# Susitna-Watana Hydroelectric Project

# (FERC No. 14241)

# Sampling Considerations for

# Study 9.5

# Fish Distribution and Abundance

# in the Upper Susitna River

Prepared for

Alaska Energy Authority

Prepared by

R2 Resource Consultants, Inc.

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| Abbreviation | Definition |
|---|---|
| ADF&G | Alaska Department of Fish and Game |
| AEA | Alaska Energy Authority |
| AWC | Anadromous Waters Catalog |
| CW | Channel width |
| GRTS | Generalized random tessellation stratified |
| ISR | Initial Study Report |
| km | kilometer |
| m | meter |
| PRM | Project River Mile |

# 1. INTRODUCTION

In 2013, AEA's study teams conducted the first year of data collection for the Study of Fish Distribution and Abundance in the Upper Susitna River (Study 9.5). Fish sampling in the Upper River primarily supported Objective 1 of the Study of Fish Distribution and Abundance in the Upper Susitna River: Fish Distribution, Relative Abundance, and Habitat Associations (RSP Section 9.5.4.3.1). Sampling in 2013 was effective at documenting fish distribution (Task A). Relative abundance estimates were effectively generated for all sampled habitats (Task B). However, analysis of habitat associations was limited by the low number of off-channel habitats in the mainstem (see Section 2.1 below) and the low number of rare habitat types in the tributaries (see Section 3.1 below). Increased sampling would better meet the objective of characterizing fish abundance by mesohabitat type (RSP Section 9.5.4.3.1, Task C). Proposed modifications to the Study Plan will be presented in the Final ISR to be filed with FERC June 3, 2014.

# 2. SAMPLING DECISION: INCREASED SAMPLING OF RARE HABITATS IN UPPER RIVER MAINSTEM SURVEYS.

## 2.1. Sampling in 2013

Sampling in the mainstem Upper River in 2013 occurred along regularly spaced transects (20 planned, 16 sampled) within the four geomorphic reaches in the inundation zone. Because remote habitat mapping for the Upper River was not available at the time of site selection for the Study 9.5 Implementation Plan (Section 5.4), the transects were widened to 1 km in an attempt to intersect rarer, off-channel habitat types. Crews also were asked to look outside the transects for nearby tributary confluences that were accessible and could be sampled. However, only one off-channel habitat unit was sampled in 2013, limiting the ability to evaluate habitat associations in the mainstem Upper River.

## 2.2. Rare Habitats

Side-channels, upland sloughs, side sloughs, as well as tributary mouths, clearwater plumes and backwaters all are relatively rare in the Upper River. The original 20 Upper River transect placements resulted in targets of 8 side channels, 3 side sloughs, and 3 tributary mouths. However, a combination of dry habitats and logistical constraints at some transects resulted in sampling 2 side channels, 1 side-slough, and 3 tributary mouths (Table 1). A review of remote line mapping after the 2013 field season indicated that additional habitats of these types were available for sampling as were other unsampled habitat types including upland sloughs, clearwater plumes and backwaters (Table 2).

**Table 1. Study 9.5 FDA UP fish sites sampled in 2013.**

| | | Sites per Geomorphic Reach | | | | |
|---|---|---|---|---|---|---|
| **Macrohabitat Type** | **Reach Length** | **UR-3** (PRM 234.5 - 224.9) | **UR-4** (PRM 224.9 - 208.1) | **UR-5** (PRM 208.1 - 203.4) | **UR-6** (PRM 203.4 – 187.1) | **TOTAL** |
| ***Main Channel Macrohabitats*** | | | | | | |
| Main Channel | 500 m | | | | | |
| Split Main Channel | | 2 (2) | 6 (1) | 2 | 6 (1) | **16 (4)** |
| Multi-Split Main Channel | | | | | | |
| Side Channel | | - | - | - | 2 | **2** |
| ***Off-Channel Macrohabitats*** | | | | | | |
| Side Slough | 200 m | - | - | - | 1 | **1** |
| Upland Slough | | - | - | - | - | **0** |
| ***Special Habitat Features*** | | | | | | |
| Tributary Mouth | 200 m | - | 3 | - | - | **3** |
| Clear Water Plume | | - | | - | - | **0** |
| Backwater | | | | | | **0** |
| ***Total*** | | ***2(2)*** | ***9(1)*** | ***2*** | ***9(1)*** | ***22 (4)*** |

(#) indicates number of sites deemed unsafe for sampling

**Table 2. Study 9.5 FDA UP potential generalized random tessellation stratified (GRTS) fish sampling sites based on line mapping of macrohabitats.**

| | | Number of Potential Sites per Geomorphic Reach* | | | | |
|---|---|---|---|---|---|---|
| **Macrohabitat Type** | **Reach Length** | **UR-3** (PRM 234.5 - 224.9) | **UR-4** (PRM 224.9 - 208.1) | **UR-5** (PRM 208.1 - 203.4) | **UR-6** (PRM 203.4 – 187.1) | **TOTAL** |
| ***Main Channel Macrohabitats*** | | | | | | |
| Main Channel | 500 m | 101 | 155 | 45 | 169 | **470** |
| Split Main Channel | | - | 35 | 6 | 11 | **52** |
| Multi-Split Main Channel | | - | - | - | - | **-** |
| Side Channel | | 11 | 80 | 15 | 246 | **352** |
| ***Off-Channel Macrohabitats*** | | | | | | |
| Side Slough | 200 m | 6 | 70 | - | 25 | **101** |
| Upland Slough | | - | 15 | - | 3 | **18** |
| ***Special Habitat Features*** | | | | | | |
| Tributary Mouth | 200 m | 3 | 7 | 1 | **4** | **15** |
| Clearwater Plume | | 6 | 27 | - | **-** | **33** |
| Backwater | | - | 6 | - | **-** | **6** |
| ***Total*** | **-** | ***127*** | ***395*** | ***67*** | ***458*** | ***1,047*** |

*Potential sites based on total lengths reported in Upper River line mapping. Total site numbers may be fewer based on habitat configuration.

When considering modifications to the sampling approach, it is important to consider the ability to compare data across years. One solution that would allow for comparison with 2013 data is a hybrid approach in which we continue to survey select transects for main channel habitats would continue to be surveyed and GRTS-based sampling for rarer habitat types including side channels, off-channel habitats and special habitat features would be added. Remote line mapping provided the necessary length information for application of a spatially-balanced GRTS sampling approach to these habitats. The advantage of the GRTS approach is that oversamples can be selected and provided to field crews for use in the event that a selected site is not suited for sampling (e.g., dry or inaccessible).

## 2.3. Sampling Stratification

The Draft ISR for Study 9.5 characterized fish distribution (Section 5.1.1) and relative abundance (5.1.2) nested within geomorphic reaches, following the pattern of the Middle River analysis (Draft ISR Study 9.6; Sections 5.1.1 and 5.1.2). Transect data was aggregated within Geomorphic Reaches for UR-3 through UR-6. Although this geomorphic-reach based approach is helpful in the Middle River where impacts will likely decrease longitudinally downstream from the dam and the impacts of flow changes are dependent on channel form, a reach-based approach is not necessary within the Upper River where the scale of inference will be on the future inundation zone that spans four Geomorphic Reaches from the upper extent of UR-3 (PRM 234.5) to the downstream extent of UR-6 (PRM 187.1). Within the inundation zone, impacts will be relatively uniform and independent of channel form. Therefore additional sampling may not need to be stratified by geomorphic reach. For context, the summed length of habitats in the inundation zone (368,961 ft) is similar to MR-6 (349,877 ft). AEA proposes that it is not necessary to stratify targeted sampling or analysis of fish distribution by Geomorphic Reach in the Upper River. Therefore the hybrid approach that AEA proposes for the next year of sampling would include an additional 4 side channel sites and 6 sites of each off-channel and special feature habitat type within the future reservoir inundation zone as well as repeating 21 mainstem and 2 side channel transect sites (Table 3). This would increase the total number of planned sampling sites from 35 to 57.

Implementing this modification will maintain the integrity of the data AEA collected in 2013. It will minimize the risk of selecting sites impossible to sample by providing a list of oversample sites to draw upon. It will also increase both the types of habitat as well as the overall area of habitat sampled in the Upper River and there by improve AEA's ability to characterize fish-habitat associations in the Upper Susitna River.

**Table 3. Study 9.5 FDA UP Hybrid sampling recommendation.**

| | | Sites per Geomorphic Reach | | | | |
|---|---|---|---|---|---|---|
| **Macrohabitat Type** | **Reach Length** | **UR-3 (PRM 234.5 - 224.9)** | **UR-4 (PRM 224.9 - 208.1)** | **UR-5 (PRM 208.1 - 203.4)** | **UR-6 (PRM 203.4 – 187.1)** | **TOTAL** |
| | | ***Main Channel Macrohabitats*** | | | | |
| Main Channel | 500 m | 2 | 3 | 2 | 3 | **10** |
| Split Main Channel | | | | | | |
| Multi-Split Main Channel | | | | | | |
| Side Channel | | 6 | | | | **6** |
| | | ***Off-Channel Macrohabitats*** | | | | |
| Side Slough | 200 m | 6 | | | | **6** |
| Upland Slough | | 6 | | | | **6** |
| | | ***Special Habitat Features*** | | | | |
| Tributary Mouth | 200 m | 6 | | | | **6** |
| Clear Water Plume | | 6 | | | | **6** |
| Backwater | | 6 | | | | **6** |
| | | | | | ***Total*** | ***46*** |

# 3. SAMPLING DECISION: INCREASED SAMPLING EFFORT IN UPPER RIVER TRIBUTARIES

## 3.1. Study Objectives

## 3.2. Sampling in 2013

The April FERC Study Plan Determination recommended scaling sampling in proportion to stream size (p. B-124). To achieve a spatially-balanced and random sample of fish habitats within Upper River tributaries, the length of the tributaries were divided into GRTS panels that were 200, 400, or 800 m long depending on the tributary drainage area. However, logistical constraints required sub-sampling 100 m-long units within GRTS panels. Specifically, within a selected GRTS panel fish sampling occurred in either a complete mesohabitat unit or up to 100 m per mesohabitat for each mesohabitat type present. Post-season analysis indicates that the 2013 tributary sampling program was effective at documenting the fish species present and the distribution of these species within Upper River tributaries (Table 4, Figure 1).

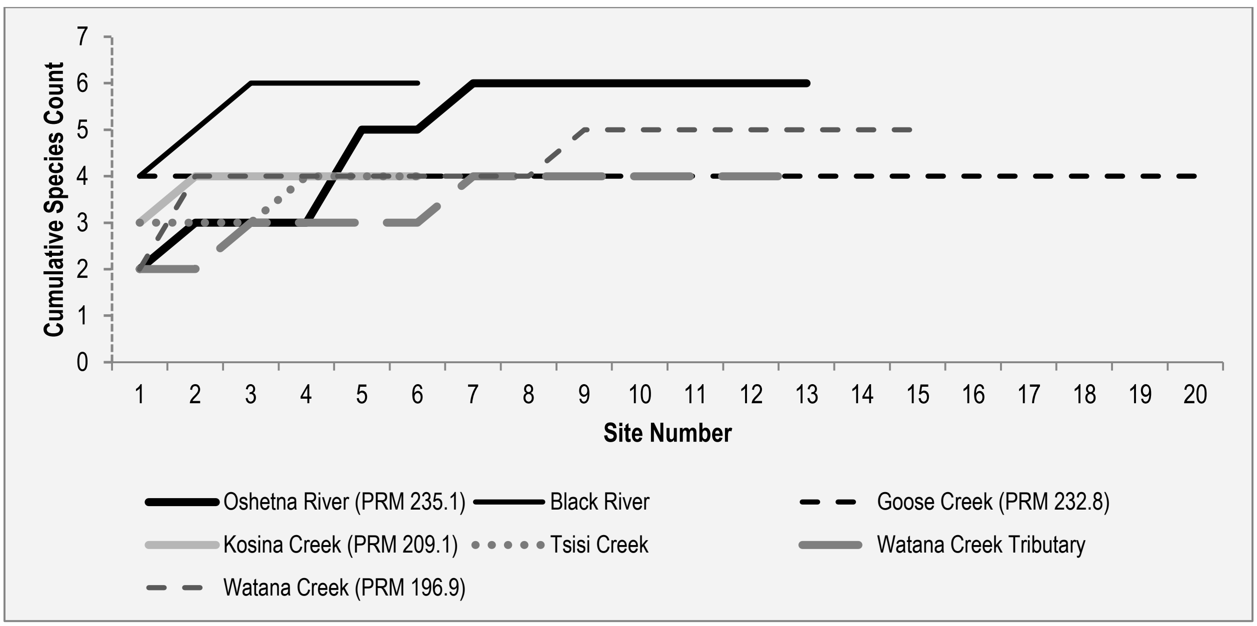


**Figure 1. Species accumulation among Upper River tributary GRTS sampling sites in 2013.**

**Table 4. Summary of sampling sufficiency measures for tributaries with at least six GRTS sampling sites in the Upper River in 2013.**

| Upper River Tributary | Number of 2013 Sample Sites | SR[a] | Site when SR first observed | $TSR_{H-T}$[b] | Site when $TSR_{H-T}$ -1 first observed | $TSR_{H-T}$ minus SR |
|---|---|---|---|---|---|---|
| Oshetna River (PRM 235.1) | 13 | 6 | 7 | 6.81 | 7 | 0.81 |
| Black River | 6 | 6 | 3 | 6.60 | 3 | 0.60 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Goose Creek (PRM 232.8) | 20 | 4 | 1 | 4.003 | 1 | 0.003 |
| Kosina Creek (PRM 209.1) | 6 | 4 | 2 | 4.10 | 1 | 0.10 |
| Tsisi Creek | 6 | 4 | 4 | 4.52 | 4 | 0.52 |
| Watana Creek (PRM 196.9) | 15 | 5 | 9 | 5.55 | 9 | 0.55 |
| Watana Creek Tributary | 13 | 4 | 7 | 4.58 | 7 | 0.58 |

[a] Observed species richness - the total number of species found in a Tributary
[b] Horvitz-Thompson estimate (Cochran 1977) of the true species richness in a tributary

However, the 2013 sub-sampling resulted in a sampling effort that was inconsistent with the intent of the FERC SPD with smaller basins receiving proportionally more effort and larger basins receiving proportionally less (Table 5). In addition, a post-2013 field season review of the remote video within each GRTS panel indicated that there were some habitat types (pools, alcoves, percolation channels) that were under-represented in 2013 fish sampling and would benefit from additional replicates. These two findings related to the 2013 fish sampling effort have prompted AEA to modify the Upper River study by increasing the number of sub-sampling units within the GRTS panels for the next year of study using an approach that increases sampling proportional to stream width and increases the number of under-represented fish habitats.

## 3.3. Increased Sampling Effort

When considering modifications to the sampling approach, it is important to consider the ability to compare data across years. Thus, AEA's proposal is to repeat sampling at all 2013 sampling units while allocating increased effort strategically among tributaries. AEA has reviewed a number of sampling sufficiency analyses based on stream size including a recent publication by ADF&G for sampling in Alaska streams (Kirsch et al. 2014). AEA proposes to apply the recommendation from the ADF&G analysis to Upper River tributaries and will use this approach as described below to generate increased total sample lengths by tributary. One caveat in applying the ADF&G approach is that in most tributaries AEA will maintain or increase sample length beyond that accomplished in 2013, to allow for inclusion of additional mesohabitat replicates. The stream-specific sample length increases are presented in Table 5.

The sole exception to this proposal is in Goose Creek. The Implementation Plan incorrectly identified Goose Creek as having documented Chinook salmon presence and being listed in the Anadromous Water Catalog (AWC). Therefore, sampling was intensive, striving towards a goal of sampling up to 25 percent of the 80 GRTS panels generated for this system. AEA proposes to scale back the effort in Goose Creek to sub-sampling in 12 panels to be consistent with the sampling effort in other non-Chinook salmon bearing streams.

## 3.4. Measures of Sampling Sufficiency

Sampling sufficiency for characterizing fish distribution is often evaluated in relation to channel width (Paller 1995, Patton et al. 2000, Hughes et al. 2002, Maret and Ott 2003, Reynolds et al. 2003, Kirsch et al. 2014). Fish sampling and habitat surveys completed in 2013 provide channel width information that was not available to incorporate into the Implementation Plan. The AEA study team has reviewed the 2013 sampling effort in the context of field measurements of channel width in order to prioritize additional sampling. Kirsch et al. (2014) recommended sampling lengths of 40 wetted channel widths for wadeable streams, 120 channel widths for nonwadeable streams in basins with a watershed area of 100-300 km, and more than 140 channel widths in nonwadeable streams in larger drainage basins. Applying these recommendations to Upper River tributaries, the study team has developed revised distance targets for future sampling. AEA proposes to maintain the spatial configuration of the original GRTS panel sampling and apportion the additional sampling length within the existing panels by increasing the number of replicates of mesohabitat units sampled per panel. The review of mesohabitats within with panels is ongoing, but once complete will provide a menu of mesohabitat units to add and increase sampling lengths according to the updated targets (Table 5).

**Table 5. 2013 tributary sampling summary and proposed future sampling length targets for Study 9.5.**

| GRTS Sampled Tributaries | Drainage Basin Area ($km^2$) | Chinook Salmon Presence | GRTS Sampling Unit Size (m) | Number of GRTS Population Sample Units | Number of 2013 Sample Sites | Number of Meso-habitats Sampled 2013 | Meters sampled 2013 | % Sampled | Average Wetted Width (m) | Average bankful width (m) | CWs Sampled (wetted) | Kirsch et al. 2014 Target (CW) | Kirsch et al. 2014 Target (m) | Kirsch et al. 2014 Target (%) | Proposed Change (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oshetna River (PRM 235.1) | 1424.5 | yes | 800 | 52 | 13 | 28 | 2,604 | 6% | 36 | 41.9 | 73 | 140 | 5,026 | 12% | 2,422 |
| Black River | NA | no | 400 | 24 | 6 | 11 | 1,050 | 11% | 23 | 24.5 | 46 | *140* | 3,178 | 33% | 2,128 |
| Goose Creek (PRM 232.8) | 269.1 | *no* | 200 | 81 | 20 | 38 | 3,107 | 19% | 14 | 16.8 | 219 | 120 | 1,704 | 11% | (1,403) |
| Kosina Creek (PRM 209.1) | 1036.5 | yes | 800 | 24 | 6 | 10 | 1,000 | 5% | 32 | 34.7 | 31 | 140 | 4,522 | 24% | 3,522 |
| Tsisi Creek | NA | no | 400 | 23 | 6 | 10 | 980 | 11% | 14 | 15.2 | 69 | *140* | 1,988 | 22% | 1,008 |
| Unnamed Tributary 206.3 | <80.3 | no | 200 | 29 | 0 | 0 | - | 0% | 3 | 4.8 | 0 | 40 | 124 | 2% | 124 |
| Unnamed Tributary 204.5 | <80.3 | no | 200 | 21 | 0 | 0 | - | 0% | 5 (est) | 5 (est) | 0 | 40 | 200 | 5% | 200 |
| Unnamed Tributary 197.7 | <80.3 | no | 200 | 41 | 0 | 0 | - | 0% | 5 (est) | 5 (est) | 0 | 40 | 200 | 2% | 200 |
| Watana Creek (PRM 196.9) | 452.7 | yes | 400 | 60 | 15 | 30 | 2,561 | 11% | 11 | 15.5 | 231 | 140 | 1,554 | 6% | - |
| Watana Creek Tributary | NA | no | 200 | 67 | 13 | 18 | 1,459 | 11% | 10 | 13.3 | 154 | *140* | 1,330 | 10% | - |
| Unnamed Tributary 194.8 | 321.2 | no | 400 | 32 | 2 | 4 | 300 | 2% | 3 | 5.5 | 88 | 140 | 476 | 4% | 176 |
| **Total** | **--** | **--** | **--** | **454** | **81** | **149** | **13,061** | **8%** | | | | | **20,302** | **12%** | **8,377** |

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