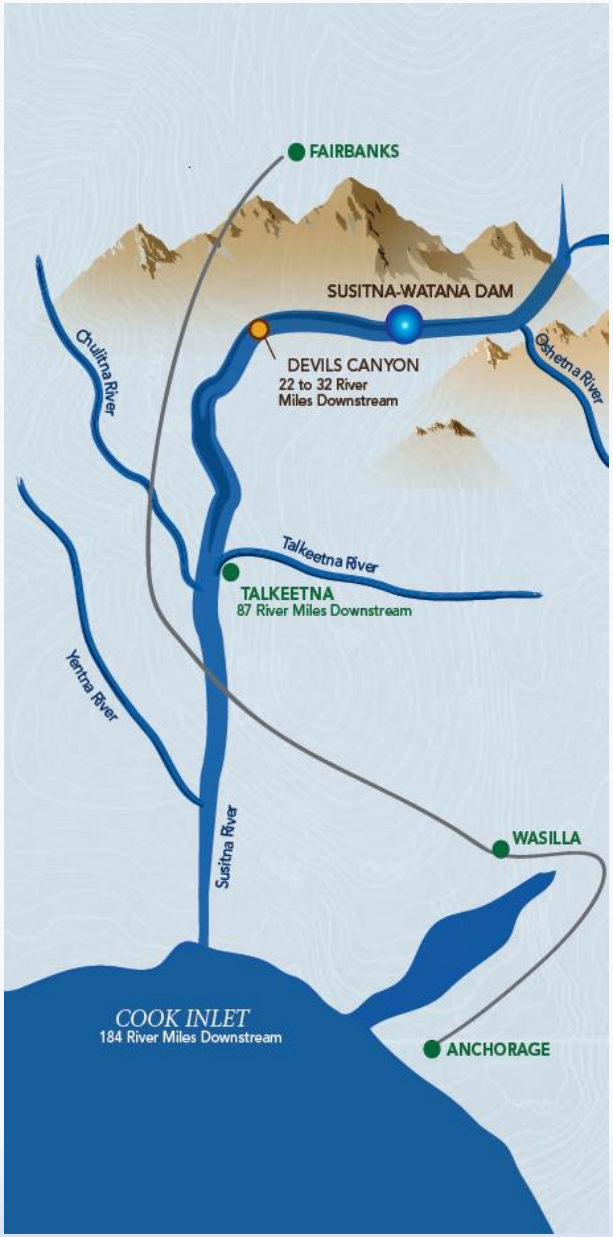

Initial Study Report Meeting

Study 9.8 River Productivity

March 22, 2016

Prepared by

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Study 9.8 Status

- ISR Documents (ISR Part D Overview)
  - Initial Study Report (Jun 3, 2014)
  - 2013 Initial River Productivity Results Technical Memorandum (Sept 26, 2014)
  - 2014 Field Season River Productivity Progress Report Technical Memorandum (Sept 26, 2014)
  - Initial Study Report Meetings, October 15, 2014 (Nov 14, 2014)
  - Initial Study Report, Errata to Appendix A (Nov 26, 2014)
  - Fish Diet Sample Size Sufficiency Analysis Technical Memorandum (Dec 17, 2014)
  - Study Implementation Report (Nov 6, 2015)
- Sample analysis was completed for all 2013 data sets. Results were summarized and discussed in the *2013 Initial River Productivity Results Technical Memorandum,* and in the *2014 Study Implementation Report.*
- Drift samples, sample components for Stable Isotope Analyses, and a collection of stomach contents from 449 target fish species for the Fish Diet Analysis and Trophic Modeling objectives were collected during the three sampling events in 2014. Results were summarized and discussed in the *2014 Study Implementation Report.* **These objectives are completed.**
- Macroinvertebrate, algae, and water quality samples were collected during July 2014 from nine selected tributaries and three large lakes located above Devils Canyon within the Middle and Upper Susitna River basin. Results were summarized and discussed in the *2014 Study Implementation Report.* **This objective is completed.**

Objectives

1. Synthesize existing literature on the impacts of hydropower development and operations on benthic communities.
2. Characterize the pre-Project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the Middle and Lower Susitna River.
3. Estimate drift of benthic macroinvertebrates in selected habitats within the Middle and Lower Susitna River to assess food availability to juvenile and resident fishes.
4. 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.
5. Conduct a trophic analysis to describe the food web relationships within the current riverine community within the Middle and Lower Susitna River.
6. Develop habitat suitability criteria for Susitna benthic macroinvertebrate and algal habitats to predict potential change in these habitats downstream of the proposed dam site.
7. Characterize the invertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).
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.
9. 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.

Components

- Synthesize existing information on the impact of hydropower development and operations (ISR Part A, Section 4.3; pg 8).
- Characterize the pre-Project benthic macroinvertebrate and algal communities in the Middle and Lower Susitna River (ISR Part A, Section 4.4; pg 9).
- Estimate drift in selected habitats within the Middle and Lower Susitna River (ISR Part A, Section 4.5; pg 15).
- Conduct a feasibility study in 2013 to evaluate the suitability of using reference sites on the Talkeetna River (ISR Part A, Section 4.6; pg 17).
- Conduct a trophic analysis to describe the food web relationships within the Middle and Lower Susitna River (ISR Part A, Section 4.7; pg 18).
- Generate habitat suitability criteria for Susitna benthic macroinvertebrate and algal (ISR Part A, Section 4.8; pg 23).
- Characterize the invertebrate compositions in the diets of representative fish species (ISR Part A, Section 4.9; pg 23).
- Characterize organic matter in the Middle and Lower Susitna River (ISR Part A, Section 4.10; pg 25).
- Estimate benthic macroinvertebrate colonization rates in the Middle River under pre-Project baseline conditions (ISR Part A, Section 4.11; pg 26).

Variances 2013-2014

(ISR Part D – Section 6)

- Lower River site was moved from Trapper Creek to Montana Creek (IP Section 2.1.3). See ISR Part A, Section 4.2.4.1.
- In 2013, sampling at the FA-173 (Stephan Lake Complex) upland slough replaced by small unnamed tributary mouth (FERC SPD, B-181). In 2014, land access for CIRWG lands was permitted, and this upland slough site was sampled (RP-173-5) while the unnamed tributary mouth was retained (RP-173-1). See ISR Part A, Section 4.2.4.2.
- Storm event sampling at side slough at FA-173 (Stephan Lake Complex) instead of FA-144 (Slough 21); upper and lower end sites not established (RSP Section 9.8.4.3; IP Section 2.1.2). See ISR Part A, Sections 4.2.4.3 and 4.4.3.2.
- Frequent and rapid river stage changes limited sampling sites available with 30-day periods of continuous inundation (RSP Section 9.8.4.3; IP Section 2.2.1). See ISR Part A, Section 4.4.3.1.
- Number of depth and velocity measures intended to evaluate shoreline bathymetry reduced for each Hess sample (RSP Section 9.8.4.3; IP Section 2.2.1). See ISR Part A, Section 4.4.3.1.
- Algae samples were taken from stones and woody debris as opposed to fine sediment in grab samples (FERC SPD, B-187). See ISR Part A, Section 4.4.3.3.

Variances 2013-2014

(ISR Part D – Section 6)

- Plankton tows were conducted at 5 still water sites instead the potential total of 11 recommended by FERC (FERC SPD, B-188). See ISR Part A, Section 4.5.1.1.
- Dry weights for macroinvertebrate taxa will be estimated using length-weight relationship data from UAF (RSP Section 9.8.4.3; IP Sections 2.2.2. and 2.8.2.). See ISR Part A, Sections 4.4.3.4. and 4.9.1.2.
- The Talkeetna reference station features a side channel, side slough, and upland slough, and does not include a main channel macrohabitat type (IP Section 2.1.4). See ISR Part A, Section 4.6.1.
- Stable isotope site selection was increased from the original two stations (3 sites each) to four stations, sampling 16 sites total (IP Section 2.11.1; FERC SPD, B-201). See ISR Part A, Section 4.7.3.1.
- Macrohabitat-specific subcutaneous dye marking was not used to track movements of juvenile chinook, coho or rainbow trout less than 60 mm long (FERC SPD, B-199). See ISR Part A, Section 4.7.3.2.
- Fish stomach content samples were not assessed in the field as to whether the stomach was empty or not (IP Section 2.8.1.). See ISR Part A, Section 4.9.1.1.
- Hester-Dendy Samplers were not pre-conditioned before deployment (IP Section 2.9.1). See ISR Part A, Section 4.11.1.

Study 9.8 Variances in 2014

ISR Part D – Section 6.2

Proposed modifications (ISR Part C, Section 7.1.2) implemented in 2014:

- Arctic Grayling juveniles and adults added as target species/lifestages for the trophic modeling and stable isotope analysis objectives (ISR Part C, Section 7.1.2.4).
- Arctic Grayling juveniles and adults added as target species/lifestages for the Fish Diet Analysis objective (ISR Part C, Section 7.1.2.5).
- Nine Susitna River tributaries and three lake systems were sampled (ISR Part C, Section 7.1.2.7).

Summary of Results – Whitepaper & Benthics

(ISR Part D – Section 3)

- Completed Literature Review on the impacts of hydropower development and operations on benthic macroinvertebrate and algal communities (ISR Part A, Appendix A).
- Benthic samples collected during the three sampling events in 2013 were comprised of 301 Hess samples, 155 LWD (snag) samples, 85 petite Ponar grab samples, 47 adult emergence traps, and 105 Hester-Dendy samples (ISR Part A, Section 4.4.1).

Results presented in the *2013 Initial River Productivity Results Technical Memorandum (Section 3.1):*

- Tributary mouths generally highest in mean benthic density, taxa richness, and EPT richness, with higher percentages of EPT taxa in community compositions.
- Side sloughs and upland sloughs with higher densities and taxa richness measures later in the sampling season, during summer and fall.
- Main channel and side channel sites often with lowest density and taxa richness measures in comparison to other macrohabitats, with exceptions within side channels that became more disconnected from main channel influence.

Summary of Results – Benthics

(ISR Part D – Section 3)

Benthic Results presented in the *SIR Section 5.1*:

2013 Adult Emergence

- Above Devils Canyon, main channel habitats had higher daily emergence densities.
- Below Devils Canyon, upland sloughs and tributary mouths were generally higher in daily emergence densities compared to main channels and side channels.
- Peaks of emergence largely in July and August, dominated by chironomids.

2013 Benthic Community on Woody Debris

- Densities and taxa richness on wood were higher overall in larger tributary mouths and off-channel sites compared to main channel and most side channel sites.

- 2013 Benthic Algae collected during the three sampling events were comprised of 309 composite algae samples. Results were summarized (ISR Part A, Section 5.2), and generally indicated that algae were lower in mainstem macrohabitats than off-channel habitats (side sloughs, upland sloughs).

Summary of Results – Drift

(ISR Part D – Section 3)

- In 2013, drift samples collected during the three sampling events were comprised of 104 drift samples and 95 plankton tows. Results are presented in the ***2013 Initial River Productivity Results Technical Memorandum (Section 3.2).***
- In 2014, drift samples collected during the three sampling events were comprised of 108 drift samples and 105 plankton tows. Results are presented in the ***SIR (Section 5.2).***
  - Results in 2014 showed trends similar to those seen in 2013, with some expected degree of annual variability for sites.
  - 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.
  - Higher drift density and taxa richness in tributary mouths, lower in off-channel sites.
  - Plankton tows in upland sloughs and side sloughs showed among the highest overall averaged densities by volume (per cubic foot), but lowest taxa richness, due to zooplankton.

Summary of Results – Talkeetna River

(ISR Part D – Section 3)

- The Talkeetna River was sampled for 30 Hess samples, 45 composite algae samples, 15 petite Ponar grabs, 12 drift samples, and 10 plankton tows during the three index events in 2013, to assess the feasibility of the Talkeetna as a reference site for the Middle Susitna River. Results are presented in the ***2013 Initial River Productivity Results Technical Memorandum (Section 3.3).***
  - Side slough and upland slough sites displayed higher benthic densities.
  - Side slough showed higher benthic taxa richness measures during the sampling season than were seen at the side channel and upland slough sites.
  - Drift sampling showed higher taxa richness in the side slough than the side channel.
  - Plankton tows in the upland slough showed higher densities by volume (per cubic foot), but lowest taxa richness, due to zooplankton.

Summary of Results – Organic Matter

(SIR – Section 5.6)

- 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.
  - Upland sloughs had among the highest averaged overall total benthic OM.
  - Flowing water sites 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.
  - Overall drift organic matter during 2013 was higher in main channel sites than in off-channel sites; no differences seen in 2014 drift samples.
  - Drift OM in main channel and side channel sites contained more FPOM compared to CPOM amounts, whereas tributary mouths usually contained more CPOM than FPOM.
  - Drift OM contained a higher CPOM in samples than was seen in benthic OM.

Summary of Results – Fish Diet Analysis

(SIR– Section 5.4 and 5.5)

2013 Results in the ***2013 Initial River Productivity Results Technical Memorandum (Sections 3.4 and 3.5).***

- 196 non-empty fish stomachs analyzed; 4,375 diet items identified and measured.
- Stomach contents: strong reliance on fish (including newly emerged salmon fry) during June 2013 and on salmon eggs during August-October 2013.
- Stable Isotope Analysis: 1,242 sample components, including 261 target species fish.
  - 3 fish species ate substantial amounts of marine-derived food, in addition to freshwater and terrestrial invertebrates.

2014 Results in the ***2014 SIR for Study 9.8 (Sections 5.4 and 5.5)***.

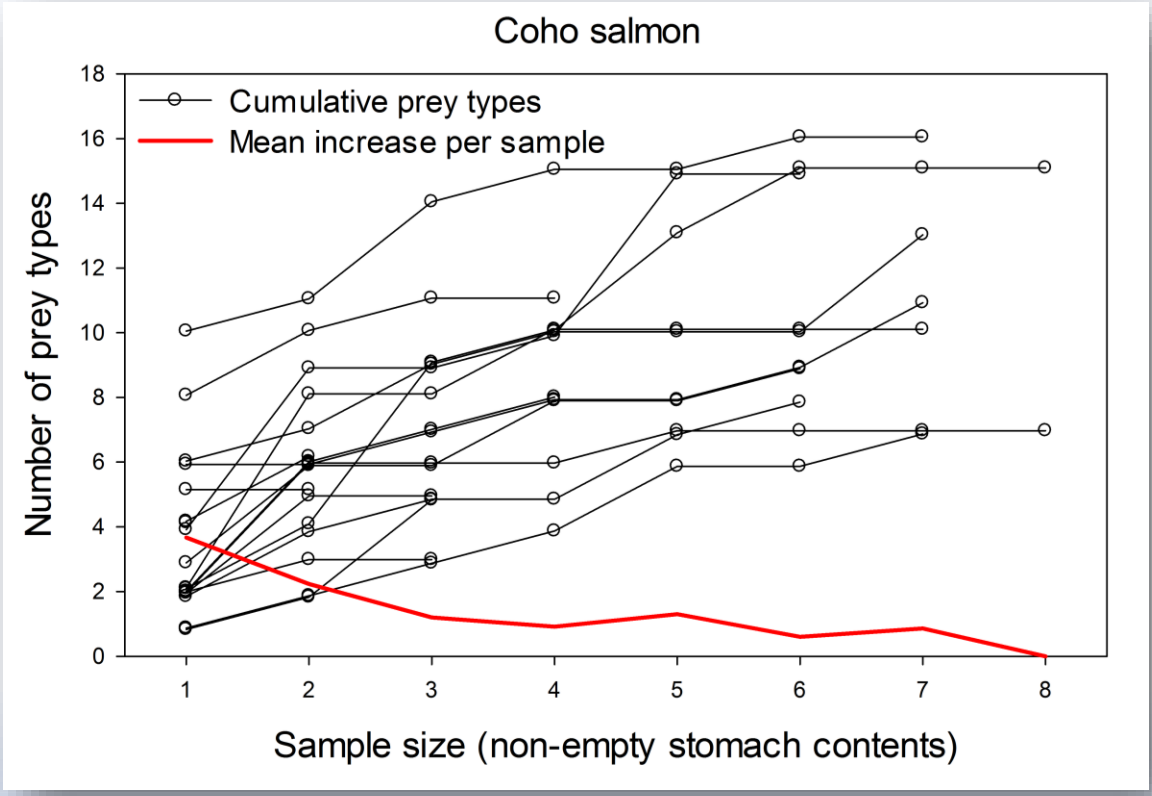
- 410 non-empty fish stomachs analyzed; 39,597 diet items identified and measured.
- Stomach contents: most target species consumed primarily freshwater prey (including aquatic and terrestrial adult life-stages); large Rainbow Trout preyed more heavily on fish and fish eggs than on invertebrates overall, and juvenile Coho and Chinook Salmon also relied heavily on salmon eggs when present.
- Stable Isotope Analysis: 1,557 sample components, including 449 target species fish.
  - many invertebrates relied on instream algae ; freshwater energy pathways were most important in supporting all salmonid target species overall.

Summary of Results – Fish Diet Analysis

(Fish Diet Sample Size Sufficiency Analysis TM, filed 12/17/2014)

Analysis was requested during the October 15, 2014 ISR meeting:

1. Plotted cumulative prey curves to determine if sample size target (*n* = 8) was sufficient to characterize diet composition.
2. One curve per site per season.
3. Most curves stabilized between 4-8 samples.
4. Red line: diminishing returns as sample size approaches 8.
5. Chinook and rainbow curves were similar.
6. Suggests *n* = 8 is sufficient.
7. Stable isotopes provide additional information on diet and are more robust to low sample size.



Summary of Results – Trophic Model

(SIR– Section 5.4)

Trophic Modeling

- 2013 growth patterns of age-0 Chinook salmon; age-0 and 1 coho salmon similar to 1980s.
- More age-2 Chinook salmon present in age samples from 2013 than during 1980s.
- Age-0 Chinook Salmon and Coho Salmon, and Age-1 Coho Salmon grew larger in 2013 than in 2014. Age-0 Chinook Salmon and Age-1 Coho Salmon also differed in size among habitat types during 2014.

From bioenergetics model:

- In 2013, feeding rate was the primary factor limiting the growth of while temperature and food quality were secondary.
- Salmon that fed heavily on eggs had higher growth efficiency (consumed less energy per unit of growth).
- In 2014, feeding rate was a primary factor limiting the growth of juvenile Coho Salmon, and temperature and food quality were of secondary importance.
- In 2014, 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.

Summary of Results – Upper Tribs & Lakes

(SIR – Section 5.8)

Benthic Macroinvertebrates in Tributaries and Lakes above Devils Canyon

- Nine Tributaries: 45 Hess samples, 45 composited algae samples, and 18 drift samples, along with water quality grab samples.
- Three Lakes: 45 petite Ponar grab samples, nine D-net composite sweep samples, and 45 plankton tows, along with 21 water quality grab samples.
- *Run-off streams* – densities exceeded 5,000 individuals/m^2, with high diversity and high taxa richness. Drift densities were moderately high, but very diverse with high taxa richness. Algal growth was moderate.
- *Lake-influenced streams* – high densities (20,000 to >100,000 individuals/m^2), along with moderate to high diversity and taxa richness. Drift densities were highest in these streams, but with the lowest drift diversities and taxa richness. Algal growth on substrates was highest at the lake-influenced sites.
- *Glacially-influenced streams* – lowest mean density (1,360 individuals/m^2) and lower taxa richness, but EPT taxa richness comparable to those seen in the run-off streams. Drift densities were moderate, but very diverse with high taxa richness, especially with EPT taxa. Algal growth on substrates was low, likely due to the higher turbidity from the glacial silt.
- *Lakes* – most invertebrate production in the three lakes was within the euphotic zones, likely attributed to zooplankton in the water column, mostly early-instar copepods with a smaller percentage of cladocerans. Deep water substrates displayed low benthic densities (75 to 1,102 individuals/m^2) and low taxa richness, comprised mostly of chironomids and non-insects.

AEA Proposed Modifications - CLARIFICATION

(ISR Part D – Section 7)

ISR Part D Section 7.2 Clarification:

- AEA proposes to implement the modifications detailed in ISR Part D Section 7.1 in the next year of study.

AEA Proposed Modifications

(ISR Part D – Section 7.1)

- Carrying forward all 2013 variances reported and discussed within the ISR Part A, Section 4 and ISR Part C, Section 7.1.2. (and summarized in ISR Part D, Section 6.1). This modification was partially implemented in 2014, with the variances stated in ISR Part D, Section 6.2.
- A redesign of the adult insect emergence traps to provide increased floatation, and to improve anchoring and deployment methodology, thus minimizing losses and improving AEA's ability to evaluate insect emergence, as proposed in the ISR Part C, Section 7.1.2.1.
- Change colonization sampling to investigate the overall differences in colonization rates and compositions among the five macrohabitat types within sites, instead of by turbidity and temperature conditions. This modification was proposed in the ISR Part C, Section 7.1.2.6.
- Add an extra collection of six Hester-Dendy sampler sets at a main channel site at increasing depth increments to record the effects of stage changes and exposures along the main channel's fluctuating shoreline, deployed for 4-6 week periods over the open water period. This modification was proposed in the ISR Part C, Section 7.1.2.6.

Steps to Complete Study

(ISR Part D – Section 8)

1. Characterize the pre-Project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the Middle and Lower Susitna River (RSP Sections 9.8.4.2, 9.8.4.3, and 9.8.4.4) as modified in ISR Part C, Section 7.1.2.1.

2. Evaluate the suitability of using reference sites on the Talkeetna River (RSP 9.8.4.6), pursuant to a decision point based on 2013 results, as described in ISR Part C, Section 7.1.1. Should the decision be made to continue with an additional season of collections from the Talkeetna Station sites, the methods for sampling will be employed as described in the Study Plan, with modifications incorporating variances described in ISR Part A, Section 4.6.1. See ISR Part C, Section 7.1.2.3.

3. Develop habitat suitability criteria for Susitna benthic macroinvertebrate and algal habitats (RSP Section 9.8.4.10), with no modifications.

4. Characterize organic matter resources in the Middle and Lower Susitna River (RSP Section 9.8.4.12), with no modifications.

5. Estimate benthic macroinvertebrate colonization rates in the Middle Susitna River Segment under pre-Project baseline conditions (RSP Section 9.8.4.13) as modified in ISR Part C, Section 7.1.2.6.

Licensing Participants Proposed Modifications to Study 9.8?

- Agencies
- CIRWG members and Ahtna
- Public