Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Study of Fish Distribution and Abundance in the Upper Susitna River
Study Plan Section 9.5

Initial Study Report
Part A: Sections 1-6, 8-10

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO
Clean, reliable energy for the next 100 years.

Prepared by

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June 2014

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
ADF&G	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
APA	Alaska Power Authority
AWC	Anadromous Waters Catalog
CIRWG	Cook Inlet Regional Working Group
CPUE	catch per unit effort
ELH	early life history
FDA	Fish Distribution and Abundance
FERC	Federal Energy Regulatory Commission
FL	fork length
FWS	Fish and Wildlife Service
GIS	Geographic Information System
GPP	Gas-Powered Pulsator
GPS	global positioning system
ILP	Integrated Licensing Process
IP	Implementation Plan
ISR	Initial Study Report
JOA	Juvenile/Adult
JUV	juvenile
MC	main channel
N/A	Not applicable
NMFS	National Marine Fisheries Service
PIT	passive integrated transponders
PRM	Project River Mile
Project	Susitna-Watana Hydroelectric Project
RM	River mile
RSP	Revised Study Plan
RST	rotary screw traps
SPD	study plan determination
TWG	Technical Workgroup

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 Study of Fish Distribution and Abundance in the Upper Susitna River, Section 9.5. RSP Section 9.5 focuses on describing the current fish assemblage including spatial and temporal distribution, and relative abundance by species and life stage in the Susitna River upstream of the proposed Watana Dam.

On February 1, 2013, FERC staff issued its study determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. FERC requested additional information before issuing a SPD on the remaining studies. The Susitna River Fish Distribution and Abundance Implementation Plan (FDA IP) was filed with FERC on January 31, 2013 and was subsequently presented and discussed during a Technical Work Group (TWG) meeting on February 14, 2013. With consideration of the comment and suggestions received from licensing participants, a FDA IP was filed with FERC on March 1, 2013. On April 1, 2013 FERC issued its study determination (April 1 SPD) for the remaining 14 studies; approving 1 study as filed and 13 with modifications. RSP Section 9.5 was one of the 13 approved with modifications. In its April 1 SPD, FERC recommended the following:

Tributary Sampling Lengths

> *- We recommend that the sampling unit lengths for the seven accessible tributaries and four tributaries with unknown accessibility that would be subject to the GRTS sampling design, as specified in section 5.2 of the Implementation Plan, include the entire classified mesohabitat for those units less than 200 meters, 400 meters, or 800 meters in length (as proposed based on basin area) or sampling units of these lengths, whichever is smaller, rather than the proposed 40-meter subsample.*

Mainstem Sampling Lengths

> *- We recommend that sampling unit lengths for all main channel and side channel habitat units be equal to 20 times the wetted channel width of the habitat unit, the entire length of the habitat unit, or 500 meters, whichever is less.*
>
> *- We recommend that sampling unit lengths for all slough macrohabitats encompass the entire length of the slough, a distance equal to 20 times the wetted channel width of the slough, or 200 meters, whichever is less. We also recommend that slough sampling be initiated at the downstream end of the slough.*
>
> *- We recommend that, to the extent possible based on site-specific field conditions, AEA sample all main channel and side channel macrohabitat units with boat electrofishing methods.*

- We recommend that AEA's proposed tributary mouth sampling unit lengths include the backwater area within the tributary, if present, and extend a distance 200 meters downstream of the tributary mouth/confluence with the mainstem.

Sample Timing

- We recommend that the proposed summer sampling events be conducted in mid-July, and again in either late August or early September.

Catch Per Unit Effort Metrics

- We recommend that calculation of CPUE from electrofishing data be based only on the first pass, as requested by NMFS and FWS.

- We recommend that minnow traps be soaked for 24 hours and placed within locations most likely to capture fish (e.g., low-velocity habitat in close proximity to cover).

Outmigrant Trap Locations

- We recommend that AEA install and operate one additional outmigrant trap in the mainstem Susitna River, downstream of the mouth of Kosina Creek near the proposed dam site. The actual location should be selected after consultation with the TWG.

Resident Fish Radio Telemetry Tagging

- To the extent possible given the constraints of field sampling conditions, we recommend that AEA target its fish sampling to meet the following specific objectives: (1) a minimum of 10 tags per species be allocated for tagging adult grayling and rainbow trout of sufficient size for spawning at tributary mouths during the spring sampling event; (2) a minimum of 10 tags should be allocated for tagging adult Dolly Varden of sufficient size for spawning at tributary mouths during a late summer or early fall sampling event; (3) a minimum of 10 tags should be allocated for tagging adult whitefish prior to spawning in early September; and (4) a minimum of 10 tags should be allocated for tagging burbot in the early fall prior to fall or winter spawning migrations.

In accordance with the April 1 SPD, AEA has adopted the FERC requested modifications in the FDA IP and the Final Study Plan.

Following the first study season, FERC's regulations for the Integrated Licensing Process (ILP) require AEA to "prepare and file with the Commission an initial study report describing its overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)) This Initial Study Report on the Fish Distribution and Abundance in the Upper Susitna River Study has been prepared in accordance with FERC's ILP regulations and details AEA's status in implementing the study, as set forth in the FERC-approved RSP and as modified by FERC's April 1 SPD and FDA IP TM (collectively referred to herein as the "Study Plan").

2. STUDY OBJECTIVES

As established in RSP Section 9.5.1., specific objectives include the following:

1) Describe the seasonal distribution, relative abundance (as determined by catch per unit effort [CPUE], fish density, and counts), and fish-habitat associations of resident fishes, juvenile anadromous salmonids, and the freshwater life stages of non-salmon anadromous species.
2) Describe seasonal movements of juvenile salmonids and selected fish species such as rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Pacific lamprey, Arctic grayling and burbot within the hydrologic zone of influence upstream of the Project.
    a. Document the timing of downstream movement and catch using rotary screw traps.
    b. Describe seasonal movements using biotelemetry (passive integrated transponders [PIT] and radio-tags).
    c. Describe juvenile Chinook salmon movements.
3) Describe early life history of anadromous salmonids. Determine movement patterns and timing of juvenile salmonids from spawning to rearing habitats. (Note that this objective was not part of the Study Plan; it was added during implementation.)
4) Characterize the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type.
5) Determine whether Dolly Varden and humpback whitefish residing in the Upper River exhibit anadromous or resident life histories.
6) Determine baseline metal concentrations in fish tissues for resident fish species in the mainstem Susitna River (see RSP Section 5.5 Water Quality and Section 5.7, Mercury Assessment and Potential for Bioaccumulation Study).
7) Document the seasonal distribution, relative abundance, and habitat associations of invasive species (lake trout and northern pike).
8) Collect tissue samples to support the Genetic Baseline Study for Selected Fish Species (RSP Section 9.14).

3. STUDY AREA

As established by RSP Section 9.5.3, the study area encompasses the mainstem Susitna River and its tributaries from the proposed Watana Dam site (PRM 187.1) upstream to an including the Oshetna River (PRM 235.1) (Figure 3-1). The Upper Susitna River is delineated by the location of the proposed Watana Dam because effects of the Project are anticipated to be different upstream and downstream of the proposed dam. The mainstem Susitna River and its tributaries upstream of the proposed dam will be within the impoundment zone and subject to Project operations that affect daily, seasonal, and annual changes in pool elevation plus the effects of initial reservoir filling. Tributary surveys upstream of the proposed Watana Dam are further delineated by the 3,000-ft elevation contour, which is based on the known extent of juvenile Chinook salmon distribution. Some study components, such as resident fish life-history studies and juvenile Chinook salmon distribution sampling, may extend beyond the core area.

4. METHODS

This study employed a variety of field methods to build on the existing information related to the distribution and abundance of fish species in the Upper Susitna River consistent with the Study Plan except for specific variances as described below. The following sections provide brief descriptions of study site selection, sampling frequency, the approach, and suite of methods that were used to accomplish each objective of this study. This study was initiated in 2012 and will continue in the next year of study to meet study objectives.

Fish Distribution and Abundance Sampling Plan

A final sampling scheme was developed as part of the detailed Fish Distribution and Abundance Implementation Plan (IP), for ISR Studies 9.5 and 9.6. The IP included (1) a summary of relevant fisheries and an overview of the life history needs for fish species known to occur in the Susitna River to guide site selection and sampling protocols, (2) a review of the preliminary results of habitat characterization and mapping efforts in 2012 (Study 9.9), (3) a description of site selection and sampling protocols, (4) development of field data collection forms, (5) development of database templates that complied with 2012 AEA QA/QC procedures, and (6) the FERC requested modifications included in the April 1 SPD. The IP included the level of detail sufficient to instruct field crews in data collection efforts. In addition, the plan included protocols and a guide to the decision-making process in the form of a chart that was used in the field, specific sampling locations, details regarding the choice and use of sampling techniques and apparatuses, and a list of field equipment needed. The Implementation Plan addressed the random selection of sampling locations. The Implementation Plan outlined measures to ensure that fish collection efforts occurred in a consistent and repeatable fashion across field crews and river segments. Sampling methods by objective are presented below and in Table 2-1. Brief descriptions of each sampling technique are provided in Section 4.12.

4.1. Study Site Selection

AEA implemented site selection as described in the Study Plan with the exception of variances explained below (Section 4.1.6). The Upper Susitna River includes the area where the mainstem river will be inundated and tributaries will be partially altered. The sampling effort was tailored to collect information to document fish assemblages, distribution, and abundance generally within the mainstem river and more intensely within the tributary habitat to be inundated up to an elevation of 3,000 ft, which was based on the known upper extent of juvenile Chinook salmon distribution.

4.1.1. Early Life History Sites

Early life history (ELH) sampling was added to Upper River fish distribution sampling. The focus was to locate juvenile Chinook salmon in Upper River tributaries in June. A secondary objective was to investigate the outlet area of two lakes for the presence of juvenile sockeye salmon. Sites were selected in the field to represent geomorphic reaches within select tributaries based on the following criteria: 1) proximity to previously identified Chinook habitats; 2) proximity to lakes with potential sockeye spawning habitat; 3) helicopter access; 4) landowner permission; 5) suitable habitat for effective backpack electrofishing; and 6) accessibility and proximity to other mesohabitat types. A total of 41 mesohabitat units were sampled within 21 sites during the first sampling event (Figure 4.1-1).

A second sampling event was conducted in late June to replicate the first event by visiting the same locations and sampling the same mesohabitat units. However, substantially lower water made replication difficult and several macrohabitat units were replaced with similar nearby units during the second event. A total of 43 mesohabitat units were sampled within 20 sites during the second sampling event. .

4.1.2. Fish Distribution and Abundance Sampling Sites

4.1.2.1. Tributaries

All known Chinook salmon-bearing tributaries and other tributaries that are not currently listed in ADF&G's Anadromous Waters Catalog (AWC) in the Upper River, upstream of the proposed dam site (PRM 187.1) were incorporated into the site selection process for fish distribution and abundance sampling (ADF&G 2012). Initially 13 Upper River tributary streams were selected for sampling based on: AWC catalog listings, drainage basin, historical sampling efforts, and the potential for impact or inundation from the proposed Project (Figure 4.1-2). These tributaries were screened for sampling accessibility based on stream gradient, channel morphology (i.e., confined canyon), mesohabitat type (e.g. rapid and cascade) and physical access. The screening resulted in seven tributaries known to be accessible or to have substantial lengths of accessible reaches, two tributaries that were largely inaccessible, and four tributaries where access was unknown (Table 4.1-1).

The accessible portion of each selected tributary up to the 3,000-ft (914 m) elevation contour was divided into units of equal length based on channel width and drainage basin area. Large tributary streams with drainage basins greater than 1,000 km^2 (386 mi^2) and with channel widths of 35 to 45 m (115-148 ft) were assigned 800 m (2,625 ft) sampling units. Tributaries with drainage areas ranging from 300 to 1,000 km^2 (115 to 386 mi^2) and with channel widths of 15 to 35 m (49 to 115 ft) were assigned 400 m (1,312 ft) sampling units. Tributaries draining less than 300 km^2 (115 mi^2) and with channel widths of 5 to 15 m (16 to 49 ft) were assigned 200 m (656 ft) units. Sampling unit lengths for each of the selected tributaries are shown in Table 4.1-1. Within each tributary, the target for total length sampled was up to 25 percent of the length of the accessible portion of the tributary from the mouth upstream to the location of 3,000 ft (914 m) elevation contour. This target was dependent upon documentation of Chinook salmon presence in the tributary watershed (Table 4.1-2). In tributaries without Chinook salmon present the target for total sample length was 15 percent..

The seven accessible or partially accessible tributaries and the four tributaries where access conditions were unknown were subjected to a statistical sampling design. A generalized random tessellation stratified (GRTS) sampling method was used to select study units within each tributary (Stevens and Olsen 2004). Specifically, the *grts* routine in package *spsurvey* (Kincaid and Olsen 2012) for R (R Core Team 2012) was used to generate the GRTS samples. This sampling method is a compromise between random and systematic sampling that allows random ordering of population units with spatial balance. Using the GRTS samples, oversampling (e.g., selecting 10 samples but planning to use only the first 3) is allowed; thus, when units were determined to be inaccessible in the field, the next unit on the randomized list was used while maintaining spatial balance in the final sample set.

For each selected tributary, the sample size was based on the targeted percent coverage of the accessible population for distribution sampling (Table 4.1-1) and 10 percent coverage for abundance sampling. For example, if there were 100 population units on a given tributary, 25 were selected for distribution sampling, and the first 10 of these would also be used for relative abundance sampling. There was a minimum sample size of three units for abundance sampling in each tributary. The remaining population units (75 percent) were termed oversample sites and retained as back-up sample sites in the event that a site was unable to be sampled.

Oversamples were used a total of 13 times in cases when the initially selected site occurred on private lands that could not be accessed, when no landing zones were available near the site, or when site conditions were unsafe for sampling. Twenty out of the 101 sample sites selected were not sampled in 2013 because of a lack of suitable landing zone and no available oversample site as all proximate oversample sites had been previously selected. These included Unnamed Tributary 197.7 (6 Sites) and Unnamed Tributary 204.3 (3 Sites), Unnamed Tributary 206.3 (4 Sites), Unnamed Tributary 206.3 (3 Sites) and Watana Creek (4 Sites).

Within each GRTS study unit, one unit of each available mesohabitat type was randomly selected for sampling. Study units evaluated for mesohabitats were 200 m (656 ft), 400 m (1,312 ft), or 800 m (2625 ft) in length (as proposed based on basin area). Sampling units within study GRTS units were either the complete mesohabitat unit length or 200 m (656 ft) per mesohabitat type per site, whichever was shorter.

After video and field reconnaissance, a total of 81 Upper River tributary sites were selected and sampled using the GRTS selection method (Table 4.1-2). This included 44 and 37 sites where distribution and relative abundance sampling took place respectively. The 81 sampling sites were further delineated into 151 mesohabitat units (e.g. pool, riffle, glide) for gear selection and fish habitat association purposes (Table 4.1-2). A target of three and a minimum of two gear types were used for sampling each mesohabitat unit to capture a variety of fish species, sizes, and life stages. Maps showing the final sample locations are provided for Watana Creek, Watana

Creek Tributary, Unnamed Tributary 197.7, and Unnamed Tributary 194.8 (Figure 4.1-3); Unnamed Tributary 204.3, Unnamed Tributary 206.3, Kosina Creek, and Tsisi Creek (Figure 4.1-4); and the Oshetna River, Black River and Goose Creek (Figure 4.1-5).

A direct sampling methodology was implemented on the two tributary streams (Jay and Deadman Creeks) with minimal to moderate access and limited feasible sampling areas (Table 4.1-2; Figure 4.1-2). Following reconnaissance, an average of two days of sampling effort was conducted in Jay Creek; Deadman Creek could not be accessed (Table 4.1-3). Two locations were sampled in Jay Creek (Table 4.1-3), representing differences in elevation or other habitat features. Effort at each sampling unit was considered complete when the field lead judged that the unit was sufficiently represented or that additional sampling effort would not provide additional information.

4.1.2.2. Mainstem

Fish distribution and relative abundance sampling in the Upper Susitna River mainstem was conducted from the proposed dam site (PRM 187.1) upstream to the Oshetna River confluence (PRM 235.1). This survey area included Geomorphic Reaches UR-3 (PRM 234.5-224.9), UR-4 (PRM 224.9-208.1), UR-5 (PRM 208.1-203.4), and UR-6 (PRM 203.4-187.1). Due to channel morphology in the Upper River and corresponding limitations of habitat mapping therein, a systematic transect approach was adopted whereby fish sampling sites were selected within habitat units encountered along transects. Using a random start for the Upper River study area, 20 transects were equally spaced every 3.9 km (2.4 mi) (Figure 4.1-6). Following ground-level reconnaissance, 4 of the 20 transects were not sampled due to land access and safety issues (Table 4.1-4).

Some Upper River transects spanned multiple habitat types (e.g., main channel, side channel, upland slough, and side slough). When multiple habitat types were encountered, one habitat unit of each type was selected along each transect. When multiple habitat units of the same type were present, units were randomized and one was selected for sampling. One transect per geomorphic reach was selected for relative abundance sampling, for a total of four relative abundance transects. The remaining transects were sampled for distribution only (e.g., no block nets, single pass sampling).

Main and side channel habitats were sampled with boat electrofishing whenever site conditions and permit stipulations allowed (conductivity, visibility, and absence of adult salmonids). The sampling length for all mainstem habitat units sampled using boat electrofishing was equal to 20 times the wetted channel width of the habitat unit, the entire length of the habitat unit, or 500 m (1,640 ft), whichever was less. When site conditions did not allow for boat electrofishing, 200 m (328 ft) were sampled using wadeable sampling techniques parallel to the bank. The sampling unit length for all upland and side slough habitat units was 20 times the wetted channel width of the habitat unit, the entire length of the habitat unit, or 200 m (656 ft), whichever was less. If the randomly selected habitat unit was totally inaccessible to field crews, then a second randomly selected habitat unit was sampled.

4.1.3. Rotary Screw Trap Sites

Final site selection for Upper River rotary screw traps used the following criteria: 1) a position downstream of documented Chinook salmon; 2) landowner permission to access; 3) accessibility by helicopter; 4) a minimum depth of 1.25 m (4.1 ft) during low flow periods; and 5) consistent laminar flow with velocities in the range of 0.6 to 2 m/s (2 to 6.6 ft/s). Site reconnaissance included review of aerial videography from summer 2012, a pre-bank-ice break-up site visit to a short list of locations on May 24, and a final pre-installation site visit on June 7. For the Oshetna River, a location just upstream of the confluence with the Susitna River (PRM 235.1) at Oshetna RM 0.1 was selected (Figure 4.1-7). This location is downstream of the only documented observation of juvenile Chinook in the Oshetna basin at a side channel near Oshetna RM 1.7 (Buckwalter 2011). A second rotary screw trap site was selected on Kosina Creek near RM 2.2. This location was downstream of the Tsisi and Kosina Creeks confluence where Chinook salmon spawning has been documented upstream (HDR 2013).

4.1.4. PIT Interrogation Antenna Sites

PIT tag antenna interrogation sites were determined using the following criteria: 1) a location downstream of documented Chinook salmon, 2) landowner permission to access, 3) helicopter accessibility, 4) a maximum depth of around 0.5 m (1.64 ft), and 5) lower velocity areas where installation and maintenance could be done safely under a range of flow conditions.

In the Oshetna River, site selection focused on locations as near to the Susitna River confluence as possible. A side channel near RM 1.9 along the left bank (facing downstream) was initially selected that could be monitored across its full width and in which Buckwalter (2011) had documented juvenile Chinook salmon. However, water levels dropped upon returning to this location and the continued reductions in flow expected through the summer would limit fish use of this feature. Instead, a site at the head of a side channel along the left bank near Oshetna RM 4.5 was chosen. A 60-ft antenna was installed on June 19, 2013 at the head of the side channel and then rotated out into the main channel as side channel flow decreased during the season (Figure 4.1-7).

The area of Kosina Creek near the Tsisi Creek confluence was generally high energy with abundant boulder substrates, which can confound the effective installation of an antenna. During the reconnaissance survey, areas where an antenna would capture a substantial portion of the channel had water depths and velocities that precluded wading and antenna installation. The lower portion of Tsisi Creek was also investigated but had the same limitations. Areas of Kosina Creek upstream of the Tsisi Creek confluence were found to have a lower gradient more suitable for antenna installation. However, the channel was substantially broader (greater than 300 ft) and an antenna along the channel margin here could only cover an inconsequential portion of the channel with minimal detection efficiency. Sites lower in Kosina Creek were investigated and the side channels near the Susitna River confluence were found to have conditions more suitable for antenna installation. Full coverage of a side channel increased detection probabilities by confining fish movements within a closed channel. Likewise, installing an antenna lower in the tributary (RM 0.2) increased the number of fish moving past the antenna to or from the Susitna River. A 5 x 1.5 m (16 x 4.9 ft) swim-though type antenna was installed in a Kosina side channel on June 18, 2013. This location and antenna style were selected for robust operation over a range of flow conditions downstream of documented Chinook spawning location (Link et al. 2013).

4.1.5. Fixed Radio Telemetry Sites

Three fixed radio telemetry stations were installed in the Upper Susitna River. Stations at the mouths of Kosina Creek (PRM 209.1) and the Oshetna River (PRM 235.1) monitored the movement of radio-tagged fish in the mainstem Susitna River as well as in their respective tributaries. The Deadman station (PRM 191.2) was located on the north bank of the Susitna River between Deadman and Watana creeks and monitored the movement of fish in the mainstem of the Susitna River (Figure 4.1-7).

4.1.6. Variances from the Study Plan

4.1.6.1. Fish Distribution and Abundance Sites

4.1.6.1.1. Sampling Unit Length

Fish distribution and abundance sampling units were sampled at lengths of 500 m (0.3 mi) when boat electrofishing was feasible as recommended the in April 1, 2013 Study Plan Determination and outlined in the Implementation Plan (IP Section 5.4). However, the level of effort required to effectively cover and gather a representative sample in long units, using other techniques including backpack electrofishing, snorkeling, minnow trapping, and seining, was deemed incompatible with the seasonal sampling goals and the number of sites targeted for sampling given the remoteness of the sampling locations. Therefore, when boat electrofishing was not feasible, sampling units were shortened to either the complete mesohabitat unit or 200 m (656 ft) per mesohabitat type per site, whichever was shorter.

4.1.6.1.2. Site Access Issues

The lower reaches of tributaries of the Upper Susitna River are typified by high gradient, confined canyons, with dense vegetation. These conditions, particularly in the smaller tributaries, limited helicopter access. Other factors that influenced sampling locations included dangerous sampling conditions (high water, high wind, and icy conditions) and dry target sites.

Land ownership and accessibility influenced fish sampling in discrete areas of the Upper River. Upper River tributary sites on Cook Inlet Regional Working Group (CIRWG) land were restricted from access; this included an area from the proposed dam site (PRM 187.1) to PRM 198.7 (right bank) and 204.9 (left bank) and directly impacted sampling Unnamed Tributaries 197.7 and 204.5.

Prior to sampling in July, the 121 target sites (101 GRTS selected tributary sites: IP Section 4.4.1; 20 Upper River mainstem transects: IP 4.4.2) and 2 direct sample tributaries were visited and assessed for safety. Following the reconnaissance visit, 13 target GRTS sites deemed not conducive to sampling were replaced, consistent with GRTS protocol. Sampling took place at 81 GRTS selected tributary sites, 1 direct sample tributary, and 16 Upper River mainstem transects for a total of 97 target sites. Of the 33 GRTS tributary sites that were not sampled or replaced with oversamples; 24 (73 percent) had no safe landing zone in the vicinity, 7 (21 percent) were located on CIRWG land where access was not permitted, and 2 (6 percent) were deemed to have dangerous sampling conditions. During each seasonal sampling event, two days of sampling effort were applied to Jay Creek, the accessible direct sampling tributary. Deadman Creek could not be sampled due to CIRWG land in the lower reaches and a lack of safe landing zones in upper reaches. A total of 16 Upper River mainstem transects were sampled; three transects were deemed to be unsafe for sampling efforts due to swift water and boulder gardens in constricted canyons and one transect could not be accessed for sampling due to CIRWG land extending to the water's edge.

4.1.6.2. Rotary Screw Traps

The inability to access areas above ordinary high water mark along CIRWG land restricted the placement of rotary screw traps (IP Section 5.7.1) and fixed radio receivers (IP Section 5.8.2.1) in the Upper River to locations on State of Alaska or Federal land. A third rotary screw trap could not be cited near the proposed dam site as recommend in the April 1, FERC SPD (B-134). Rotary screw traps were fished near the mouths of the only two known Upper River tributaries that support Chinook salmon, Kosina Creek and the Oshetna River.

4.1.6.3. PIT tag interrogation system

The IP proposed that two stationary PIT tag interrogation systems would be installed in tributaries to the Upper River mainstem, specifically in the Oshetna River near its confluence with the Susitna River and in Kosina Creek at the confluence with Tsisi Creek. A reconnaissance survey was conducted on June 11, 2013 to determine the feasibility of installing PIT antennas at these two sites and to identify alternative sites if necessary. The mainstem channels of both the Oshetna River and Kosina Creek were found to be too wide, typically greater than 61 m (200 ft) for installing antennas that would span the entire channel. Thus, alternate sites were investigated where channel margin or side channel antennas would be feasible and the likelihood of detecting tagged fish moving past the site would be maximized given the size constraints of PIT antenna technology.

4.1.6.4. Radio Telemetry Fixed Receivers

Section 5.8.2.1 of the Implementation Plan included information on proposed fixed-station receiver sites for the Salmon Escapement Study will be operated at ten strategic locations in the Middle and Upper River including: Lane Creek Station (PRM 116.7), Gateway (PRM 130.1), Fourth of July Creek (PRM 134.3), Indian River (PRM 142.1), Slough 21 (Approximately PRM 144), Portage Creek (PRM 152.3), Cheechako Station (RM 152.4), the Chinook Creek confluence (PRM 160.5), Devils Station (PRM 166.9, located upstream of the Devils Creek confluence), and the Kosina Creek confluence (PRM 209.2). The locations for the eight proposed resident fish stations are included in Figure 5.6-1 and include: Montana Creek confluence (PRM 80.1), Whiskers Creek confluence (PRM 105.1), Indian River confluence (PRM 142.1), Portage Creek confluence (PRM 152.3), Fog Creek confluence (PRM 179.3), Watana dam site (PRM 187.1), Watana Creek confluence (PRM 196.9), and Oshetna River confluence (PRM 235.1). However, the lack of access to Cook Inlet Region Village Corporation land necessitated a number of changes from the Study Plan in regard to the quantity and location of telemetry fixed stations in the Upper River during 2013. Fixed stations planned for the

Watana Dam Site and the mouth of Watana Creek were not installed due to the lack of land access. To gather radio tag detections in this area, a fixed receiver was installed on the bluff on the north side of the Susitna River between Deadman and Watana creeks.

4.2. Sampling Frequency

Sampling frequency varied among sites based on study objectives. Generally, sampling occurred seasonally during the ice-free period. Breakup in 2013 was unusually late across Southcentral and Interior Alaska. Sustained record-cold weather in April and May prevented substantial snowmelt or ice decay until late May, several weeks after breakup is typically over in the region (ISR Study 7.6). Ice breakup activity was concentrated between May 25 and May 29 and the Susitna River at Gold Creek was above flood stage from May 28 to June 4, 2013. Bi-weekly early life history sampling was initiated shortly after ice-out out and continued through June in an attempt to capture critical juvenile Chinook salmon out-migration from natal tributaries to rearing habitats (Table 4.2-1). Fish distribution and abundance sampling was conducted in three seasonal blocks in 2013: July 13 to August 11, August 12 to September 9, and September 10 to October 4. PIT tag interrogation antennas were installed on June 18 and 19, 2013 in the Oshetna River and Kosina Creek and were operated nearly continuously until October 8 (Figure 4.2-1). Installation of rotary screw traps took place between June 12 and14 at Kosina Creek (RM 2.2) and on June 14 at the Oshetna River (RM 0.1). Rotary screw traps were then operated on a 48-hours-on/72-hours-off schedule until the rivers began to freeze up and the traps were removed on October 3 and October 9, 2013 (Figure 4.2-2). Stationary radio receivers were installed at the Deadman Creek, Kosina Creek, and Oshetna River sites between June 29 and July 2 (Table 4.2-2). Fixed radio telemetry monitoring efficiency was tested on a weekly basis (Table 4.2-3). Aerial surveys were conducted approximately weekly between July 2 and October 7 (Table 4.2-4) and continued monthly thereafter. The monthly schedule is planned to continue through April 2014.

4.2.1. Variances from the Study Plan

The applicant accepted and followed the FERC recommendation of sampling in mid-July and late August/early September and added an additional fall sampling effort in late September/early October. Additional sampling for early life history was also added in June.

4.3. Fish Sampling Approach

The initial task of this study, included in the Implementation Plan, consisted of a focused literature review to guide selection of appropriate sampling methods. Products from the literature review included the following:

- A synthesis of existing information on life history, spatial and temporal distribution, and relative abundance by species and life stage.
- A review of sampling strategies, methods, and procedures used in the 1980s fish studies.
- Periodicity charts for each species within the study area (timing of adult migration, holding, and spawning; timing of incubation, rearing, and out-migration).

- A summary of mainstem Susitna River habitat utilization for each species, by riverine habitat type (main channel, side channel, side slough, upland slough, tributary mouth, tributary).
- A summary of existing age, size, and genetics information.
- A summary of distribution of invasive species, such as northern pike.

The fish sampling techniques selected depended on habitat characteristics, season, and the species or life history of interest. A summary of relevant existing fish and aquatic habitat information collected in the Susitna River study area was provided in the Implementation Plan. The literature review focused on five study topics: (1) resident and juvenile fish distribution and abundance in the Upper Susitna River (1980s and 2012); (2) adult salmon escapement and distribution (1980s and 2012); (3) salmon and trout incubation and emergence (1980s); (4) aquatic habitat delineation (2012); and (5) open-water flow routing modeling (2012). Although an abundance of data had been collected, the 1980s information summarized was selected primarily to guide site selection and sampling techniques for the Study of Fish Distribution and Abundance in the Upper River.

4.4. Objective 1: Fish Distribution, Relative Abundance, and Habitat Associations

AEA implemented the methods as described in the Study Plan with the exception of variances explained below (Section 4.4.4). Two general approaches to fish sampling were used. The first focused on gathering data on general fish distribution (presence). This sampling involved a single pass with appropriate gear types without using block nets. To the extent possible, transects were standardized and the methods were repeated during each sampling event to evaluate temporal changes in fish distribution. The second sampling approach was to gather data on relative abundance as determined by CPUE and density; complementary data on fish size, age, and condition factor were also collected. The transects and fish capture methods (e.g., number of passes, amount of soak time, use of block nets when feasible) were standardized such that they were repeatable on subsequent sampling occasions. This approach also emphasized the identification of foraging and spawning habitats.

4.4.1. Task A: Fish Distribution Surveys

4.4.1.1. Field Methods

Fish distribution surveys included seasonal sampling events during the ice-free seasons. Methods were selected based on target species, life stages, and water conditions. Snorkeling and electrofishing were preferred methods for juvenile fishes in clear water areas where velocities were safe. Minnow traps, beach seines, set nets, and fyke nets were employed as alternatives in deeper waters and in habitats with limited access, low visibility, or high velocities. For larger fishes, gillnets, seines, trotlines, hoop traps, and angling were used. Whereas snorkeling, minnow trapping, backpack electrofishing, and beach seines were applicable to sloughs and other slow-moving waters, gillnetting, boat electrofishing, hoop traps, and trot lines were more applicable to the mainstem. The decisions about what methods to apply were made by field crews based on Appendix 3 of the Fish Distribution Abundance Implementation Plan (Gear Selection) after initial site selection in coordination with Fish Distribution and Abundance Study Lead and the Fish Program Lead and in accordance with state and federal fish sampling permit requirements.

4.4.1.2. Analytical Methods

For the purposes of describing juvenile salmon and resident fish distribution in the Upper River, locations where species were documented during the various study components of this study were pooled with other available information from 2012 and 2013 AEA fish studies. The list of data sources included: early life history sampling, rotary screw trapping, fish distribution and abundance sampling, PIT array detections, resident fish radio-telemetry detections, directed fish sampling efforts for interrelated studies, genetics sampling efforts (ISR Study 9.14), and metal/mercury sampling efforts (ISR Study 5.5). The 2013 data for fish distribution was pooled with 2012 fish distribution data (HDR 2013).

To describe seasonal distribution, fish collections were then assigned the following seasons: Salmon Early Life History (June 4 to June 30), Early Summer (July 1 to August 10), Late Summer (August 11 to September 9), and Fall (September 10 to October 7).

4.4.2. Task B: Relative Abundance

4.4.2.1. Field Methods

Relative abundance surveys included seasonal sampling events during the ice-free season. As described above, methods were selected based on target species, life stage, and water conditions. All methods were conducted with a level of effort consistent with generating estimates of CPUE that facilitated comparison of counts or densities of fish over space and time. This included calibration and quality control of methods and documentation of conditions that affected sampling efficiency, such as visibility, water temperature, and conductivity, to ensure that consistent effort was applied within and among sampling units and events.

4.4.2.2. Analytical Methods

Sites identified as distribution sampling and relative abundance sampling were combined for estimates of CPUE because multiple pass sampling was not employed for relative abundance. This resulted in a larger overall sample size for estimating relative abundance. The approach used to estimate CPUE was generally similar among the three types of relative abundance protocols in the Upper River (i.e., GRTS tributaries, direct-sampling tributaries, and mainstem transects). For GRTS tributary sampling, CPUE was calculated specific to each mesohabitat type present within a given GRTS segment and then averaged among segments to derive a representative CPUE value for each mesohabitat type within each GRTS tributary. Estimates derived for direct sampling tributaries were obtained in the same fashion, except estimates were averaged across direct sample sites, instead of GRTS segments, for each tributary. Mainstem CPUE estimates were derived for each mesohabitat type within a macrohabitat unit and then averaged among macrohabitat units within each mainstem geomorphic reach. Although the sampling design for the Upper River mainstem did not distinguish between various main channel types (i.e., main channel, split main channel, and multiple split main channel), average CPUE estimates for the main channel macrohabitat types have been generated at this finer level of classification. When sampling within a GRTS segment, a direct sampling site, or a mainstem macrohabitat site included multiple mesohabitat units of the same type (e.g., two distinct pools), catch and effort were summed at the mesohabitat level prior to averaging. In all cases, estimates were derived specific to the each of the three Fish Distribution and Abundance sampling events (i.e., early summer, late summer, and fall).

Although CPUE estimates were derived in a similar manner across the three types of relative abundance sampling in the Upper River study area, it is important to note that these study components had different study designs and utilized different site selection processes. Therefore, caution should be used when making quantitative comparisons among areas where different protocols were used. Tributaries sampled in the Upper River study area were non-randomly selected and thus should not be used to draw inferences about other Upper River tributaries. Furthermore, unlike the GRTS sampling design, direct sampling sites were not randomly selected with a tributary, and therefore, the relevance of the averaged CPUE estimates to the unsampled portions of a direct sample tributary is unknown.

Gear-specific CPUE estimates were derived for each species, as well as Pacific salmonid life stages. For the purposes of this draft ISR, the four gear types used to determine CPUE included: backpack electrofishing, boat electrofishing, seining, and snorkeling. For backpack and boat electrofishing, CPUE was estimated as the number of fish captured per hour of electrofishing pulse time. Snorkeling and seining CPUE estimates were standardized as the number of fish captured or observed per 1,000 m^2 sampled. Additional details regarding CPUE calculations and associated gear-specific sample sizes can be found in Appendix D.

4.4.3. Task C: Fish-Habitat Associations

In conjunction with Tasks A and B, data was collected for fish distribution and abundance by macro and mesohabitat type.

4.4.4. Variances from Study Plan

4.4.4.1. Sampling Approach

In the Revised Study Plan (Section 9.5.4.3.1), the applicant proposed that relative abundance sampling would include multiple pass sampling when electrofishing, snorkeling, and minnow trapping were employed. However due to ADF&G permit stipulations limiting electrofishing efforts to one pass, the April 1 FERC SPD recommendation that minnow traps be set for 24 hours, and the extensive level of effort involved in three pass snorkeling 200 m (656 ft) sampling units, multiple pass sampling for relative abundance was abandoned.

Study teams experimented with comparing three-pass depletion minnow trapping to 24-hour sets for relative abundance sampling during the July sampling event and found the level of effort required to return to sites to check and re-bait traps impeded the progress of sampling. Ultimately the FERC recommendation of 24-hour or overnight soaks was adopted.

The FERC Study Plan Determination recommended placing minnow traps at a density of 20 traps per 200 m (656 ft) of habitat sampled and placing traps strategically in places most likely to catch fish. However, due to limited helicopter capacity and the need to carry many gear types, it was not feasible to transport the volume of minnow traps required to meet the FERC SPD trapping density; on average this would have required each crew to carry approximately 60 traps. Instead, one to fifteen (generally 2 to 6, median =3) minnow traps were placed in each mesohabitat appropriate for minnow trapping in areas most likely to catch fish. Because of the high gradient nature of the Upper Susitna River the most common mesohabitats (boulder riffle and riffle) were only marginally suitable for minnow trapping in pocketwater. The lower density of minnow trapping in the Upper River study may impact AEA's ability to meet the stated fish relative abundance study objectives for fish species generally susceptible to this gear type. However, because multiple gear types were used at each site, it is anticipated that another type may be used for analysis, in which case, low density minnow trapping would not impact AEA's ability to meet the study objectives.

Block nets were not used in Upper River sampling because habitats were not appropriate for use. The lack of block netting may result in some fish being disturbed and moving between mesohabitats during sampling; however this is not anticipated to impact AEA's ability to meet the stated study objective for fish habitat associations.

To streamline sampling, after initial sampling with varying soak times for different gear types, fyke net and hoop trap soak times were adjusted to a sampling regime that matched that of minnow trapping: a 24-hour overnight soak. Standardization of fyke net and hoop trap soak times to an overnight soak is common practice and did not impact AEA's ability to meet the stated study objective.

In Appendix 3 of the Implementation Plan, Protocol for Site-Specific Gear Type Selection, AEA recommended that three or more sampling techniques be used at each site, but a minimum of two sampling techniques were to be attempted per habitat (or mesohabitat) type. However, during implementation there were times (approximately 4 percent of mesohabitats) when only one sampling technique was used in a habitat (or mesohabitat) unit. This occurred in habitats that were not conducive to multiple sampling techniques (e.g. very shallow, high velocity riffles were only backpack electrofished). The decision to use applicable methods was made in the field based on site conditions while using the Gear Selection Appendix as a guide. This meant that sampling techniques were not forced into habitat where they would not be effective (e.g., placing baited minnow traps where the velocity was too high). This adjustment did not compromise AEA's ability to meet study objectives.

4.4.4.2. Use of sonar

Although sonar was used as part of the escapement study, DIDSON and video cameras were not employed as techniques for sampling juvenile anadromous or resident fish in the Upper River during ice-free sampling period as proposed in the RSP (Section 9.5.4.4). Underwater video was used occasionally during snorkel surveys to document and corroborate species identification. The lack of sonar as a fish sampling technique did not impact AEA's ability to meet the stated study objective.

4.5. Objective 2: Seasonal Movements

AEA implemented the methods for Objective 2 as described in the Study Plan with the exception of the variances explained in Section 4.5.4.

4.5.1. Task A: Document the timing of downstream movement and catch for all fish species using out-migrant traps.

As described in Section 4.1.3 and Section 4.2, two rotary screw traps were deployed in the Upper River study area shortly after ice break-up. In addition to collecting data on migratory timing, size-at-migration, and growth, rotary screw traps also served as a source of juvenile fish to PIT tag (Objective 2, Task B), a way to recapture previously PIT-tagged fish, collect fish for radio tagging (Objective 2, Task B), collect fish for stomach contents analysis in support of the River Productivity Study (ISR Study 9.8), and collect tissue samples (Objectives 4,5 & 7) to support other studies including the Genetic Baseline Study for Selected Fish Species (ISR Study 9.14).

4.5.2. Task B: Describe seasonal movements using biotelemetry.

Biotelemetry techniques included radio telemetry and Passive Integrated Transponder (PIT) technology. Half duplex PIT tags (12 and 23 mm [0.5 to 0.9 in]) were surgically implanted in fish greater than 60 mm (2.4 in) to monitor movement and growth. Fish for PIT tagging were captured opportunistically during fish distribution and abundance sampling, targeted sampling for juvenile Chinook salmon, and with rotary screw traps.

PIT Tagging in the Upper River was focused in proximity to array antennas and included the Oshetna, Black, Goose, Jay, and Kosina drainages as well as the mainstem Susitna between PRMs 200 and 235.1 (Figures 4.5-1 and 4.5-2). Target species for PIT tagging included juvenile anadromous salmon, Arctic grayling, Arctic lamprey, burbot, Dolly Varden, northern pike, rainbow trout, humpback whitefish, and round whitefish. Of these species juvenile Chinook salmon, Arctic grayling, burbot, Dolly Varden, humpback whitefish, and round whitefish were present and PIT tagged in the Upper River Study area (Table 4.5-1). Because many species are rare or present in low abundance in the Upper River, progress towards PIT tagging goals was below the maximum target of 1,000 tagged fish of each species per array for all species except Arctic grayling. Recaptured fish provided information on the time and distance travelled since the fish was last handled and growth. PIT tag antenna arrays with automated data logging were installed and operated on a side channel of Kosina Creek RM 0.2 and a side/partial main channel of the Oshetna River RM 4.5 (Figures 4.5-3 and 4.5-4).

For radio telemetry, AEA targeted Arctic grayling, burbot, Dolly Varden, lake trout, longnose sucker, rainbow trout, humpback whitefish, round whitefish, and northern pike when present (Table 5.4-2). Several target species were rare or absent from the Upper River study area including humpback whitefish, lake trout, rainbow trout and northern pike. One juvenile lake trout and 12 humpback whitefish were captured during FDA sampling. Most of the humpback whitefish of taggable size were captured during installation and testing of the Oshetna rotary screw trap in June before tag implantation had begun. Of the remaining species that were more common in the study area, the tagging goal (30) for Arctic grayling was exceeded (57); numbers for round whitefish were over halfway towards the goal (18), while burbot (7) and longnose suckers (10) were difficult to acquire for tagging (Table 4.5-2). Radio transmitters were surgically implanted in adult fish of sufficient body size distributed temporally and longitudinally in the Upper River to monitor movement patterns (Table 4.5-1). Radio-tagged fish were tracked from July through October 7, 2013 with weekly aerial surveys in conjunction with the Salmon Escapement Study (ISR Study 9.7) to describe seasonal movements within the hydrologic zone of influence upstream of the Project (Table 4.2-4). Aerial surveys were partitioned into mainstem Susitna and tributary zones (ISR Study 9.6, Appendix B, Figure B20).

4.5.3. Task C: Describe juvenile Chinook salmon movements.

Juvenile Chinook salmon movement within the Upper River was described using the rotary screw traps and biotelemetry methods outlined in Objective 2, Tasks A and B. All juvenile Chinook salmon greater than 60 mm (2.4 in) in length were evaluated for PIT tagging. Fish deemed to be taggable based on size and condition were implanted with a PIT tag to document seasonal movement using antenna arrays placed in tributary mouths and side channels and rotary screw traps. Rotary screw traps were also used to document juvenile Chinook salmon migratory timing and size-at-migration from natal tributaries.

4.5.4. Variances from Study Plan

4.5.4.1. Evaluation of PIT tag interrogation system Detection Efficiencies

The IP (Section 5.6.2) proposed that the detection efficiency of PIT tag interrogation systems be determined using indirect methods as described by Connolly et al. (2008). This approach relies on the detection of fish at multiple locations (i.e., antennas located upstream and downstream) to identify missed detections of fish passing a given antenna. However, the limited availability of appropriate sites for antenna installation in 2013 precluded this approach because antenna sites could not be arranged in a longitudinal series; instead antennas were installed at a single site within a given tributary or slough. Handheld detections of fish upstream or downstream of a given PIT tag antenna during initial tagging and following recapture by rotary screw trap, electrofishing, or other methods provided some indication of the detection efficiency of each antenna. Whether the number of such recaptures was adequate to estimate detection efficiencies will be determined during analysis during the next year of study and presented in the Updated Study Report (USR).

As an alternative approach for estimating detection efficiency, AEA measured the read range of each antenna for each tag size. This information, combined with the antenna dimensions, water depth over the antenna (for a swim-over configuration), and wetted channel width was used to estimate the percentage of the channel's cross-sectional area in which a tag would be detected. This information was routinely recorded during site visits to download data. This approach did not account for behavioral factors that could influence detection, such as fish position relative to the channel bottom or margins, or swimming speed relative to the antenna. Nonetheless, this approach offered a means of quantifying the probability of a fish being detected as it moved past an antenna.

In addition, detection efficiencies were evaluated by drifting neutrally buoyant test tags past an antenna and calculating the percentage of tags that were detected. Again, this approach did not account for behavioral factors that would influence detection, but it did offer an additional means of estimating the probability of detection. This effort occurred during site visits to demobilize and winterize antennas in October 2013.

4.5.4.2. Radio Tagging Targets

The following FERC recommendation (B-135) was not adopted by AEA:

> "To the extent possible given the constraints of field sampling conditions, we recommend that AEA target its fish sampling to meet the following specific objectives: (1) a minimum of 10 tags per species be allocated for tagging adult grayling and rainbow trout of sufficient size for spawning at tributary mouths during the spring sampling event; (2) a minimum of 10 tags should be allocated for tagging adult Dolly Varden of sufficient size for spawning at tributary mouths during a late summer or early fall sampling event; (3) a minimum of 10 tags should be allocated for tagging adult whitefish prior to spawning in early September; and (4) a minimum of 10 tags should be allocated for tagging burbot in the early fall prior to fall or winter spawning migrations."

The FERC-recommended approach targets fish when they will potentially be at a phase of their life history (pre-spawning development) when they are more energetically taxed (as a result of limited food availability during the winter months) and potentially more sensitive to the stresses associated with handling. In particular, rainbow trout and Arctic grayling spawn in the early spring, and allocate the majority of their pre-winter energetic gain toward development of gametes. They have limited energy reserves remaining for metabolic processes in the spring. Further, sexually maturing fish have less space in their abdominal cavity due to enlarged sex organs; there is less room for insertion of a tag and there is a higher chance of internal injuries during the surgical procedure. Surgically tagging these species in close temporal proximity to their spawning migration (e.g., "immediately prior") may have too high a metabolic cost and a higher risk for injury that could increase post-tagging mortality relative to fish tagged outside this life history phase. The average tag life, in days, for rainbow trout and Arctic grayling tags is 450, 652, and 901 for the smallest to the largest tags, respectively. AEA recommended that the primary period for tagging these fish be the summer or fall; the time when they are at an energetic maximum and likely to be most resilient to the stresses associated with handling. The available tag life should allow data to be collected the following year on spawning migrations and spawning habitat destinations. Tagging the identified species during the specified periods was done based on the surgeon's discretion.

4.5.4.3. Aerial Surveys

Section 5.8.2.2 of the Implementation Plan stated that the proposed frequency of aerial surveys would provide a means of focusing a higher-resolution and time-intensive tracking effort on identifying exact locations of spawning and holding fish. To do this, the most recent observed river locations (to the nearest 1 km [0.62 mi]) of all fish "at large" would be made available to the aerial survey team. During the survey, the location of all detected fish would be compared to the last seen location from previous surveys to ascertain whether its position had changed by more than 2 km (1.25 mi). When tagged fish were within 2 km of their last observed location, the helicopter would circle at a lower altitude to pinpoint the fish location to mainstem, side channel, or slough habitats.

Survey methods for radio-tagged resident fish were modified from the Implementation Plan to accommodate the high number of frequencies that needed to be scanned for salmon and resident fish. Resident tag frequencies were programmed into a receiver and scanned automatically. No manual tracking, directed searching, or identification of habitat type was conducted during the period when adult salmon were being tracked. Resident tag frequencies were tracked manually during the period when adult salmon tags were not present. Specific aerial survey methods were not identified in the RSP, but were described in Section 5.8.2.2 of the Implementation Plan. The variance in aerial telemetry survey method may not have had a negative effect on meeting the stated objectives of the study because geographic positions of the tags could be related to digital habitat classifications made by other studies in AEA's program. However, the lack of directed effort at pinpointing tag locations (accuracy less 100 yd for some resident fish tags) may make habitat use inferences less accurate if habitat delineations were much smaller than the resolution of the tag positions.

4.6. Objective 3: Early Life History

AEA implemented the methods for Objective 3 as described in the Study Plan with the exception of the variance explained in Section 4.6.2.

4.6.1. Determine movement patterns and timing of juvenile salmonids from spawning to rearing habitats.

Early life history (ELH) sampling described fish distribution in Upper River tributaries with a focus on locating juvenile Chinook salmon during the early open water season. There was also a secondary objective to investigate the outlet area of two lakes for the presence of juvenile sockeye salmon. Sites were selected in the field in accordance with the methods outlined in Section 4.1.1. The target sample length was 100 m (328 ft) of each mesohabitat type accessible at each site. Sampling methods included electrofishing, fyke nets, and downstream migrant traps (Objective 2, Task A). Two sampling events took place in June as described in Section 4.2. During the first event, 41 mesohabitat units within 21 sites were sampled (Figure 4.1-1). Over 3,600 m (2.2 mi) of stream were electrofished and 12 fyke net days were completed. During the second event, a total of 43 mesohabitat units were sampled within 20 sites. Just over 3,500 m (2.2 mi) of stream were electrofished and 12 fyke net days were completed. Rotary screw trap sampling continued throughout the open water season. Biotelemetry could not be used for this task because juvenile salmonids were too small to tag at this life stage.

4.6.2. Variances from Study Plan

Unlike the RSP for the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (Study 9.6), the Upper River Study Plan and Fish Distribution and Abundance Implementation Plan did not include an objective for Upper River salmon early life history sampling (Section 9.5.5). When AEA adopted the FERC recommendation of seasonal sampling in mid-July and late August/early September in the Upper River additional locations were added to gather information during the period from ice break-up to July. Because the data from the

1980s showed the bulk of Chinook salmon moving out of Middle River rearing habitat by mid-July, AEA was concerned the same outmigration timing could occur in the Upper River and thus, tributary sampling starting in mid-July might miss a large component of rearing juvenile Chinook salmon. Thus, AEA added two directed sampling events to survey habitats where early life stages of juvenile salmon might be expected to be rearing based on 2012 known spawning distributions as well as incidental reports of salmon spawning activity from ADF&G.

4.7. Objective 4: Characterize the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type.

AEA implemented the methods for Objective 4 as described in the Study Plan with the exception of the variances explained in Section 4.7.1. In conjunction with Objectives 1 and 2, captured fish were identified to species and classified to life stage or smolt index when possible. A summary of fish length-at-maturation for the region was used as a basis for assigning life stages (Table 4.7.1). Each time a gear was used for sampling, a random sample of 25 individuals per species, life stage, and site were measured for fork length (FL) in millimeters and measured in grams. For species without a forked tail (e.g., sculpin and burbot), total length was measured laterally along the mid-line from the anterior edge of the snout to the posterior edge of the tail. The total sample size of fishes measured for length and weight in 2013 is presented in (Table 4.7-2). Species were classified by life stage (Table 4.7-1) and when sample sizes were sufficient natural breaks in length-frequency were used to further refine size bins. Recaptured PIT-tagged fish (Objective 2, Task B) provided growth rate information. Parameters recorded in each habitat unit included the number of fish by species and life stage, fork length, weight, global positioning system (GPS) location of sampling unit, time of sampling, weather conditions, water temperature, water transparency, behavior, and the location and distribution of observations.

For the ISR, condition factors were compared by habitat for Chinook salmon and Arctic grayling only. Prior to analysis of fish condition by habitat type, outliers that might skew comparisons were identified and removed. A log-log regression on length vs. weight for all measured fish within a species was fitted, including fish captured in migrant traps. The Grubbs test (Grubbs, 1950, Lukasz, 2011) was then used for sequentially identifying outliers in the residuals from these regressions. The experiment-wise error for the outlier removal for each species was maintained at 0.05 by using alpha of 0.05 divided by the total number of outliers for each sequential test. The resulting condition factors were also evaluated to ensure there were no obvious differences among size or age classes of fish before combining. Fish condition, or wellbeing, was estimated using Fulton's condition factor where the coefficient of condition, K-FL was derived from the formula: K-FL = W x 105/L3, where K-FL = condition factor by fork length, W = weight of fish in grams, and L = fork length of fish (mm) (Fulton 1902, Fulton 1904). Specific growth rates were estimated as SGR= 100*(ln(L2) –ln(L1))/(d2 - d1), where L2 = mean length on day (d) 2 and L1 = mean length on day (d) 1, and (d2 - d1) is the number of days between measurements. When all data were combined, fish condition factors were relatively stable across life stages, although estimates for fry were more variable and perhaps higher for Arctic grayling (Figure 4.7-1). Therefore, life stages were combined for the habitat analysis, but fry (less than 50mm [2 in] for Chinook; less than 60mm [2.4 in] for Arctic grayling) were not included. The total sample sizes of fish included in the condition factor analysis by

Geomorphic Reach or Tributary are included in Table 4.7-3. Note that fish from distribution and abundance sampling (Objective 1, Section 4.4), and ELH studies (Objective 3, Section 4.6) were included in this analysis.

4.7.1. Variances from Study Plan

4.7.1.1. Collection of Lengths and Weights

The Implementation Study Plan stated that each time sampling gear was checked, a random sample of 25 individuals per species, life stage, and site would be measured for fork length (FL) and weighed (IP Section 5.1.5). However, the FERC SPD mistakenly interpreted AEA's study plan as proposing to measure and weigh all fish and no modifications were recommended (SPD p. B-130). Due to ADF&G fish collection permit restrictions on fish handling; only the first 25 individuals of each species were weighed and measured during each check of a rotary screw trap. The sample size of 25 measurements per species per life stage per site is consistent with collecting the data necessary to evaluate length frequency distributions and condition factor for fish by species, gear type and macrohabitat and thus, will be sufficient to meet the study objective.

4.7.1.2. Age Assignment

As an initial step towards assigning age-classes to the 2013 fish collections, a literature review was conducted compiling information collected in the Susitna Basin during the 1980s hydropower licensing efforts and relevant studies from Alaska. The literature review revealed substantial individual variability in growth and overlap in size-at-age classes, particularly for fish two years of age and older. The review also found considerable variability in growth and size-at-age from different locations or regions within the basin adding further ambiguity to the task of assigning age to size. AEA determined that ages could not be assigned with certainty to Susitna River fishes based on length. The objective of documenting the seasonal age class structure of juvenile anadromous and resident fish by habitat type (RSP Section 9.6.4.3.5) was therefore replaced with seasonal size structure by habitat type. Evaluating habitat associations by size instead of age will continue to meet the objective of documenting the seasonal life stage use, growth and condition of species associations with habitat types.

4.8. Objective 5: Determine whether Dolly Varden and humpback whitefish residing in the Upper River exhibit anadromous or resident life histories.

AEA implemented the methods for Objective 5 as described in the Study Plan with no variances. Dolly Varden and humpback whitefish greater than 200 mm (7.9 in) in length were targeted for otolith collection to test for marine-derived elements indicative of an anadromous life history pattern. AEA assumed that larger fish were more likely to have exhibited anadromy and therefore otoliths were collected from fish greater than 200 mm (7.9 in) in length. Thirty fish of each species were targeted for collection during 2013 with an additional 30 proposed for the next year of study (60 fish of each species total). A total of 28 adult Dolly Varden were collected in the Upper River in 2013. Adult humpback whitefish were extremely scarce in the Upper River and none were collected (Table 4.8-1). Analysis will be conducted during the next study year.

4.9. Objective 6: Determine baseline metal and mercury concentrations in fish tissues for resident fish species in the mainstem Susitna River.

AEA implemented the methods for Objective 6 as described in the Study Plan with the exception of the variance explained in Section 4.9.1. Tissue or whole fish samples were collected in the reservoir inundation zone for assessment of metals (ISR Study 5.5, Baseline Metal Levels in Fish Tissue) and mercury concentrations (ISR Study 5.7, Mercury Assessment and Potential for Bioaccumulation Study). Target fish species for baseline metals testing included: Arctic grayling, burbot, Dolly Varden, longnose sucker, lake trout, rainbow trout, and whitefish species. Targets for mercury sampling included seven adult individuals of the following species: Arctic grayling, burbot, Dolly Varden, long nose sucker, sculpin, stickleback, lake trout, rainbow trout, humpback whitefish, and round whitefish (Table 4.9-1).

4.9.1. Variances from Study Plan

In an effort to obtain target samples sizes, collection of fish for mercury analysis occurred from June to September as opposed to the August and September window proposed in the Study Plan (RSP 5.7.4.2.6). Target sample sizes were not obtained for some species including: burbot, stickleback, rainbow trout, and humpback whitefish because either species were not captured or because fish of sufficient body size were rare. Two lake trout were collected from Sally Lake in 2012 but additional lake trout could not be collected from Sally Lake in 2013 due to land access restrictions. Seven lake trout were collected from Deadman Lake, within the watershed but outside of the inundation zone. None of these variances should reduce AEA's ability to determine baseline metal and mercury concentrations in fish tissues for resident fish species; it was anticipated prior to the field season that flexibility over time and space would be needed to achieve target fish collections.

4.10. Objective 7: Document the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike).

AEA implemented the methods for Objective 7 as described in the Study Plan with no variances. Northern pike were likely established in the Susitna River drainage in the 1950s through a series of illegal introductions (Rutz 1999). The proliferation of this predatory species is of concern owing to the negative effect of northern pike on salmonids and other species such as stickleback. At this time, northern pike have not been documented in the Upper River, so no targeted collection effort for pike was made. However, the presence and habitat associations of northern pike have been documented as a component of all fish capture and observation sampling events associated with Objectives 1 and 2.

4.11. Objective 8: Collect tissue samples from juvenile salmon and resident and non-salmon anadromous fish.

AEA implemented the methods for Objective 8 as described in the Study Plan with no variances. In support of the Genetic Baseline Study for Selected Fish Species (ISR Study 9.14), fish tissues were collected opportunistically in conjunction with all fish capture events. The target species, number of samples, and protocols are outlined in the ISR for Study 9.14. Tissue samples included an axillary process from all adult salmon, caudal fin clips or mucus swabs from fish greater than 60 mm (2.4 in), and whole fish less than 60 mm (2.4 in). Genetics samples were collected from juvenile and adult Chinook salmon, Arctic grayling, burbot, Dolly Varden, longnose sucker, sculpin, humpback whitefish and round whitefish (Table 4.11-1). A total of 717 tissue samples were collected during the Fish Distribution and Abundance sampling in the Upper River Study Area; 195 samples were collected from the Susitna River and 522 samples in tributaries (Table 4.11-1).

4.12. Fish Sampling Techniques

A combination of gillnetting, electrofishing, angling, trot lines, minnow trapping, snorkeling, rotary screw trapping, beach seining, fyke netting, and hoop trapping was used to meet the eight study objectives discussed above. Brief descriptions of how these field methods were implemented across field teams and study sites is presented below. Several assumptions were associated with the use of these methods:

- Boat electrofishing and gillnetting were likely the most effective means of capturing fish in open-water areas of the main Susitna River channel.
- All fish sampling and handling techniques described within this study were conducted under state and federal biological collection permits. Limitations on the use of some methods during particular time periods or locations may have affected the ability to make statistical comparisons among spatial and temporal strata.
- Fish sampling techniques provided imperfect estimates of habitat use and relative fish abundance. Use and comparison of multiple sampling methods provided the opportunity to identify potential biases, highlight strengths and weaknesses of each method, and ultimately improve estimates of fish distribution and relative abundance.
- Sampling in tributaries within the reservoir inundation zone was scaled based on elevation and Chinook salmon distribution. Sampling was conducted to 3,000 ft in elevation, the upper known extent of Chinook salmon distribution.

4.12.1. Gillnets

Variable mesh gillnets (7.5-ft-deep panels with 1-in to 2.5-in stretched mesh) were deployed in appropriate habitats. In open water and at sites with high water velocity, gillnets were deployed as drift nets, while in slow water sloughs, gillnets were deployed as set (fixed) nets. The location of each gillnet set was mapped using hand-held GPS units and marked on high-resolution aerial photographs. To reduce variability among sites, soak times for drift gillnets were standardized; all nets were retrieved a maximum of 30 minutes after the set was completed. The following formula was used to determine drifting time:

T = ([(set time + retrieval time)/2] + soak time)

4.12.2. Electrofishing

4.12.2.1. Backpack Electrofishing

All backpack electrofishing procedures followed NMFS (2000) *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act*. Personnel operating electrofishing units were trained and certified as per ADF&G permit requirements.

A Smith-Root LR-24 backpack electrofishing unit was operated by a trained field crew leader who was assisted by one or two people with dipnets. Each backpack unit was fitted with a standard Smith-Root cathode and a single anode pole with a steel ring. Electrofishing was often paired with snorkel surveys, where snorkel surveys were conducted first as a reconnaissance to make sure there were no large salmonids in the area. Single-pass fish distribution electrofishing surveys were conducted through the selected study reach moving in an upstream direction. Block nets were used for relative abundance sampling when sites conditions allowed. Depending on stream width, an additional crew leader sometimes operated a second electrofishing unit. All stunned fish were captured with dipnets away from the electric field and held in buckets for later processing.

An ADF&G-generated table that recommends target voltage settings for juvenile salmonid sampling in cold water was used as a reference at the onset of sampling (Buckwalter 2011). Backpack electrofisher settings were determined in the field based on water quality conditions, professional judgment, and the overall goal of minimizing impacts to fish health (Temple and Pearsons 2007). Prior to electrofishing, ambient water chemistry was recorded including conductivity (microSiemens), turbidity (nephelometric turbidity units [NTU]), and surface water temperature (°C) with a digital meter at the downstream end of sampling site to determine initial backpack electrofishing unit settings. In all cases, the electrofishing unit was operated and configured with settings consistent with guidelines established by the manufacturer (Smith-Root 2009), ADF&G (Buckwalter 2011) and NMFS (2000). The location of each electrofishing unit was mapped using hand-held GPS units and marked on high-resolution aerial photographs. Start and stop times were recorded to quantify sampling effort between surveys. Habitat measurements were collected at each study site location. All captured fish were identified to species, measured for length, and returned to the stream unharmed. For each sample unit, fish capture data and sampling effort (e.g., electrofishing ‘power on’ recorded in seconds) was documented separately so that CPUE could be calculated.

4.12.2.2. Boat Electrofishing

In study site locations that were too deep or too swift to safely operate a backpack electrofishing unit, boat-based electrofishing was used as a fish sampling technique. Boat-based electrofishing was conducted while drifting in a downstream direction by an experienced three- or four-person field crew. One person operated the boat, while the field crew leader operated the electrofishing unit and one or two netters captured stunned fish. In the remote Upper River, an inflatable cataraft with a collapsible aluminum frame was used. The boat was outfitted with either a Smith-Root 2.5 Gas-Powered Pulsator (GPP) electrofisher powered by a smaller generator for use in low-conductivity waters or a 5 GPP electrofisher for use in higher-conductivity waters.

As standard practice, low frequency pulse settings were selected initially to avoid exposing fish to more harmful higher pulse frequencies.

Boat electrofisher settings were determined in the field based on water quality conditions, professional judgment, and the overall goal of minimizing impacts to fish health (Temple and Pearsons 2007). Prior to electrofishing, ambient water chemistry was recorded including conductivity (microSiemens), turbidity (NTU), and surface water temperature (°C) with a digital meter at the downstream end of sampling site to help determine initial unit settings (Temple and Pearsons 2007). In all cases, the electrofishing unit was operated and configured with settings consistent with guidelines established by the manufacturer and ADF&G (Buckwalter 2011). The field team recorded a GPS location at the upstream start of each stream or sample segment prior to moving downstream to sample. Start and stop times were recorded to quantify sampling effort between surveys. Habitat measurements were also collected at each study site location. All captured fish were identified to species, measured for length, and returned to the stream unharmed. For each sample unit, fish capture data and sampling effort (e.g., electrofishing 'power on' recorded in seconds) was documented separately so that CPUE could be calculated. Electrofishing surveys were only conducted during daylight hours due to safety concerns.

4.12.3. Angling

Angling with hook and line was an effective way to collect fish samples for select target species under certain conditions. During field trips organized for other sampling methods, hook-and-line angling was conducted on an opportunistic basis using artificial lures or flies with single barbless hooks. The primary objective of hook-and-line sampling was to capture fish for radio and PIT tagging and to determine presence; a secondary objective was to evaluate seasonal fish distribution. Because it was labor and time intensive, angling was best used as an alternative method if other more effective means of sampling were not available. Angling was also used in conjunction with other methods, particularly if information on the presence and size of adult fish was required.

4.12.4. Trot Lines

Trot lines consisted of a long line with a multitude of baited hooks and were typically anchored at both ends and set in the water for a period of time. Trot lines consisted of 14 to 21 ft of seine twine with six leaders and hooks lowered to the river bottom. Trot lines were checked and re-baited after 24 hours and pulled after 48 hours. Hooks were baited with salmon eggs, herring, or whitefish. Trot line construction and deployment followed the techniques used during the 1980s studies as described by ADF&G (1982). As per ADF&G Fish Resource Permit stipulations, all salmon eggs used as bait were commercially sterilized or disinfected with a 10-minute soak in a 1/100 Betadyne solution prior to use.

4.12.5. Minnow Traps

Both wire and fabric collapsible minnow traps were used in 2013. The wired two-piece minnow traps were 16.5 in long, with a 9 in diameter, and had an 1-in opening. The collapsible traps had a length of 18 in and a width of 10 in. The openings of the collapsible trap were 2.5 in in diameter. Minnow traps were baited with commercially processed salmon roe. As per ADF&G

Fish Resource Permit stipulations, all salmon eggs used as bait were commercially sterilized or disinfected with a 10-minute soak in a 1/100 Betadyne. After roe was sterilized, 1 Tbsp of roe was measured out and placed in a 1-oz plastic Whirl-Pak bag (Fort Atkinson, WI, USA). Filled plastic bags were perforated using a fork or utility knife before bait was placed inside the trap.

One to two minnow traps were deployed for every 10 m (33 ft) sampled depending on the habitat unit size and complexity. The unit was divided into quadrants and the number of traps was equally distributed among quadrants. Traps were placed in the low velocity areas with cover that were most likely to contain fish. Traps were placed on the stream bottom, parallel to the current. To prevent loss, each trap was anchored to the stream bank by a tether line and flagged. Baited and set minnow traps were soaked overnight for 18 to 24 hours. After each soak period, captured fish were measured and identified to species. Fish were held in a live well and released unharmed to the same site where they were originally captured.

4.12.6. Snorkel Surveys

Single-pass snorkel surveys (Dolloff et al. 1993) were conducted by a two-person field crew trained in snorkel survey methods and fish species identification. Climatological and hydrological conditions, such as air and water temperatures, cloud cover, and water clarity/visibility, were documented before beginning a survey and snorkeling was only conducted if conditions were adequate based on Appendix 3 of the Implementation Plan. Snorkelers used a plastic salmonid silhouette with parr marks to evaluate visibility as the horizontal underwater distance at which the parr marks were visible. As the snorkeler approached the model, the distance at which the parr marks on the silhouette became visible was measured. Similarly, during retreat, the distance at which the parr marks were no longer visible was measured, and visibility was calculated as the average of these two distances (Thurow 1994). Habitat units were snorkeled by starting at the downstream end of the sample area and working upstream unless water velocity precluded upstream movement. Snorkeled distance depended on the length of the habitat unit being sampled.

Snorkel surveys consisted of a single snorkeler. Observations were collected by counting fish on both sides of the stream channel while alternating from left to right counts. Snorkelers visually identified and counted all species encountered and fish counts were grouped by species and size-class-bins estimated in 20 mm (0.8 in) increment bins (e.g., 1-20 millimeters, 21-40 millimeters, etc.). Snorkel observations were called out to a non-snorkeling team member and recorded. For most of the snorkel surveys in this study, one experienced biologist was the designated snorkeler, while a field technician acted as a recorder. A hand-held GPS unit was used to record the downstream and upstream extent of the area surveyed and the location was marked on high-resolution aerial photographs.

To facilitate comparison of relative abundance estimates from snorkel surveys with estimates from other sampling methods (e.g., minnow trapping or electrofishing), block nets were used to ensure a closed population within a single habitat unit and prevent fish from leaving or entering the unit (Hillman et al. 1992). The survey length and average wetted width of the sample area were recorded to facilitate estimation of relative fish abundance.

4.12.7. Fyke/Hoop Nets

In general, a fyke net consists of a large hoop net with wings that act as funnels to direct fish into the network of hoops. A hoop net has a similar set up, but lacks wings for directing fish into the net. Fyke/hoop nets were deployed to collect fish in tributaries, sloughs, and side channels with moderate water velocity (i.e., less than 3 ft per second). After a satisfactory location was identified at each site, the same location was used during subsequent collection periods. The fyke nets were approximately 40 ft long and consisted of two rectangular steel frames (3 ft wide by 2.5 ft high), and four steel hoops, all covered by 0.25-in delta stretch mesh nylon netting. A 26 ft long by 4.1 ft deep leader net made of 0.33-in delta stretch nylon netting was sometimes attached to a center bar of the first rectangular frame (net mouth). The second rectangular frame had two 4-in wide by 28-in high openings, one on each side of the frame’s center bar. The four hoops followed the second frame. The throats, 4-6 in diameter, were located between the second and third hoops. The net ended in a cod end bag 8 ft long with an 8-in opening at the end, which was tied shut while the net was fishing. Each fyke/hoop net was configured with two wings, set perpendicular to the shore, to guide the majority of water and fish to the net mouth. Where possible, the guide nets were configured to maintain a narrow open channel along one bank. Where the channel size or configuration did not allow an open channel to be maintained, the area below the fyke/hoop net was checked regularly to assess whether fish were blocked and unable to pass upstream. A live car was located at the downstream end of the fyke/hoop net throat to hold captured fish until they were processed. The fyke/hoop net wings and live car were checked at least once per day while fishing, to record and measure captured fish. The location of the fyke/hoop net sets were mapped using a hand-held GPS unit and marked on high-resolution aerial photographs. Fyke nets were set overnight for 18 to 24-hours.

4.12.8. Hoop Traps

Hoop traps are essentially a hoop net that is baited with fish or salmon roe to attract fish into the net (Larson 2000). Hoop traps can also be known as fyke traps if they include the wings to help funnel fish into the trap (Larson 2000). Hoop traps had between 4 to 7 hoops. Smaller traps consisted of four 0.25-in steel hoops with diameters tapered from 3 ft at the entrance to 2.25 ft at the cod end. Larger traps consisted of seven 0.25-in thick steel hoops inside with diameters that tapered from 2 ft at the entrance to 1.5 ft at the cod end. Both the four- and seven-hooped traps had two necks inside and were made up of 0.25-in diameter knotless delta mesh. Each trap was kept stretched open with two sections of PVC pipe spreader bars attached by snap clips to the end hoops. Hoop traps were generally set overnight for 18 to 24-hours.

4.12.9. Beach Seine

Seining methodology was dependent on habitat type and the target species. Typically, speed and coordination were essential parts of successful seining. The size and swiftness of the target fish influenced both the length of the seine used and the speed at which it was deployed and retrieved. In wadeable systems, smaller nets were used and deployed by hand with one end of the net anchored to the shore and the other end extended out from shore and then looped around to encircle the fish as the ends were pulled in against the beach or gravel bar. Once all fish were withdrawn from the net, the net was cleaned of all leaf litter, sticks, rocks, and other debris, checked for damage, and reloaded for the next set. Damage to seines was repaired following instructions in Gebhards (in Murphy and Willis 1996).

Seine nets of various sizes were available for use that ranged from 14 to 120 ft long, 3 to 6 ft wide, and had mesh diameters that ranged from 0.125 to 1 in. The largest and smallest available nets were 120'x5' x0.5" mesh and 14'x6'x0.125" mesh, respectively. With this range in net sizes a large variety of fishes and habitats were sampled; because the area sampled was noted, the net size was noted, and the nets were deep enough to fill the water column, comparisons could be made. The location of beach seining was recorded using a hand-held GPS unit, in addition to being marked on high-resolution aerial photographs. The area seined was delineated using fiberglass measuring tapes or a marked wading rod.

4.12.10. Rotary Screw Trap

Rotary screw traps were useful for determining the timing of emigration by downstream migrating juvenile salmonids and resident fish (Objective 2). In the Upper River, the Oshetna River near the confluence with the Susitna River (PRM 235.1) and Kosina Creek (PRM 209.1) near RM 2.2 were selected as locations where hydrologic conditions were suitable and logistically favorable for the deployment of rotary screw traps (Figure 4.1-7). Flow conditions permitting, traps were fished on a cycle of 48 hours (two days and nights) on, 72 hours off throughout the ice-free period. Each trap was checked at least daily when fishing (Figure 4.2-2).

When checked, fish were removed from the live-boxes for processing using dip and minnow nets. To reduce fish losses from the live-box, fish refuge structures, flow deflectors, and debris separators were sometimes installed to dissipate water velocities and reduce predation. Before fish were removed from the live-box, floating and large submerged debris was removed.

Once removed from the live-box, fish were sorted by species and size class and placed in 5-gallon buckets with supplemental aeration or a holding pen situated in flowing water. For juvenile anadromous salmonids a life stage index was be used for grouping life stage classes (alevin, fry/parr/smolt). Standard fish handling procedures were followed (Section 4.12.11). Any additional processing and data collection (e.g., tissue sampling, PIT tagging) was also performed if applicable to the species, life stage, and site location. Fish were held until fully recovered, and the time and water temperature (°C) at release was recorded.

4.12.11. Fish Handling

Special care was taken to ensure that all fish were handled properly and that unintended mortalities were minimized. In general, fish were kept in cool, well-oxygenated water, and the amount of time spent away from the river environment was minimized to the extent possible.

Strategies to minimize fish stress and mortality included the following:

1. Minimizing handling to that necessary to meet Project objectives.

2. Minimizing the time fish were held.

3. Minimizing the time fish were held in anesthetic.

4. Starting with low concentrations of anesthetic and then increasing as necessary. Fish were anesthetized only to the point at which they could be handled easily without strain.

5. Removing smaller or more sensitive fish from anesthetic first, followed by larger, less sensitive species.

6. Holding fish in fresh or flow-through river water during examination.

7. Using wet transfers.

8. Monitoring water temperatures and dissolved oxygen concentrations in closed systems regularly and adjusting as necessary.

Field crews recorded the date, start and stop times, and level of effort for all sampling events, as well as water temperature and dissolved oxygen at sampling locations. All captured or observed fish were identified to species and life stage when possible. For juvenile anadromous salmonids, a life stage index was used for grouping life stages (e.g., alevin, fry/parr/smolt). When possible, resident fishes were grouped as young-of-year (0+), juvenile (typically age 1+ and 2+), and adult (typically age 3+). Each time a gear was sampled, a random sample of 25 individuals per species, life stage, and site were measured for fork length (FL) in mm and weighed (grams). For species without a forked tail (e.g., sculpin and burbot), length was measured laterally along the mid-line from the anterior edge of the snout to the posterior edge of the tail. The remaining fish of each species and age class were then enumerated.

For methods in which fish were observed but not captured (e.g., snorkeling), an attempt was made to identify all fish to species. For snorkeling, fork lengths of observed fishes were estimated to 20-mm bins of sizes. If present, observations of poor fish condition, lesions, external tumors, or other abnormalities were noted. All juvenile salmon, Arctic grayling, burbot, Dolly Varden, rainbow trout, and whitefish greater than 60 mm (2.4 in.) in length were scanned for PIT tags using a portable tag reader and a PIT tag was implanted in untagged fish. Because Chinook salmon were of particular interest and in low abundance, all suitable juvenile Chinook salmon of taggable size received PIT tags. Radio tags were surgically implanted in targeted fish as described in Section 4.12.13.

4.12.12. Remote Fish Telemetry

Remote telemetry techniques included radio telemetry and PIT tags. Both of these methods were intended to provide detailed information from relatively few individual fish. PIT tags were surgically implanted in small fish greater than 60 mm (2.4 in); radio transmitters were surgically implanted in adult fish of sufficient body size of selected species distributed temporally and longitudinally in the Upper River. The target species to radio-tag included Arctic grayling, burbot, Dolly Varden, longnose sucker, northern pike, lake trout, rainbow trout, humpback whitefish, and round whitefish. Radio-tracking provided information on fine and coarse spatial scales related to location, speed of movement, and habitat use by surveying large areas and relocating tagged individuals during aerial surveys. PIT tags were used to document relatively localized movements of fish as well as growth information from tagged individuals across seasons and years. However, the "re-sighting" of PIT-tagged fish was limited to the sites where antenna arrays were placed. Determining movement in and out of side sloughs or tributaries required that tagged fish pass within several feet of an antenna array, thereby limiting array use to sufficiently small water bodies. To characterize growth rates, recaptured fishes were measured.

4.12.12.1. Radio Telemetry

The primary function of the telemetry component was to track tagged fish spatially and temporally with a combination of fixed station receivers and mobile tracking. Time/date stamped, coded radio signals from tags implanted in fish were recorded by fixed station or mobile positioning. All telemetry gear (tags and receivers) across both studies was provided by ATS, Inc. (Advanced Telemetry Systems, www.atstrack.com).

The types of behavior to be characterized include the following:

- Arrival and departure timing at specific locations/positions
- Direction of travel
- Residence time at specific locations/positions
- Travel time between locations/positions
- Migratory, holding, and spawning time and locations/positions
- Movement patterns in and between habitats in relation to water conditions (e.g., discharge, temperature, turbidity)

Locating radio-tagged fish was achieved by fixed receiver stations and mobile surveys (aerial, boat, and foot). Three telemetry fixed stations were installed in the Upper Susitna River. Stations at the mouths of Kosina Creek (PRM 209) and the Oshetna River (PRM 235) monitored the movement of radio-tagged fish in the mainstem Susitna as well as in their respective tributaries. The Deadman station (PRM 191) was located north of the Susitna River between Deadman and Watana creeks and monitored the movement of fish in the mainstem of the Susitna River (Figure 4.1-7). These stations were serviced in conjunction with the Salmon Escapement Study during the July through October period. The Kosina Creek station was extended to track resident fish into the winter. Fixed stations were downloaded weekly during the salmon spawning period (approximately July through October). The Salmon Escapement Study provided approximately weekly aerial survey coverage of the study area (approximately July through October). At other times of the year, the frequency of aerial surveys was reduced to every third week. Spatial and temporal allocation of survey effort was finalized based on the actual locations and number of each species of fish tagged.

Relocation data from the radio telemetry component of this study was used to characterize the timing of use and degree of movements among macrohabitats and over periods during which the radio-tags remain active (potentially two or three years for large fish). This objective is being achieved with the use of long-life tags (e.g., greater than one year) and shorter life tags (e.g., three-month tags) applied to appropriate-sized fish over time. In general, successful radio telemetry studies use a tag weight to fish weight guideline of 3 percent (with a common range of 2 to 5 percent depending on the species). Actual tag life was determined by the appropriate tag for the size of the fish available for tagging.

This study intended to capitalize on the use of the existing telemetry platform (ATS telemetry equipment) to sufficiently monitor target species, but that directly constrained the potential options for tagging and monitoring. More specifically, the smallest ATS coded tag weighed 6 g (0.2 oz) which precluded its application to all the species at the lower portion of their most frequently occurring size range (Table 4-2).

Tags were surgically implanted in fish of sufficient body size, distributed temporally and longitudinally in the Upper River with a goal of 30 per-species. These fish were captured during sampling events targeting adult fish and with directed effort using a variety of methods. The tag's signal pulse duration and frequency, and, where appropriate, the transmit duty cycle, was a function of the life history of the fish and configured to maximize battery life and optimize the data collection. Larger tags accommodated the greatest battery life and therefore were used when fish were large enough, but smaller, shorter life tags were used across the range of adult body sizes.

4.12.12.2. PIT Tag Antenna Arrays

As described above, fish of appropriate size from target species were implanted with a PIT tag for mark-recapture studies. Half-duplex PIT tags, either 12 mm (0.5 in) in length or 23 mm (0.9 in) in length, were used depending on the size of the fish to be implanted. Each PIT tag had a unique code that allowed identification of individuals.

PIT tag antenna arrays with automated data logging were deployed at two selected side channel, slough, and tributary mouths to detect movement of tagged fish into or out of the site with particular focus on juvenile Chinook salmon (Figure 4.1-7). With input from the Fish and Aquatic TWG, site selection for antenna arrays was based on habitats and tributaries identified as suitable habitat for juvenile Chinook salmon. Antennas were deployed shortly after ice-out in 2013. Each PIT tag interrogation system consisted of a power source, data logger, antenna, and tuning capacitor. A solar panel and controller was used to power the reader and charge the battery bank. Data loggers were downloaded every two to four weeks depending on the need to replace batteries and on reliability of logging systems.

5. RESULTS

5.1. Objective 1: Fish Distribution, Relative Abundance, and Habitat Associations

5.1.1. Task A: Fish Distribution

Table 5.1-1 describes the species distribution within the Upper River study area, including the mainstem Susitna River geomorphic reaches (UR-3, UR-4, UR-5, and UR-6), tributaries, and lakes, as documented during 2012 and 2013 field studies. Additionally, the table incorporates historic fish distribution information from ADF&G (1981 & 1984), Sautner and Stratton 1983, 1984) and Buckwalter (2011). Fish distribution maps based on 2012 and 2013 fish observations are presented in Appendix B (Figures B1 through B8). Tables C1 through C9 in Appendix C further describe the distribution of these species with respect to four seasonal sampling events defined as spring Early Life History (ELH) sampling (June 4 to June 30), early summer (July 1 to August 10), late summer (August 11 to September 9), and fall (September 10 to October 7). Although these sampling events are based on 2013 sampling protocols, observations made during 2012 field studies have also been grouped into these seasonally defined events. For Chinook salmon, the tables, figures, and discussion below focus only on the juvenile life stage; accounts of adult Pacific salmon in the Upper Susitna River are provided in ISR Study 9.7.

Nine fish species are known to inhabit the Upper Susitna River study area. These include one anadromous species (Chinook salmon) and eight resident species (Arctic grayling, burbot, Dolly Varden, lake trout, longnose sucker, sculpin, humpback whitefish, and round whitefish) (Sautner and Stratton 1983; Buckwalter 2011; HDR 2013; Table 5.1-1). During field surveys sculpin were not always identified to the species level; therefore, they are reported herein as sculpin spp. When sculpin were identified to species, identifications included only slimy sculpin. Each of these nine species was documented in the Upper River study area in 2012 (HDR 2013) and 2013. With the exception of lake trout and humpback whitefish, each species was also documented between Devils Canyon and the proposed Watana Dam site (Table 5.1-1), and all species except for lake trout have been documented downstream of Devils Canyon (ISR Study 9.6).

Generally, distribution patterns among species varied, particularly with regard to differences between the mainstem Susitna River and tributary habitats. Only Arctic grayling and sculpin were widely distributed in both the mainstem river and its tributaries (Table 5.1-1; Figures B2 and B6). Burbot, longnose sucker, and round whitefish were also widespread in the Susitna River, but their distribution within tributaries was limited primarily to larger streams such as Kosina Creek and the Oshetna River (Figure B3; Figure B5; Figure B8). Other species (e.g., juvenile Chinook salmon and humpback whitefish) were observed at a few mainstem locations, and humpback whitefish observations within tributaries were also limited (Figure B1; Figure B7). Dolly Varden were found exclusively in tributary streams, and lake trout were found primarily in lakes although they were observed at a single tributary location (Figures B4 and B3). Additional information regarding the spatial and seasonal distribution of each of the nine documented species is provided in the subsections that follow. Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_FishObservations).

5.1.1.1. Chinook salmon

Juvenile Chinook salmon were documented in Kosina Creek, the Oshetna River, and the Black River, a tributary of the Oshetna River (Table 5.1-1; Figure B1). All three of the streams where juvenile Chinook salmon were documented were sampled during each of the four seasonal events defined above (Table C1). During the spring event, juveniles were observed only in the Black River. During the other sampling events, they were documented in each of these three streams with the exception of the Oshetna River during late summer.

5.1.1.2. Arctic grayling

Within the Upper Susitna River, Arctic grayling were distributed throughout the mainstem river (PRM 187.1 to 235.1), in 15 of the 20 tributaries surveyed, and in 3 lakes (Table 5.1-1; Figure B2). The 15 streams included Deadman Creek, Unnamed Tributary 194.8, Watana Creek, 3 unnamed Watana Creek tributaries, Unnamed Tributary 197.7, Unnamed Tributary 203.4, Kosina Creek, 2 Kosina Creek tributaries (Tsisi and Gilbert creeks), Jay Creek, Goose Creek, the Oshetna River, and 1 Oshetna River tributary (the Black River). Lake observations occurred in an unnamed lake in the Deadman Basin, Sally Lake in the Watana Basin, and Tsisi Lake in the Kosina Basin. Upstream of the study area, Arctic grayling were also documented in the Susitna River and in the lower reach of Clearwater Creek (PRM 266.6), thus extending their distribution from the Oshetna River to Clearwater Creek.

The distribution of Arctic grayling was largely consistent among sampling seasons (Table C2). Arctic grayling were present in the Susitna River during the early summer, late summer, and fall sampling events. Four of the streams in which Arctic grayling were observed (Kosina Creek, Tsisi Creek, the Oshetna River, and the Black River) were sampled during all four seasonal events; within these streams, Arctic grayling were present during all four events. Similarly, they were consistently found in 3 of the 5 streams that were sampled during early summer, late summer, and fall (Watana, Jay, and Goose creeks). In the other two streams that were sampled across multiple events, Arctic grayling were detected only during early summer in Unnamed Tributary 194.8 and only during late summer in an unnamed tributary to Watana Creek. In Tsisi Lake, which was the only lake sampled across multiple events, Arctic grayling were observed only during the spring event.

5.1.1.3. Burbot

Within the Upper Susitna River (PRM 187.1-235.1), burbot were present throughout the mainstem river and in four streams: Kosina and Jay creeks, and the Oshetna and Black rivers (Table 5.1-1, Figure B3). Within Kosina and Jay creeks, burbot were observed in only in the lower stream reaches. In the Oshetna River, burbot observations extended upstream to its confluence with the Black River and then continued in the Black River to the upstream sampling extent.

On a seasonal basis, the distribution of burbot was largely consistent in the Susitna, Oshetna, and Black rivers, whereas observations in Kosina and Jay creeks were limited to only certain events (Table C3). In the Susitna, Oshetna, and Black, burbot were observed during all events with the exception of the spring event in the Susitna River. In Kosina Creek, which was sampled during all four events, burbot observations occurred only during the spring period. Jay Creek was sampled during early summer, late summer, and fall, yet burbot were documented only during the late summer and fall. In Kosina and Jay creeks, where burbot were observed only in the lower stream reaches, it is plausible that burbot are moving into the creeks on a seasonal basis, whereas their use of larger riverine habitats, such as the Susitna, Oshetna, and Black rivers, is more consistent across seasons.

5.1.1.4. Dolly Varden

As mentioned above, Dolly Varden were observed exclusively in tributary habitats. Six tributaries supported Dolly Varden including: Unnamed Tributary 194.8, Watana Creek, 1 unnamed Watana Creek tributary, Unnamed Tributary 198.4, Kosina Creek, and Jay Creek (Table 5.1-1; Figure B4).

There was little seasonal variation in the presence of Dolly Varden (Table C4). Among the streams that were sampled across multiple events and that supported Dolly Varden, Dolly Varden were observed in all cases with the exception of early summer in Kosina Creek.

5.1.1.5. Lake Trout

Three of the five lakes that were sampled in the Upper Susitna River supported lake trout (Table 5.1-1; Figure B3). These lakes included Deadman Lake in the Deadman Basin, an unnamed lake also in the Deadman Basin, and Sally Lake in the Watana Basin. No lake trout were observed in a small unnamed lake near PRM 205.9 or in Tsisi Lake in the Kosina Basin. Within riverine habitats, there was a single juvenile lake trout observation made in an unnamed tributary to Watana Creek draining Big Lake.

The one stream in which lake trout were observed was sampled during the early summer, late summer, and fall events, yet the only observation of lake trout occurred during fall sampling (Table C5). With this single observation, and the fact that each of the three lakes supporting lake trout were sampled during only a single sampling season, there is insufficient data to characterize seasonal distribution patterns for lake trout in the Upper Susitna River study area. However, it should be noted that lake trout are typically associated with lacustrine habitats; thus the specimen collected likely originated in Sally Lake or Big Lake (Figure B3).

5.1.1.6. Longnose Sucker

Longnose suckers were distributed throughout the mainstem Susitna River and a few tributary streams (Table 5.1-1; Figure B5). Within the Upper Susitna River study area, they were observed in geomorphic reaches UR-6, UR-5, UR-4, and UR-3, and in five tributaries: Watana, Kosina, and Goose creeks, and the Oshetna and Black rivers. Upstream of the study area, longnose suckers were also documented in the Susitna River and the lower reach of the Tyone River (PRM 247.3), thus extending their distribution from the Oshetna River to the Tyone River.

Seasonal distribution patterns in the Upper River study area tended to vary by stream (Table C6). Longnose suckers were consistently observed across all four sampling events in the Susitna and Oshetna rivers. Among the tributary streams that supported longnose suckers and that were sampled during each event, detections occurred only during the spring and fall events in Kosina Creek and only during late summer in the Black River. In Watana and Goose creeks, which were sampled during all events except spring, longnose suckers were observed during early summer in both creeks and during late summer in Goose Creek.

5.1.1.7. Sculpin

Sculpin were widely distributed throughout the Upper Susitna River study area (Table 5.1-1; Figure B6). They were present in the mainstem river from PRM 187.1 to 235.1, in 18 of the 20 tributaries surveyed, and in one lake. The 18 streams included Deadman Creek, Unnamed Tributary 194.8, Watana Creek, 4 unnamed Watana Creek tributaries, Unnamed Tributary 197.7, Unnamed Tributary 203.4, Unnamed Tributary 206.3, Kosina Creek, 3 Kosina Creek tributaries (Tsisi and Gilbert creeks, and one unnamed tributary), Jay Creek, Goose Creek, the Oshetna

River, and 1 Oshetna River tributary (the Black River). The single lake that supported sculpin was Sally Lake, located in the Watana Basin.

The distribution of sculpin within the study area varied little among seasons (Table C7). Among the streams that supported sculpin and were sampled across multiple seasons, the only events in which sculpin were not detected were: the spring event in the Susitna River, and early summer and fall events in one of the unnamed Watana Creek tributaries.

5.1.1.8. Humpback whitefish

Of the eight riverine species documented in the Upper Susitna River study area, humpback whitefish were the least commonly observed (Table 5.1-1; Figure B7). Observations in the mainstem Susitna River were limited to a single location in UR-6. Humpback whitefish were also observed at a few locations in Kosina Creek and the Oshetna River. Based on observations of unidentified whitefish, it is possible that humpback whitefish were also present in Tsisi Creek (Table 5.1-1).

The distribution of humpback whitefish appears to have varied seasonally in the mainstem river and in Kosina Creek, but was more consistent in the Oshetna River (Table C8). In UR-6 and Kosina Creek, humpback whitefish were detected only during fall. In the Oshetna River, presence was documented during the spring event and during early and late summer. However, these seasonal patterns should be viewed with caution due to the relatively few humpback whitefish observations in the study area.

5.1.1.9. Round whitefish

Round whitefish were documented in the mainstem Susitna River from PRM 187.1 to 235.1 and in seven streams within four tributary basins (Table 5.1-1; Figure B8). Streams that supported round whitefish were: Watana Creek, an unnamed Watana Creek tributary, Kosina Creek, Tsisi Creek in the Kosina Basin, Goose Creek, the Oshetna River, and the Black River within the Oshetna Basin. All occurrences of unidentified whitefish were in tributaries with confirmed round whitefish presence (Table 5.1-1).

Patterns of seasonal distribution were evident in both mainstem and tributary habitats (Table C9). In the mainstem Susitna River, round whitefish were not observed during the spring event, yet as time progressed, their occurrence in each of the mainstem geomorphic reaches became more common. In early summer, they were observed only in UR-6; in late summer, they were observed in UR-6, UR-4, and UR-3; and in the fall, they were detected in all four of the UR reaches within the study area (UR-6, UR-5, UR-4, and UR-3). In tributaries, the seasonal distribution was opposite of that seen in the mainstem, although some tributaries supported round whitefish throughout all sampling periods. For example, in early summer, round whitefish were detected in all seven streams, yet during late summer and fall, they were detected in five and three of the seven streams, respectively. The streams in which round whitefish were consistently found across the early summer, late summer, and fall sampling events included Kosina and Goose creeks and the Oshetna River. Round whitefish were also observed in two of four streams that were sampled during the spring event (i.e., Kosina Creek and the Oshetna River).

5.1.2. Task B: Relative Abundance

During 2013 all Upper River fish sampling, a total of 12,700 fish were captured or observed (Table 5.1-2). Backpack electrofishing and snorkeling accounted for 84 percent of the total catch (Table 5.1-2). Table 5.1-3 lists total fish counts for relative abundance sampling for all three sampling events for each gear type by species and life stage. Fish counts including all sampling and relative abundance as determined by catch-per-unit-effort (CPUE) analysis are presented below. CPUE was calculated to be species and gear specific using catch data from distribution and abundance sampling as described in Section 4.4.2.1 and was averaged across mesohabitats within a macrohabitat for discussing relative abundance. Summaries of CPUE in the Upper River are presented in Appendix D. Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_FishObservations, and ISR_9_5_FDAUP_FishCPUEData).

5.1.2.1. Juvenile Chinook Salmon

During 2013, 281 juvenile Chinook salmon were observed during all sampling in the Upper River (Table 5.1-2). Averaged CPUE for juvenile Chinook salmon was variable across sampling locations and methods (Tables D19 and D20). In tributaries, CPUE ranged from 0 at 95 percent of the mesohabitats to 80 fish per 1000 m^2 in Kosina Creek run habitat (Table D19). No juvenile Chinook were captured in the mainstem Susitna during the 196 distribution and abundance samples. The three highest estimates of CPUE were from sites in spawning tributaries (Kosina Creek and the Black River). In general Upper River CPUE averages for juvenile Chinook salmon were similar in magnitude to estimates of CPUE for Middle and Lower River sites. For the tributary sites where juvenile Chinook salmon were present, CPUE data indicated that backpack electrofishing and snorkeling were effective capture techniques for juvenile Chinook salmon (Table D14). Averaged CPUE estimates for juvenile Chinook salmon during Upper River fish distribution and abundance sampling are displayed in Tables D19 and D20.

5.1.2.2. Arctic Grayling

Arctic grayling was the second most abundant species in the 2013 Upper River fish sampling with 4,869 Arctic grayling observed during all sampling (Table 5.1-2). Averaged CPUE for Arctic grayling was highly variable across sampling locations and methods with 59 percent of sites containing Arctic grayling (Table D14). In tributaries, CPUE averages ranged from 0 to 1,500 fish per 1000 m^2 in Goose Creek riffle habitat (Table D24). In the mainstem Susitna, CPUE averages ranged from 0 to 77.7 fish per hour in UR-3 riffle habitat (Table D21). The CPUE averages for Arctic grayling were greater in tributaries than in the mainstem and also were an order of magnitude greater than estimates of average CPUE estimated from Middle and Lower River sites. For the tributary sites where Arctic Grayling were present, CPUE data indicates that snorkeling and backpack electrofishing were effective capture techniques. For the mainstem sites where Arctic Grayling were present, CPUE data indicated that backpack electrofishing, boat electrofishing, and seining were effective capture techniques (Table D14).

5.1.2.3. Burbot

During 2013, 129 burbot were observed during all sampling (Table 5.1-2). Averaged CPUE for burbot was low to moderate across sampling locations and methods with burbot observed at 10 percent of sampling sites (Table D14). In tributaries, average CPUE estimates ranged from 0 to a maximum of 17.1 fish per hour in Jay Creek pool habitat (Table D25). In the mainstem Susitna, average CPUE ranged from 0 to 11.7 fish per hour in UR-3 riffle habitat (Table D26). The CPUE averages for burbot were similar in tributaries and mainstem macrohabitat and were similar to average CPUE from Middle and Lower River sites. For the main channel mesohabitats, CPUE data indicated that backpack and boat electrofishing were effective capture techniques for burbot (Table D14).

5.1.2.4. Dolly Varden

During 2013, 778 were observed during all sampling (Table 5.1-2). Averaged CPUE for Dolly Varden was calculated only in tributaries (Table D14) and was variable across mesohabitats. Averaged CPUE estimates ranged from 0 at 88 percent of the mesohabitats to 191 fish per 1000 m^2 in Watana Creek pool habitat (Table D29). The CPUE averages for Dolly Varden were similar to averaged CPUE from Middle River mesohabitats. The CPUE data indicate that snorkeling and backpack electrofishing were effective capture techniques for Dolly Varden (Table D14).

5.1.2.5. Lamprey

No lamprey were observed during Upper River fish distribution and abundance sampling.

5.1.2.6. Longnose Sucker

During 2013, 336 longnose sucker were observed during all sampling (Table 5.1-2). Averaged CPUE for longnose sucker generally was low across sampling locations and was zero for 93 percent of sampling sites (Table D14). Moderate average CPUEs were observed in pool and riffle habitat in a UR-6 side channel (Table D30 and D32). In tributaries, CPUE averages ranged from 0 to 5.3 fish per 1000 m^2 in Unnamed Tributary 194.8 run habitat (Table D33). In the mainstem Susitna, longnose sucker CPUE ranged from 0 to 47.2 fish per 1000 m^2 in UR-6 riffle habitat (Table D32). The CPUE averages for longnose sucker were similar in Upper River tributaries and mainstem macrohabitats and generally were similar to the averaged CPUE from Middle and Lower River mesohabitats; however, occasionally higher average CPUEs were evident in Middle and Lower river habitats (ISR Study 9.6). For both tributary and mainstem mesohabitats, CPUE data indicated that backpack and boat electrofishing, seining, and snorkeling all were effective capture techniques for longnose sucker (Table D14).

5.1.2.7. Sculpin

Sculpin was the most abundant species group in the Upper River with 5,944 sculpin observed during all 2013 fish sampling (Table 5.1-2). Averaged CPUE was highly variable across sampling locations and methods with no sculpin observed at 22 percent of sites (Table D14). In tributaries, CPUE averages ranged from 0 to 210.9 fish per hour in Black River pool habitat (Table D34). In the mainstem Susitna, CPUE averages ranged from 0 to 59.2 fish per hour in

UR-4 clearwater plume habitat (Table D34). The CPUEs for sculpin were greater in tributaries than in the mainstem and generally were similar to CPUEs estimated from Middle and Lower River mesohabitats. For the sites where sculpin were present, CPUE data indicated that backpack electrofishing, snorkeling, and seining were effective capture techniques (Table D14).

5.1.2.8. Lake trout

Only one lake trout was observed during Upper River fish distribution and abundance sampling in 2013 (Table 5.1-3).

5.1.2.9. Humpback Whitefish

No humpback whitefish were observed during Upper River fish distribution and abundance sampling in 2013 (Table 5.1-3).

5.1.2.10. Round Whitefish

During 2013, there were 280 round whitefish observed during all 2013 sampling (Table 5.1-2). Averaged CPUE for round whitefish was low to moderate across sampling locations and methods with 0 CPUE at 88 percent of sampling sites (Table D14). In tributaries, CPUE averages ranged from 0 to 11.5 fish per 1000 m^2 and 11.5 fish per hour in Goose Creek run and pool habitat, respectively (Tables D39 and D42). In the mainstem Susitna, CPUE averages ranged from 0 to 40.8 fish per hour in UR-3 run habitat (Table D39). The CPUE averages for longnose sucker generally were lower in Upper River tributaries than in mainstem macrohabitats. The averaged CPUEs for Upper River tributaries generally were similar to the averaged CPUE from Middle and Lower River mesohabitats (ISR Study 9.6). For both tributary and mainstem mesohabitats, CPUE data indicated that backpack and boat electrofishing, seining, and snorkeling all were effective capture techniques for longnose sucker (Table D14).

5.1.3. Task C: Habitat Associations

Fish observation data were used to provide a preliminary look at fish-habitat associations in the Upper River because 2013 data QA/QC and analysis is ongoing. Combining counts from all data sources, a total of 12,700 fish observations were made in 12 Upper River tributaries and the mainstem Susitna River (Table 5.1-2). The highest total counts of fish were obtained in the Oshetna River, largely driven by high numbers of sculpin documented during distribution and relative abundance sampling (Table D11) and Arctic grayling captured in the Oshetna rotary screw trap (Table 5.2-1). In general, more fish were observed in tributaries than in the mainstem reaches.

To begin to understand species-specific patterns in habitat use, species counts are presented by mesohabitat unit and sampling event in Appendix D (Tables D2 to D13). The following general patterns are evident from this early data.

- Juvenile Chinook salmon were found in tributary habitats during all three sampling events. They were documented in fast water habitats only, e.g. boulder rifle and run habitats.

- Arctic grayling were observed in a variety of habitats in tributaries, the main channel Susitna River and off-channel Susitna River. Arctic graying counts were higher and more frequent in fast water mesohabitat types, e.g. boulder riffles, riffles, runs, and glides.
- Burbot observations by mesohabitat were low overall, on the order of an individual fish observed in all fast water habitats and an occasional pool or percolation channel.
- Dolly Varden were observed only in tributaries. They were found in fast and slow mesohabitats including rapids, boulder riffles, riffles, runs, glides, pools, and percolation channels.
- One juvenile lake trout was found during fish distribution and abundance sampling. This fish was found in a riffle in a tributary to Watana Creek, 7.5 km (4.7 mi) downstream of Big Lake and 16 km (10 mi) upstream from Sally Lake.
- Longnose sucker were found in a variety of habitats in tributaries as well as main channel and off-channel habitats in the Susitna River. Longnose sucker were observed in boulder riffles, riffles, runs and pools.
- Sculpin were found in tributaries as well as main channel and off-channel habitats in the Susitna River. They were found in all fast water habitat types, pools, percolation channels, and in a beaver pond.
- Very few humpback whitefish were observed in the Upper River. These few fish were found in riffles in the Oshetna River and Kosina Creek and in a run in the Susitna River.
- Round whitefish were observed frequently in tributaries and in the main channel of the Susitna River. They were found predominantly in fast water mesohabitats including rapids, boulder riffles, riffles, and runs but were also observed in pools.

Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_FishObservations).

5.2. Objective 2: Seasonal Movements

5.2.1. Task A: Document the timing of downstream movement and catch for all fish species using out-migrant traps.

Rotary screw traps (RST) operated in Kosina Creek (PRM 209.1) and the Oshetna River (PRM 235.1) were used to document seasonal fish movements of anadromous salmon and resident fish species out of these Upper River tributaries between mid-June and early October. During this period, the Kosina Creek trap caught 153 total fish while the Oshetna River trap caught 1,001 total fish (Table 5.2-1). The Kosina Creek trap caught one anadromous fish, a juvenile Chinook salmon, and six species of resident fish including Arctic grayling, Dolly Varden, longnose sucker, sculpin, humpback whitefish, and round whitefish. The Oshetna trap also caught seven total fish species, including juvenile Chinook salmon, Arctic grayling, burbot, longnose sucker, sculpin, humpback whitefish, and round whitefish. Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr(ISR_9_5_FDAUP_Fish Observations).

The Kosina Creek rotary screw trap catch was comprised primarily of juvenile Arctic grayling (Figure 5.2-1). Minimal fish movement was documented during spring sampling; catch consisted of only one adult Arctic grayling. Catch of Arctic grayling increased slightly during early summer and included both Arctic grayling and Chinook salmon smolts. A pulse of nine juvenile Chinook salmon smolts and one adult was documented between August 8 and 18, 2013. More resident fish were caught during the mid-summer season including: Arctic grayling, Dolly Varden, sculpin, and round whitefish and undifferentiated whitefish. Capture of Arctic grayling continued during fall when other species included small numbers of longnose sucker, sculpin, humpback whitefish, round whitefish and undifferentiated whitefish. One late-season Chinook salmon parr was documented on September 27, 2013.

In the Oshetna River rotary screw trap, spring sampling documented high numbers of fish shortly after the trap was installed (Figure 5.2-2). Catch was comprised mostly of Arctic grayling and adult longnose sucker but also included, burbot, juvenile longnose sucker, sculpin, and humpback, round, and undifferentiated whitefish. Catch dropped off and few fish were captured during early July, most of which were Arctic grayling. During the early summer season, catches peaked, remained relatively high, and consisted primarily of juvenile Arctic grayling, along with lower numbers of adult Arctic grayling, adult and juvenile longnose sucker, all life stages of sculpin, undifferentiated whitefish and occasional humpback and round whitefish. One Chinook salmon smolt was also captured in late July. As the mid-summer season arrived, catches of Arctic grayling decreased slightly but remained relatively steady. Other resident fish species were caught more frequently including longnose sucker, sculpin and unidentified and round whitefish. A final large pulse of fish occurred during the transition from mid-summer to fall. Arctic grayling numbers remained high, and an increase in catches of all life stages of juvenile longnose sucker and round whitefish was also observed. Other species caught during this final period included burbot, sculpin, undifferentiated whitefish, and round whitefish.

5.2.2. Task B: Describe seasonal movements using biotelemetry

The radio telemetry results below include reporting from fish tagged in July and August and tracked through the end of August 2013.

5.2.2.1. Radio Telemetry

Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_RadioTelemetry).

5.2.2.1.1. Tagging Locations

Arctic grayling

Arctic grayling were primarily radio-tagged where clearwater tributaries entered the Susitna River (Table 5.2-2 and Figures A1, A2, A3). These locations offered good numbers of fish for tagging, did not have land access issues, and most were within the regular flight paths for aerial surveys. Tags were released at Deadman (7), Watana (3), Kosina (8) and Goose (3) creeks in the

Project inundation zone. Additional Arctic grayling were tagged in the Oshetna River (8) and Clearwater Creek (2), outside of the inundation zone, to observe if fish in those locations entered the inundation zone during their yearly migrations. Thirty-two tags were released in Arctic grayling during the reporting period ending 30 August. An additional 25 Arctic grayling were tagged in September (Table 4.5-2).

Burbot

Seven burbot were tagged in September 2013, after the reporting period ending August 30.

Longnose sucker

Longnose sucker were captured with a fyke net and radio-tagged at one location on the Tyone River (Table 5.2-3 and Figures A4, A5, A6). This site is outside the Project inundation zone. A total of five tags were released in longnose sucker in the reporting period ending August 30, 2013. An additional 5 longnose sucker were tagged in September.

Round Whitefish

Eighteen round whitefish were tagged in September 2013, after the reporting period ending August 30.

5.2.2.1.2. Timing of tags released

The majority of the Arctic grayling tags (31 of 57) and half of the longnose sucker tags (5 of 10) were released between July 15 and 31 during the first radio-tagging effort in the Upper River (Table 4.5-2). Difficulty procuring fish of sufficient size from standard operations forced the crew to angle for the majority of the fish. Catches from angling were limited to Arctic grayling. The second field stint, which occurred during late August, was stopped after a day and half due to high water conditions and produced one radio-tagged Arctic grayling (Table 4.5-2). Tagging continued more successfully in September, and included burbot and round whitefish.

5.2.2.1.3. Movements

Arctic grayling

Arctic grayling displayed a variety of migratory patterns after being radio-tagged. Most fish, such as 9089 (Figure A7), 9102 (Figure A8), and 9108 (Figure A9) moved downstream from where they were tagged and were observed at other stream mouths. From its tagging site at the mouth of Deadman Creek, Fish 9089's migration included traveling over five miles downstream in the mainstem, to below Tsusena Creek, as well as trips of over one half mile up two tributaries. Fish 9102 traveled 12 mi downriver, from its tagging location at Kosina Creek, to Watana Creek before moving over one half mile up the tributary. After being tagged at Kosina Creek, Fish 9108 remained at Kosina Creek for a couple of weeks before migrating 50 mi downriver to Chinook Creek. Some of the fish that moved downriver stayed in the mainstem while others moved into tributaries. Other fish stayed at the creek mouth where they were tagged (Fish 9107, Figure A10) or migrated between the mainstem and tributary near where they were tagged. During the reporting period, Fish 9107 was never observed more than 1.5 mi from its tagging location at the mouth of Kosina Creek. There was little upstream movement observed through August 31. As all of the fish were tagged in areas that would not be considered migratory corridors and were tracked for less than two months, it is not surprising that there were few large scale movements observed. Some Arctic grayling tagged in the Upper River migrated past the Watana Dam site and into the Middle River.

Longnose sucker

Longnose sucker primarily moved downstream after being tagged (Fish 9123, Figure A11), although in a couple cases this may have been due to a fish dying and drifting downriver (Fish 9120). Fish 9123 migration took it almost 100 mi downriver from its tagging site in the Tyone River to the mouth of Portage Creek where it remained through the conclusion of the reporting period. A single longnose sucker was not observed downstream from where it was tagged (Fish 9119). Multiple longnose sucker tagged in the Upper River migrated downstream past the Watana Dam site and into the Middle River.

5.2.2.1.4. Identification of foraging and spawning locations

Arctic grayling

Arctic grayling tagged in the Upper River were observed at a number of possible foraging areas in the Upper and Middle River. Radio-tagged fish primarily spent time at the mouths of clearwater streams but also moved into some tributaries for portions of the summer. Arctic grayling were not spawning during the reporting period.

Longnose sucker

A single longnose sucker held at a possible foraging location at the mouth of Portage Creek. Other longnose sucker in this study were not observed holding in a single location for multiple surveys or with other radio-tagged longnose sucker at the same location. Longnose sucker were not spawning during the reporting period.

5.2.2.1.5. Tag life

All tags released through August 31 had enough battery life to broadcast a signal past August 31 (end of reporting period). According to the manufacturer, the earliest date the battery life of a tag may stop it from broadcasting a signal is October 29. In total, seven tags could lose power starting the last days of October and through the first week of November.

5.2.2.1.6. Post-Tagging Survival

Arctic grayling

Initial survival from radio tagging was high with only two of the 31 Arctic grayling tagged from July 15 to 31 dying by August 15 (Table 5.2-2). Mortalities increased during the second half of August and at the end of the reporting period when 8 of the 32 (25 percent) Arctic grayling tags were in mortality mode. The tag groups with the highest mortalities at the end of August were fish tagged at the mouth of Kosina Creek and at Goose Creek, with two of eight (25 percent) and two of three (67 percent) dying, respectively.

Longnose sucker

Of the five longnose sucker radio-tagged in the Upper River, three (60 percent) were still alive at the end of the reporting period ending August 30, 2013 (Table 5.2-2).

5.2.2.2. PIT Tagging

A total of 1,224 PIT tags were implanted in eight fish species in the Upper River (Table 5.2-4). Arctic grayling were the most frequently tagged species (n=913), followed by Dolly Varden (n=109), round whitefish (n=98), and burbot (n=31). Only 22 Chinook salmon were tagged and none of these were subsequently detected or recaptured. Smaller numbers of PIT tags were applied to undifferentiated whitefish (21), longnose sucker (20), humpback whitefish (9), and lake trout (1) (Table 5.2-4).

Of the fish implanted with PIT tags and released, 3 percent (n=42) were subsequently observed in the Upper River, either via detection at stationary PIT antennas or recapture during later sampling (Table 5.2-4). These fish constitute the dataset of PIT-tagged individuals for which movement information can be discerned. Arctic grayling (n=35) comprised most of the fish observed subsequent to tagging, while a small number of tagged round whitefish (n=3), Dolly Varden (n=2), burbot (n=1), and longnose sucker (n=1) were also observed. Three additional Dolly Varden were recaptured, however, implant records (i.e., date and location of release) for these fish were not available. The Oshetna River antenna array detected more individuals (24) with a higher number of detections (28.876) than the Kosina Creek array (10 individuals and 171 detections; Table 5.2-5). Details regarding movements or recapture of PIT-tagged fish are presented by species. Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_PITTagData).

5.2.2.2.1. Arctic grayling

Of the 35 Arctic grayling that were observed subsequent to tagging, nine were documented moving between streams; the majority (n=26) were detected or recaptured exclusively in the same stream in which they were tagged. One juvenile (180 mm [7 in]) was tagged and released at the Oshetna River rotary screw trap (RM 0.1, upstream of PRM 235.1) on June 16 and detected eight days later on June 24 at the Kosina Creek PIT antenna (RM 0.2, upstream of PRM 209.1), having covered a distance of roughly 26 mainstem river miles. The remaining eight Arctic grayling observed moving between streams were all classified as juvenile/adult. One of these fish (190 mm [7.5 in]) was tagged in Goose Creek (upstream of PRM 232.8) on August 17 and detected 18 days later on September 4 at the Oshetna River PIT antenna (RM 4.5). Another juvenile/adult (190 mm [7.5 in]) was captured and tagged in the Susitna River mainstem (PRM 209) on August 4 and detected three days later at the nearby Kosina Creek PIT antenna.

The remaining seven juvenile/adult Arctic grayling that exhibited inter-stream movements (mean length 272 mm [10.7 in]) were all tagged and released at the Oshetna River rotary screw trap and subsequently detected at the Kosina Creek PIT antenna, covering a distance of roughly 26 mainstem river miles. The average interval between release at the Oshetna River rotary screw trap and detection in Kosina Creek was 40 days (range 6-79 days). All of these fish were released from the Oshetna River over a six-day period (June 15-20), while their detections in Kosina Creek spanned from June 21 to September 2.

Of the 27 Arctic grayling that were observed exclusively in the stream in which they were tagged, the majority (19) were tagged in the Oshetna River and detected at the Oshetna River PIT antenna. For this subset of fish, the average time between a fish's tagging event and its final antenna detection was 23 days (range 0-104 days).

Arctic grayling were the only species in the Upper River that was detected or recaptured in sufficient numbers to offer a comparison of different macrohabitats used by individual fish. For each macrohabitat type in which fish were tagged, Table 5.2-6 displays the corresponding number of fish detected or recaptured by macrohabitat type. Movements were documented between split, single, and complex tributary channels as well as between complex tributary and split main channels. It should be noted that the majority of these fish were tagged at rotary screw traps and subsequently observed at PIT antennas, each of which were situated in a fixed macrohabitat type. Only three Arctic grayling were observed subsequent to tagging at sites other than a rotary screw trap or PIT antenna. Thus, a comparison of movements is largely limited to the macrohabitat types in which the two rotary screw traps and two PIT antennas were located in the Upper River.

5.2.2.2.2. Burbot

One burbot (355 mm [14 in]) initially captured at the Oshetna River rotary screw trap (RM 0.1) and tagged on June 15 was detected 27 days later roughly 4.4 river miles upstream at the Oshetna River PIT antenna (RM 4.5) on July 12.

5.2.2.2.3. Dolly Varden

Two recaptured Dolly Varden were found in the same tributaries in which they were initially captured. One juvenile/adult (85 mm [3.3 in]) was tagged in Watana Creek on July 31 and recaptured 29 days later on August 29. The other juvenile/adult (113 mm [4.4 in]) was tagged in Jay Creek on August 9 and recaptured 53 days later on October 1.

5.2.2.2.4. Longnose sucker

One juvenile longnose sucker (177 mm [7 in]) was captured in a Susitna River side channel near PRM 202.7 on August 6 and recaptured at the same site 14 days later on August 20.

5.2.2.2.5. Humpback Whitefish

While not detected or recaptured in the Upper River, one juvenile humpback whitefish (225 [8.9 in]) tagged at the Oshetna River rotary screw trap (PRM 235) on June 21 was recaptured 16 days later on July 7 at the Curry Station rotary screw trap (PRM 124), having covered a distance of roughly 111 river miles. This fish was then detected 27 days later on August 3 near PRM 104 at the Whiskers Slough PIT antenna.

5.2.2.2.6. Round Whitefish

Each of the three round whitefish observed subsequent to tagging were initially captured in the Oshetna River. After being tagged and released at the Oshetna River rotary screw trap (RM 0.1) on July 30, one juvenile/adult (237 mm [9.3 in]) was detected 9 days later on August 8 at the

Kosina Creek PIT antenna (RM 0.2), having covered a distance of roughly 26 mainstem river miles. One juvenile (147 mm [5.8 in]) tagged in the Oshetna River on September 12 was detected at the Oshetna River PIT antenna on 15 separate days between September 16 and October 6. One juvenile/adult (285 mm [11.2 in]) was tagged in the Oshetna River on September 12 and detected on the same day at the Oshetna River PIT antenna as well as seven days later on September 19.

5.2.3. Task C: Describe juvenile Chinook salmon movements.

Although 22 juvenile Chinook salmon were PIT tagged in the Upper River study area, none of these fish were subsequently detected. Thus, descriptions of juvenile Chinook salmon movements in the Upper River are currently based solely on information from rotary screw trap data, as described in Section 5.2.1.

5.3. Objective 3: Early Life History

Juvenile Chinook salmon in the Upper River were documented on June 29, 2013 in two locations on the Black River, a tributary to the Oshetna River. Six total Chinook salmon fry (fork lengths 38 to 39 mm) were captured by backpack electrofishing in riffle habitats in a complex, braided channel (Table 5.3-1). The two locations, situated in close proximity, were located 2.9 km (1.8 mi) upstream of the confluence with the Oshetna, suggesting that these young-of-the-year fish are likely the offspring of adults that spawned in the Black River in 2012. Low catch during the spring precluded the evaluation of movement of juvenile salmon from spawning rearing habitats in the Upper River. Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_FishObservations).

5.4. Objective 4: Characterize the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type.

Total sample sizes of fish measured for length and weight, by hydrologic segment, are presented in Table 4.7-2. A summary of fish size, growth and condition factor by habitat types is discussed in the subsections below:

5.4.1. Growth by Habitat Type

The number of recaptured PIT-tagged fish used in the growth analysis for the Upper Susitna River is presented in Table 5.4-1. No juvenile Chinook salmon and six Arctic grayling were recaptured. Fish recaptures less than seven days in duration were eliminated from the growth analysis. The tally of fish with seven or more days in duration between recapture events resulted in a sample size of only one adult Arctic grayling. The site-specific growth rate for this fish is described below. Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_PITTagData).

5.4.1.1. Arctic Grayling

One adult Arctic grayling was recaptured in the Upper Susitna River at Watana Creek within the single-channel tributary habitat type. This fish grew at a rate of 0.11 mm/day for a specific growth rate (SGR) of 0.03 percent of its length per day. No comparisons with seasons, fish sizes, or habitat types could be made for Arctic grayling in the Upper River.

5.4.2. Condition Factor by Habitat Type

A summary of the condition factors by habitat type is described for the pilot species below. Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_FishCondFactors).

5.4.2.1. Chinook Salmon

5.4.2.1.1. Juveniles

In the Upper River, 90 juvenile Chinook salmon met the criteria for this analysis. All juvenile Chinook were captured in tributaries including: Kosina Creek, the Black River, and the Oshetna River. Condition factors were similar for Chinook salmon from all three tributaries (Figure 5.4-1); however, only Kosina Creek fish had mean and median condition factors greater than one.

5.4.2.2. Arctic Grayling

5.4.2.2.1. Juvenile / Adult

In the Upper River, 1,049 Arctic grayling met the analysis criteria (Table 4.7-3). Most of these fish (83 percent) were collected from tributaries including the Black and Oshetna rivers, as well as Goose, Watana, Kosina, and Tsisi creeks. Nevertheless, the numbers captured in the mainstem Susitna River in various habitat types were sufficient for analysis. The condition factors for these fish are summarized in Table 5.4-4. There were no differences in Arctic grayling condition factors among habitat types (Figure 5.4-2).

5.5. Objective 5: Determine whether Dolly Varden and humpback whitefish residing in the Upper River exhibit anadromous or resident life histories.

Dolly Varden and humpback whitefish greater than 200 mm (7.9 inches) in length were targeted for otolith collection to test for marine-derived elements indicative of an anadromous life history pattern. Laboratory testing for the presence of marine derived nutrients is not complete at this time and no results are available for this report.

5.6. Objective 6: Determine baseline metal and mercury concentrations in fish tissues for resident fish species in the mainstem Susitna River.

Tissue or whole fish samples were collected in the reservoir inundation zone for assessment of metals and mercury in support of the Baseline Water Quality Study and the Mercury Assessment and Potential for Bioaccumulation Study (ISR Studies 5.5 and 5.7, respectively). The results of baseline sampling for metals, total mercury, and methylmercury (MeHg) concentrations in fish tissue samples are summarized in Section 5.6 and discussed in Section 6.2.3 of the bioaccumulation study (ISR Study 5.7).

5.7. Objective 7: Document the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike).

Northern pike were not previously documented in the Upper River, so no targeted collection efforts for pike were made. No northern pike have been collected in the Upper River fish sampling events conducted by AEA to date (Tables 4.5-1, 4.8-1, 4.9-1 and 4.11-1). Data developed in support of the ISR is available for download at http://gis.suhydro.org/reports/isr (ISR_9_5_FDAUP_FishObservations).

5.8. Objective 8: Collect tissue samples from juvenile salmon and all resident and non-salmon anadromous fish.

Fish tissues were collected opportunistically in conjunction with all fish capture events in support of the Fish Genetic Baseline Study (ISR Study 9.14). Analysis of these samples is reported in that study's ISR.

6. DISCUSSION

The study of Fish Distribution and Abundance in the Upper Susitna River is ongoing. As indicated in Section 4, tasks associated with each of the eight study objectives were initiated in 2013. To address interannual variation and expand upon the current data set, additional work will continue in the next study year (see Section 7.1).

Summary information specific to the status of each of the study objectives is provided in the sections that follow. The discussions include: an overview of interdependencies with other ISR studies, the current status of ISR studies that support the specific objectives of the Study of Fish Distribution and Abundance in the Upper Susitna River, a summary of key findings in 2013, and an assessment of the adequacy of the data collected in 2013 to meet the study objectives. Where applicable, a comparison between 2013 results and previously collected data in the Upper River study area is also provided.

6.1. Fish Distribution, Relative Abundance and Habitat Associations

Three ISR studies support Objective 1 of the Study of Fish Distribution and Abundance in the Upper Susitna River: the Geomorphology Study (Study 6.5), Characterization and Mapping of Aquatic Habitats Study (Study 9.9), and the Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Study 9.12). These studies were initiated in 2012 and study results have been used to inform the site selection process for Fish Distribution and Abundance studies in the Upper Susitna River study area. Study variances for these studies are not anticipated to affect the successful completion of the Study of Fish Distribution and Abundance in the Upper Susitna River. As fish distribution and abundance data analysis continues, the Characterization and Mapping of Aquatic Habitats Study (ISR Study 9.9) provides information relevant to fish-habitat associations in the Upper Susitna River.

Work completed under Objective 1 supports five other ISR studies. Fish collections in the Upper River are being used to: 1) identify species that could colonize the future reservoir site (ISR Study 9.10); 2) provide data on fish barriers for the Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries (ISR Study 9.12) and 3) fish movements for the Study of Fish Passage Feasibility at Watana Dam (ISR Study 9.11. In addition, patterns of distribution and abundance from standardized sampling methods will complement information from opportunistic sampling conducted for radio telemetry, fishwheel, and sonar observations of as part of the Salmon Escapement Study (ISR Study 9.7). Fish distribution and abundance is also being used to provide distribution and relative abundance information relevant to the Fish Harvest Study (ISR Study 9.15).

During the 2013 study year, nine fish species were documented in the Upper Susitna River study area: Chinook salmon, Arctic grayling, burbot, Dolly Varden, lake trout, longnose sucker, sculpin, humpback whitefish, and round whitefish (Table 5.1.1-1). Each of these species was also documented within the study area during studies conducted in the 1980s (ADF&G 1981; ADF&G 1983a; ADF&G 1984) and during 2012 field efforts (HDR 2013).

Distribution patterns varied among species particularly with respect to the use of mainstem Susitna River habitat versus use of tributaries. The most widely distributed species were Arctic grayling and sculpin, which occupied both mainstem and tributary habitats. Some species, such as burbot, longnose sucker, and round whitefish, were most commonly found in the mainstem Susitna River and in larger tributaries. Dolly Varden were found exclusively in tributary habitats. Species with the fewest observations and most constricted distributions were juvenile Chinook salmon, humpback whitefish, and lake trout.

Overall, the relative abundance of juvenile Chinook salmon in the Upper River was low; however, high abundances were observed in localized areas. During 2013sampling efforts, 281 juvenile Chinook salmon observations were made; these occurred in Kosina Creek and the Oshetna and Black rivers (Table 5.1-2). Estimated CPUE values were zero in 95 percent of mesohabitats (Table D15). Exceptions were observed in Kosina Creek and the Black River where CPUE was moderate. Juvenile chinook salmon were most commonly associated with fast water habitats.

Arctic grayling and sculpin were the most abundant and widely distributed species found in the Upper River study area, occurring in 59 percent and 78 percent of sites respectively. As determined by CPUE, Dolly Varden was abundant in specific tributaries and all other species had low to moderate abundance in Upper River sites. Although gear-specific CPUE was frequently zero for other species, comparisons across species for each gear provide confidence that fishes were captured when present.

Estimates of relative abundance and a description of habitat associations for in the Upper River were not available from the 1980s studies. Thus, no comparisons between 2013 findings and historic data were made for these components of Objective 1.

Work completed in 2013 is on-track for meeting Objective 1. Work will continue in the next year of study in order to obtain additional data in support of this task.

6.2. Seasonal Movements

Objective 2 of the Study of Fish Distribution and Abundance in the Upper Susitna River is supported by the Salmon Escapement Study (Study 9.7). The Salmon Escapement Study provides movement data for target species and life stages via fixed receiver and aerial tracking of radio-tagged fish. The study is ongoing, and variances in 2013 are not anticipated to affect the successful completion of the Study of Fish Distribution and Abundance in the Upper Susitna River.

Work completed under Objective 2 of the Study of Fish Distribution and Abundance in the Upper Susitna River supports three other ISR studies. Information on fish movement patterns in the Upper River will be used to support the Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Study 9.12), the Study of Fish Passage Feasibility at Watana Dam (ISR Study 9.11), and the Future Watana Reservoir Fish Community and Risk of Entrainment Study (Study 9.10).

In 2013, information about seasonal patterns of fish movement in the Upper River was obtained via downstream migrant trapping and biotelemetry surveys. The downstream migrant traps, which were located in Kosina Creek and the Oshetna River, resulted in 153 and 1,001 fish captures, respectively. During trap operation in 2013, eight species were captured in the traps: Chinook salmon, Arctic grayling, burbot, Dolly Varden, longnose sucker, sculpin, humpback whitefish, and round whitefish. Each of these species was captured in both the Kosina and Oshetna traps with the exception of burbot, which was captured only in the Oshetna River, and Dolly Varden, which was captured only in Kosina Creek. Biotelemetry surveys utilized PIT and radio tags to track the movement of the seven species: Chinook salmon, Arctic grayling, burbot, Dolly Varden, longnose sucker, humpback whitefish, and round whitefish.

Pulses in the numbers of fish captured at the downstream migrant traps can be used to infer movement patterns for individual species. This was particularly the case for Arctic grayling, which was the most abundant species captured in both the Kosina and Oshetna traps. Pulses in catch indicate downstream movement of grayling during early-, mid- and late-summer sampling periods, suggesting a relatively constant low level of movement out of the Oshetna and into the mainstem Susitna. Similar patterns in seasonal movement were observed for other resident fish species including longnose sucker, humpback whitefish, and round whitefish. Occasional catches of other resident species in traps included Dolly Varden, burbot, and sculpin; but were too low to infer any patterns about seasonal movements. For juvenile Chinook salmon, a single smolt was captured at the Oshetna trap in late July, and a pulse of nine smolts was observed at the Kosina trap in early to mid-August. A single Chinook salmon parr was caught late season,.

Interbasin movements were evident from recaptures of radio-tagged and PIT-tagged Arctic grayling and humpback whitefish. Within the Upper River study area, inter-stream migration distances up to approximately 26 miles were observed, as some Arctic grayling PIT-tagged in the Oshetna River and Goose Creek were subsequently detected in Kosina Creek and the Oshetna River respectively. More extensive inter-basin movements were also observed from radio telemetry surveys; radio-tagged Arctic grayling tagged in the Upper River migrated downstream past the proposed Watana Dam site and travelled as far as 50 miles downstream to Chinook Creek. Finally, one humpback whitefish that was PIT tagged in the Oshetna River was subsequently recaptured twice in the Middle River, first in the Curry rotary screw trap and again by the Whiskers Creek PIT array.

During the 1980s studies, seasonal movement studies were not conducted in the Upper River. Thus, no historic data are available for comparison with the results of Objective 2.

Work completed in 2013 is on-track for meeting Objective 2. However, small sample sizes for some species may limit the ability to draw conclusions regarding species-specific seasonal movement patterns. Downstream migrant trapping and biotelemetry efforts will continue in the next year of study in order to increase sample sizes and obtain additional information on fish movement patterns and timing.

6.3. Early Life History

Objective 3 of the Study of Fish Distribution and Abundance in the Upper Susitna River is not dependent on other ISR studies.

Five fish species were captured during the spring, Early Life History sampling in the Upper River including: Chinook salmon, Arctic grayling, Dolly Varden, humpback whitefish, and round whitefish. For Chinook salmon, which is the only Pacific salmon species known to occur in the Upper River, observations occurred in late June in the Black River approximately 2.9 km (1.8 mi) upstream of its confluence with the Oshetna River.

Early life history was not originally proposed as a component of the Upper River Study but was added during the 2013 study season to specifically target juvenile anadromous salmon during the timeframe from ice break up to June 30. Thus, even with low numbers of juvenile Chinook salmon observed in the Upper River, work completed in 2013 will supplement the Middle River data collection toward Objective 3. This spring sampling effort will continue in the next study year to collect more information on juvenile salmonids movement patterns and timing of movement from spawning to rearing habitats.

6.4. Seasonal size-class structure, growth and condition

Objective 4 of the Study of Fish Distribution and Abundance in the Upper Susitna River is not interrelated with other ISR studies.

To meet Objective 4, over 5,000 paired length-weight measurements were obtained from individual fish representing nine species: Chinook salmon, Arctic grayling, burbot, Dolly Varden, lake trout, longnose sucker, sculpin, humpback whitefish, and round whitefish. For the two species reported on within this ISR (i.e., Chinook salmon and Arctic grayling), 123 and 1,652 paired measurements were obtained, respectively.

Arctic grayling growth analysis was limited to data available for a single adult Arctic grayling that was PIT-tagged and subsequently recaptured and measured. The growth rate of this fish was 0.11 mm/day and had a specific growth rate of 0.03 percent of its length per day. There is currently insufficient data to compare growth rates among seasons, fish size, or habitat types. Arctic grayling condition factors were largely consistent among mainstem Susitna River and tributary macrohabitat types. This could reflect that food resources are not limiting or that the species is high mobile and opportunistically moving to habitats with resources. Condition factors of Arctic grayling observed in the Upper River were consistent with those from the Middle/Lower River.

Condition factors calculated for Upper River juvenile Chinook salmon were greatest in Kosina Creek compared to other locations. Although sample sizes are relatively small and the study is ongoing, Kosina Creek may provide better juvenile rearing habitats than other locations in the Upper River. Condition factors in Kosina Creek were consistent with those observed in the Middle/Lower Study Area while the condition factor of juvenile Chinook salmon from the Oshetna and Black Rivers were on average the lowest found in the Upper/Middle/Lower Susitna Basin.

During the 1980s studies growth rates and condition factors were not determined in the Upper River study area. Thus, no historic data is available for comparison with the results of Objective 4.

Work completed in 2013 is on-track for meeting Objective 4. However, sample sizes for growth analyses are currently limited and preclude growth rate comparisons among seasons, fish size, and habitats. Work will continue in the next study year to increase sample sizes for the size-class, growth, and condition factor analyses.

6.5. Anadromous life-histories

Objective 5 of the Study of Fish Distribution and Abundance in the Upper Susitna River is not dependent on used to support other ISR studies. Results of this study objective will be used to directly address the study objective and the question of whether anadromous forms of Dolly Varden or Humpback Whitefish migrate up through Devils Canyon and are present above the proposed Watana Dam location.

Twenty-eight otolith samples were collected from adult Dolly Varden during the fish distribution surveys in the Upper River in 2013. No samples were obtained from humpback whitefish, due to the scarcity of adults in the Upper River. Results from laboratory testing for the presence of marine derived nutrients are not available at this time.

Work completed in 2013 is on-track for meeting Objective 5. Work will continue in the next year of study to meet the established target sample sizes.

6.6. Baseline metals and mercury

Objective 6 of the Study of Fish Distribution and Abundance in the Upper Susitna River is not dependent on other ISR studies. However, fish tissue sample collections are being used to support the Baseline Metal Levels in Fish Tissue (Study 5.5) and Mercury Assessment and Potential for Bioaccumulation (Study 5.7) studies. During fish distribution and abundance sampling in the Upper River in 2013, 66 tissue samples representing eight species were collected for metals and mercury analysis. Samples were collected from Arctic grayling, burbot, Dolly Varden, longnose sucker, sculpin, lake trout, humpback whitefish, and round whitefish. Results are presented and discussed in ISR Study 5.5 and ISR Study 5.7.

Work completed in 2013 is on-track for meeting Objective 6. Work will continue in the next year of study to meet the established target sample sizes.

6.7. Invasive Species

Objective 7 of the Study of Fish Distribution and Abundance in the Upper Susitna River is not dependent on other ISR studies. If documented, the presence of invasive species would be used to identify species that could colonize the future reservoir site (Study 9.10).

No non-native fish species were documented in the Upper River study area. Work completed in 2013 is on-track for meeting Objective 7. The presence of a single invasive lake trout individual was documented in an unnamed tributary of Watana Creek midway between two lake habitats. Observation of invasive and non-native species will continue to be documented during surveys conducted in the next study year.

6.8. Tissue Collection

Objective 8 of the Study of Fish Distribution and Abundance in the Upper Susitna River is not dependent on other ISR studies. However, fish tissue sample collections are being used to support the Genetics Baseline Study for Selected Fish Species (Study 9.14). During fish distribution and abundance sampling in the Upper River in 2013, 717 tissue samples representing eight species were collected for genetics analysis. Samples were collected from juvenile and adult Chinook salmon, Arctic grayling, burbot, Dolly Varden, longnose sucker, sculpin, humpback whitefish, and round whitefish. Results are presented and discussed in ISR Study 9.14.

Work completed in 2013 is on-track for meeting Objective 8. Work will continue in the next year of study to meet the established target sample sizes.

7. COMPLETING THE STUDY

[Section 7 appears in the Part C section of this ISR.]

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9. TABLES

Table 2-1. Study objectives for the Study of Fish Distribution and Abundance in the Upper Susitna River from the Revised Study Plan. Note that the Revised Study Plan was succeeded by the Final Susitna River Fish Distribution and Abundance Implementation Plan (March 2013).

Obj	Task	Species/ Life stage	Study Sites	Proposed Methods by Season
1A	Distribution	Juvenile salmon, non-salmon anadromous, resident	Representative habitat types	• Single pass sampling • Selection of methods will be site-specific, species-specific, and life-stage-specific. • For juvenile and small fish sampling, electrofishing, snorkeling, seining, fyke nets, angling, DIDSON and video camera where feasible and appropriate. • For adults, directed efforts with seines, gill nets, trot lines, and angling. • To the extent possible, the selected transects will be standardized and the methods will be repeated during each sampling period at a specific site to evaluate temporal changes in fish distribution. • Additional info from radio telemetry studies (Objective #2).
1B	Relative abundance	Juvenile salmon, non-salmon anadromous, resident	Representative habitat types	• Multi-pass sampling • To the extent possible, the selected transects will be standardized and the methods will be repeated during each sampling period at a specific site to evaluate temporal changes in fish distribution. • Snorkeling, beach seine, electrofishing, fyke nets, gillnet, minnow traps, fish wheels, rotary screw traps, etc.
1C	Fish habitat associations	Juvenile salmon, non-salmon anadromous, resident	Representative habitat types	• Analysis of data collected under Objective 1: Distribution. Combination of fish presence, distribution, and density by mesohabitat type by season.
2A	Timing of downstream movement and catch using out-migrant traps	All species; juveniles	At selected out-migrant trap & PIT tag array sites	• Rotary Screw Traps: Maximum of 2. One near the proposed dam site; one near the mouth of a known Chinook salmon spawning tributary. • Combine with fyke net sampling to identify key site-specific differences. • Sampling in mainstem lateral habitats downstream of tributaries with fyke nets, seines, and out-migrant traps
2B	Describe seasonal movements using biotelemetry (PIT and radio-tags)	All species	PIT arrays sites River-wide aerial tracking surveys	• PIT tags: tags opportunistically implanted from a variety of capture. Antenna arrays 2 sites at selected side channel, side slough, tributary mouth, or upland sloughs in the Upper River. • Radio-tags surgically implanted in up to 30 fish of sufficient body size of each species distributed temporally & longitudinally.
2C	Describe juvenile Chinook salmon movements	Juvenile Chinook salmon	Representative habitat types	• PIT tag arrays at tributary mouths, sloughs, and side channels (Obj 2B) • Rotary screw trap in known Chinook spawning tributaries • Monthly measurements of fish size/ growth

Obj	Task	Species/ Life stage	Study Sites	Proposed Methods by Season
3A	Describe emergence timing of salmonids	Juvenile salmonids	Select Tributary Habitat	• Bi-weekly sampling from breakup to July 1 using fyke nets, seines, electrofishing and minnow traps in salmon spawning areas within Focus Areas.
3B	Determine movement patterns and timing of juvenile salmonids from spawning to rearing habitats	Juvenile salmonids	Select Tributary Habitat	• Focus on timing of emergence and movement of newly emergent fish from spawning to rearing areas
4	Document age structure, growth, and condition by season	Juvenile anadromous and resident fish	All study sites for Obj 1B	• Stock biology measurements – length from captured fish up to 100 individuals per season per species per life stage. • Emphasis placed on juvenile Chinook salmon.
5	Seasonal presence/absence and habitat associations of invasive species	Northern pike	All study sites	• Same methods as #1 and #2 above. • The presence of northern pike and other invasive fish species will be documented in all samples • Additional direct efforts with angling as necessary
6	Collect tissue samples to support the Genetic Baseline Study	All	All study sites in which fish are handled	• Opportunistic collections in conjunction with all capture methods listed above. • Tissue samples include axillary process from all adult salmon, caudal fin clips from fish >60 mm, and whole fish <60 mm.

Table 4.1-1. Tributaries selected for fish distribution and abundance sampling in the Upper Susitna River in 2013.

Tributary	Susitna River Mainstem PRM	Listed in AWC Catalog	Stream Accessibility	Average Wetted Width[1] (m)	Drainage Basin Area (km^2)	Average Channel Width[2] (m)	GRTS Sampling Unit Size (m)
Oshetna River	235.1	yes	yes	17	1424.5	34	800
Black River	NA	no	yes	14	NA	NA	400
Goose Creek	232.8	yes	yes	10	269.1	12	200
Proposed Reservoir Inundation Zone PRM 232.5							
Jay Creek	211.0	no	no	8	160.1	14	DIR
Kosina Creek	209.1	yes	partial	33	1036.5	45	800
Tsisi Creek	NA	no	yes	58	NA	NA	400
Unnamed Tributary	206.3	no	unknown	NA	<80.3	NA	200
Unnamed Tributary	204.5	no	unknown	NA	<80.3	NA	200
Unnamed Tributary	197.7	no	unknown	NA	<80.3	NA	200
Watana Creek	196.9	yes	partial	11	452.7	16	400
Watana Creek Tributary	NA	no	yes	NA	NA	13	200
Unnamed Tributary	194.8	no	unknown	NA	321.2	NA	400
Deadman Creek	189.4	no	no	32	453.5	27	DIR
Proposed Dam Site PRM 187.1							

Notes:
1 Data taken from AEA (unpublished 2012 data).
2 Data taken from Saunter and Stratton (1983).
DIR = tributary subject to direct rather than statistical sampling due to accessibility issues.
NA = data not available or applicable

Table 4.1-2. Sampling Effort for GRTS and direct sampling tributaries, 2013.

Tributary	Susitna River Project River Mile	Chinook Salmon Presence Documented	Percent Sampling by Length	Number of GRTS Population Sample Units	Target Number of Distribution Samples	Number of Distribution Sites Sampled[1]	Target Number of Abundance Samples	Number of Abundance Site Sampled	Number of Mesohabitat Units Sampled
GRTS Sampled Tribs									
Oshetna River	235.1	yes	25	52	8	8	5	5	27
Black River	NA	no	25	24	3	3	3	3	12
Goose Creek	232.8	yes	25	81	12	12	8	8	40
Proposed Reservoir Inundation Zone PRM 187.1-232.5									
Kosina Creek	209.1	yes	25	24	3	3	3	3	10
Tsisi Creek	NA	no	25	23	3	3	3	3	10
Unnamed Tributary[4]	206.3	no	15	29	1	0	3	0	0
Unnamed Tributary[3]	204.5	no	15	21	0	0	3	0	0
Unnamed Tributary[3]	197.7	no	15	41	2	0	4	0	0
Watana Creek	196.9	yes	25	60	9	9	6	6	30
Watana Creek Tributary[2]	NA	no	25	67	10	6	7	7	18
Unnamed Tributary[3]	194.8	no	15	32	2	0	3	2	4
Total	**--**	**--**	**--**	**454**	**53**	**44**	**48**	**37**	**151**
Direct Sample Tribs									
Jay Creek	211	no	NA	NA	NA	2	NA	NA	8
Deadman Creek[3]	189.4	no	NA	NA	NA	0	NA	NA	0
Total	**--**	**--**	**--**	**--**	**--**	**2**	**--**	**--**	**8**
Grand Total	**--**	**--**	**--**	**--**	**--**	**46**	**--**	**37**	**159**

Notes:

1 These are single-pass samples without block nets; abundance samples will also be used for distribution (81 total samples)

2 Not all sites sampled due to lack of safe landing zones

3 Not sampled die to private land ownership lower reaches and lack of landing zones in upper reaches. Two days of sampling effort applied each season.

4 Only 1 landing zone present, stream conditions deemed unsafe to sample

Table 4.1-3. Upper Susitna River tributary habitat classification and mesohabitat sampling, 2013

Trib Hab Type	Single Channel							Split Channel											Complex Channel							OCH						
Trib MC/OC HabType	Main Chanel							Split Main Channel					Side Channel						Multi Split MC				Side Channel			Side Slough		SS-BC	Up Slough			
Mesohabitat	Beaver pond	Boulder riffle	Perc channel	Pool	Riffle	Run	Single Total	Boulder riffle	Pool	Rapid	Riffle	Run	Boulder riffle	Glide	Pool	Riffle	Run	Split Total	Boulder riffle	Pool	Riffle	Run	Boulder riffle	Riffle	Complex Total	Glide	Perc channel	Beaver pond	Pool	Run	OCH Total	Grand Total
Black River-01						100	100																						100		100	**200**
Black River-02																						100		100	200					100	100	**300**
Black River-04		100					100																									**100**
Black River-06								100				100					50	250														**250**
Black River-07		100					100																									**100**
Black River-09		100					100																									**100**
Goose Creek-01		100					100																									**100**
Goose Creek-02								100	70								60	230														**230**
Goose Creek-03		100				25	125																									**125**
Goose Creek-04								100				52						152														**152**
Goose Creek-05		100		20		38	158																									**158**
Goose Creek-06								100					100					200														**200**
Goose Creek-07								100								100		200														**200**
Goose Creek-08									100				100					200														**200**
Goose Creek-09								100					80					180														**180**
Goose Creek-10								100				29					40	169														**169**
Goose Creek-11		100					100																									**100**
Goose Creek-12								100								100		200														**200**
Goose Creek-13		100					100																									**100**
Goose Creek-14		100					100																									**100**
Goose Creek-15		100					100																									**100**
Goose Creek-17		100		33			133																									**133**
Goose Creek-18								100								60		160														**160**
Goose Creek-19								100					100					200														**200**
Goose Creek-20												100					70	170														**170**
Goose Creek-28		65				65	130																									**130**
Kosina Creek-01																					100	100			200							**200**
Kosina Creek-02																			100						100							**100**
Kosina Creek-03								100					100					200														**200**
Kosina Creek-04																			100				100		200							**200**
Kosina Creek-05																					100				100							**100**
Kosina Creek-06																			100			100			200							**200**

Trib Hab Type	Single Channel							Split Channel											Complex Channel							OCH						
Trib MC/OC HabType	Main Chanel							Split Main Channel					Side Channel						Multi Split MC				Side Channel			Side Slough		SS-BC	Up Slough			
Mesohabitat	Beaver pond	Boulder riffle	Perc channel	Pool	Riffle	Run	Single Total	Boulder riffle	Pool	Rapid	Riffle	Run	Boulder riffle	Glide	Pool	Riffle	Run	Split Total	Boulder riffle	Pool	Riffle	Run	Boulder riffle	Riffle	Complex Total	Glide	Perc channel	Beaver pond	Pool	Run	OCH Total	Grand Total
Oshetna River-01		100	54				154																									154
Oshetna River-02		100					100																			100					100	200
Oshetna River-03						100	100																									100
Oshetna River-04					100		100																									100
Oshetna River-05										100		65				100		265														265
Oshetna River-06		100					100	100				100					100	300														400
Oshetna River-07						85	85																									85
Oshetna River-08											100	100			100			300														300
Oshetna River-09		100					100																									100
Oshetna River-10								100				100		100				300														300
Oshetna River-11								100				100	100					300														300
Oshetna River-12											100					100		200														200
Oshetna River-13		100					100																									100
Tsisi Creek-01								100				100						200														200
Tsisi Creek-02					100		100																									100
Tsisi Creek-03																					100				100							100
Tsisi Creek-04								100					100					200														200
Tsisi Creek-05												100				100		200														200
Tsisi Creek-06					100		100																				80				80	180
Trib 194.8-01				50	50		100																									100
Trib 194.8-13				100		100	200																									200
Watana Creek-03					100	100	200																					78			78	278
Watana Creek-04											100					100		200														200
Watana Creek-05					100	35	135																									135
Watana Creek-07																				75	100	100			275							275
Watana Creek-08		100					100																									100
Watana Creek-09					100	70	170																									170
Watana Creek-10	50			65	55	75	245																									245
Watana Creek-11					100	100	200																				48				48	248
Watana Creek-13		100					100																									100
Watana Creek-14				100		100	200																			50					50	250
Watana Creek-15					100	60	160																									160
Watana Creek-18																					100				100							100
Watana Creek-20						100	100																									100
Watana Creek-22		100					100																									100
Watana Creek-23												100						100														100

Trib Hab Type	Single Channel						Single Total	Split Channel										Split Total	Complex Channel						Complex Total	OCH					OCH Total	Grand Total
Trib MC/OC HabType	Main Chanel							Split Main Channel					Side Channel						Multi Split MC				Side Channel			Side Slough		SS-BC	Up Slough			
Mesohabitat	Beaver pond	Boulder riffle	Perc channel	Pool	Riffle	Run		Boulder riffle	Pool	Rapid	Riffle	Run	Boulder riffle	Glide	Pool	Riffle	Run		Boulder riffle	Pool	Riffle	Run	Boulder riffle	Riffle		Glide	Perc channel	Beaver pond	Pool	Run		
Watana Creek Trib-02					100		100																									**100**
Watana Creek Trib-06					100		100																									**100**
Watana Creek Trib-07		35			60	55	150																									**150**
Watana Creek Trib-08					100		100																			45					45	**145**
Watana Creek Trib-12											100						34	134														**134**
Watana Creek Trib-13					100		100																									**100**
Watana Creek Trib-16								100				30						130														**130**
Watana Creek Trib-17					100		100																									**100**
Watana Creek Trib-21					100		100																									**100**
Watana Creek Trib-22					100		100																									**100**
Watana Creek Trib-23					100		100																									**100**
Watana Creek Trib-24					100		100																									**100**
Watana Creek Trib-28					100		100																									**100**
Total	**50**	**2,000**	**54**	**368**	**1,965**	**1,208**	**5,645**	**1,700**	**170**	**100**	**400**	**1,076**	**680**	**100**	**100**	**660**	**354**	**5,340**	**300**	**75**	**500**	**400**	**100**	**100**	**1,475**	**195**	**128**	**78**	**100**	**100**	**601**	**13,061**
Direct Sample Tributary																																
Jay Creek-01				67		100	167																									167
Jay Creek-02				45	70	42	157																									157
Total				112	70	142	324																									324
Grand Total	**50**	**2000**	**54**	**480**	**2,035**	**1,350**	**5,969**	**1,700**	**170**	**100**	**400**	**1,076**	**680**	**100**	**100**	**660**	**354**	**5,340**	**300**	**75**	**500**	**400**	**100**	**100**	**1,475**	**195**	**128**	**78**	**100**	**100**	**601**	**13,385**

Table 4.1-4. Sample effort for mainstem transects in the Upper River, 2013.

Transect ID	PRM	Sampled	Sample Type	Main Channel	Side Channel	Side Slough	Tributary Mouth/Plume	Total
Proposed Dam Site PRM 187.1								
1	188.3	No	Distribution	0	0	0	0	**0**
2	190.7	Yes	Distribution	1	0	0	0	**1**
3	193.1	Yes	Distribution	1	0	0	0	**1**
4	195.5	Yes	Distribution	1	0	1	0	**2**
5	197.9	Yes	Distribution	1	0	0	0	**1**
6	200.3	Yes	Distribution	1	1	0	0	**2**
7	202.7	Yes	Relative Abundance	1	1	0	0	**2**
8	205.1	Yes	Relative Abundance	1	0	0	0	**1**
9	207.5	Yes	Distribution	1	0	0	0	**1**
10	209.9	Yes	Distribution	1	0	0	0	**1**
11	212.3	Yes	Distribution	1	0	0	1	**2**
12	214.7	Yes	Distribution	1	0	0	0	**1**
13	217.1	Yes	Relative Abundance	1	0	0	1	**2**
14	219.5	Yes	Distribution	1	0	0	1	**2**
15	221.9	No	Distribution	0	0	0	0	**0**
Proposed Reservoir Inundation Zone at Low Pool 222.5								
16	224.3	Yes	Distribution	1	0	0	0	**1**
17	226.7	No	Distribution	0	0	0	0	**0**
18	229.1	No	Distribution	0	0	0	0	**0**
19	231.5	Yes	Relative Abundance	1	0	0	0	**1**
Proposed Reservoir Inundation Zone at Maximum Pool 232.5								
20	233.9	Yes	Distribution	1	0	0	0	**1**
Total				**16**	**1**	**1**	**3**	**22**

Notes:
* Dangerous sampling conditions including swift bouldery habitats.
** Dangerous sampling conditions and no location to stop the raft for sampling purposes.

Table 4.2-1. Salmon early life history sampling summary, 2013.

	Event 1		Event 2	
	Start date	**End date**	**Start date**	**End date**
	6/4/13	**6/12/13**	**6/23/13**	**6/29/13**
Tributary	**Number of sites**		**Number of sites**	
Oshetna River	8		8	
Black River	2		2	
Kosina Creek	6		7	
Tsisi Creek	2		2	
Tsisi Lake 1	1		ns	
Tsisi Lake 2	1		ns	
Susitna River	1		1	
Total	**21**		**20**	

ns = not sampled

Table 4.2-2. Antenna orientation for fixed-station receiver locations in the Upper Susitna River, 2013.

Station	PRM	Installation Date	Status	Antenna Orientation			Rational
				Antenna 1	**Antenna 2**	**Antenna 3**	
Oshetna River	235.1	29-Jun	Installed	Down Susitna River	Up Susitna River	Up Oshetna River	Large accessible tributary within impoundment zone
Proposed Reservoir Inundation Zone PRM 232.5							
Kosina Creek	209.1	30-Jun	Installed	Down Susitna River	Up Susitna River	Up Kosina Creek	Salmon spawning stream
Deadman	191.2	2-Jul	Installed in place of Watana Dam Site	Down Susitna River	Up Susitna River		Monitor fish movement between the Middle and Upper rivers
Watana Dam Site	188.0	N/A	Not installed due to land access	Down Susitna River	Up Susitna River		Monitor fish moving past the proposed dam site
Proposed Dam Site 187.1							
Watana Creek	169.9	N/A	Not installed due to land access	Down Susitna River	Up Susitna River	Up Watana Creek	Large accessible tributary within impoundment zone

Table 4.2-3. Monitoring efficiency (percent operational) of fixed-station receivers in the Susitna River drainage in 2013, by week. Percentages were calculated as the number of hours of recorded receiver activity divided by the number of hours in the week; "-" = 'not deployed'. Receivers were considered active in a given hour if at least one fish detection, beacon hit, or noise event was recorded during the hour. Data are currently preliminary through 9/9. Shading indicates incomplete data series.

Week	Deadman Creek	Kosina Creek	Oshetna River
6/2 - 6/8	-	-	-
6/9 - 6/15	-	-	-
6/16 - 6/22	-	-	-
6/23 - 6/29	-	-	0%
6/30 - 7/6	57%	86%	0%
7/7 - 7/13	100%	100%	20%
7/14 - 7/20	100%	100%	100%
7/21 - 7/27	100%	100%	100%
7/28 - 8/3	100%	51%	100%
8/4 - 8/10	100%	0%	100%
8/11 - 8/17	100%	17%	100%
8/18 - 8/24	24%	0%	23%
8/25 - 8/31	0%	0%	0%

Table 4.2-4. Summary of aerial surveys of radio-tagged fish in the Upper Susitna River, 2013. Data are currently preliminary through 9/9.

Zone Number	201	203	205	207	212	215	222	225	232	235
Waterbody	Susitna River	Deadman Creek PRM 189.4	Susitna River	Unnamed Tributary PRM 194.8	Watana Creek PRM 196.9	Susitna River	Kosina Creek PRM 209.1	Susitna River	Oshetna River PRM 235.1	Susitna River
Begin	Dam Site PRM 187.1		Deadman Creek PRM 189.4			Wantana Creek PRM 196.9		Kosina Creek PRM 209.1		Above Oshetna River PRM 235.1
End	Deadman Creek PRM 189.4		Watana Creek PRM 196.9			Kosina Creek PRM 209.1		Oshetna River PRM 235.1		
7-2	H		H							
7-6	H		H				H	H		
7-7	H		H							
7-12	H		H			H		H		
7-15	H									
7-18	H		H			H				
7-19	H		H			H		H		
7-20	H		H			H		H	H	H
7-21	H									H
7-22	H									H
7-23										H
7-24										H
7-25										H
7-26	H		H			H				H
7-27	H									H
7-28	H									H
7-29										H
7-30										H
7-31	H		H			H	H	H	H	H
8-1	H	H	H		H	H				
8-6	H	H	H		H	H	H	H	H	H
8-13	H	H	H	H	H	H	H	H	H	
8-19	H	H	H	H	H	H	H	H	H	
8-26	H	H	H	H	H	H	H	H	H	

H=Helicopter Survey

Table 4.5-1. Length and weight of fish species tagged for biotelemetry studies in the Upper Susitna River, 2013.

Species	Lifestage	Tag Type	N	Median Length (mm)	Length Range (mm)
Chinook salmon	Juvenile	PIT	22	74	61-95
Arctic grayling	Adult	PIT	76	347	330-430
Arctic grayling	Juvenile	PIT	408	136	55-189
Arctic grayling	Juvenile-or-adult	PIT	429	248	190-328
Arctic grayling	Juvenile-or-adult	Radio	57	317	241-410
Burbot	Adult	PIT	2	597	590-603
Burbot	Juvenile	PIT	15	198	161-270
Burbot	Juvenile-or-adult	PIT	14	338	281-495
Burbot	Juvenile-or-adult	Radio	7	528	405-655
Dolly Varden	Juvenile	PIT	2	78	74-81
Dolly Varden	Juvenile-or-adult	PIT	107	149	85-238
Lake trout	Juvenile	PIT	1	114	-
Longnose sucker	Adult	PIT	1	370	-
Longnose sucker	Juvenile	PIT	2	171	164-177
Longnose sucker	Juvenile-or-adult	PIT	17	223	188-340
Longnose sucker	Juvenile/adult	Radio	10	374	281-412
Whitefish, humpback	Juvenile	PIT	5	249	152-268
Whitefish, humpback	Juvenile-or-adult	PIT	4	299	280-355
Whitefish, round	Adult	PIT	14	329	320-403
Whitefish, round	Juvenile	PIT	37	155	84-198
Whitefish, round	Juvenile-or-adult	PIT	47	260	199-310
Whitefish, round	Juvenile/adult	Radio	18	322	280-412
Whitefish, undifferentiated	Juvenile	PIT	4	108	80-168
Whitefish, undifferentiated	Juvenile-or-adult	PIT	17	270	215-320

Table 4.5-2. Radio tag allocation by season Upper Susitna River, 2013

	Upper Susitna					
Species	**May/June**	**July**	**August**	**Sept**	**Total**	**Live [b]**
Arctic grayling	0 (0[a])	31 (10)	1 (10)	25 (10)	57 (30)	28
Burbot	0 (10)	0 (10)	0 (10)	7 (10[a])	7 (30)	2
Dolly Varden	0 (10)	0 (10)	0 (10[a])	0 (0)	0 (30)	0
Longnose sucker	0 (10)	5 (10)	0 (10)	5 (10)	10 (30)	2
Northern pike	0 (10)	0 (10)	0 (10)	0 (10)	0 (30)	0
Lake trout	0 (10)	0 (10)	0 (10)	0 (10)	0 (30)	0
Rainbow trout	0 (0[a])	0 (10)	0 (10)	0 (10)	0 (30)	0
Humpback whitefish	0 (10)	0 (10)	0 (10[a])	0 (0)	0 (30)	0
Round whitefish	0 (10)	0 (10)	0 (10[a])	18 (0)	18 (30)	9

Format: tags applied (target number of tags).
[a] FERC recommended tagging ($n \geq 10$) periods. Tagging during spawning periods conducted at the discretion of the surgeon as based on fish condition.
[b] Live tags as of aerial survey on January 29, 2014. Data subject to ongoing evaluation of tag status.

Table 4.7-1. Summary of size-at-life stage index used to classify Susitna River species, 2013.

Species	Life stage			Source
	Juvenile	Juvenile-or-adult	Adult	
Alaska blackfish	<42	42–113	>113	Buckwalter et al. (2012)
Arctic grayling	<190	190–328	>328	Buckwalter et al. (2012)
Arctic lamprey	<125	125-219	>219	Heard 1966; Docker 2009; Vladykov and Kott 1978
Bering cisco	Not Applicable			
burbot	<280	280–498	>498	Buckwalter et al. (2012)
Dolly Varden	<83	≥83	-	Buckwalter et al. (2012)
eulachon	Not Applicable			
longnose sucker	<188	188–348	>348	Buckwalter et al. (2012)
northern pike	<330	330–448	>448	Buckwalter et al. (2012)
sculpin (slimy)	<51	51–68	>68	Buckwalter et al. (2012)
threespine stickleback	<40	40-70	>70	ADFG 1981
lake trout	<300	300-430	430	Burr 1993
rainbow trout	<200	200-325	>325	Russell 1977, Adams 1999
humpback whitefish	<280	280–363	>363	Buckwalter et al. (2012)
round whitefish	<199	199–318	>318	Buckwalter et al. (2012)
Whitefish, undifferentiated	<199	199-363	>363	
Chinook salmon	alevin, fry, parr, smolt index			
chum salmon	alevin, fry, parr, smolt index			
coho salmon	alevin, fry, parr, smolt index			
pink salmon	alevin, fry, parr, smolt index			
sockeye salmon	alevin, fry, parr, smolt index			

Table 4.7-2. Summary of fish with length and weight measurements collected in the Upper, Middle and, Lower Susitna River by hydrologic segment, 2013.

Species	Hydrologic Segment			
	Lower River	**Middle River**	**Upper River**	**Total**
Chum salmon	60	56		116
Chinook salmon	672	1,366	123	2,161
Coho salmon	487	2,820		3,307
Pink salmon	7	39		46
Sockeye salmon	253	199		452
Pacifc salmon, undifferentiated	44	77		121
Arctic grayling	38	889	1,652	2,579
Burbot	152	280	85	517
Dolly Varden	13	167	299	479
Lamprey	123	19		142
Longnose sucker	661	560	126	1,347
Northern pike	44			44
Salmonid, undifferentiated		4	1	5
Sculpin	679	2,129	2,596	5,404
Stickleback, ninespine	140			140
Stickleback, threespine	884	457		1,341
Stickleback, undifferentiated	3	48		51
Trout, lake			1	1
Trout, rainbow	142	349		491
Whitefish, Bering cisco	2			2
Whitefish, round	108	472	173	753
Whitefish, humpback	8	102	8	118
Whitefish, undifferentiated	52	317	20	389
Grand Total	**4,572**	**10,350**	**5,084**	**20,006**

Table 4.7-3. Sample sizes of juvenile Chinook salmon and Arctic grayling included in the condition factor analysis by mainstem geomorphic reach and tributary

Tributary/ Geomorphic Reach	PRM	Arctic Grayling	Chinook Salmon
Oshetna River	235.1	128	1
Black River	N/A	59	22
Goose Creek	232.8	316	
Upper Extent Watana Reservoir PRM 232.5			
Susitna River UR-3	224.9-234.5	27	
Jay Creek	211	11	
Kosina Creek	209.1	40	67
Tsisi Creek	N/A	38	
Susitna River UR-4	208.1-224.9	38	
Susitna River UR-5	203.4-208.1	15	
Watana Creek	196.9	264	
Unnamed 194.8	194.8	8	
Susitna River UR-6	187.1-203.4	96	
Proposed Watana Dam Location PRM 187.1			
Subtotal		**1,040**	**90**

Table 4.8-1. Summary of otolith collection for Dolly Varden in 2013.

Dolly Varden			
Index	Date	Length (mm)	Location
1	10/4/2013	200	Watana Creek Site 14
2	10/4/2013	200	Watana Creek Site 14
3	10/4/2013	200	Watana Creek Site 14
4	10/4/2013	204	Watana Creek Site 14
5	10/4/2013	208	Watana Creek Site 14
6	10/4/2013	209	Watana Creek Site 14
7	10/4/2013	210	Watana Creek Site 14
8	10/4/2013	214	Watana Creek Site 14
9	10/4/2013	215	Watana Creek Site 14
10	10/4/2013	216	Watana Creek Site 14
11	10/4/2013	216	Watana Creek Site 14
12	10/4/2013	216	Watana Creek Site 14
13	10/4/2013	216	Watana Creek Site 14
14	10/4/2013	217	Watana Creek Site 14
15	10/4/2013	218	Watana Creek Site 14
16	10/4/2013	218	Watana Creek Site 14
17	10/4/2013	223	Watana Creek Site 14
18	10/4/2013	224	Watana Creek Site 14
19	10/4/2013	225	Watana Creek Site 14
20	10/4/2013	226	Watana Creek Site 14
21	10/4/2013	228	Watana Creek Site 14
22	10/4/2013	231	Watana Creek Site 14
23	10/4/2013	235	Watana Creek Site 14
24	10/4/2013	238	Watana Creek Site 14
25	10/4/2013	245	Watana Creek Site 14
26	10/4/2013	248	Watana Creek Site 14
27	10/4/2013	250	Watana Creek Site 14
28	10/4/2013	263	Watana Creek Site 14

Table 4.9-1. Summary of tissue collection for baseline metal and mercury concentration evaluation, 2013.

Date	Target Species	Size (mm)	Location	Baseline Metal Tissue Samples	Mercury Tissue Samples
8/11/12	Arctic Grayling	248	Watana Creek	1	1
8/11/12	Arctic Grayling	340	Watana Creek	1	1
6/25/13	Arctic Grayling	160	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	225	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	155	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	185	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	180	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	170	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	215	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	215	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	235	Kosina Creek TRM 2.2		1
6/25/13	Arctic Grayling	75	Kosina Creek TRM 2.2		1
6/26/13	Arctic Grayling	180	Kosina Creek TRM 2.3		1
8/4/13	Arctic Grayling	310	Kosina Creek TRM 2.2		1
8/4/13	Arctic Grayling	300	Kosina Creek TRM 2.2		1
8/4/13	Arctic Grayling	330	Kosina Creek TRM 2.2		1
8/5/12	Burbot	410	RM 186.8	1	1
8/5/12	Burbot	410	RM 192.6	1	1
8/9/13	Burbot	443	PRM 193.1	1	1
8/16/13	Burbot	467	PRM 224.3	1	1
8/17/13	Burbot	390	PRM 217.1	1	1
10/4/13	Burbot	451	PRM 214.7	1	1
10/4/13	Burbot	417	PRM 214.7	1	1
9/18/13	Dolly Varden	177	Watana Creek Site 04		1
9/18/13	Dolly Varden	187	Watana Creek Site 04		1
9/18/13	Dolly Varden	204	Watana Creek Site 04		1
10/3/13	Dolly Varden	195	Watana Creek Site 14		1
10/3/13	Dolly Varden	194	Watana Creek Site 14		1
10/3/13	Dolly Varden	186	Watana Creek Site 14		1
10/3/13	Dolly Varden	196	Watana Creek Site 14		1
8/3/12	Lake Trout	510	Sally Lake	1	1
8/3/12	Lake Trout	430	Sally Lake	1	1
9/20/13	Lake Trout	625	Deadman Lake		1
9/20/13	Lake Trout	450	Deadman Lake		1
9/20/13	Lake Trout	460	Deadman Lake		1
9/20/13	Lake Trout	590	Deadman Lake		1
9/20/13	Lake Trout	455	Deadman Lake		1
9/20/13	Lake Trout	355	Deadman Lake		1

Date	Target Species	Size (mm)	Location	Baseline Metal Tissue Samples	Mercury Tissue Samples
9/20/13	Lake Trout	380	Deadman Lake		1
8/9/13	Longnose Sucker	320	PRM 195.5		1
8/9/13	Longnose Sucker	320	PRM 193.1		1
8/13/13	Longnose Sucker	350	Oshetna River		1
8/13/13	Longnose Sucker	430	Oshetna River		1
8/13/13	Longnose Sucker	340	Oshetna River		1
8/13/13	Longnose Sucker	315	Oshetna River		1
8/13/13	Longnose Sucker	350	Oshetna River		1
9/12/13	Longnose Sucker	330	PRM 217.1		1
9/12/13	Slimy Sculpin	85	PRM 219.5		1
9/12/13	Slimy Sculpin	86	PRM 219.5		1
9/12/13	Slimy Sculpin	87	PRM 219.5		1
9/16/13	Slimy Sculpin	100	PRM 202.7		1
9/16/13	Slimy Sculpin	87	PRM 202.7		1
9/16/13	Slimy Sculpin	92	PRM 202.7		1
9/18/13	Slimy Sculpin	74	PRM 195.5		1
8/13/13	Whitefish, Humpback	340	Oshetna River		1
8/16/13	Whitefish, Round	130	Oshetna River		1
8/16/13	Whitefish, Round	450	PRM 219.5		1
8/18/13	Whitefish, Round	372	PRM 212.3		1
8/18/13	Whitefish, Round	317	PRM 209.9		1
8/29/13	Whitefish, Round	309	PRM 190.7		1
8/30/13	Whitefish, Round	278	Watana Creek Site 13		1
9/10/13	Whitefish, Round	140	PRM 233.9		1
9/10/13	Whitefish, Round	175	PRM 233.9		1
9/10/13	Whitefish, Round	342	PRM 233.9		1
8/13/13	Whitefish, Undifferentiated	190	Oshetna River		1
8/14/13	Whitefish, Undifferentiated	365	Kosina Creek		1

Table 4.11-1. Summary of tissue collection for genetic baseline development, 2013.

Location	Chinook salmon	Arctic Grayling	Burbot	Dolly Varden	Longnose sucker	Salmonid, undifferentiated	Sculpin	Whitefish, humpback	Whitefish, round	Grand Total
Black River	55		15		1		24		2	**97**
Oshetna River	3	4	8		2	1	15	1	8	**42**
Goose Creek					3				6	**9**
Upper Extent Watana Reservoir PRM 232.5										
Susitna River-UR-3			7		3				10	**20**
Jay Creek			5	41						**46**
Kosina Creek	63	53	2		6		4	1	3	**132**
Susitna River UR-4			34		13		3		17	**67**
Susitna River UR-5			4						10	**14**
Watana Creek Tributary				44					2	**46**
Watana Creek				118	1				5	**124**
Unnamed Tributary 194.8				26						**26**
Susitna River UR-6			9		56		5		24	**94**
UR Study Area Total	**121**	**57**	**84**	**229**	**85**	**1**	**51**	**2**	**87**	**717**

Table 5.1-1. Fish Distribution in the Upper Susitna River 2012 & 2013 and select historical records.

Location	Poject River Mile	Drainage Basin Size (km^2)	Chinook salmon (juvenile)	Arctic grayling	Burbot	Dolly Varden	Lake trout	Longnose sucker	Sculpin	Whitefish, humpback	Whitefish, round	Whitefish, unspecified
Susita River Devils Canyon to Watana Dam 2013	166.1-187.1		X	X	X	X		X	X		X	X
Proposed Watana Dam Location	187.1	---	---	---	---	---	---	---	---	---	---	---
Susitna River UR-6	187.1-203.4			X	X			X	X	X	X	
Susitna River UR-5	203.4-208.1			X	X			X	X		X	
Susitna River UR-4	208.1-224.9			X	X			X	X		X	
Susitna River UR-3	224.9-234.5			X	X			X	X		X	
Watana Reservoir at Full Pool	232.5	---	---	---	---	---	---	---	---	---	---	---
Susitna River above Oshetna	>234.5			X								
Aerial Mainstem - Dam site to Oshetna	N/A			X				X				
Deadman Creek	189.4	453.5		X, □	□	□		□	X			
Unnamed Tributary 194.8	194.8	321.2		X		X			X			
Watana Creek	196.9	452.7		X, O	□	X, O		X, □	X, O		X, O	
Watana Creek Tributary: Unnamed L1	N/A			X					X			
Watana Creek Tributary: Unnamed L3	N/A								X			
Watana Creek Tributary: Unnamed R3	N/A			X					X			
Watana Creek Tributary: Unnamed R5	N/A			X			X		X		X	
Unnamed Tributary 197.7	197.7	<80.3		X					X			
Unnamed Tributary 198.4	198.4					X						
Unnamed Tributary 203.4	203.4			X					X			
Unnamed Tributary 206.3	206.3	<80.3							X			
Kosina Creek	209.1	1036.5	X, O	X	X, □	X, O		X, □	X, O	X, O	X	X
Kosina Creek Tributary: Tsisi Creek	N/A			X					X		X	X
Kosina Creek Tributary: Gilbert Creek	N/A			X					X, O			
Kosina Creek Tributary: Unnamed	N/A								X			
Jay Creek	211	106.1		X, O	X, □	X, □		□	X		□	
Goose Creek	232.8	269.1		X, O	□			X	X, O		X	
Oshetna River	235.1	1424.5	X, O	X, O	X			X	X	X	X	X
Oshetna River Tributary: Black River	N/A		X	X	X, □	O		X, O	X, O		X, O	
Tyone River	247.3							X				
Clearwater Creek	266.6			X								
Deadman Basin Lake: Deadman Lake	N/A			□	□	□	X, □			□	□	
Deadman Basin Lake: Unnamed Lake	N/A						X					
Watana Basin Lake: Sally Lake	196.9			X, □			X, □		X, □			
Kosina Basin Lake: Tsisi Lake	N/A			X								

X: Fish Distribution and Abudance 2012-2013

□: ADF&G 1981, 1983a, 1984

O: Buckwalter 2011

Table 5.1-2. Upper Susitna fish observations, 2013. Includes all data sources: Early-Life History sampling (ELH), GRTS tributary sampling (GRTS), Direct tributary sampling(Direct), mainstem transect sampling (Transect), rotary screw trap (RST), opportunistic sampling (Opportunistic), targeted sampling for radio tagging (RT), and targeted sampling for genetics (Genetics), and targeted sampling for metals/mercury samples (Metals).

Geomorphic Reach	Habitat	Project River Mile	Sample Type	Salmon, Chinook (adult)	Salmon, Chinook (juvenile)	Arctic grayling	Burbot	Dolly Varden	Longnose sucker	Sculpin	Trout, lake	Whitefish, humpback	Whitefish, round	Whitefish, undifferentiated	Total
NA	Clearwater Creek	266.6	RT			4									**4**
UR-2	Tyone River	247.3	RT						6						**6**
	Oshetna River	235.1	ELH, GRTS, RST, Genetics, Opportinstic, RT		4	952	22		191	2,031		11	86	45	**3,342**
	Oshetna River: Off-Channel		GRTS			7				84					**91**
	Black River		ELH, GRTS, Opportinstic		78	115	13		1	997			3		**1,207**
	Black River: Off-Channel		GRTS		2	19	1			121					**143**
UR-3	Susitna River	224.9-234.5	Transect			57	12		4	44		2	17		**136**
	Goose Creek	232.8	GRTS, RT			1,513			7	281			43		**1,844**
	Watana Reservoir at Full Pool	***232.5***													
UR-4	Susitna River	208.1-224.9	Transect, RT			70	48		13	127			19		**277**
	Jay Creek	211	Direct, RT			44	3	137		37					**221**
	Kosina Creek	209.1	ELH, GRTS, RST, Genetics, Opportinstic, RT	2	197	509	2	5	12	486		4	19	9	**1,245**
	Tsisi Creek		ELH, GRTS			310				487			4	1	**802**
	Tsisi Creek: Off-Channel		GRTS			23				32					**55**
UR-5	Susitna River	203.4-208.1	Transect, RT			22	8		4	25			22		**81**
UR-6	Susitna River	187.1-203.4	Transect, RT			168	17		80	188		1	37		**491**
	Susitna River: Off-Channel		Transect			3			16	75			1		**95**
	Watana Creek	196.9	GRTS, Opportunistic, RT			292	3	494	1	563			22		**1,375**
	Watana Creek: Off-Channel		GRTS					13		15					**28**
	Watana Creek Unnamed Tributary		GRTS			736		56		169	1		7		**969**
	Watana Creek Unnamed Tributary: Off-Channel		GRTS					2		24					**26**
	Unnamed Tribuatry	194.8	GRTS			16		71	1	158					**246**
	Deadman Creek & Lake	189.4	RT, Metals			9					7				**16**
	Proposed Watana Dam Location	***187.1***													
Upper River Total				**2**	**281**	**4,869**	**129**	**778**	**336**	**5,944**	**8**	**18**	**280**	**55**	**12,700**

Observation data are provisional and subject to revision based on ongoing QA/QC

Table 5.1-3. Fish distribution and abundance (transect, GRTS, and direct sample) sampling total observations for each gear type by species and life stage, 2013.

Species	Life stage	Gear Type							Grand Total
		Backpack Electrofish	Snorkel	Minnow Trap	Angle	Boat Electrofish	Fyke Net	Seine	
Chinook Salmon	Fry	1	6	2					**9**
	Parr	8		6					**14**
	Juvenile	84	12	18			3		**117**
	Total	**93**	**18**	**26**			**3**		**140**
Arctic Grayling	Adult	115	562		107	63		2	**849**
	Juvenile	366	467	28	12	2	15	18	**908**
	Juvenile or Adult	368	760	7	77	15	29	6	**1,262**
	Unknown	3		2			3		**8**
	Total	**852**	**1,789**	**37**	**196**	**80**	**47**	**26**	**3,027**
Burbot	Adult	13		2		14		1	**30**
	Juvenile	16		1		1			**18**
	Juvenile or Adult	22		1		1			**24**
	Total	**51**		**4**		**16**		**1**	**72**
Dolly Varden	Adult	69	23	5	5				**102**
	Juvenile	84	150	22					**256**
	Juvenile or Adult	111	189	32	1		5		**338**
	Unknown	4		3					**7**
	Total	**268**	**362**	**62**	**6**		**5**		**703**
Lake Trout	Juvenile	1							**1**
Longnose Sucker	Adult	14	4			5		18	**41**
	Juvenile	5		8				12	**25**
	Juvenile or Adult	17	1	7		1		14	**40**
	Unknown							1	**1**
	Total	**36**	**5**	**15**		**6**		**45**	**107**
Salmonid, species unknown	Juvenile	1							**1**
Sculpin	Adult	290	4	76		3	6	1	**380**
	Juvenile	108	2	2		1		1	**114**
	Juvenile or Adult	1,913	5	334			27	5	**2,284**
	Unknown	31	2	23					**56**
	Total	**2,342**	**13**	**435**		**4**	**33**	**7**	**2,834**
Species unknown	Unknown	**0**	**0**	**2**	**2**	**4**	**0**	**0**	**8**
Whitefish, round	Adult	12	38			21	2	3	**76**
	Juvenile	10	1				1	9	**21**
	Juvenile or Adult	8	18			4			**30**
	Unknown	1							**1**
	Total	**31**	**54**			**25**	**3**	**12**	**128**
Whitefish, species unknown	Adult		1						**1**
	Grand Total	**3,675**	**2,245**	**581**	**204**	**135**	**91**	**91**	**7,022**

Note: Observation data are provisional and subject to revision based on ongoing QA/QC

Table 5.2-1. Upper Susitna River rotary screw trap catch by species and life stage, 2013.

	Rotary screw trap location	Kosina Creek	Oshetna River	
	Geomorphic reach	UR-4	UR-2	
	Project River Mile	209.1	235.1	Grand
Species	**Life stage**			**Total**
Chinook salmon	Parr	1		**1**
	Smolt	9	1	**10**
	Adult	1		**1**
Arctic grayling	Juvenile	91	233	**324**
	Juvenile/Adult	22	335	**357**
	Adult	4	38	**42**
Burbot	Juvenile		3	**3**
	Juvenile/Adult		1	**1**
Dolly Varden	Juvenile/Adult	2		**2**
Longnose sucker	Juvenile		97	**97**
	Juvenile/Adult	1	42	**43**
	Adult		46	**46**
Sculpin	Juvenile	5	11	**16**
	Juvenile/Adult		21	**21**
	Adult	3	38	**41**
Whitefish, humpback	Juvenile		5	**5**
	Juvenile/Adult	2	5	**7**
Whitefish, undifferentiated	Juvenile	1	12	**13**
	Juvenile/Adult	7	33	**40**
Whitefish, round	Juvenile		34	**34**
	Juvenile/Adult	4	39	**43**
	Adult		7	**7**
Grand Total		**153**	**1,001**	**1,154**

Note: Catch data are provisional and subject to revision based on ongoing QA/QC

Table 5.2-2. Movement and survival of Arctic grayling during 2 week periods, by tagging group, Upper Susitna River, 2013.

Arctic Grayling	Rls 7/15 - 7/31				Rls 7/15 - 7/31				Rls 7/15 - 7/31				Rls 7/15 - 7/31				Rls 7/15 - 7/31				Rls 7/15 - 7/31				Rls 8/15 - 8/30	
Zone Name	Rls *	1 Aug	15 Aug	30 Aug	Rls *	1 Aug	15 Aug	30 Aug	Rls *	1 Aug	15 Aug	30 Aug	Rls *	1 Aug	15 Aug	30 Aug	Rls *	1 Aug	15 Aug	30 Aug	Rls *	1 Aug	15 Aug	30 Aug	Rls *	30 Aug
Indian River																										
Indian River trib																										
MOB - Indian trib																		1	1	1						
MOB - Indian - Slough 21																										
MOB - Slough 21																										
Powerline																										
MOB - above Powerline																										
MOB - abv Powerline - Portage																										
MOB - Jack Long Creek																										
MOB - Portage trib																										
MOB - Portage - Impediment1																										
MOB - Impediment1 - Cheechako																										
MOB - Cheechako Creek																										
MOB - Cheechako - Impediment2																										
MOB - Impediment2 - Chinook												1														
MOB - Chinook Creek																										
MOB - Chinook - Impediment3																										
MOB - Devils Creek																										
Devils Island				1							1															
MOB - Impediment3 - Devil Stn																										
MOB - Devil Stn - Fog																										
MOB - Fog Creek																										
MOB - Fog - Dam Site			1								1	1														
MOB - Tsusena Creek		2	2																							
MOB - Dam Site - Deadman		4	3	1																						
Deadman Creek																										
MOB - Deadman Creek				2																						
MOB - Deadman - Watana	7					1	2	1																		
MOB - 'Creek 192'																										
MOB - Watana Creek					3	1		1			1	1														
MOB - Wantana - Kosina						1	1								1										1	1
Kosina Creek										5	4	3		1	1	1										
MOB - Kosina Creek									8																	
MOB - Kosina - Oshetna										2			3	2	1											
Oshetna River																										
MOB - Oshetna River																	8	7	7	7						
MOB - above Oshetna																					2	2	2	2		
Total Tags Live	7	6	6	4	3	3	3	2	8	7	7	6	3	3	3	1	8	8	8	8	2	2	2	2	1	1
Mort tags **	0	1	1	3	0	0	0	1	0	1	1	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0

* unique time and location

** mortality tags not shown in table

Table 5.2-3. Movement and survival of longnose sucker during 2 week periods, by tagging group, Upper Susitna River, 2013.

Longnose Sucker		Released 7/15 - 7/31			
Zone Name		eased *	1 Aug	15 Aug	30 Aug
MOB - Deshka - Kashwitna				1	1
MOB - Caswell area tribs					
Montana					
MOB - Kashwitna - Montana					
MOB - Montana Creek					
MOB - Montana - Sunshine					
MOB - Sunshine Creek					
MOB - Rabideux Creek					
ADFG Sunshine					
ADFG Talkeetna					
MOB - Talkeetna River					
ADFG Chulitna					
MOB - Chulitna River					
ADFG - Middle Chulitna					
MOB - Sunshine - Talkeetna					
Whiskers					
MOB - Talkeetna - Lane					
MOB - Whiskers Creek					
MOB - Trib off zone 95					
Lane Creek					
MOB - Lane - Gateway					
MOB - Lane Creek					
MOB - 5th of July Creek					
MOB - Slough 8A					
Gateway					
MOB - Gateway - 4th of July					
MOB - Slough 9					
MOB - Sherman Creek					
Fourth of July					
MOB - 4th of July Creek					
MOB - 4th of July - Slough 11					
MOB - Slough 11					
MOB - Gold Creek					
MOB - Slough11 - Indian					
Indian River					

Longnose Sucker		Released 7/15 - 7/31			
Zone Name		eas ed *	1 Au g	15 Au g	30 Au g
Indian River trib					
MOB - Indian trib					
MOB - Indian - Slough 21					
MOB - Slough 21					
Powerline			1		
MOB - above Powerline					
MOB - abv Powerline - Portage				1	1
MOB - Jack Long Creek					
MOB - Portage trib					
MOB - Portage - Impediment1			1		
MOB - Impediment1 - Cheechako					
MOB - Cheechako Creek					
MOB - Cheechako - Impediment2					
MOB - Impediment2 - Chinook					
MOB - Chinook Creek					
MOB - Chinook - Impediment3					
MOB - Devils Creek					
Devils Island			1		
MOB - Impediment3 - Devil Stn					
MOB - Devil Stn - Fog					
MOB - Fog Creek					
MOB - Fog - Dam Site					
MOB - Tsusena Creek					
MOB - Dam Site - Deadman					
Deadman Creek					
MOB - Deadman Creek					
MOB - Deadman - Watana					
MOB - 'Creek 192'					
MOB - Watana Creek					
MOB - Wantana - Kosina					
Kosina Creek					
MOB - Kosina Creek					
MOB - Kosina - Oshetna					
Oshetna River					
MOB - Oshetna River					
MOB - above Oshetna		5	2	1	1
			2		

Longnose Sucker		Released 7/15 - 7/31			
Zone Name		**eas ed ***	**1 Au g**	**15 Au g**	**30 Au g**
Total Tags Live		5	5	3	3
Mort tags *		0	0	2	2
* unique time and location					
** mortality tags not shown in table					

Table 5.2-4. Number of fish in the Upper Susitna River implanted with PIT tags, detected by stationary antennas, and recaptured during subsequent sampling events, by species, 2013.

		Subsequently Observed					
	Tagged	Detected at Antenna		Recaptured		Total	
Species	N	N	%	N	%	N	%
Chinook salmon	22	0	0%	0	0%	0	0%
Arctic grayling	913	29	3%	6	1%	35	4%
Burbot	31	1	3%	0	0%	1	3%
Dolly Varden	109	0	0%	2	2%	2	2%
Lake Trout	1	0	0%	0	0%	0	0%
Longnose sucker	20	0	0%	1	5%	1	5%
Whitefish, humpback [a]	9	0	0%	0	0%	0	0%
Whitefish, round	98	3	3%	0	0%	3	3%
Whitefish, undifferentiated	21	0	0%	0	0%	0	0%
Total	1,224	33	3%	9	1%	42	3%

Notes:
[a]One humpback whitefish (PIT tag 000183327483) from the Upper River, tagged and released in the Oshetna River, was subsequently recaptured in the Middle River at the Curry Station downstream migrant trap and then detected at the Whiskers Slough PIT antenna.
Values exclude a small number of PIT tags with missing implant records, multiple implant records, or inconsistent species identification upon recapture. Longnose sucker are not a target species
Data are provisional and subject to revision based on ongoing QA/QC

Table 5.2-5. Number of individual fish detected and total number of detections[a] by species at Upper River PIT antenna stations at Kosina Creek and the Oshetna River in 2013.

	Kosina Creek Antenna		Oshetna River Antenna		Total	
Species	Fish	Detections	Fish	Detections	Fish	Detections
Arctic grayling	9	77	21	19,195	29[b]	19,272
Burbot			1	10	1	10
Round whitefish	1	94	2	9,671	3	9,765
Total	**10**	**171**	**24**	**28,876**	**33**	**29,047**

Note:
[a]"Detections" reflects the number of unique records for a given fish encounter with an antenna; each "detection" is typically comprised of many consecutive readings of the PIT tag by the antenna reader.
[b]Includes one Arctic grayling (PIT tag 000183327467) that was detected at both antenna stations.
Values exclude a small number of PIT tags with missing implant records, multiple implant records, or inconsistent species identification upon recapture.
Data are provisional and subject to revision based on ongoing QA/QC

Table 5.2-6. Arctic grayling movement between macrohabitat types in the Upper River in 2013 based on a comparison of initial tagging events versus subsequent recapture or detection at PIT antennas. Values indicate the number of individual fish[a]

		Detection/Recapture Macrohabitat		
		Single Tributary Channel[b]	Split Tributary Channel[c]	Complex Tributary Channel[d]
Tagging Macrohabitat	Single Tributary Channel[b]	4	10	8
	Split Tributary Channel		10	
	Complex Tributary Channel		1	
	Split Main Channel			1
	Not reported		2	

Notes:
[a] Values include one fish that was detected in two different macrohabitat types.
[b] Includes Oshetna River and Kosina Creek rotary screw traps
[c] Includes Oshetna River PIT antenna
[d] Includes Kosina Creek PIT antenna
Data are provisional and subject to revision based on ongoing QA/QC

Table 5.3-1. Early life history sampling catch by location and gear type, 2013.

	Tributary	Black River	Kosina Creek		Oshetna River	Tsisi Lake Outlet	Tsisi Creek	Grand Total
	Gear type							
Species	Life stage	Backpack e-fish	Fyke net	Backpack e-fish	Backpack e-fish	Fyke net	Backpack e-fish	
Chinook salmon	Fry	6						**6**
	Total	6						**6**
Arctic grayling	Adult	4	80	3	10	4	1	**102**
	JOA	1	22	22	14		3	**62**
	JUV	5	8	9	9			**31**
	Total	10	110	34	33	4	4	**195**
Burbot	Adult			1	1			**2**
	JOA	2						**2**
	JUV	1		1	1			**3**
	Total	3		2	2			**7**
Dolly Varden	Adult		2					**2**
	JOA		1					**1**
	Total		3					**3**
Longnose sucker	Adult			2	2			**4**
	JUV		1	5				**6**
	Total		1	7	2			**10**
Sculpin	JOA	81		54	89		1	**225**
Whitefish, humpback	Adult			1	1			**2**
Whitefish, round	Adult		7	1	1			**9**
	JUV				1			**1**
	Total		7	1	2			**10**
Grand Total		**100**	**121**	**99**	**129**	**4**	**5**	**458**

Data are provisional and subject to revision based on ongoing QA/QC

Table 5.4-1. Number PIT-tagged recaptured PIT-tagged juvenile Chinook salmon and Arctic grayling available for growth analysis for the Upper Susitna River, 2013.

River Location	Species Name	Implanted (N)	Detected (N)	Recaptured (N)	Recaptured or Detected (N)
UR	Chinook salmon	22	0	0	0
UR	Arctic grayling	913	29	6	35
Total		**935**	**29**	**6**	**35**

Data are provisional and subject to revision based on ongoing QA/QC

Table 5.4-3. Condition factor of juvenile Chinook salmon by tributary, Upper Susitna River, 2013.

Location	PRM	Sample Size (N)	Mean Condition Factor	Mean Standard Error	Median Condition factor
Oshetna River	235	1	0.79	n/a	0.79
Black River	N/A	22	0.86	0.045	0.84
Kosina Creek	209	67	1.04	0.023	1.08

Data are provisional and subject to revision based on ongoing QA/QC

Table 5.4-4. Condition factor of Arctic grayling by macrohabitat type and tributary, Upper Susitna River, 2013.

Macrohabitat	Tributary/ Geomorphic Reach	Sample Size (N)	Mean Condition Factor	Mean Standard Error	Median
Main Channel	UR-3	27	0.9	0.018	0.9
	UR-4	11	0.81	0.031	0.85
	UR-5	15	0.88	0.015	0.9
	UR-6	66	0.94	0.015	0.92
Split Main Channel	UR	30	0.85	0.026	0.85
Side Channel	UR	10	0.96	0.061	0.9
Clear Water Plume	UR	15	0.88	0.036	0.85
Side Slough	UR	8	0.92	0.09	0.87
Side Slough, Beaver	UR	n/a	n/a	n/a	n/a
Upland Slough	UR	15	0.92	0.04	0.97
Tributary	Black River	59	0.90	0.024	0.91
	Goose Creek	316	0.94	0.012	0.93
	Jay Creek	11	0.85	0.025	0.87
	Kosina Creek	40	0.77	0.021	0.78
	Oshetna River	128	0.89	0.02	0.89
	Tsisi Creek	34	0.89	0.027	0.91
	Unnamed 194.8	8	0.88	0.037	0.89
	Watana Creek	264	0.83	0.013	0.86

10. FIGURES

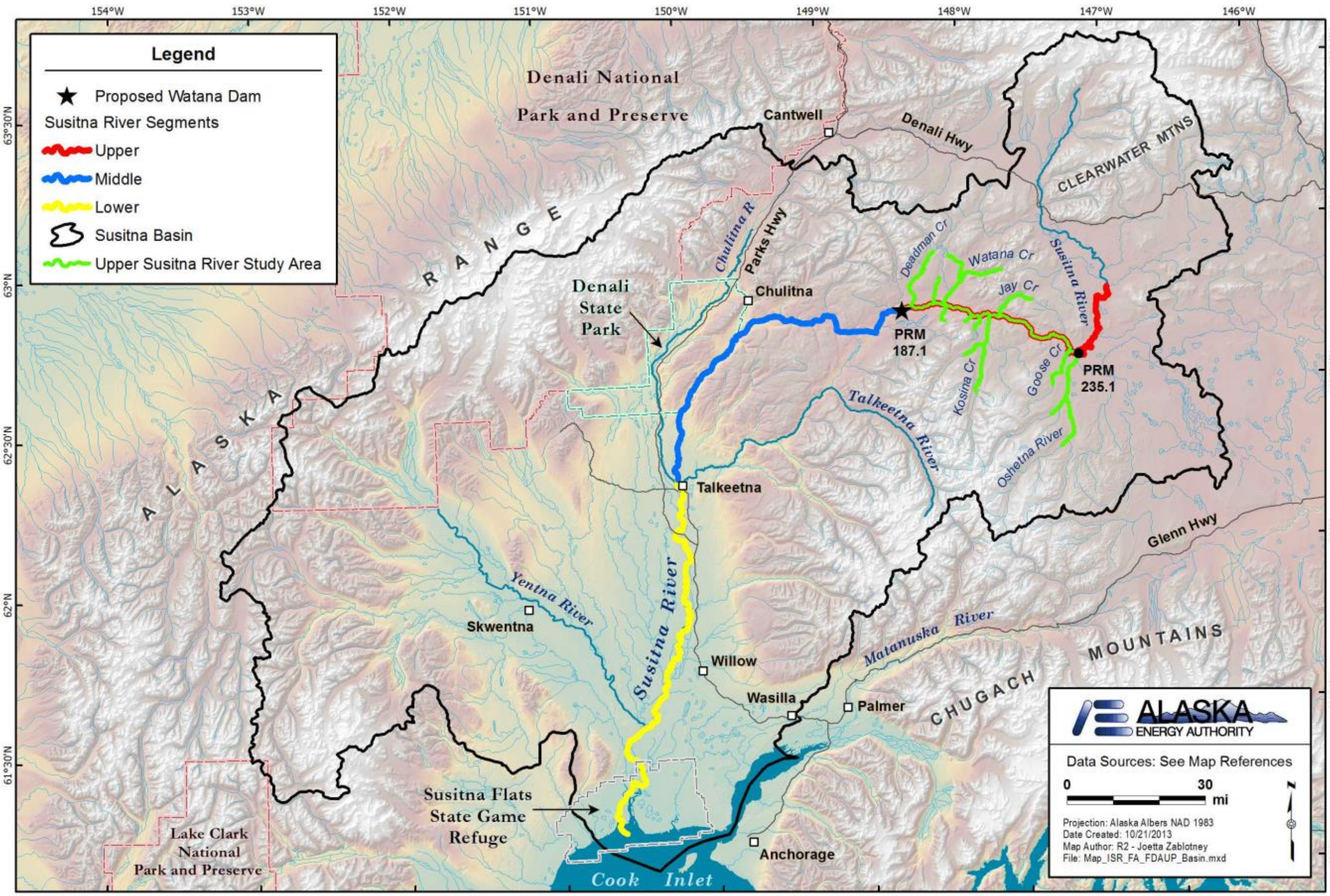


Figure 3-1. Upper Susitna River fish distribution and abundance study area.

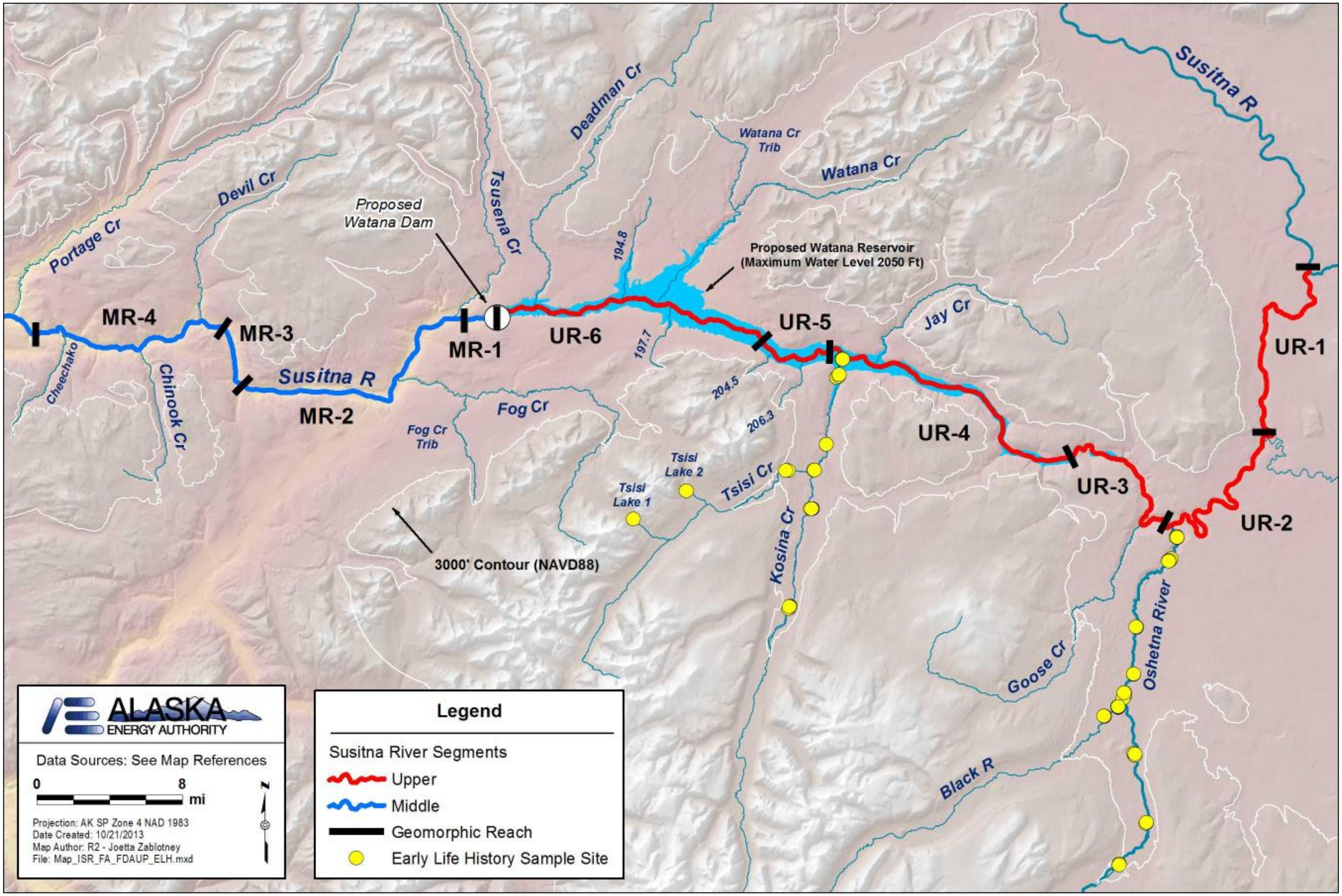


Figure 4.1-1. Salmon Early Life History sampling sites in the Upper Susitna River basin, 2013.

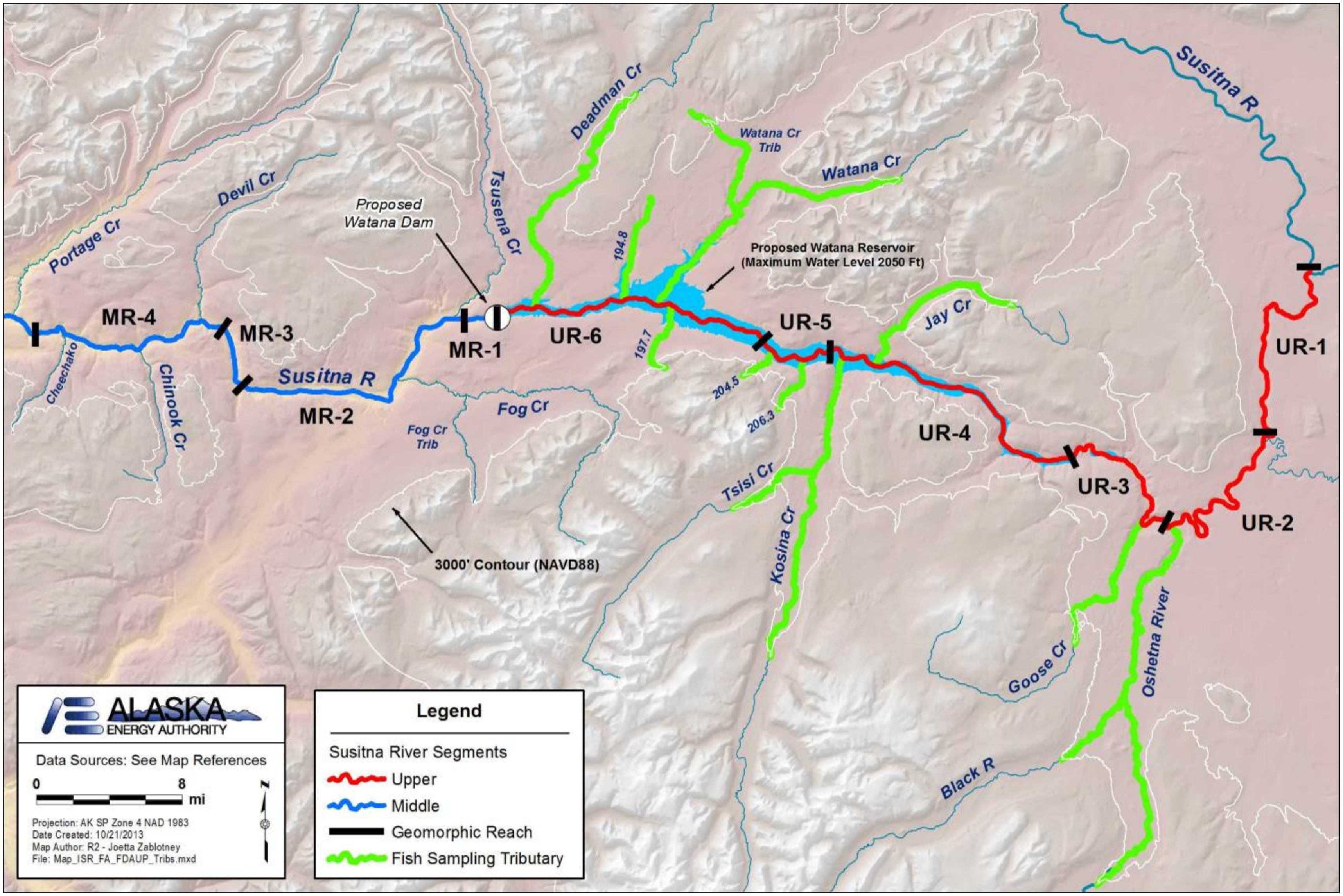


Figure 4.1-2. Locations of 13 tributaries upstream of the proposed Watana Dam location selected for sampling up to the 3,000 ft contour, 2013.

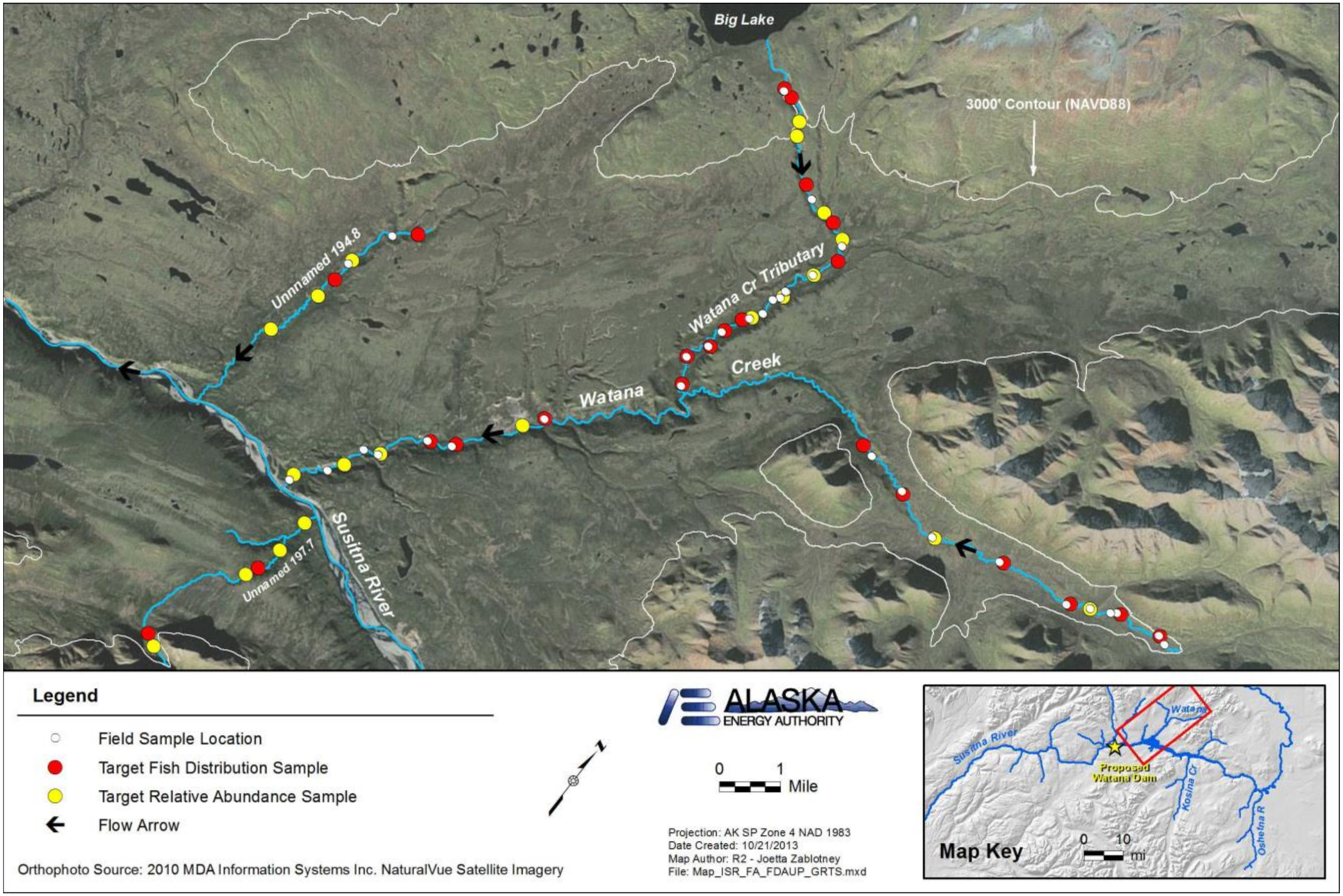


Figure 4.1-3. GRTS fish distribution and abundance sampling targets and field sampling locations (including oversamples) in Unnamed Tributary 194.8, Watana Creek, Watana Creek Tributary, and Unnamed Tributary 197.7, 2013.

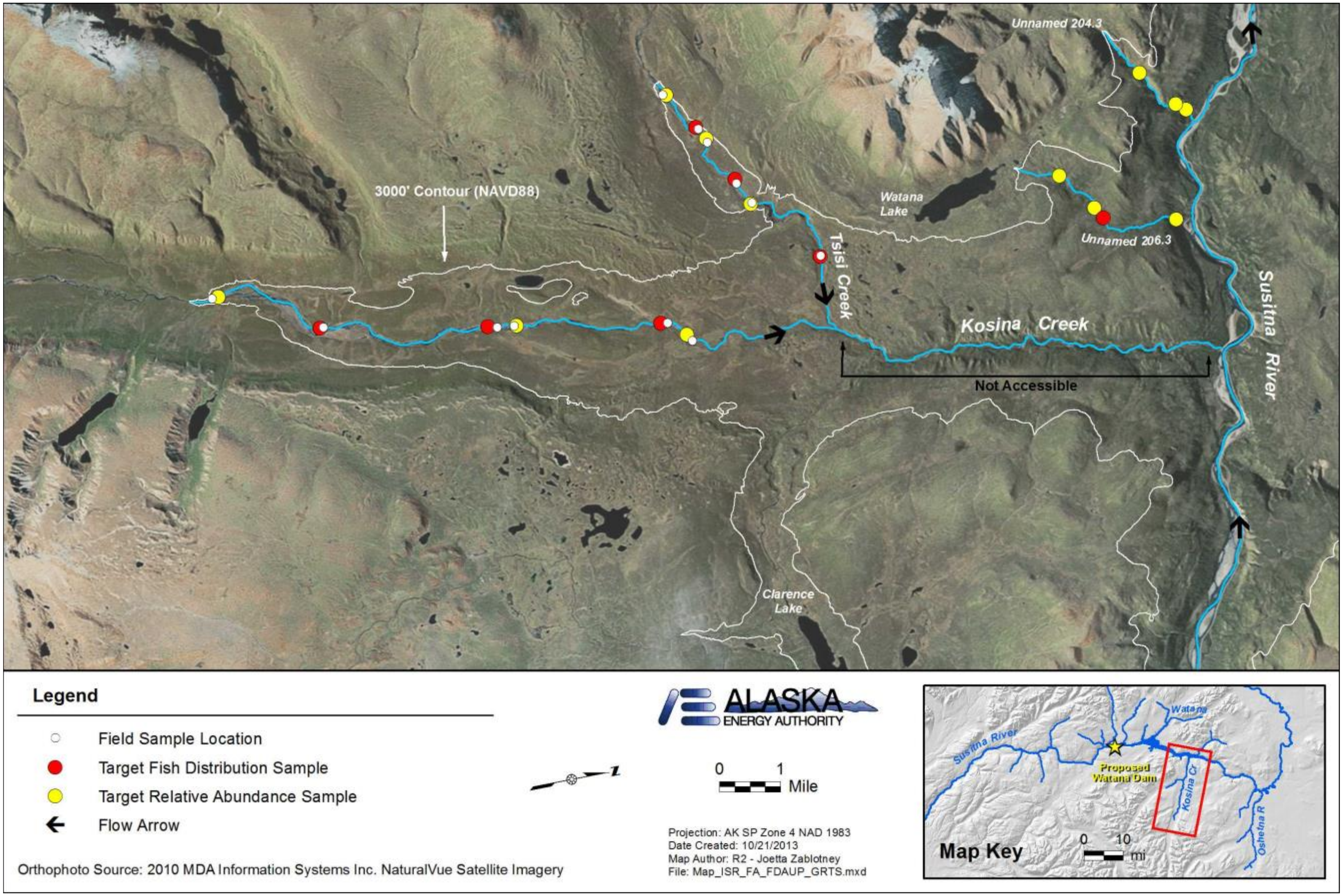


Figure 4.1-4. GRTS fish distribution and abundance sampling targets and field sampling locations (including oversamples) in Unnamed Tributary 204.3, Unnamed Tributary 206.3, Kosina Creek, and Tsisi Creek, 2013.

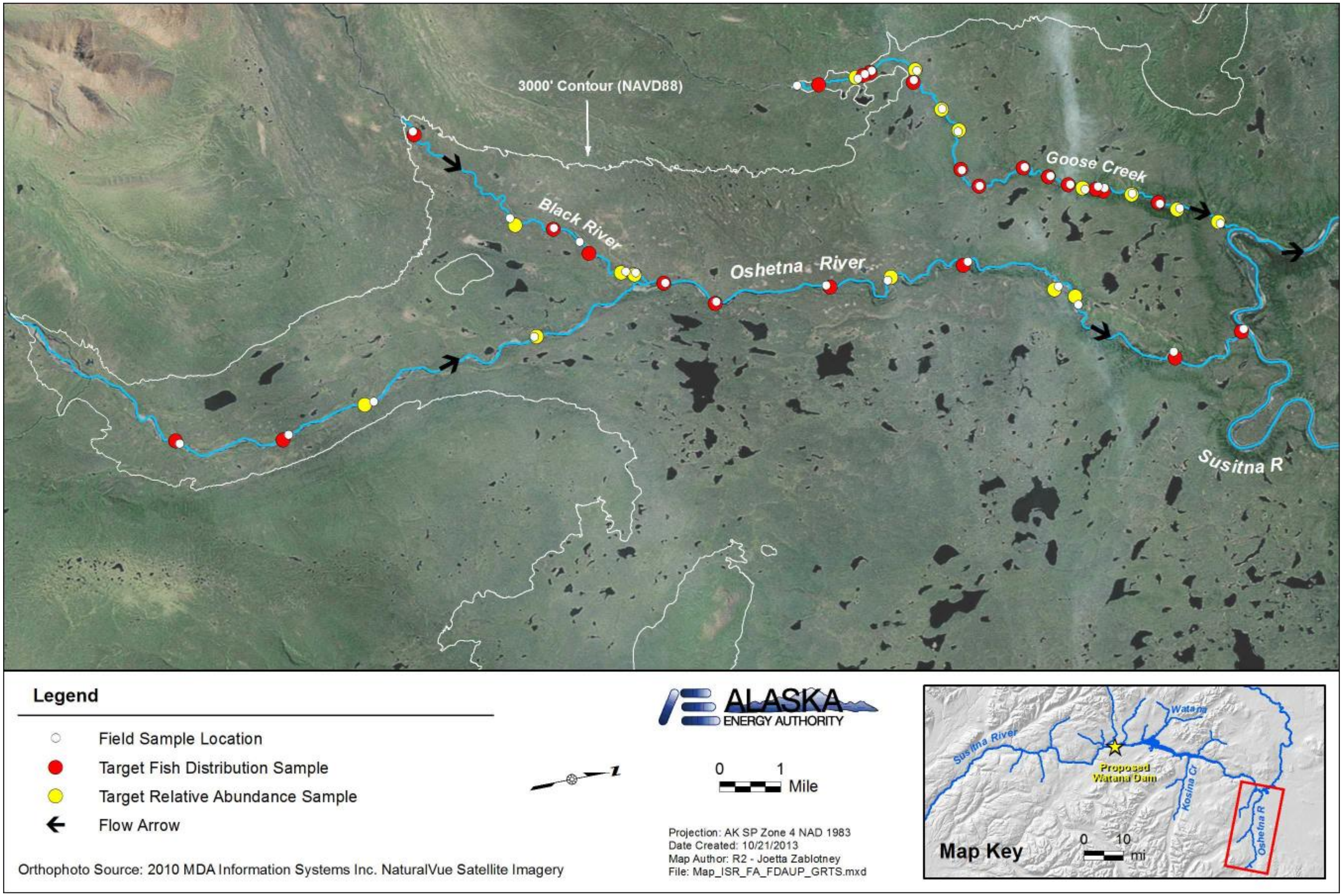


Figure 4.1-5. GRTS fish distribution and abundance sampling targets and field sampling locations (including oversamples) in Goose Creek, the Oshetna River, and the Black River, 2013.

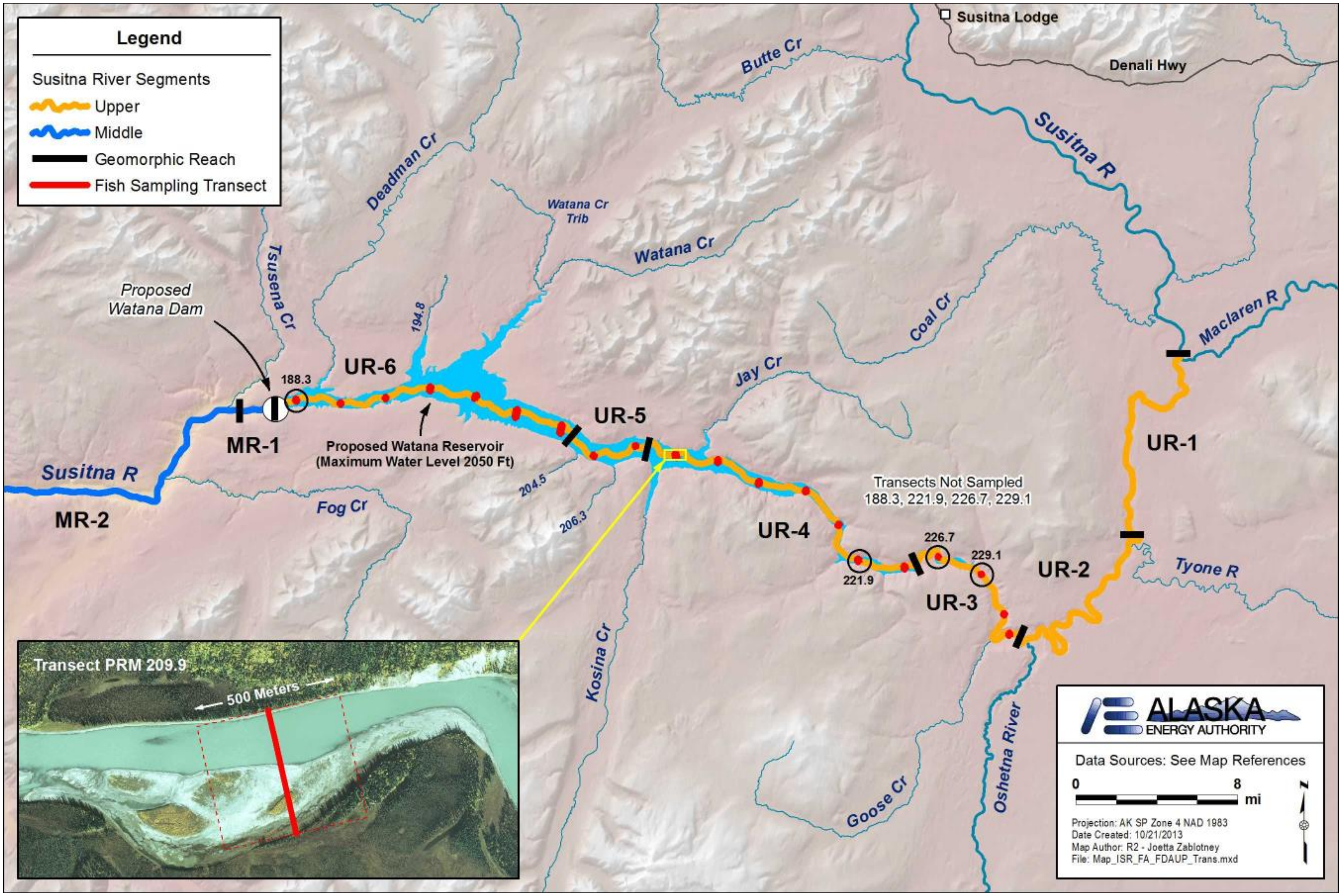


Figure 4.1-6. Fish distribution and abundance transect sampling locations in the Upper Susitna River, 2013.

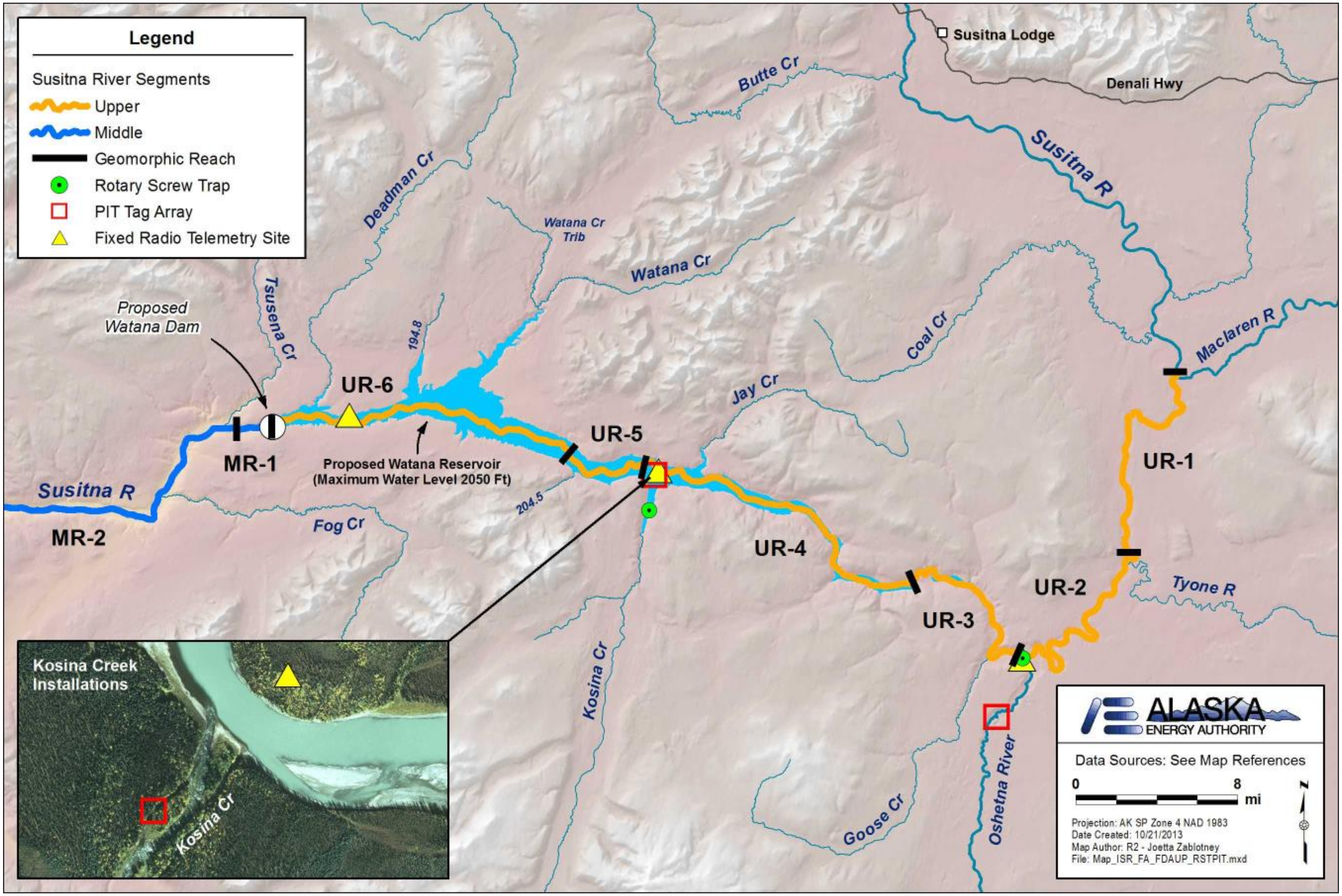


Figure 4.1-7. Outmigrant (rotary screw) trap, PIT tag array, and radio fixed receiver locations in the Upper Susitna River Study Area, 2013.

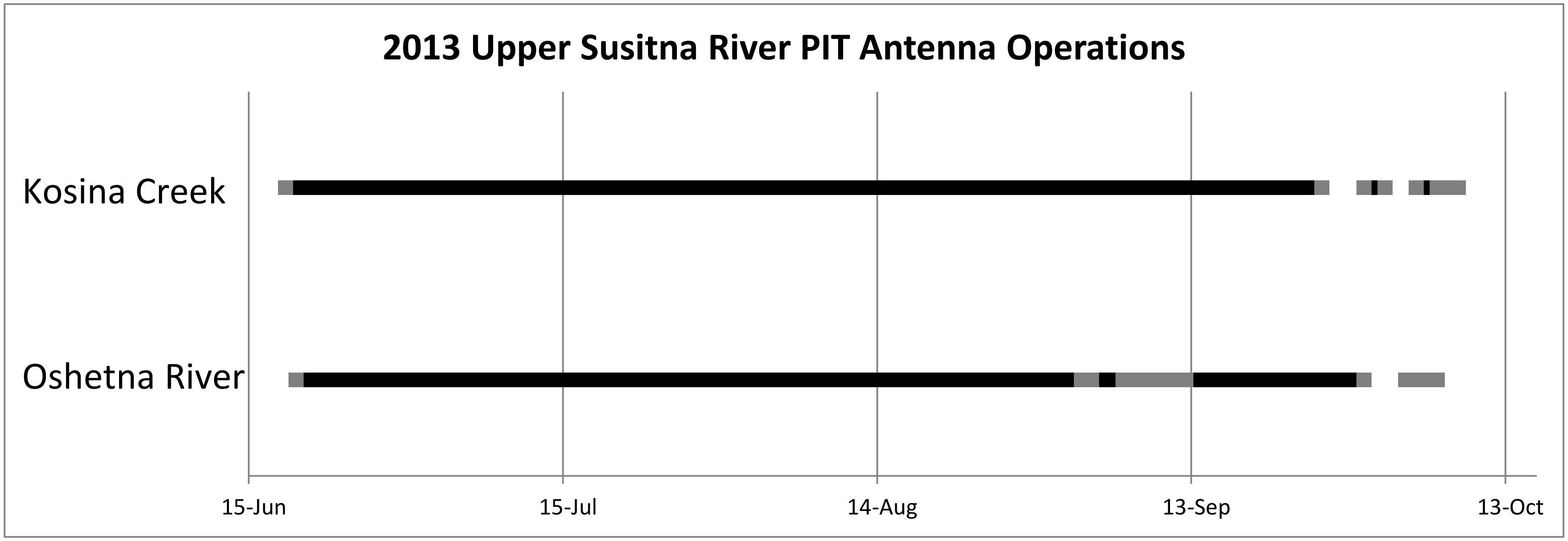


Figure 4.2-1. Summary of PIT tag interrogation system operation in the Upper Susitna River, 2013. Black indicates continuous operation; gray indicates partial or interrupted operation.

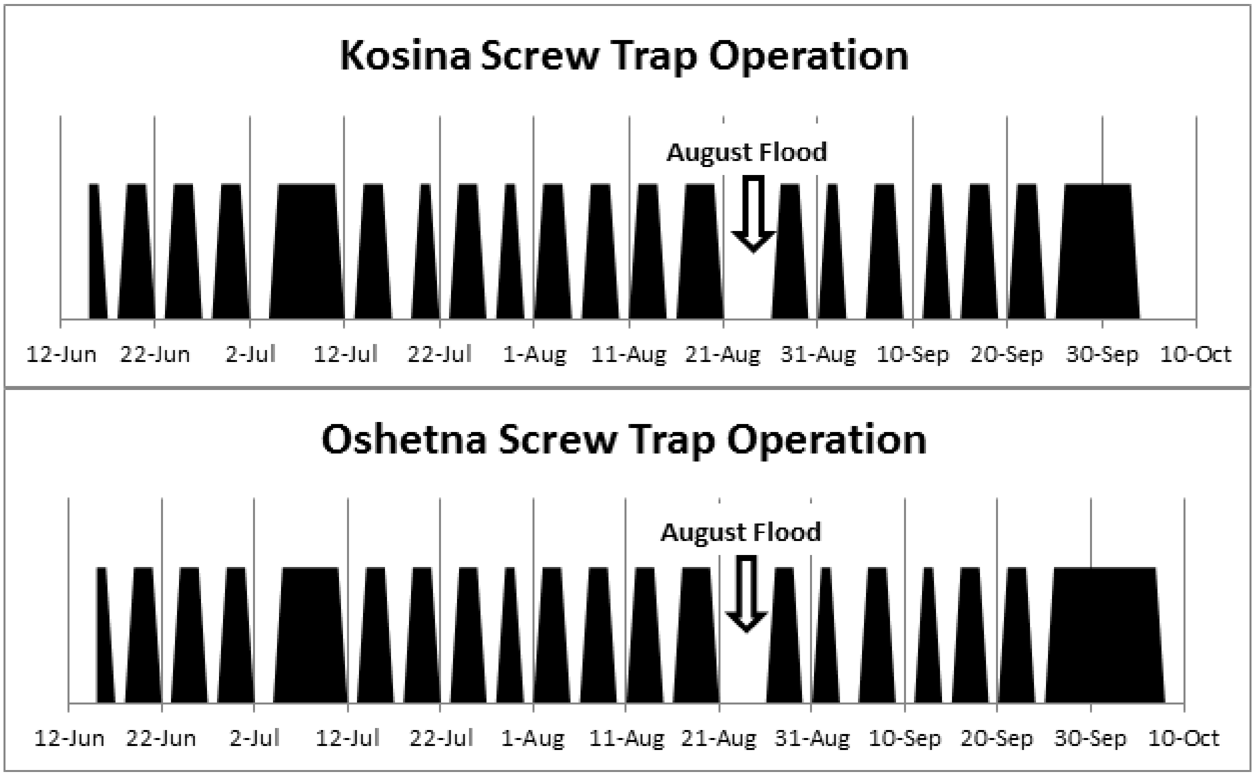


Figure 4.2-2. Screw trap operation in the Upper Susitna River, 2013.

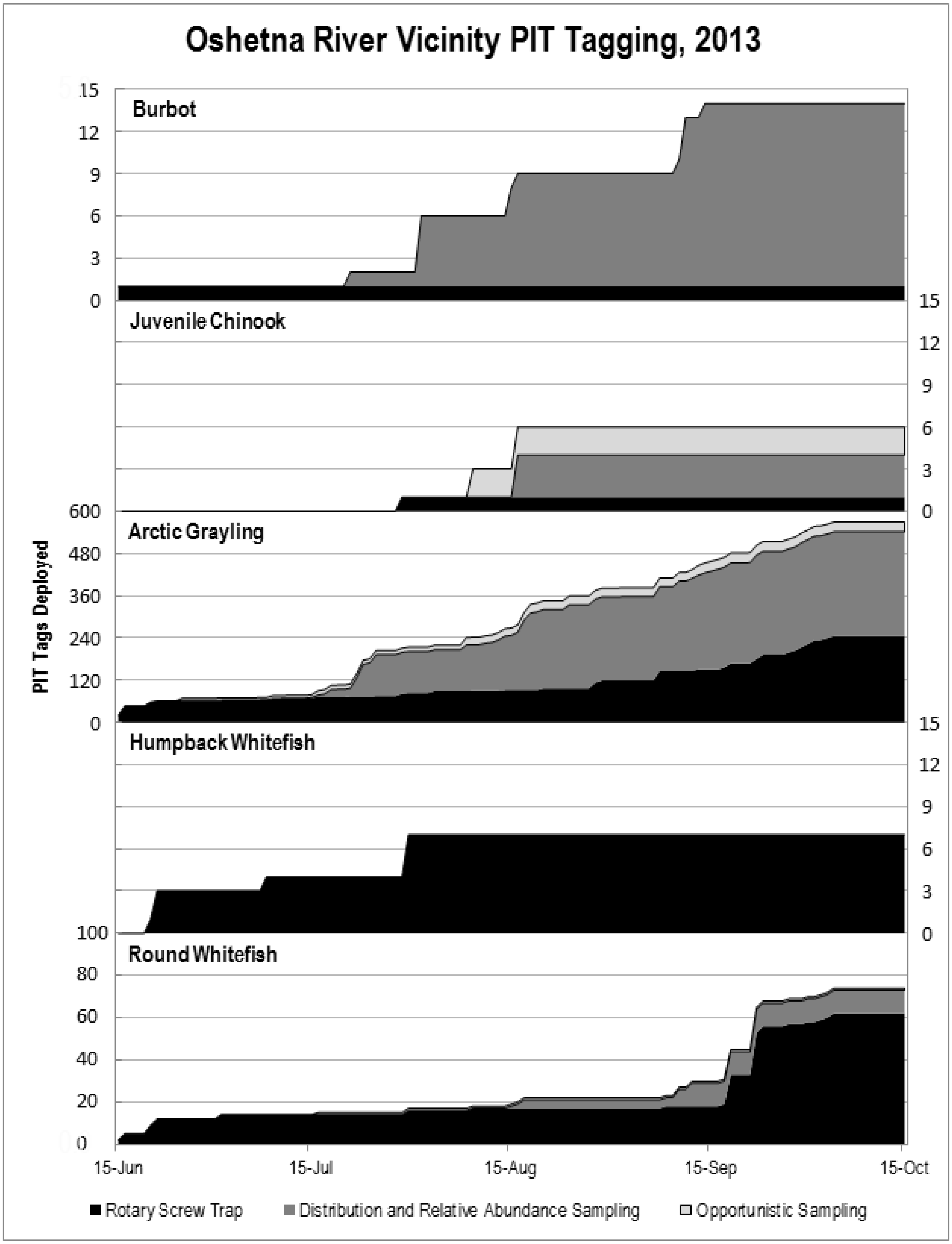


Figure 4.5-1. Summary of PIT tagging effort in the vicinity of the Oshetna River, 2013.

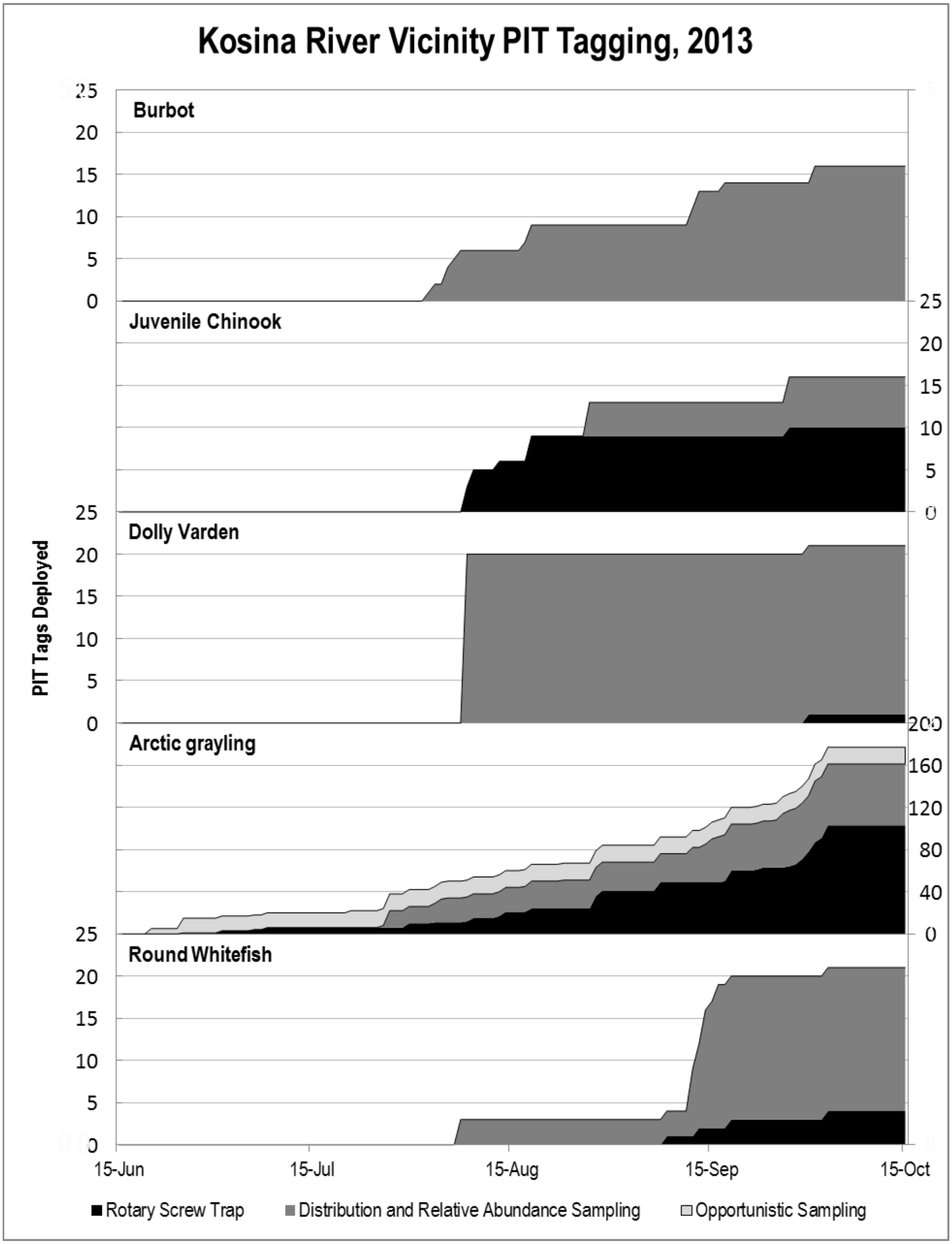


Figure 4.5-2. Summary of PIT tagging effort in the vicinity of Kosina Creek, 2013.

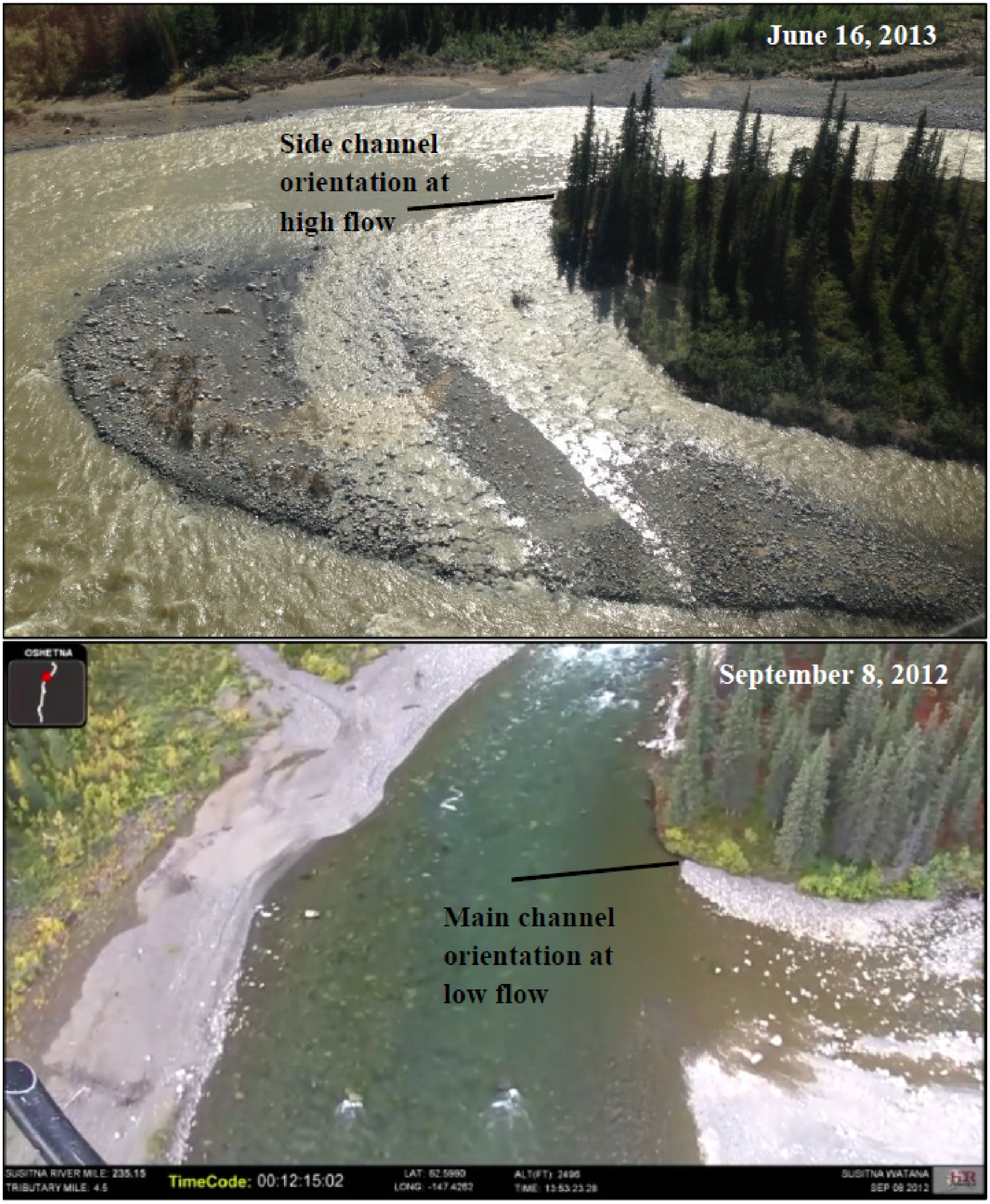
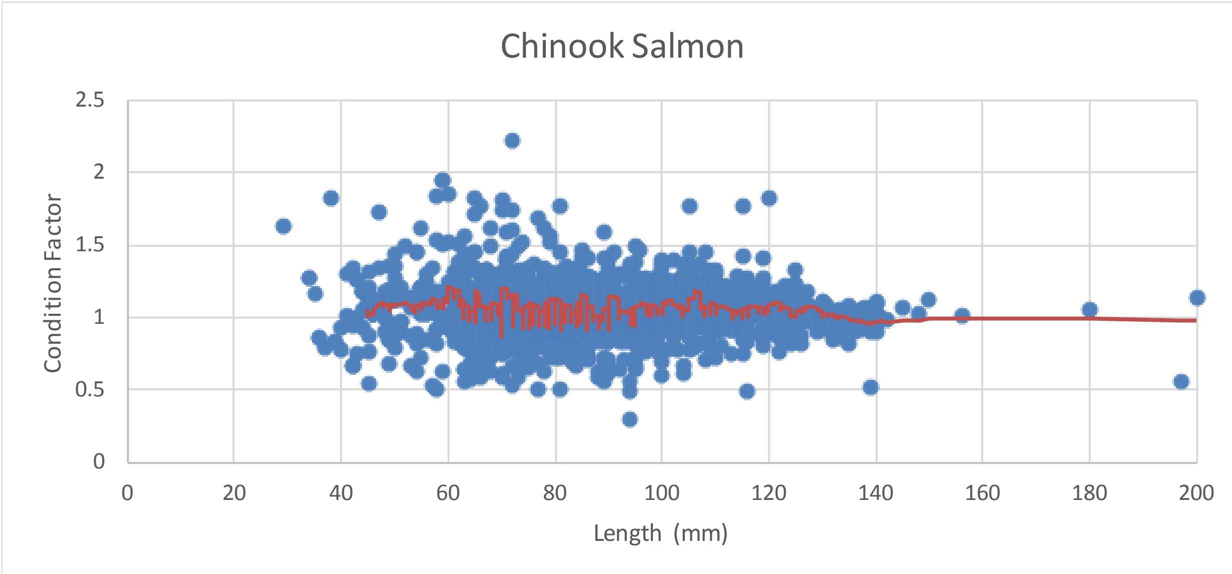


Figure 4.5-3. Illustration of swim over Oshetna River PIT tag interrogation antenna orientation positioning at high (top) and low flow (bottom), 2013.

Figure 4.5-4. Swim through PIT tag interrogation antenna on Kosina Creek side channel at RM 0.2, 2013.



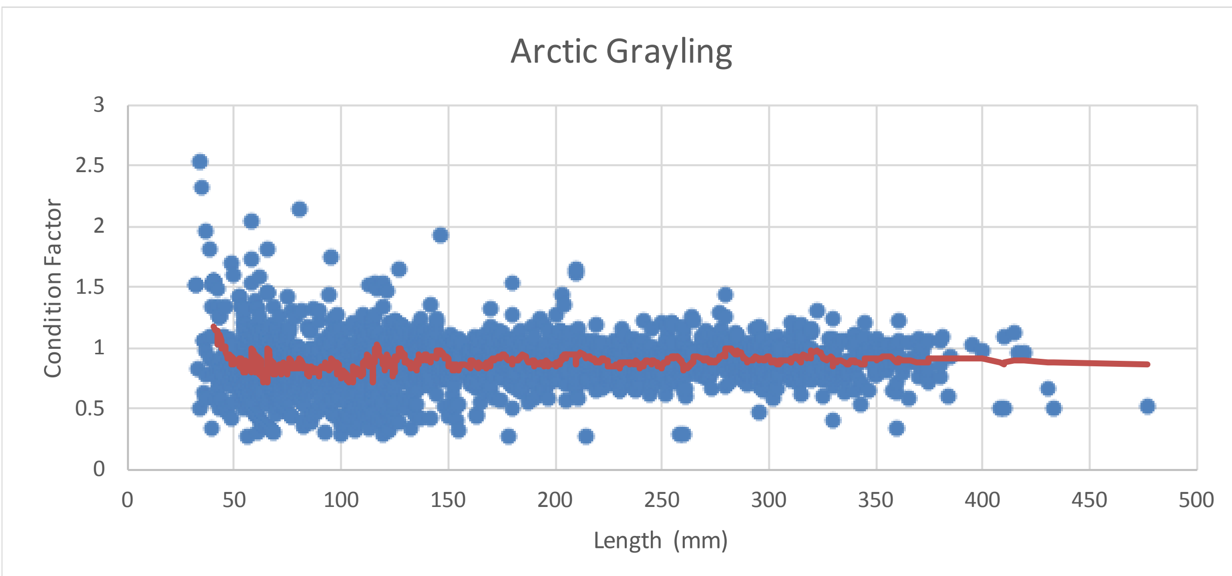


Figure 4.7-1. Condition factor by size (fork length mm) for juvenile Chinook salmon (top) and Arctic Grayling (bottom) for Lower, Middle, and Upper Susitna River, 2013.

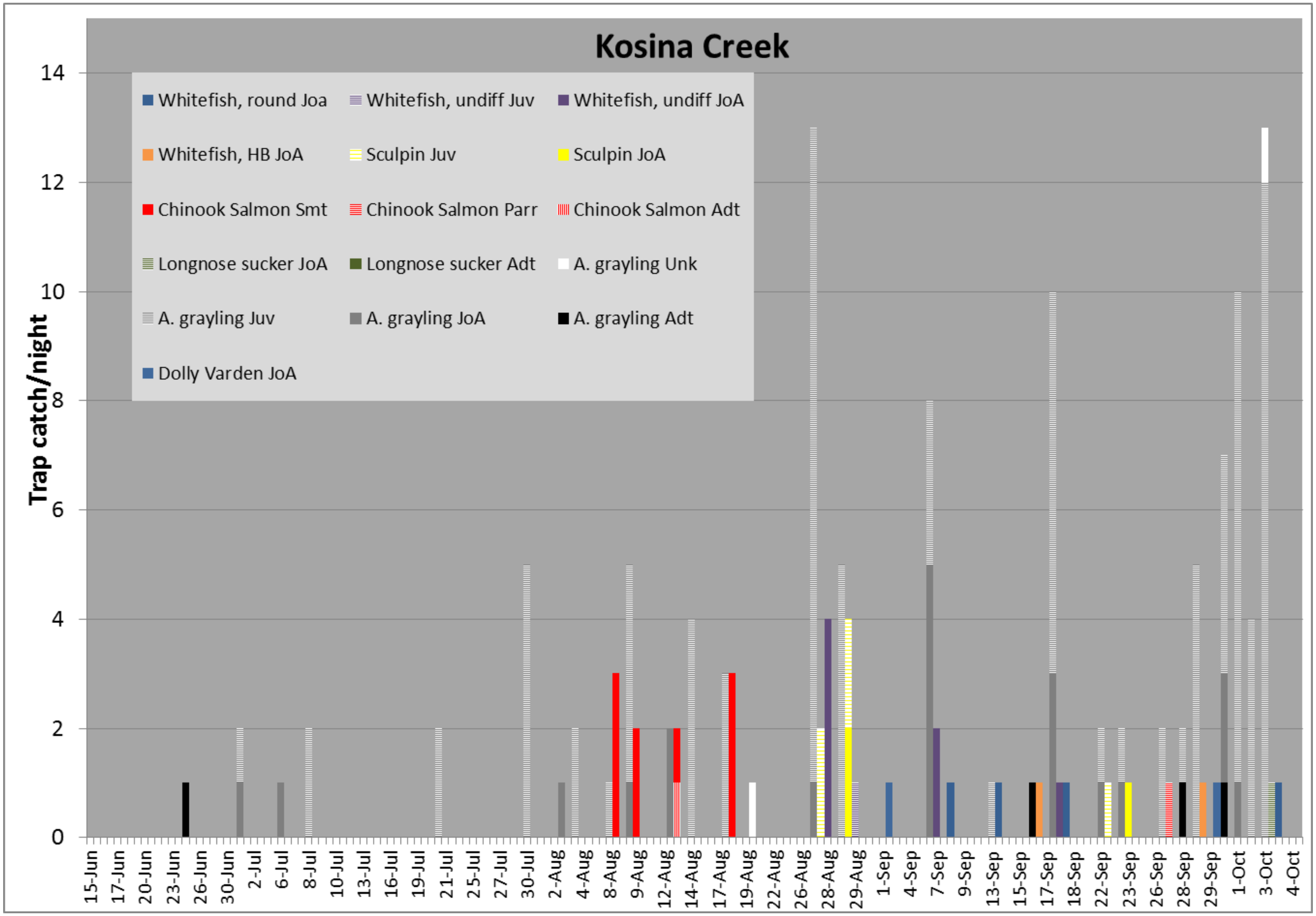


Figure 5.2-1. Kosina Creek rotary screw trap catch by species and life stage, 2013. Adt=adult, Juv=juvenile, JoA= Juvenile/Adult, Smt=smolt, Unk=unknown

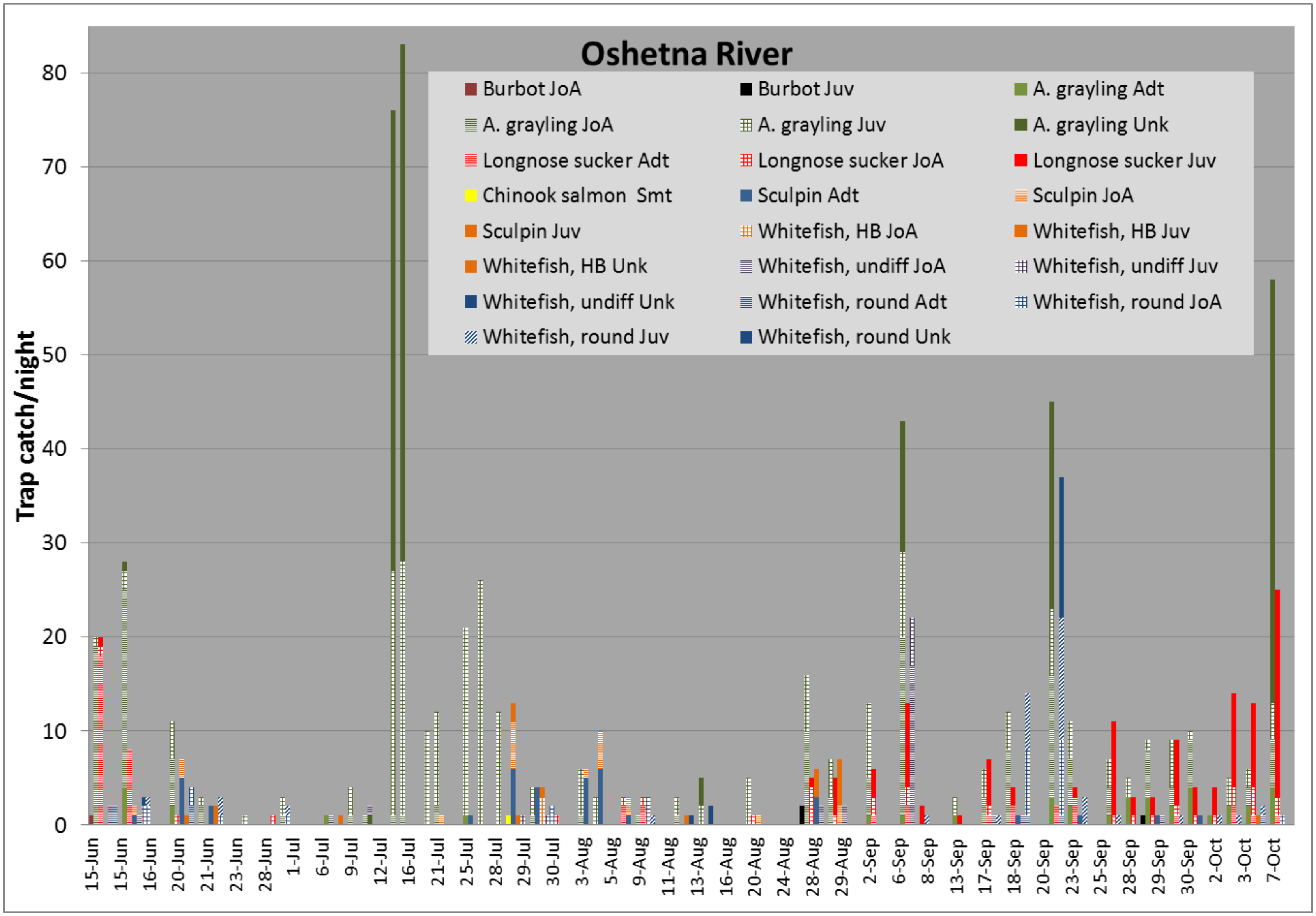


Figure 5.2-2. Oshetna River rotary screw trap catch by species and life stage, 2013. Adt=adult, Juv=juvenile, JoA= Juvenile/Adult, Smt=smolt, Unk=unknown

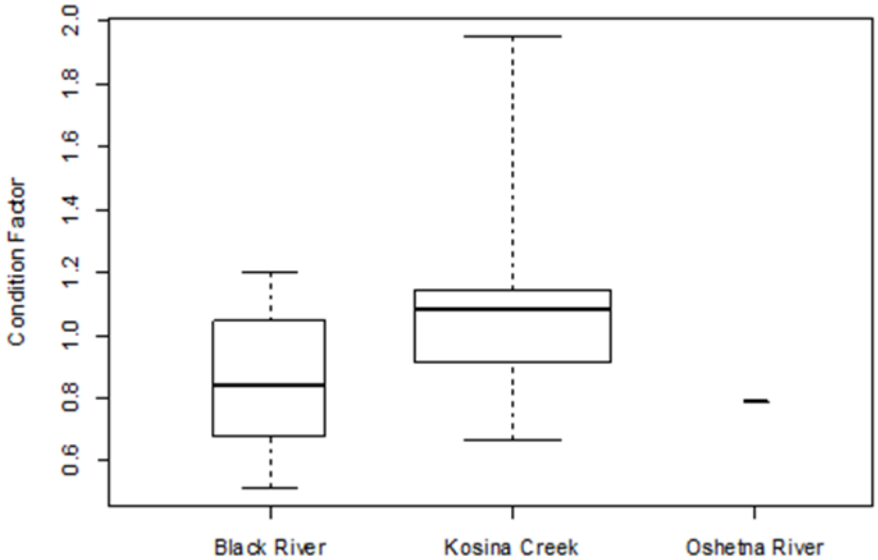


Figure 5.4-1. Box-and-whisker plot of juvenile Chinook salmon condition factor in Upper River tributaries, 2013.

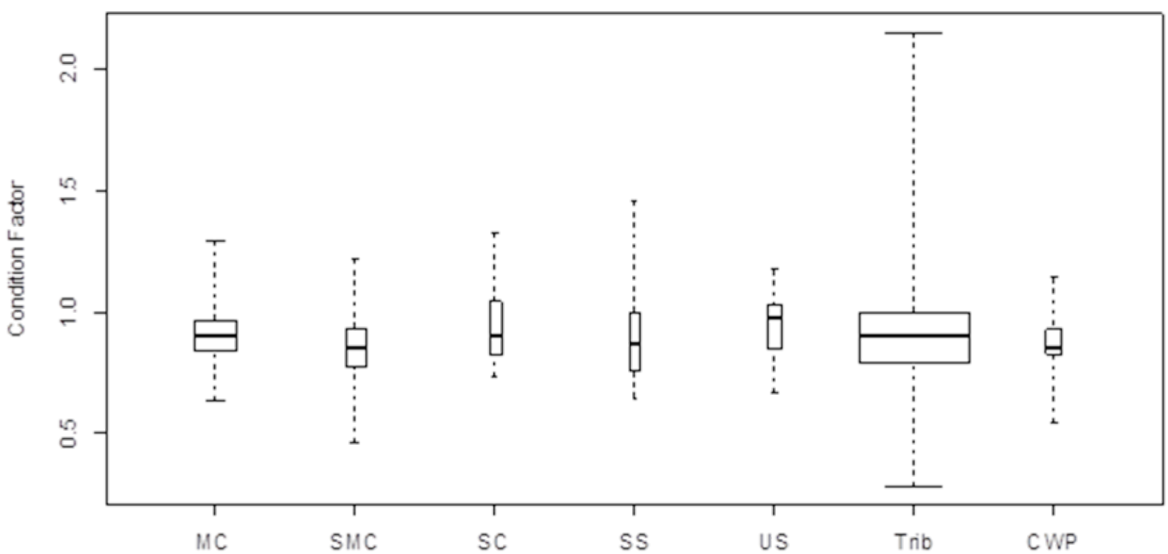


Figure 5.4-2. Box-and-whisker plot of Arctic Grayling condition factor in Upper River Tributaries (Trib) various mainstem Susitna River macrohabitats. MC=main channel, SMC=split main channel, SC=side channel, SS=side slough, US=upland slough, CWP= clear water plume (special mesohabitat type).

PART A - APPENDIX A: DISTRIBUTION OF FISH RADIO-TAGGED IN THE UPPER SUSITNA RIVER, 2013

[See separate file for Appendix.]

PART A - APPENDIX B: FISH DISTRIBUTION MAPS FOR THE UPPER SUSITNA RIVER 2012 AND 2013

[See separate file for Appendix.]

PART A - APPENDIX C: SEASONAL FISH DISTRIBUTION, UPPER SUSITNA RIVER 2012 AND 2013

[See separate file for Appendix.]

PART A - APPENDIX D: UPPER RIVER FISH OBSERVATIONS AND RELATIVE ABUNDANCE, 2013

[See separate file for Appendix.]