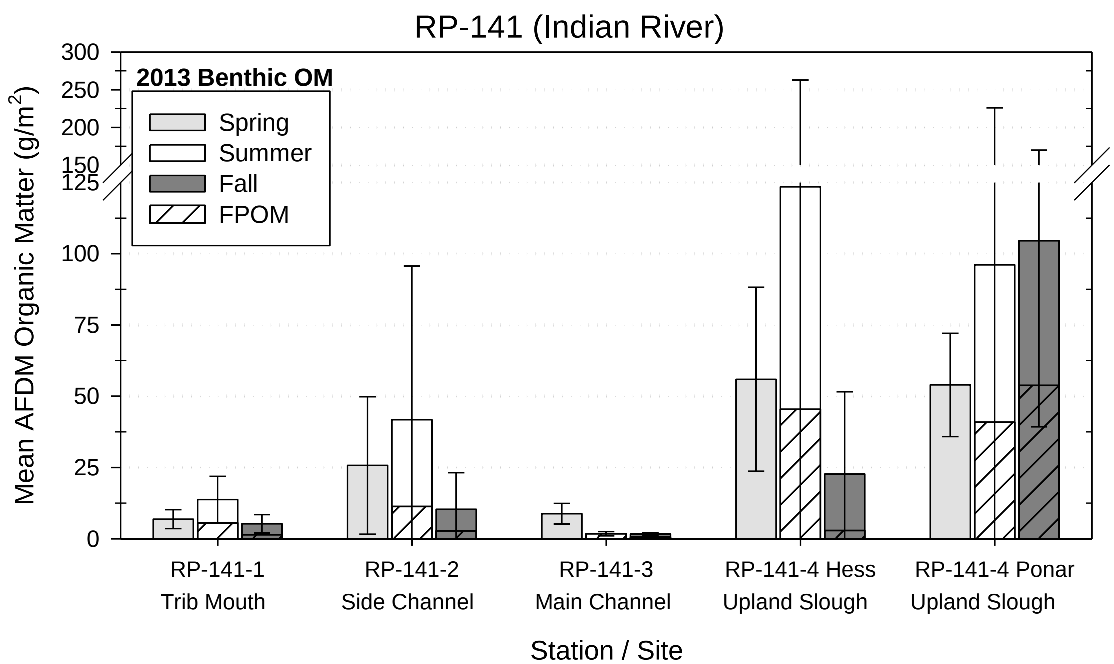


Figure 5.6-7. Mean benthic organic matter estimates (g/m^2) from Hess and petite Ponar grab samples collected in 2013 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

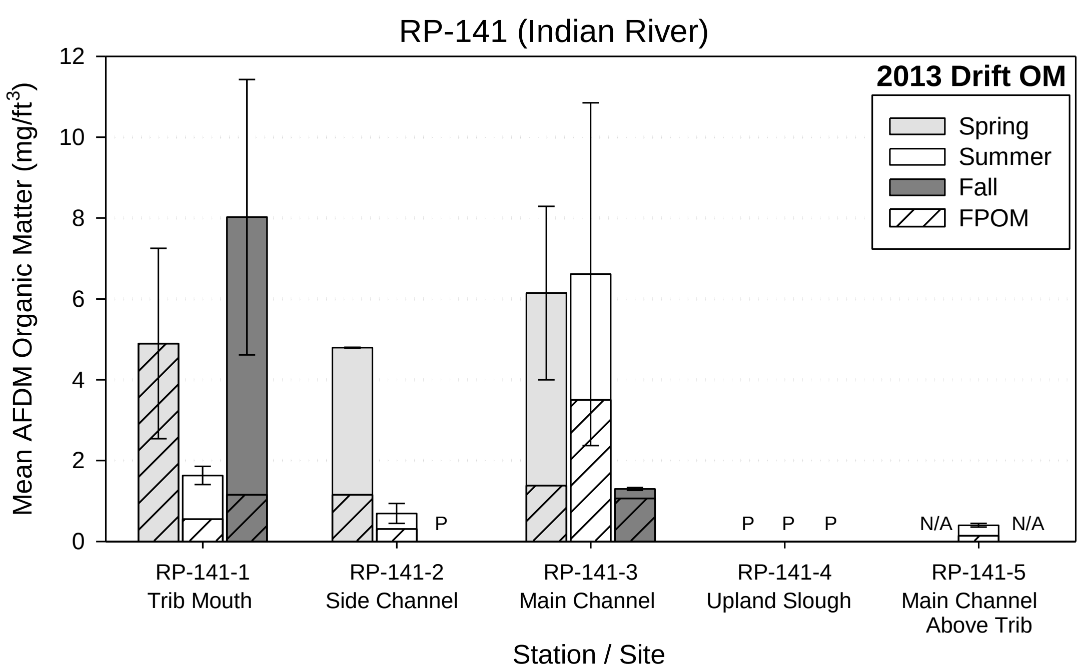


Figure 5.6-8. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2013 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected. "N/A" indicates that no samples were collected.

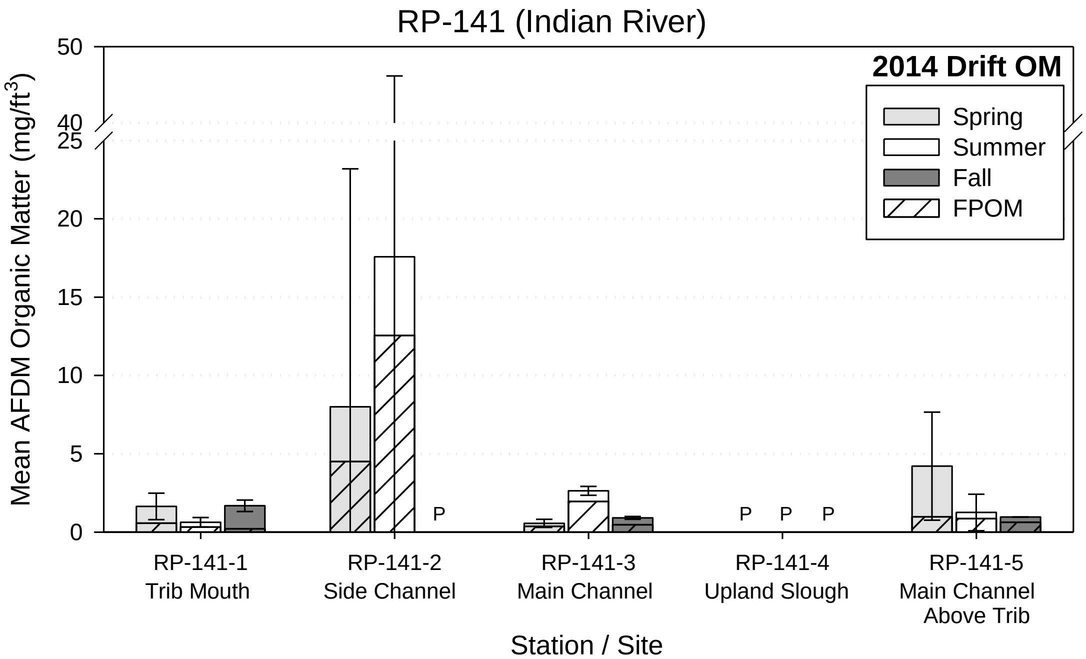


Figure 5.6-9. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2014 during three sampling events for sites within the Indian River Focus Area (FA-141) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected.

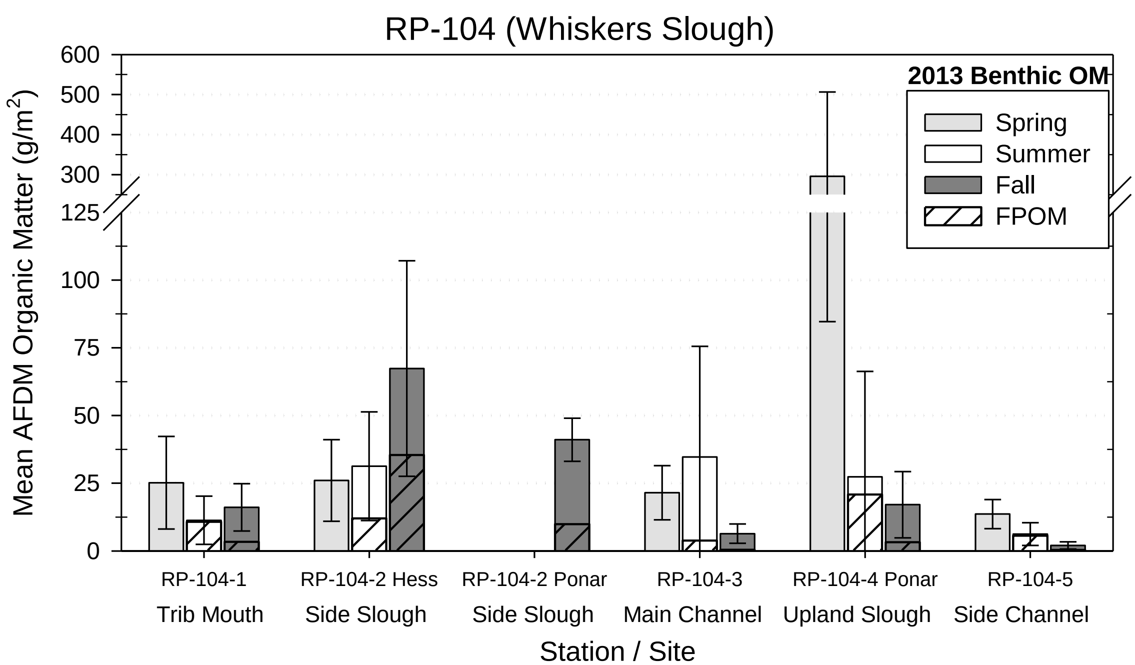


Figure 5.6-10. Mean benthic organic matter estimates (g/m^2) from Hess and petite Ponar grab samples collected in 2013 during three sampling events for sites within the Whiskers Slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

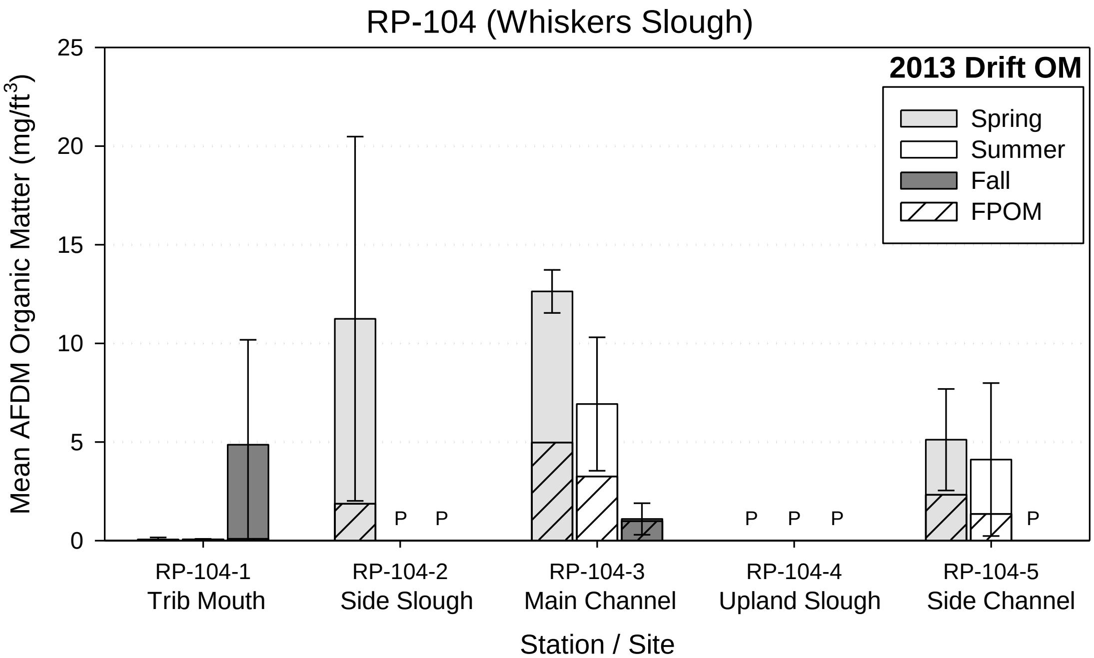


Figure 5.6-11. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2013 during three sampling events for sites within the Whiskers Slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected.

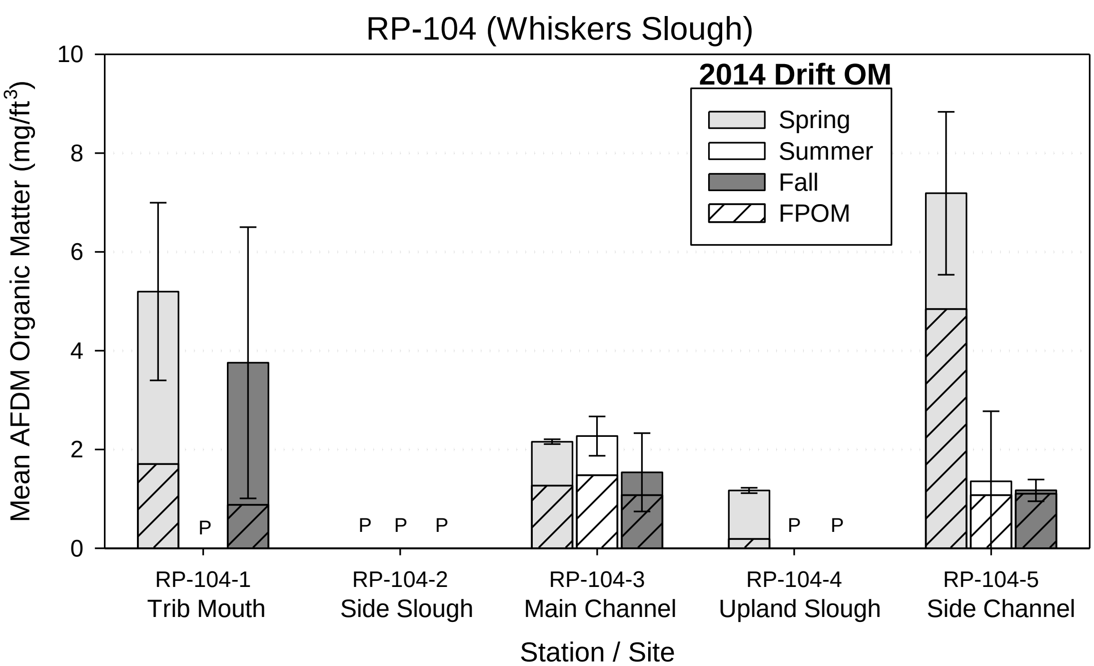


Figure 5.6-12. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2014 during three sampling events for sites within the Whiskers Slough Focus Area (FA-104) in the Middle River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected.

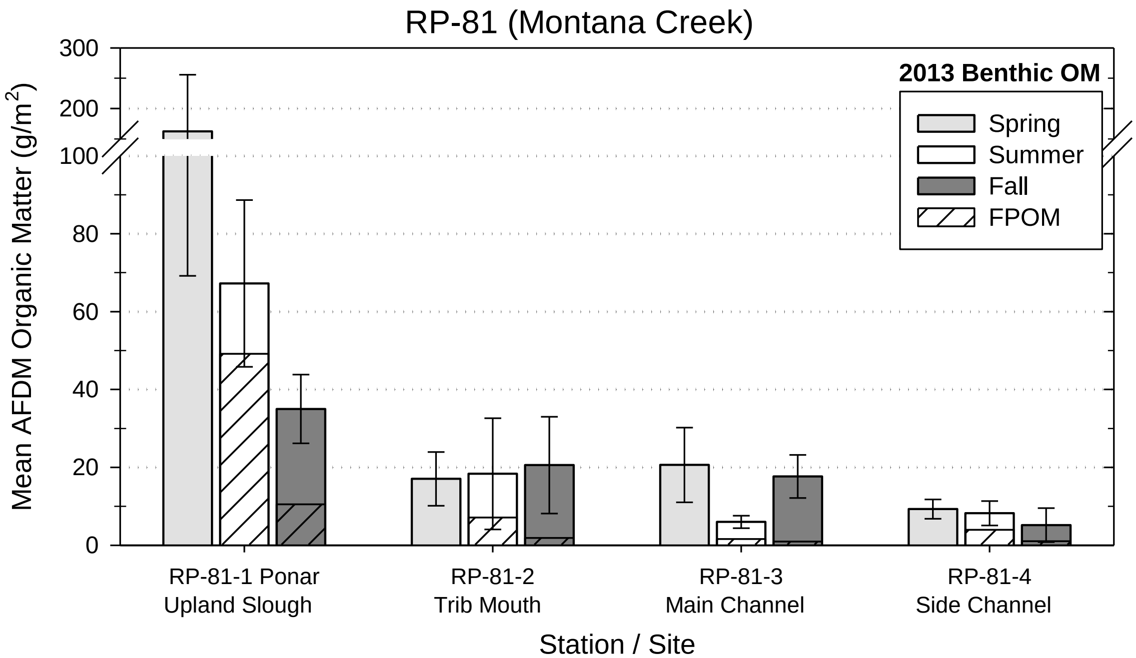


Figure 5.6-13. Mean benthic organic matter estimates (g/m²) from Hess and petite Ponar grab samples collected in 2013 during three sampling events for sites within the Montana Creek Study Area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

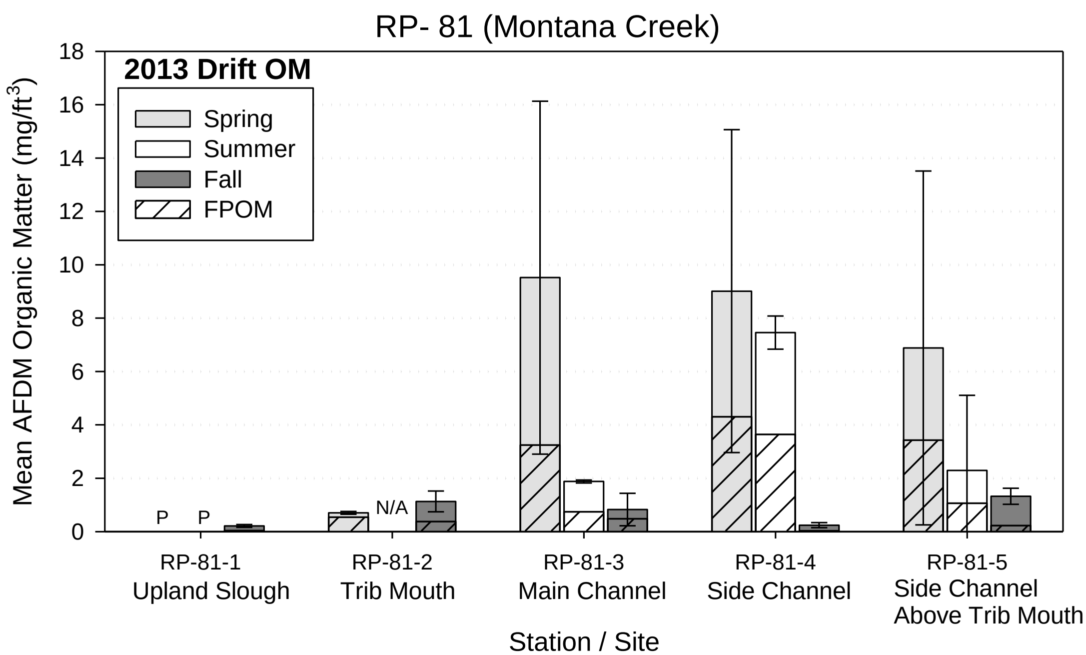


Figure 5.6-14. Drift (seston) organic matter estimates (mg/ft³) from drift samples (n=2) collected in 2013 during three sampling events for sites within the Montana Creek Study Area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected. "N/A" indicates that no samples were collected.

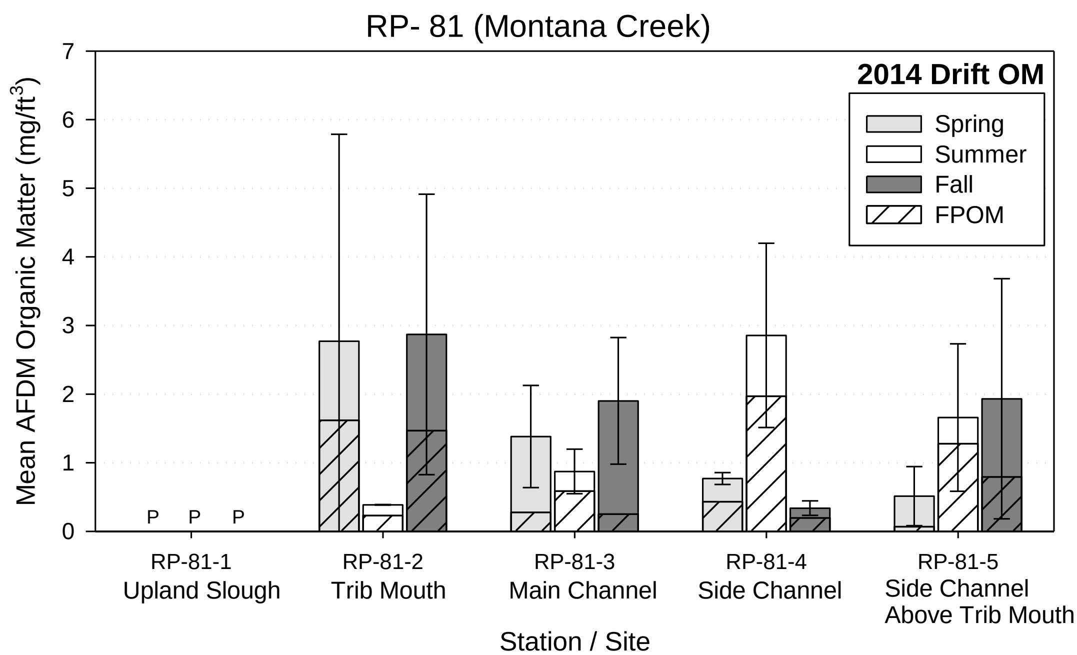


Figure 5.6-15. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2013 during three sampling events for sites within the Montana Creek Study Area (RP-81) in the Lower River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected.

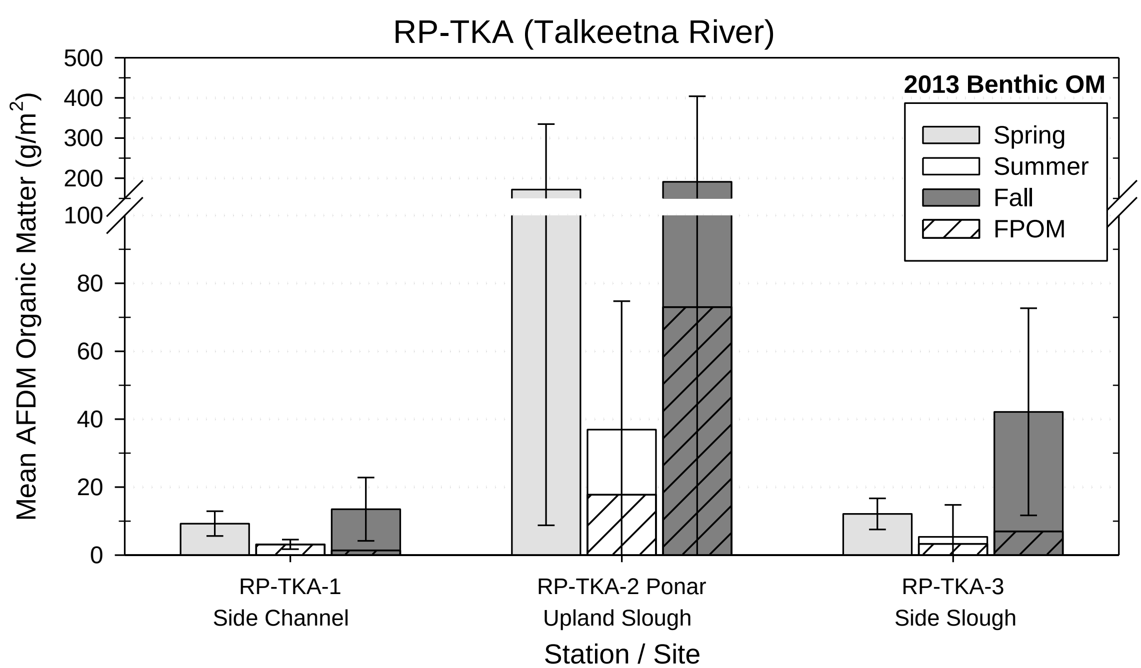


Figure 5.6-16. Mean benthic organic matter estimates (g/m^2) from Hess and petite Ponar grab samples collected in 2013 during three sampling events for sites within the Talkeetna River Study Area (RP-TKA) in the for the River Productivity Study. Error bars represent 95-percent confidence intervals.

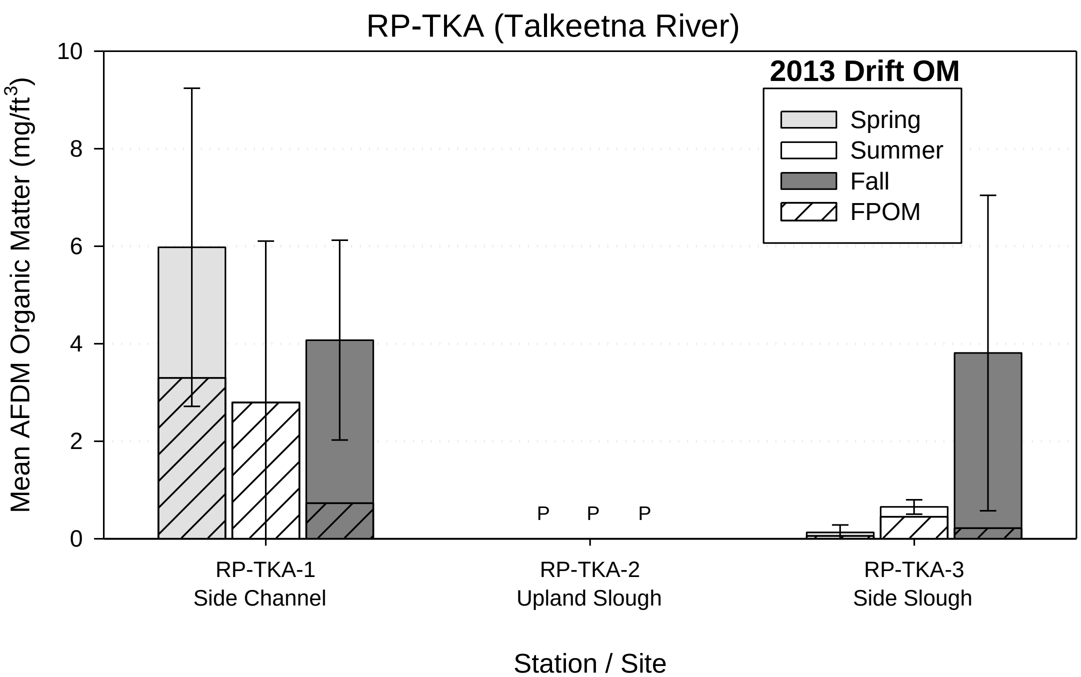


Figure 5.6-17. Drift (seston) organic matter estimates (mg/ft^3) from drift samples (n=2) collected in 2013 during three sampling events for sites within the Talkeetna River Study Area (RP-TKA) for the River Productivity Study. Error bars represent 95-percent confidence intervals. "P" indicates plankton tow samples were taken, and no organic matter was collected.

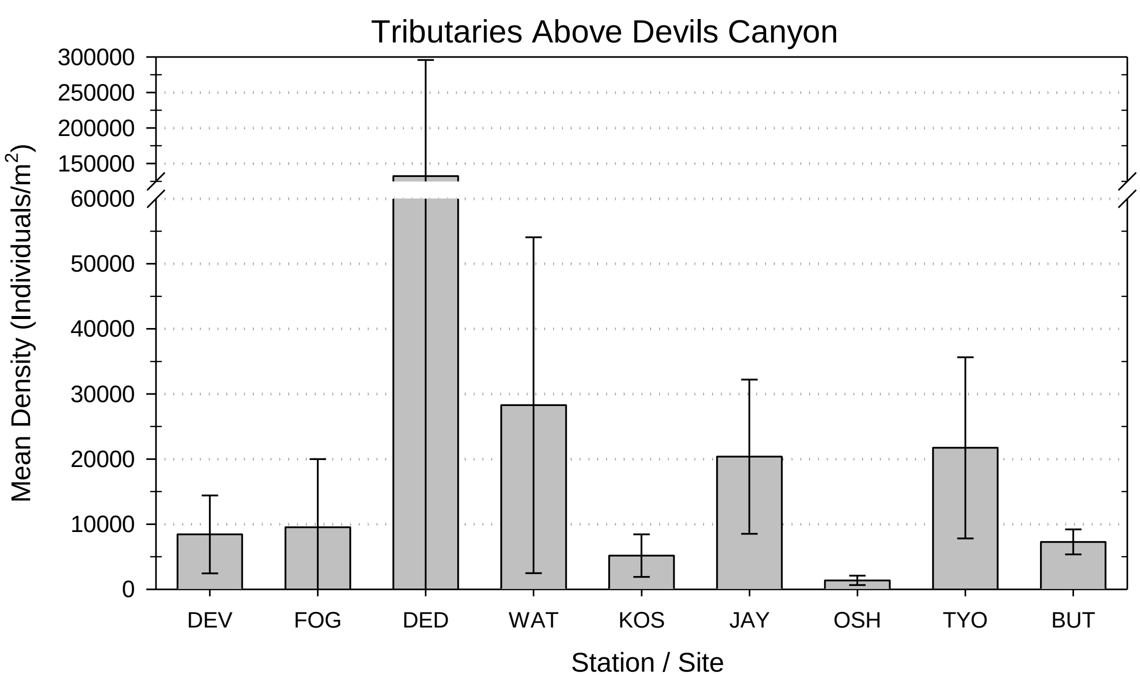


Figure 5.8-1. Mean density estimates (n=5) from Hess samples collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

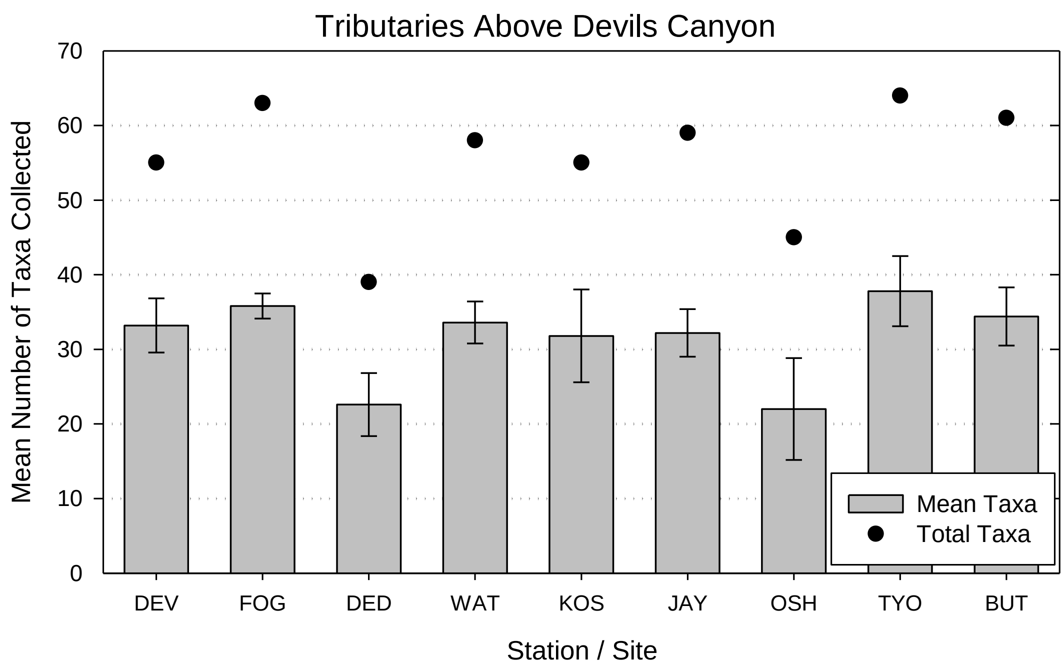


Figure 5.8-2. Mean and total taxa richness estimates (n=5) from Hess samples collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

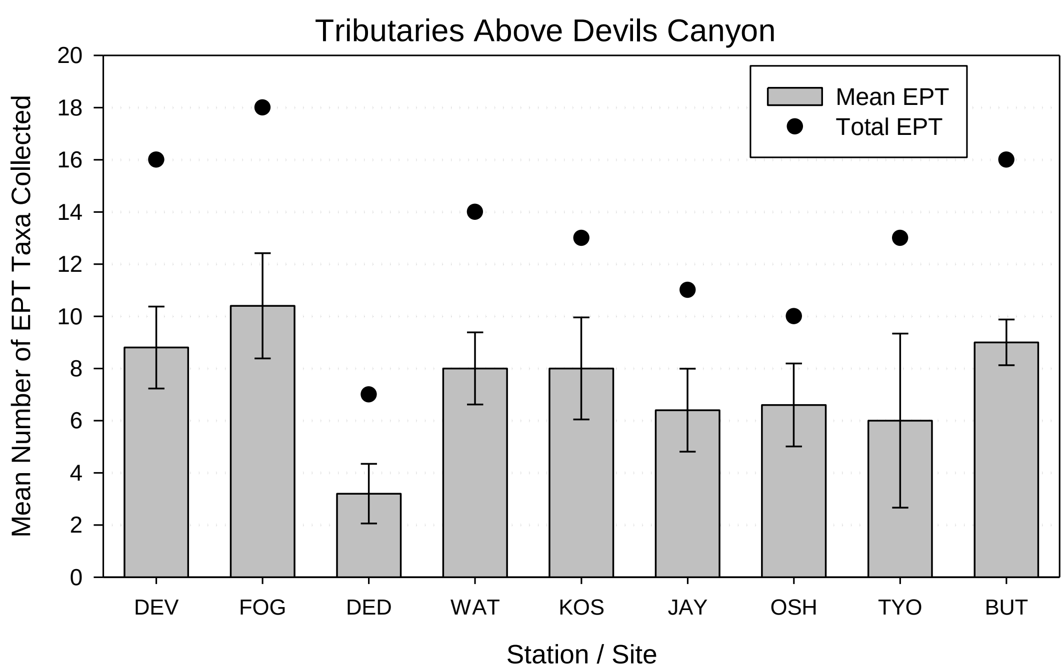


Figure 5.8-3. Mean and total EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness estimates (n=5) from Hess samples collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

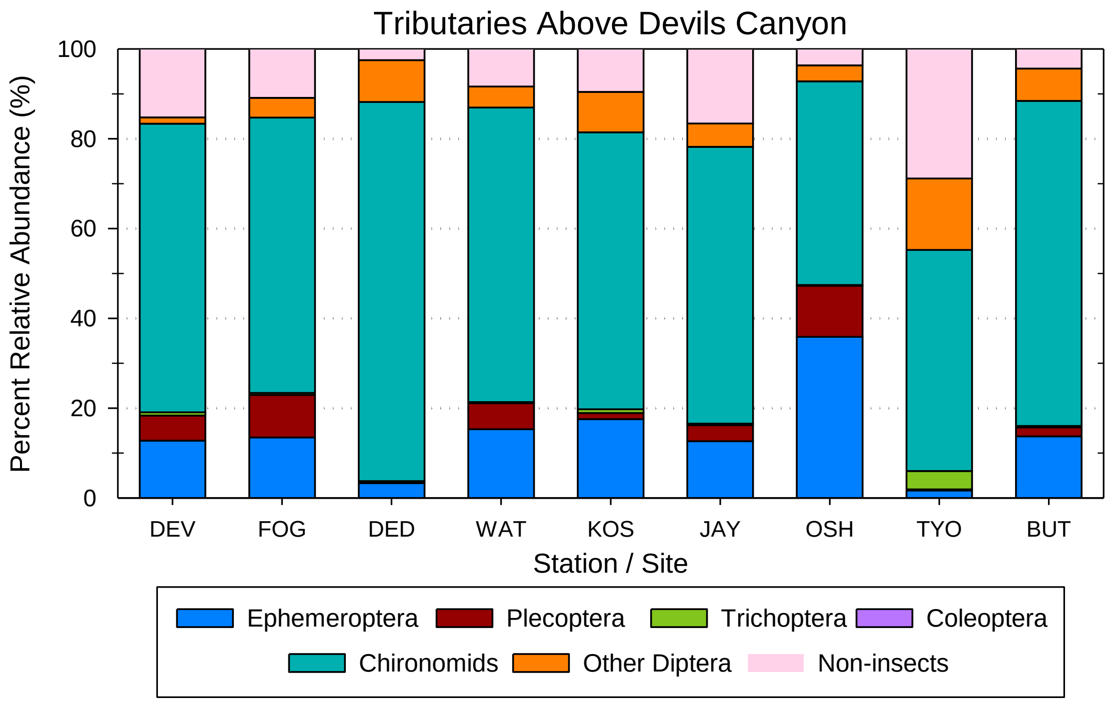


Figure 5.8-4. Mean percent relative abundances of major taxonomic groups from Hess samples (n=5) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

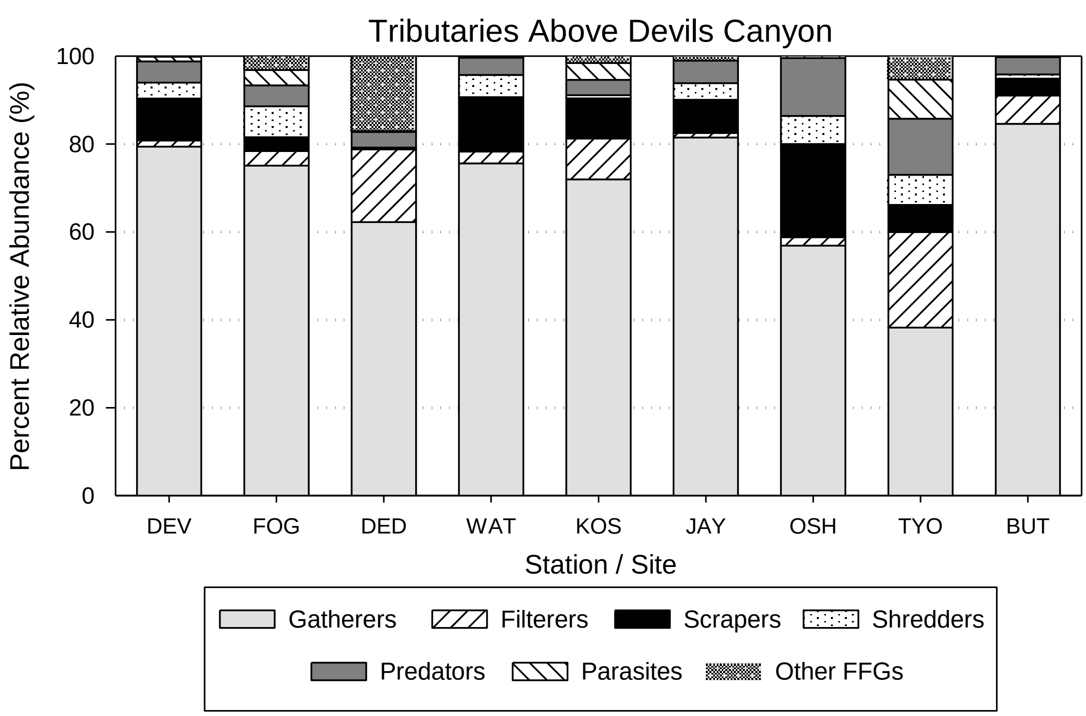


Figure 5.8-5. Mean percent relative abundances of functional feeding groups from Hess samples (n=5) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

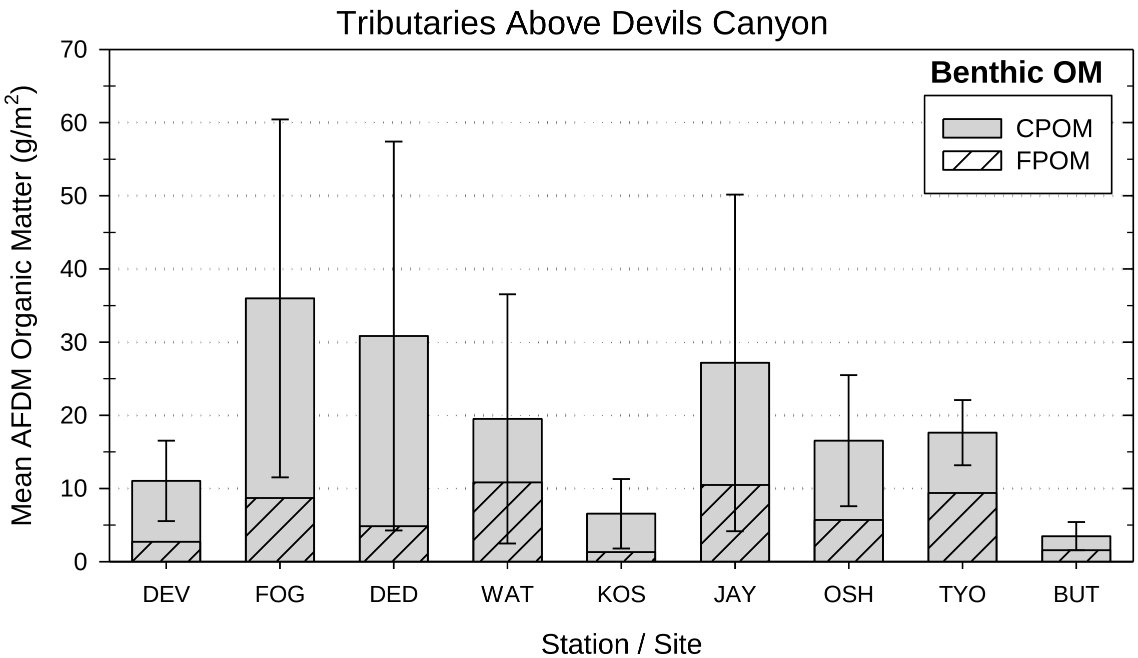


Figure 5.8-6. Mean benthic organic matter estimates (g/m^2) from Hess samples (n=5) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

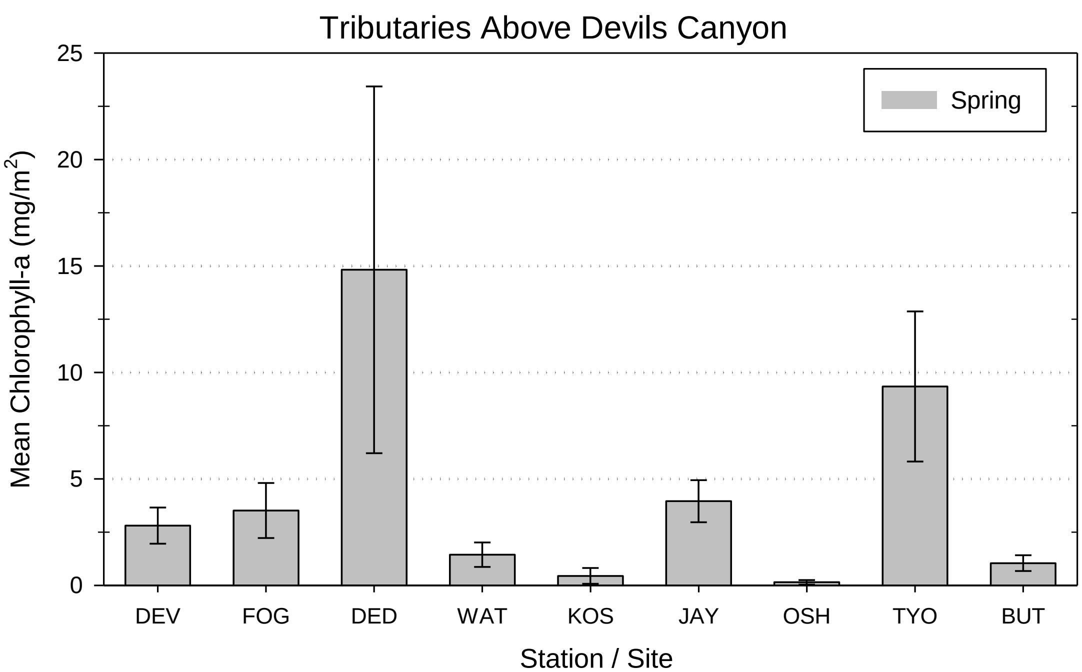


Figure 5.8-7. Mean chlorophyll-*a* (mg/m^2) from composite algae samples (n=5) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

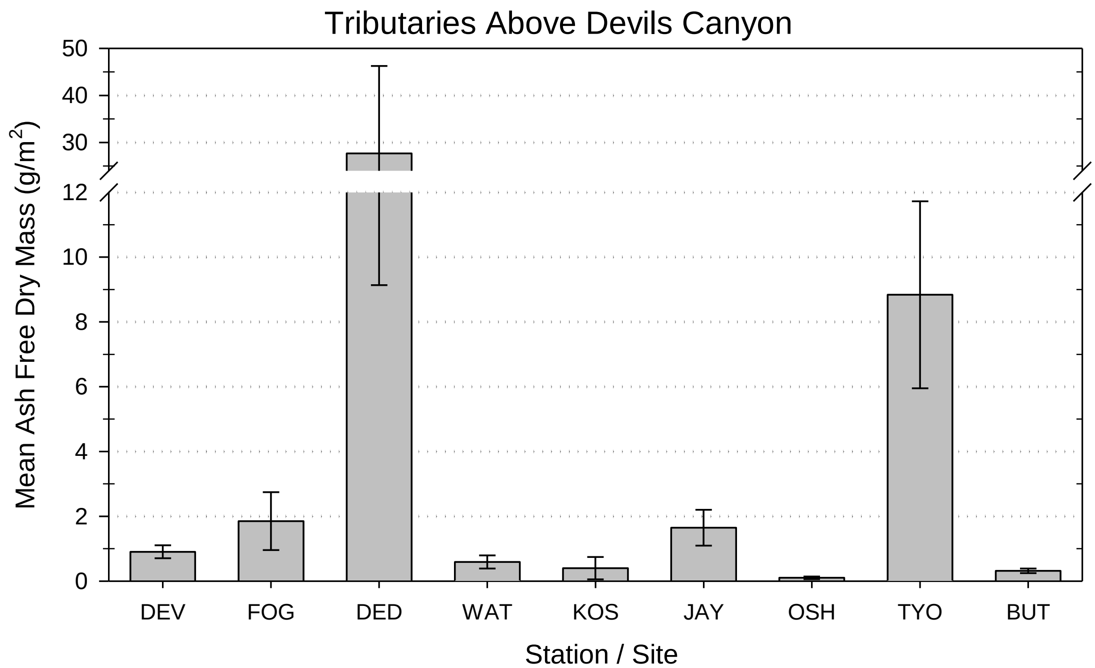


Figure 5.8-8. Mean ash free dry mass (AFDM, g/m^2) from composite algae samples (n=5) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

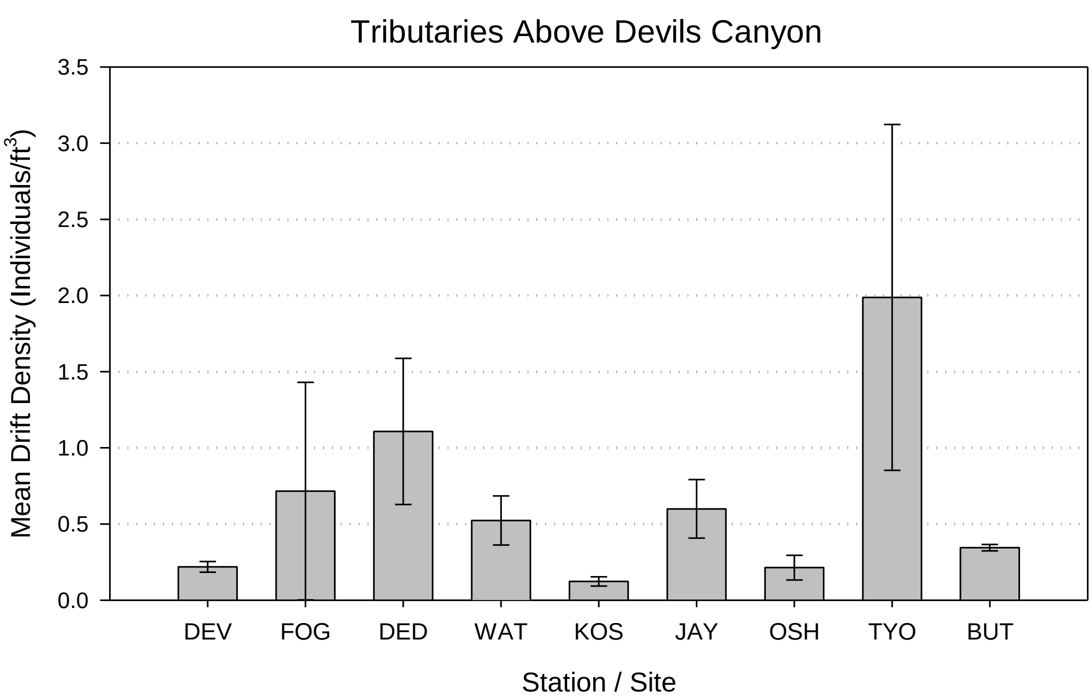


Figure 5.8-9. Mean drift density estimates from drift net samples (n=2) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

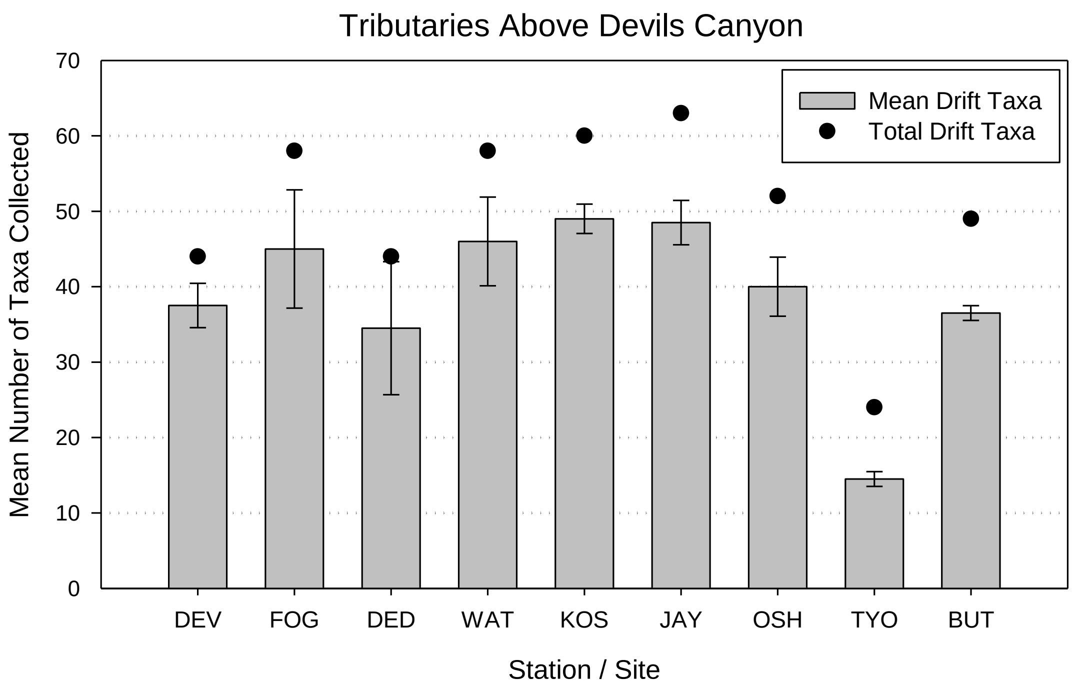


Figure 5.8-10. Mean and total drift taxa richness estimates from drift net samples (n=2) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

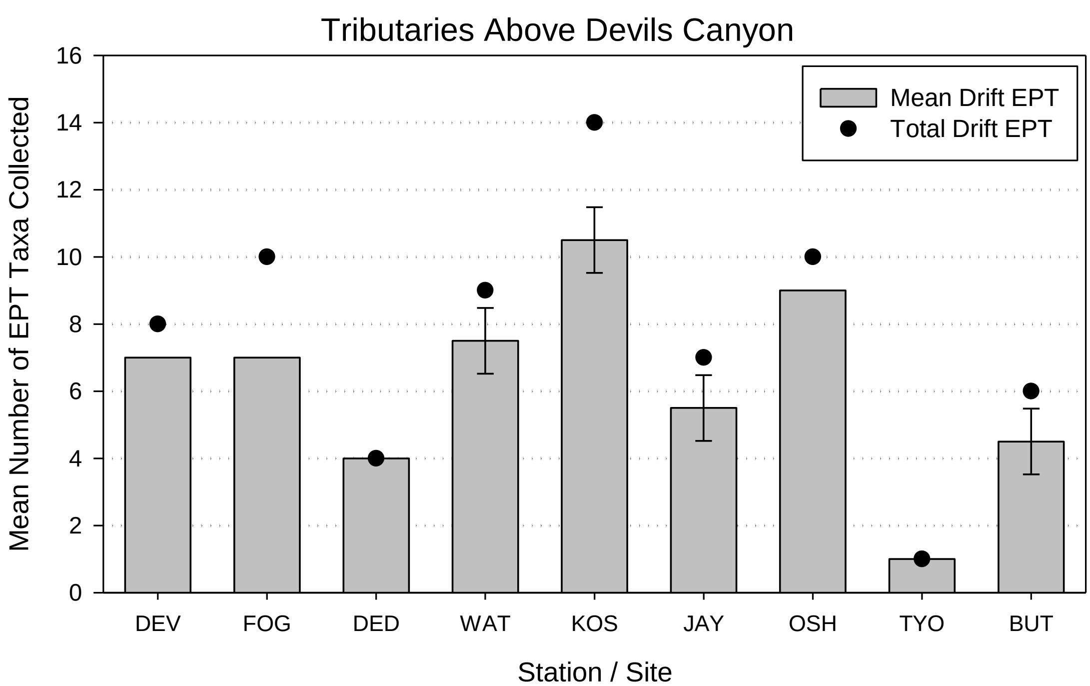


Figure 5.8-11. Mean and total drift EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness estimates from drift samples (n=2) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

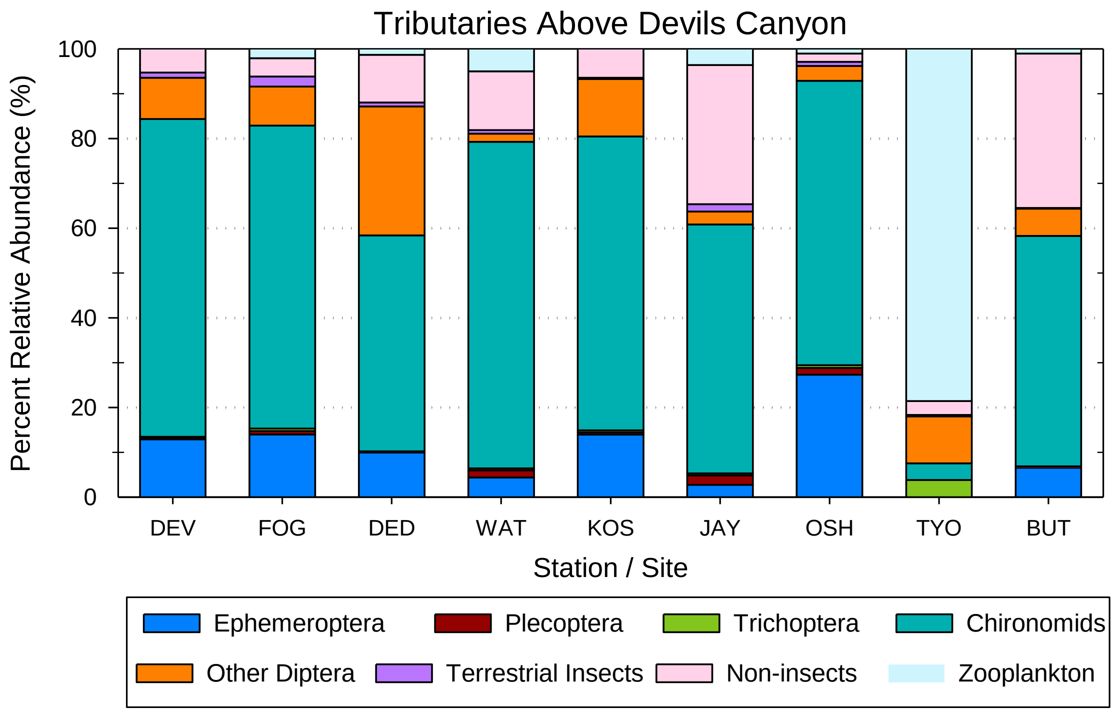


Figure 5.8-12. Mean percent relative abundances of major taxonomic groups from drift net samples (n=2) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study.

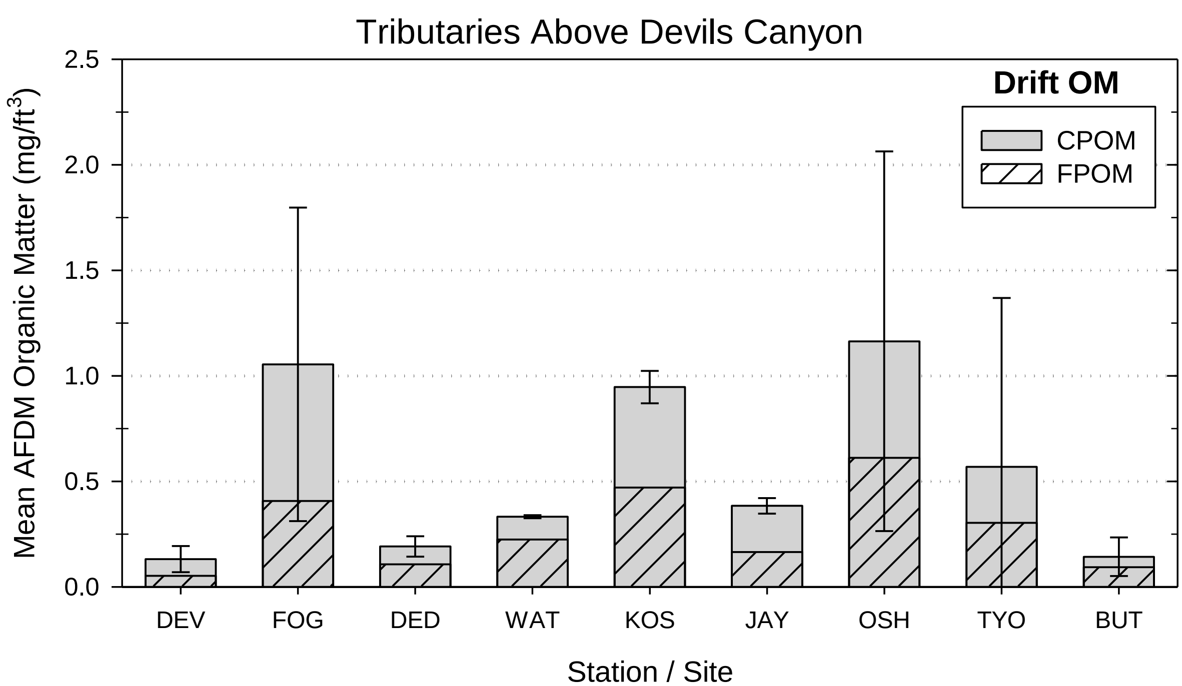


Figure 5.8-13. Mean drift (seston) organic matter estimates (g/m^2) from drift net samples (n=2) collected in July 2014 for sites in nine tributaries above Devils Canyon in the Middle and Upper River segments of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

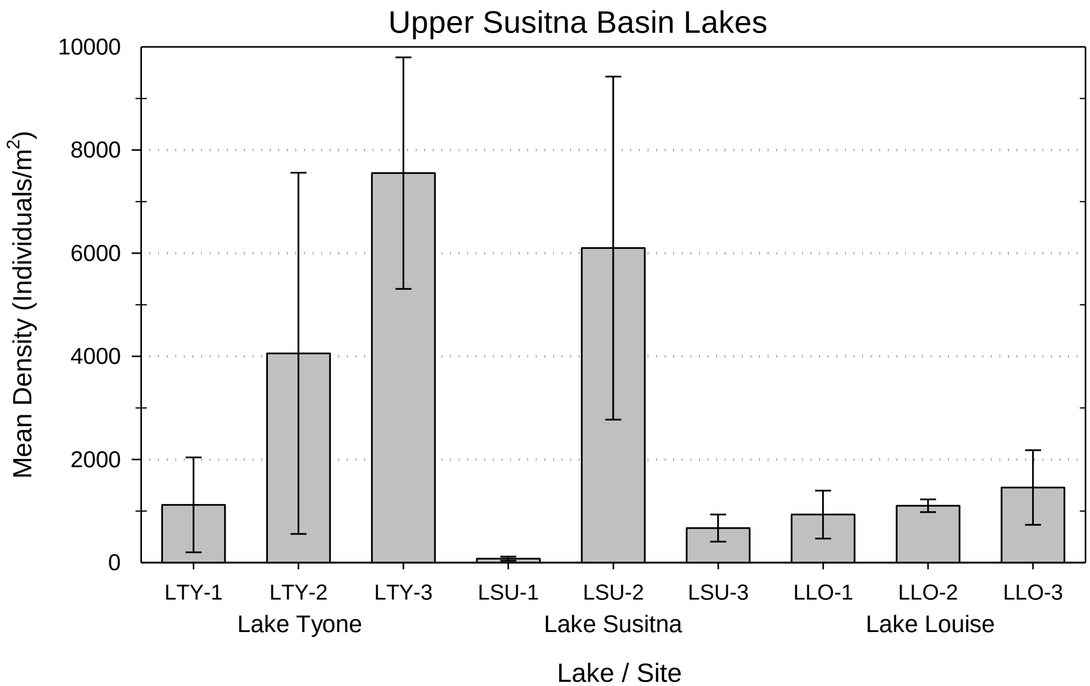


Figure 5.8-14. Mean density estimates (n=5) from petite Ponar samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

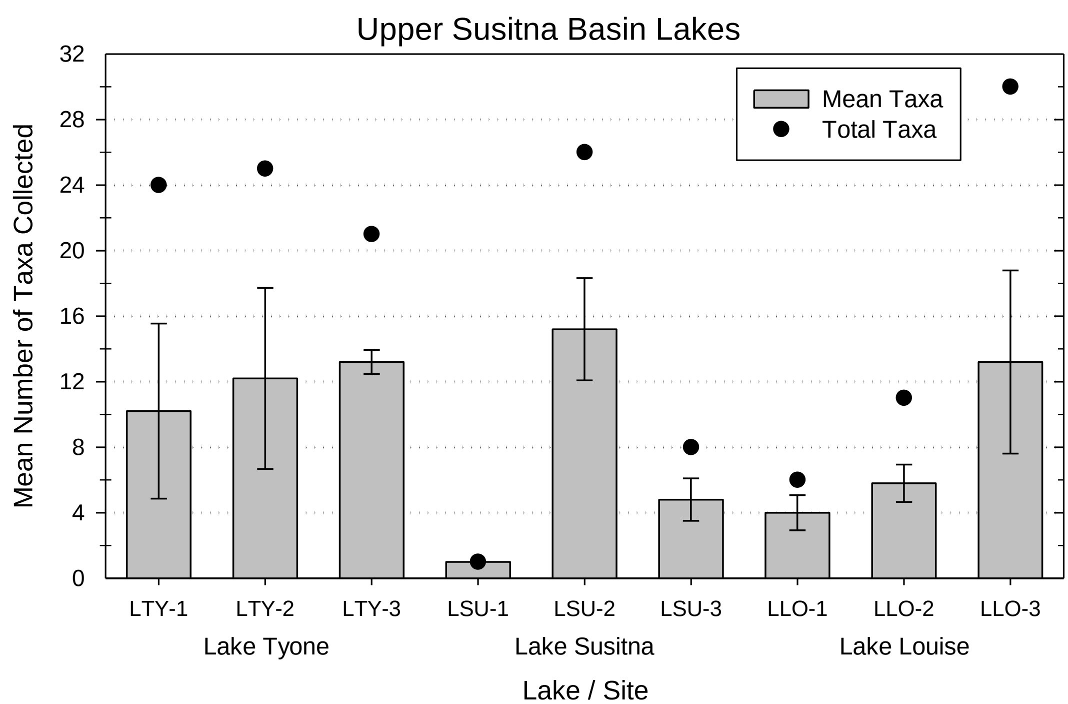


Figure 5.8-15. Mean and total taxa richness estimates (n=5) from petite Ponar samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

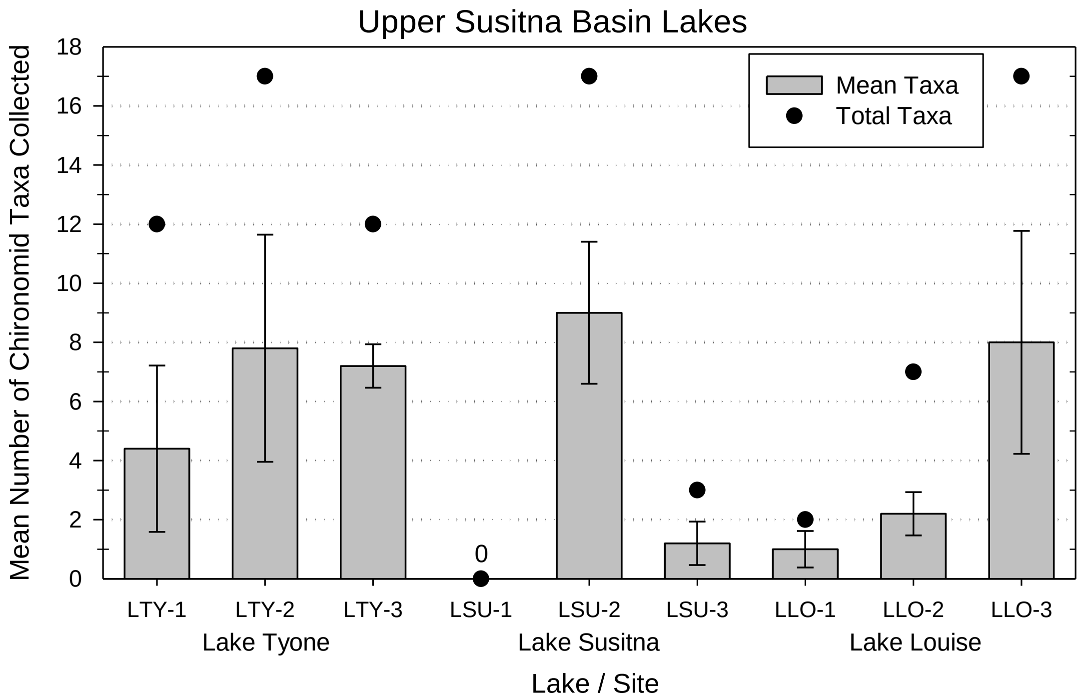


Figure 5.8-15. Mean and total chironomid (midge) taxa richness estimates (n=5) from petite Ponar samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

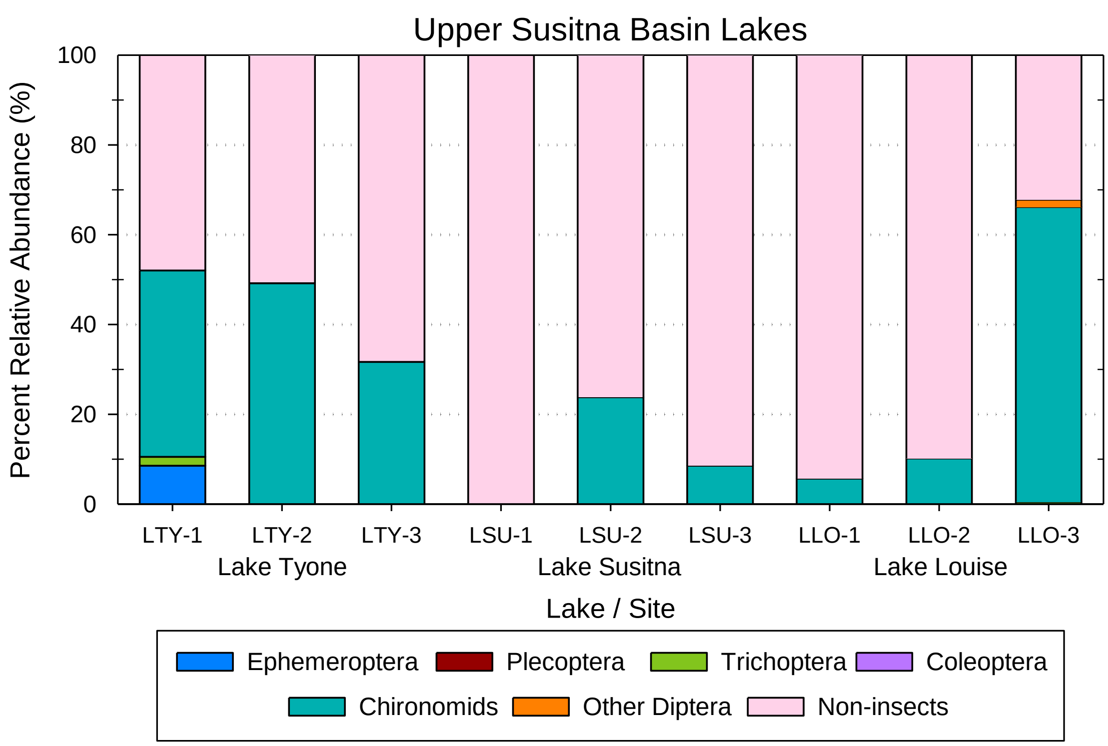


Figure 5.8-16. Mean percent relative abundances of major taxonomic groups from petite Ponar samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

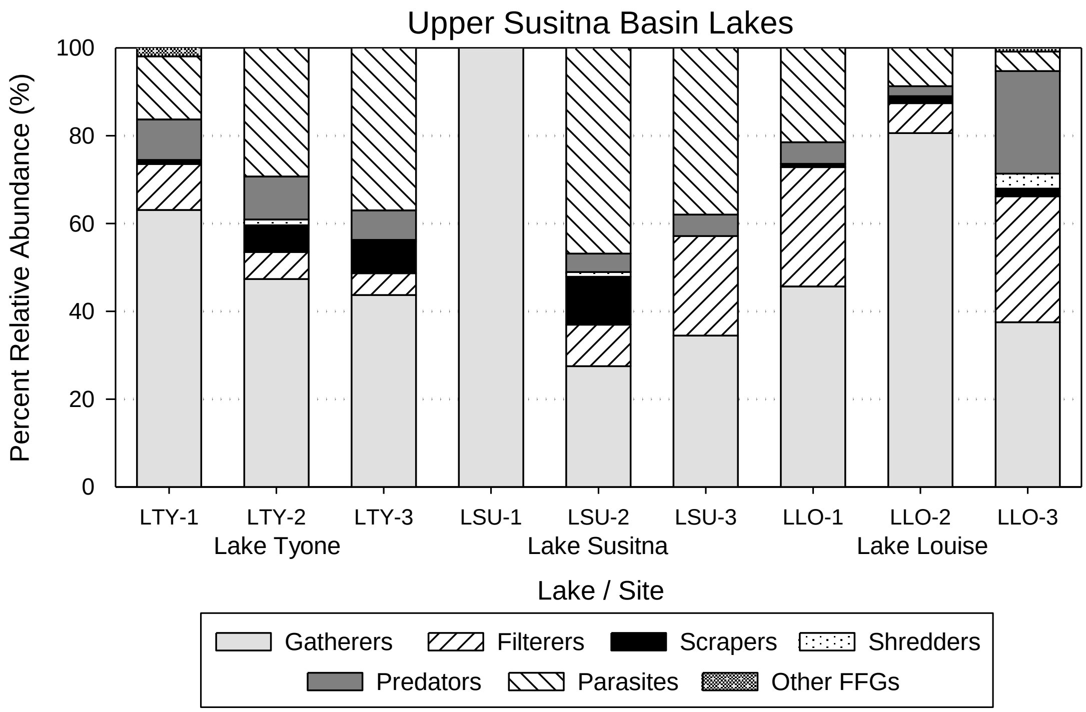


Figure 5.8-17. Mean percent relative abundances of functional feeding groups from petite Ponar samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

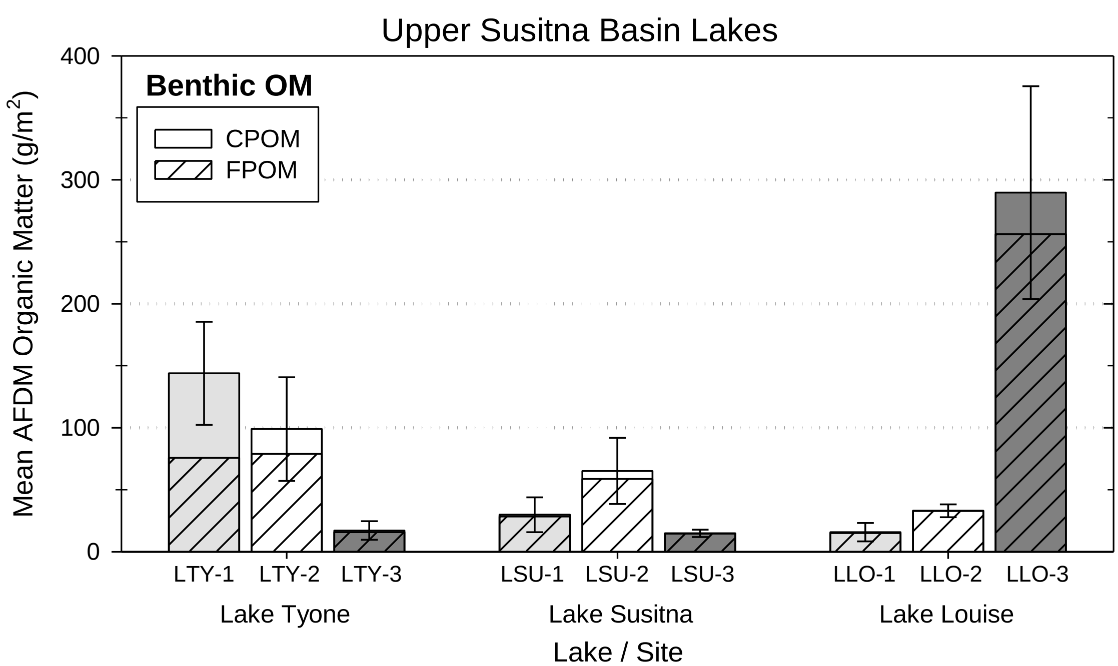


Figure 5.8-18. Mean benthic organic matter estimates (g/m^2) from petite Ponar samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

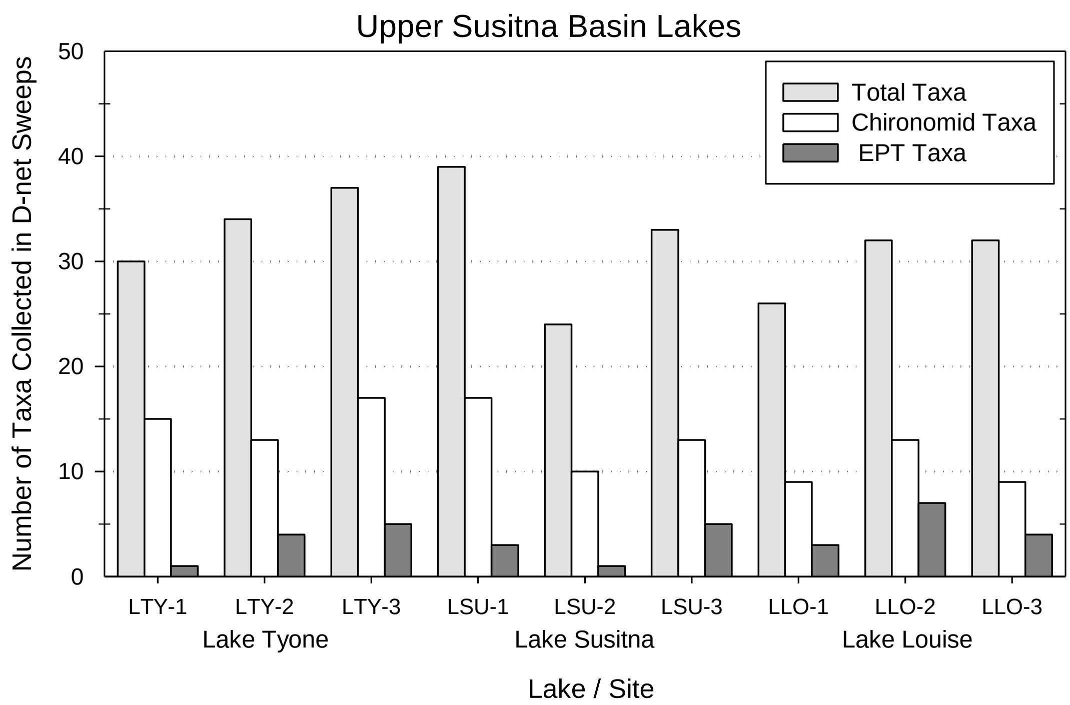


Figure 5.8-18. Taxa richness, chironomid taxa richness, and EPT taxa richness estimates from qualitative shoreline D-net sweep samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

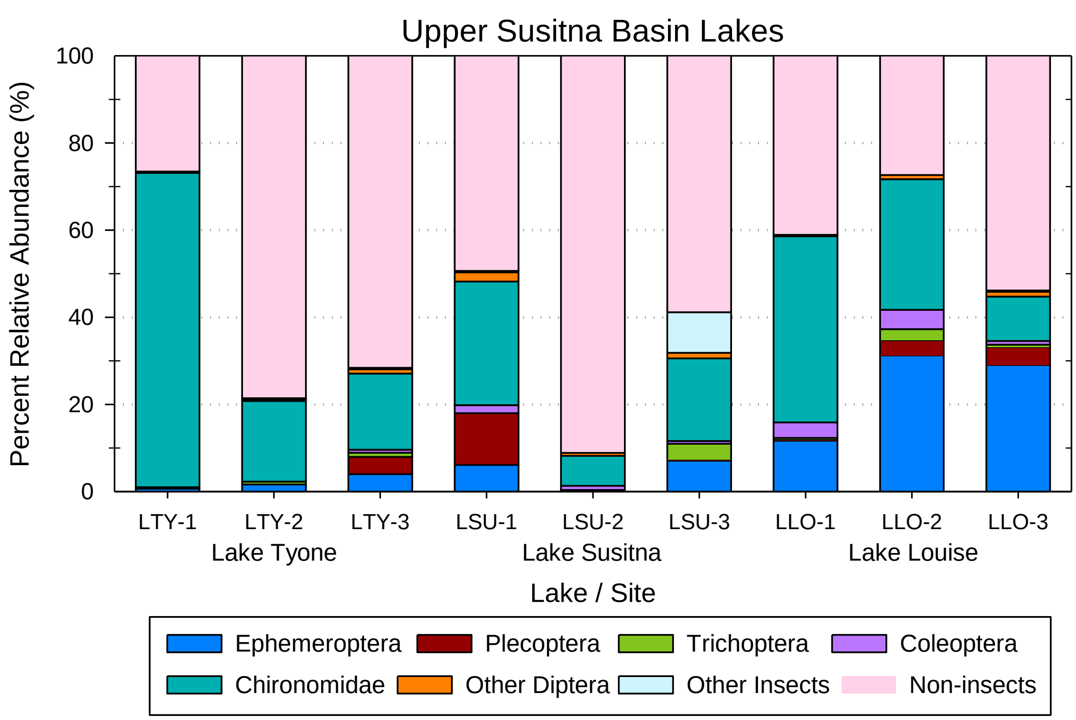


Figure 5.8-19. Mean percent relative abundances of major taxonomic groups from qualitative shoreline D-net sweep samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

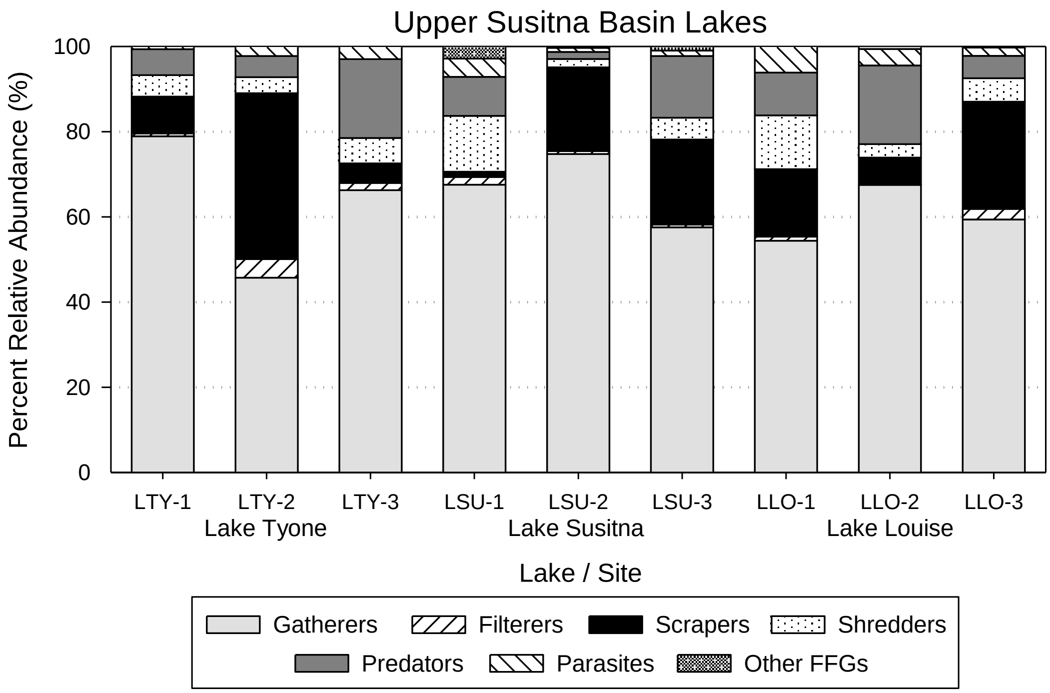


Figure 5.8-20. Mean percent relative abundances of functional feeding groups from qualitative shoreline D-net sweep samples collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

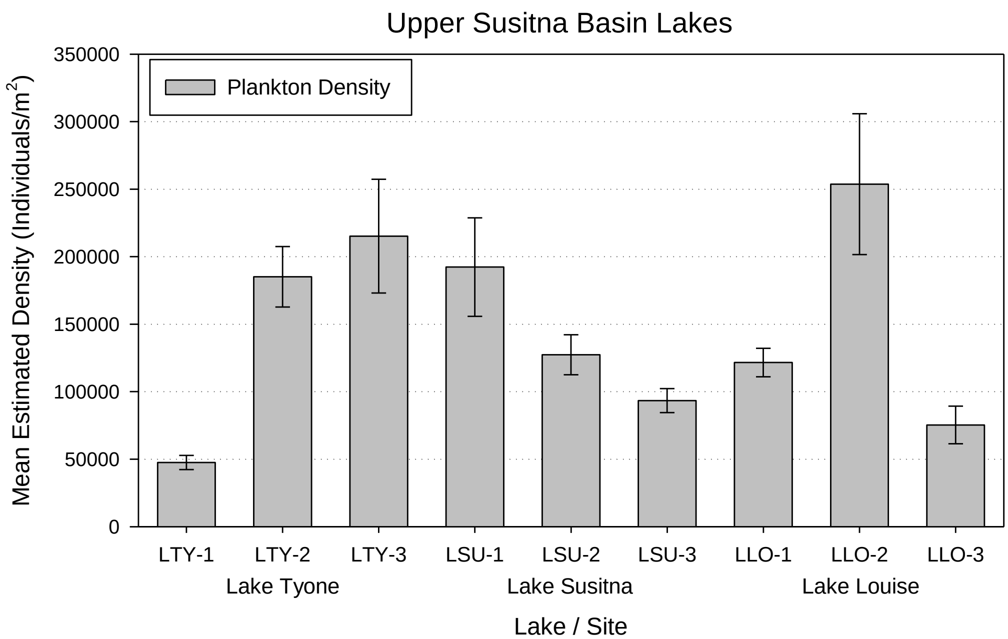


Figure 5.8-21. Mean plankton tow density estimates (individuals/m^2) from vertical tow net samples (n=5) collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

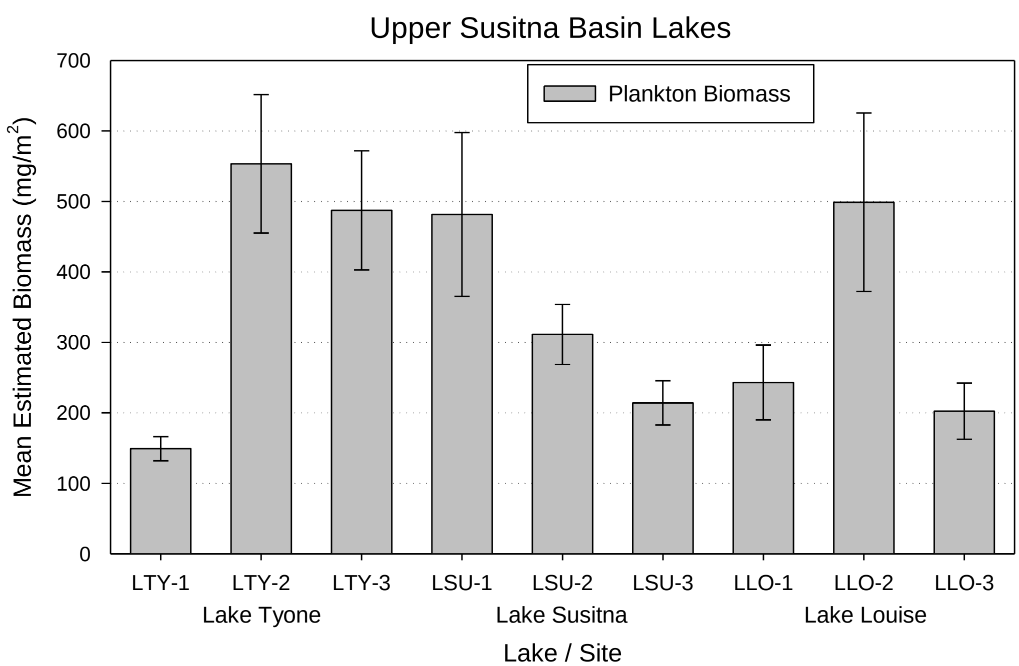


Figure 5.8-22. Mean plankton tow dry weight biomass estimates (mg/m^2) from vertical tow net samples (n=5) collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. Error bars represent 95-percent confidence intervals.

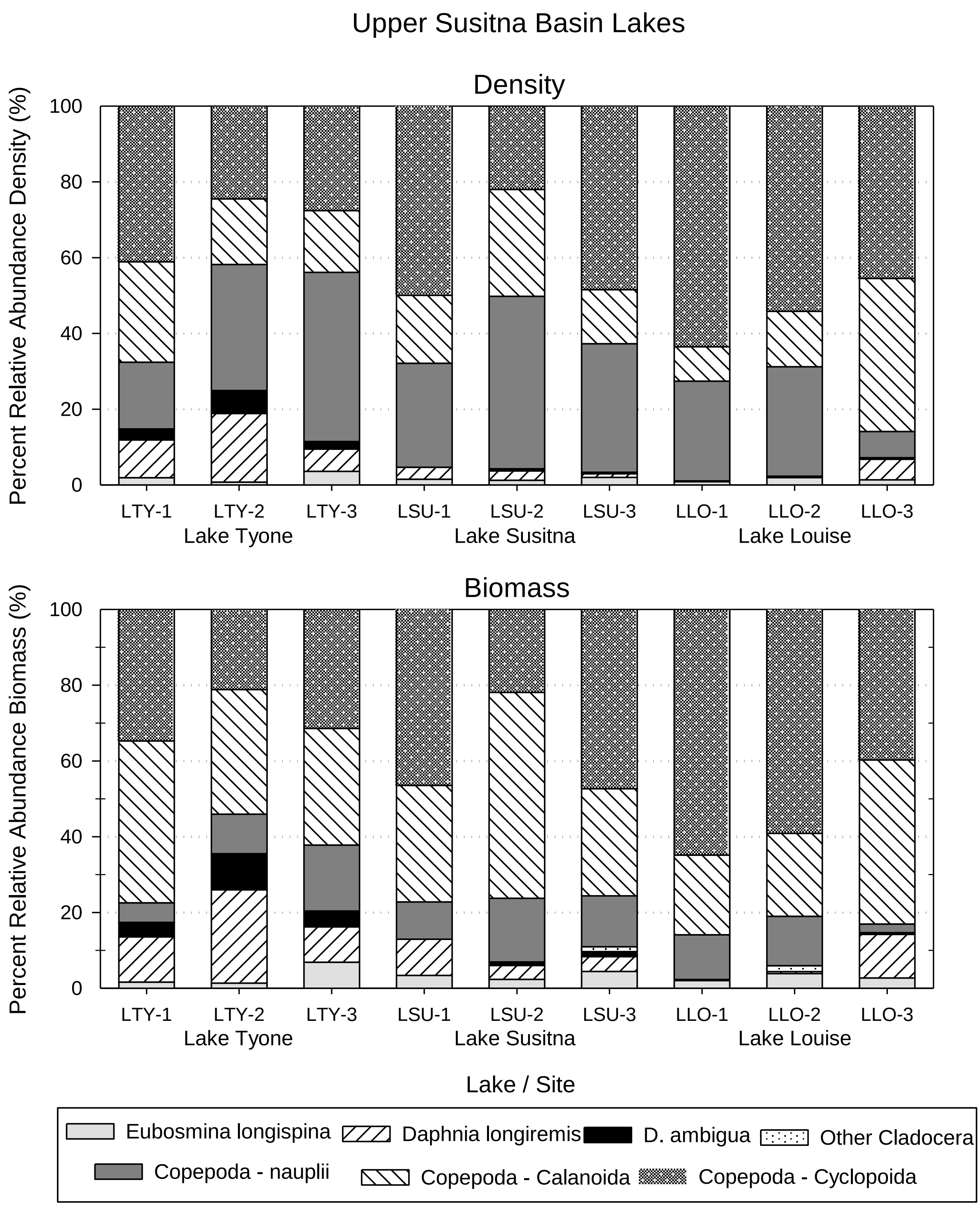


Figure 5.8-23. Mean percent relative abundances of zooplankton taxa density and biomass from vertical tow net samples (n=5) collected in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study.

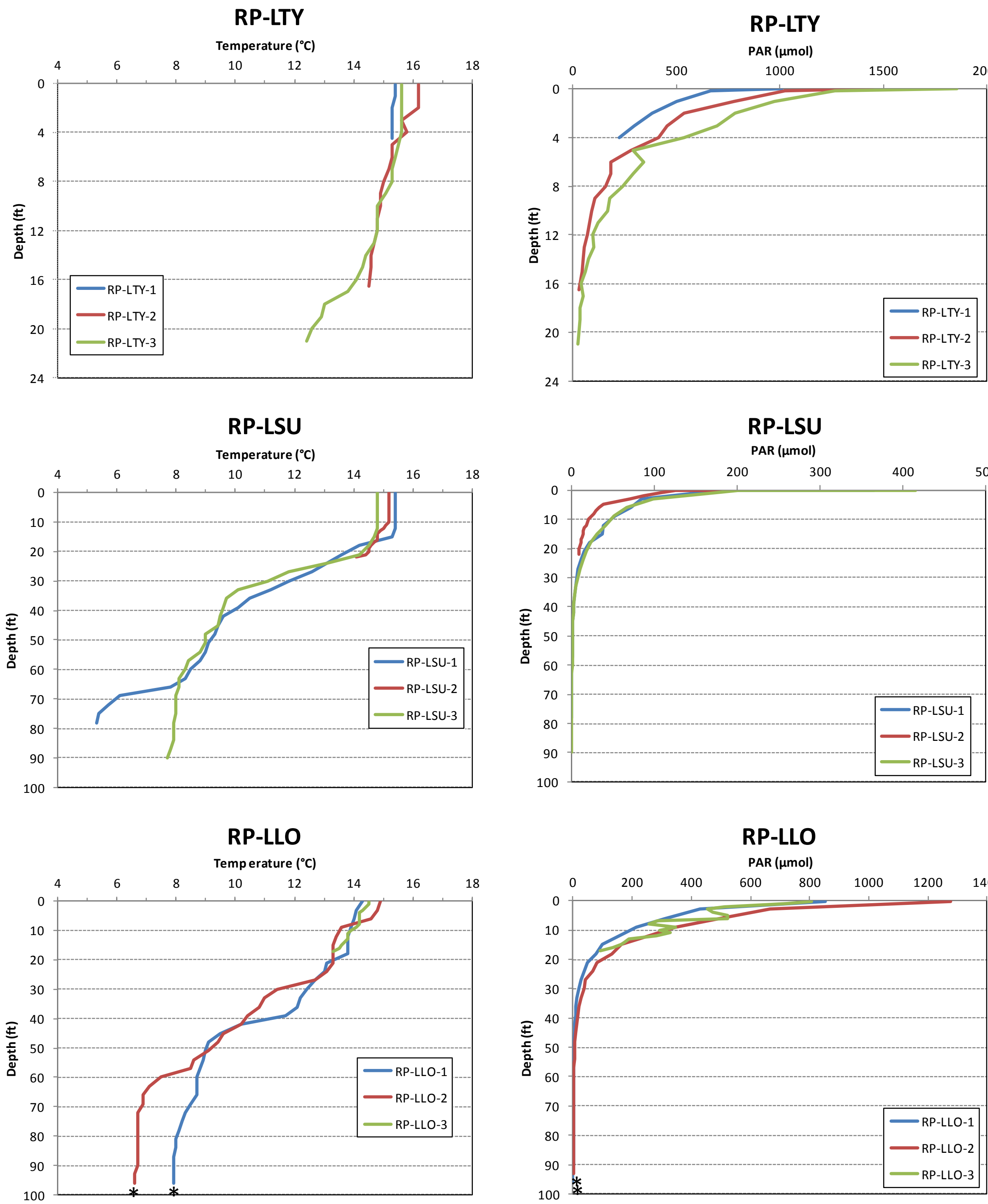


Figure 5.8-24. Depth profiles for temperature and photosynthetically active radiation (PAR) light levels recorded in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. "*" indicates measurements were limited by probe cable length (approx. 96 ft), and did not reach the lake bottom.

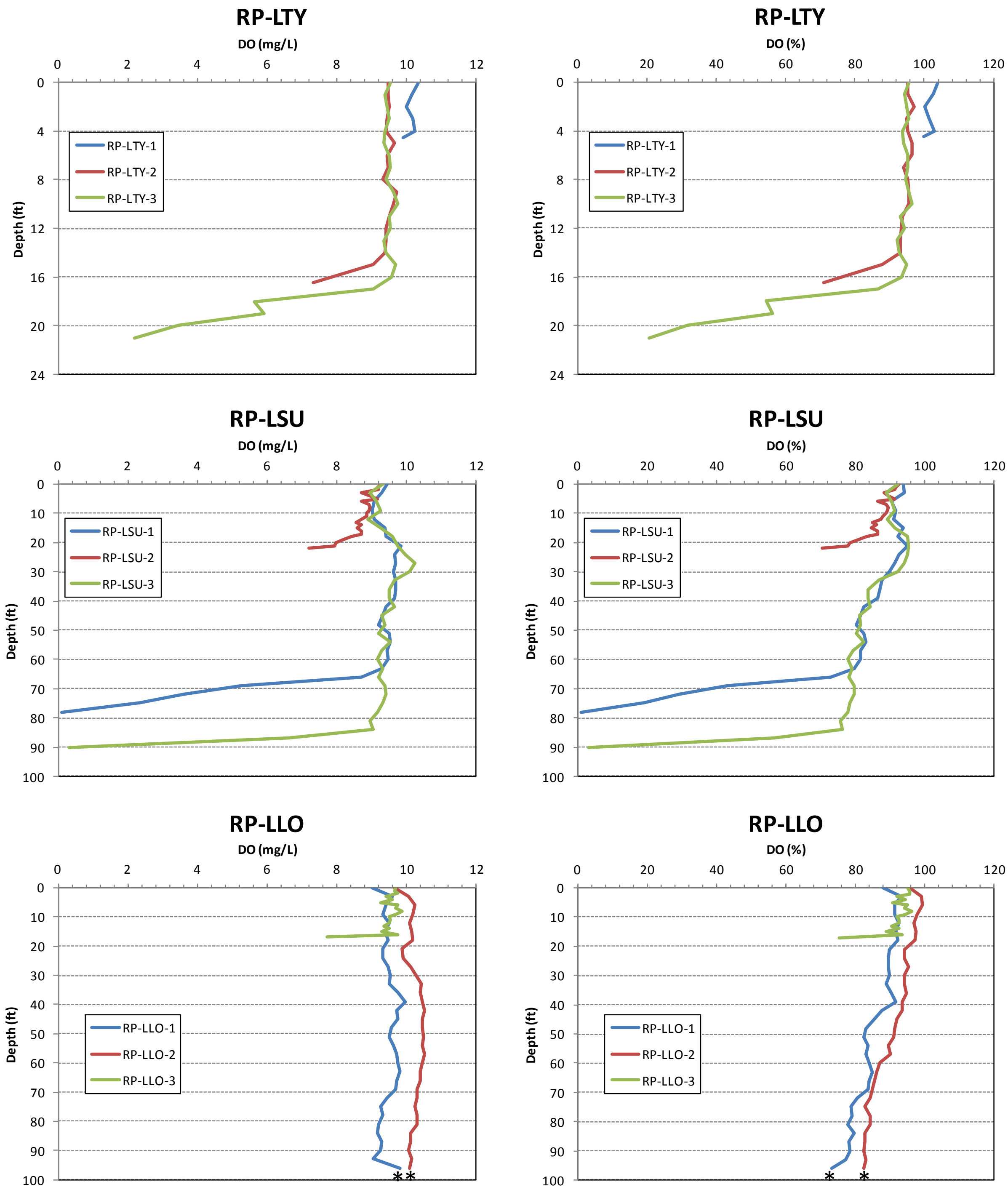


Figure 5.8-25. Depth profiles for dissolved oxygen (DO) and percent dissolved oxygen recorded in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. "*" indicates measurements were limited by probe cable length (approx. 96 ft), and did not reach the lake bottom.

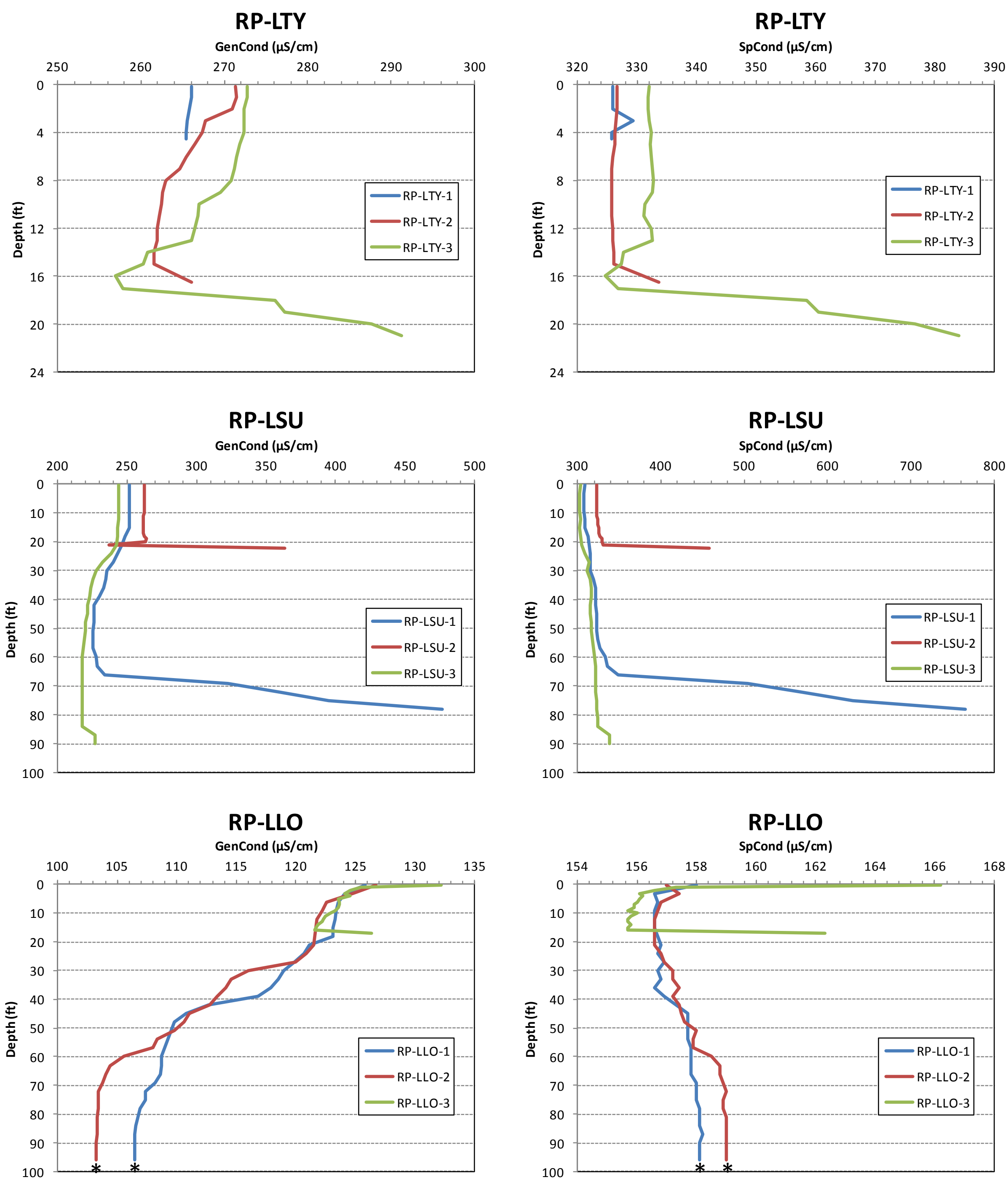


Figure 5.8-26. Depth profiles for general and specific conductivity recorded in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. "*" indicates measurements were limited by probe cable length (approx. 96 ft), and did not reach the lake bottom.

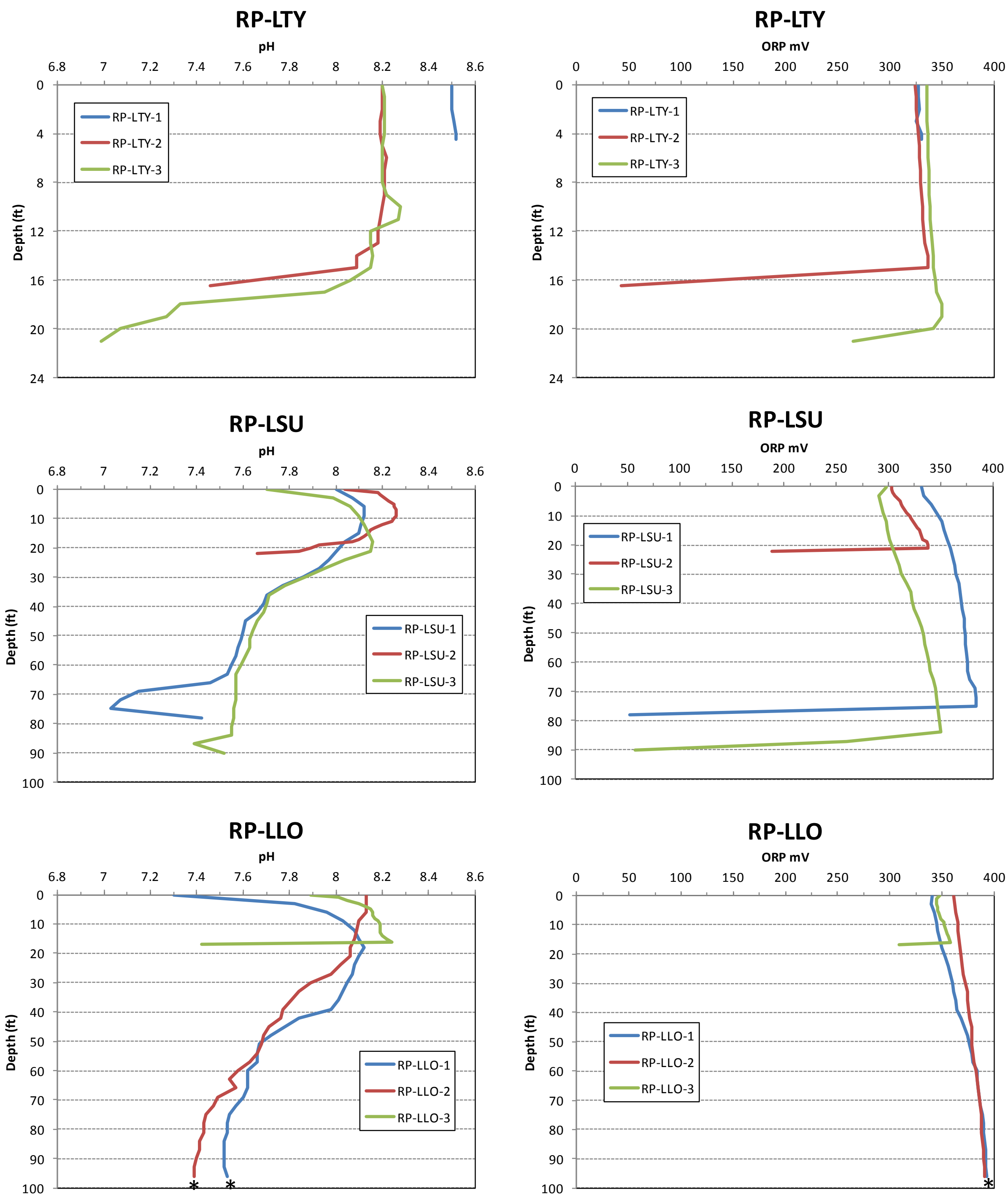


Figure 5.8-27. Depth profiles for pH and Oxidation Reduction Potential (ORP) recorded in July 2014 for sites within three lakes in the Upper River Segment of the Susitna River for the River Productivity Study. "*" indicates measurements were limited by probe cable length (approx. 96 ft), and did not reach the lake bottom.