

# Initial Study Report Meeting

## ***Study 8.5 Fish and Aquatics Instream Flow***

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Prepared by  
**R2 Resource Consultants**  
**Miller Ecological Consultants**  
**Golder Associates**



## Study 8.5 Objectives

- **Map the current aquatic habitat in main channel and off-channel habitats of the Susitna River affected by Project operations.** This objective will be completed as part of the Characterization of Aquatic Habitats Study (Study 9.9) (Figure 2-1)
- **Select study areas and sampling procedures to collect data and information that can be used to characterize, quantify, and model mainstem and lateral Susitna River habitat types at different scales.** This objective will be completed via a collaborative process with the other resource studies (Riparian Instream Flow [Study 8.6], Groundwater [Study 7.5], Geomorphology [Studies 6.5 and 6.6], Water Quality [Studies 5.5 and 5.6], and Fish and Aquatics studies), and is described in ISR Study 8.5, Section 4
- **Develop a mainstem Open-water Flow Routing Model that estimates water surface elevations and average water velocity along modeled transects on an hourly basis under alternative operational scenarios.** See ISR Study 8.5, Sections 4.4 and 5.3
- **Develop site-specific Habitat Suitability Criteria (HSC) and Habitat Suitability Indices (HSI) for various species and life stages of fish for biologically relevant time periods selected in consultation with the TWG.** Criteria will include observed physical phenomena that may be a factor in fish preference (e.g., depth, velocity, substrate, embeddedness, proximity to cover, groundwater influence, turbidity). If study efforts are unable to develop robust site-specific data, HSC/HSI will be developed using the best available information and selected in consultation with the TWG. See ISR Study 8.5, Sections 4.5 and 5.5

## Study 8.5 Objectives

- **Develop integrated aquatic habitat models that produce a time series of data for a variety of biological metrics under existing conditions and alternative operational scenarios.** These metrics may include (but are not limited to) the following:
  - Water surface elevation at selected river locations
  - Water velocity within study areas subdivisions (cells or transects) over a range of flows during seasonal conditions
  - Length of edge habitats in main channel and off-channel habitats
  - Habitat area associated with off-channel habitats
  - Clear water area zones
  - Effective spawning and incubation habitats
  - Varial zone areas
  - Frequency and duration of exposure/inundation of the varial zone at selected river locations
  - Habitat suitability indices
  - See ISR Study 8.5, Sections 4.6 and 5.6
- **Evaluate existing conditions and alternative operational scenarios using a hydrologic database that includes specific years or portions of annual hydrographs for wet, average, and dry hydrologic conditions and warm and cool Pacific Decadal Oscillation (PDO) phases.** See ISR Study 8.5, Sections 4.3 and 5.4

## Study 8.5 Objectives

- **Coordinate instream flow modeling and evaluation procedures with complementary study efforts**, including Riparian Instream Flow (Study 8.6), Geomorphology (Studies 6.5 and 6.6), Groundwater (Study 7.5), Baseline Water Quality (Study 5.5), Fish Passage Barriers (Study 9.12), and Ice Processes (Study 7.6) (see Figure 2-1)
- **Develop a Decision Support System-type framework to conduct a variety of post-processing comparative analyses derived from the output metrics estimated under aquatic habitat models.** These include (but are not limited to) the following:
  - Seasonal juvenile and adult fish rearing
  - Habitat connectivity
  - Spawning and egg incubation
  - Juvenile fish stranding and trapping
  - Ramping rates
  - Distribution and abundance of benthic macroinvertebrates
  - See ISR Study 8.5, Sections 4.8 and 5.8

## *Study 8.5 Components*

- IFS Analytical Framework (ISR Part A, Section 4.1; pg 5)
- River Stratification and Study Area Selection (ISR Part A, Section 4.2; pg 7)
- Hydrologic Data Analysis (ISR Part A, Section 4.3; pg 18)
- Reservoir Operations Model and Open-water Flow Routing Model (ISR Part A, Section 4.4; pg 22)
- Habitat Suitability Criteria Development (ISR Part A, Section 4.5;pg 26)
- Habitat-Specific Model Development (ISR Part A, Section 4.6; pg 42)
- Temporal and Spatial Habitat Analysis (ISR Part A, Section 4.7; pg 50)
- Instream Flow Study Integration (ISR Part A, Section 4.8; pg 51)

## Study 8.5 Variances

- The Study Plan indicated **13 mainstem water-level recording stations** would be maintained in 2013 (RSP Section 8.5.4.3.1). After calibration and validation of the Version 1 Open-water Flow Routing Model, and in response to land owner access issues, five stations were not maintained in 2013 (ISR Study 8.5, Section 4.4.2).
- The Study Plan indicated continuous stage measurements would be collected in the mainstem (RSP Section 8.5.4.3.1). Due to ice damage, flooding and land access issues, some short and long-term data gaps of water stage exist for eight hydrology locations (ISR Study 8.5, Section 4.3.2).
- The Study Plan indicated **continuous gaging would be installed at Fog Creek and Portage Creek** (RSP Section 8.5.4.4.1.1). Due to land access issues, these were not installed in 2013 (ISR Study 8.5, Section 4.3.2).
- The Study Plan indicated that **specific representative years** and the duration of the continuous flow record would be selected by AEA in consultation with the TWG in Q3 2013 (RSP Section 8.5.4.4.1.2). This selection was discussed at the November 13-15, 2013 Riverine Modelers meeting and Q4 2013 TWG meeting. (ISR Study 8.5, Section 4.3.2). The recommended representative years and the rationale for selection were presented at the April 15-17, 2014 Proof of Concept meeting and described in ISR Study 8.5, Appendix J.
- The Study Plan indicated that hydrologic parameters for **IHA analysis** would be developed in consultation with the TWG in Q3 2013 and interim results of IHA-type analysis would be presented in the ISR (RSP Section 8.5.4.4.1.3). A description of the initial proposed methodology is provided in ISR Study 8.5, Section 5.3, and Section 7.3 and will undergo continued discussion and coordination with the TWG (ISR Study 8.5, Section 4.3.2). An Instream Flow Study (IFS) Technical Team (TT) meeting occurred on March 21, 2014 which reviewed candidate metrics and proposed analysis for IHA and EFC.

## Study 8.5 Variances

- The Study Plan indicated that **HSC sample sites** would be stratified and randomly selected from within the **Middle River Segment and Lower River Segment** (RSP Section 8.5.4.5.1.1.3). Due to access restrictions, the Middle River Segment was limited to habitat areas between Portage Creek and Three Rivers Confluence. Due to flow related delays in completing the habitat mapping surveys and the desire to focus sampling in 2013 on the Middle River, the Lower River segment was not sampled (ISR Study 8.5, Section 4.5.2).
- The Study Plan indicated **spawning redd dimensions** would be collected (RSP Sections 8.5.4.5.1.1.4 and 8.5.4.5.1.1.5). These were collected in 2012 but in 2013 deemed unnecessary for developing evaluation metrics (ISR Study 8.5, Section 4.5.2).
- The Study Plan indicated that **substrate size** (dominant, sub-dominant, and percent dominant) would be characterized in accordance with a Wentworth grain size scale modified to reflect English units (RSP Sections 8.5.4.5.1.1.4, 8.5.4.5.1.1.5, 8.5.4.5.1.1.6.1, and 8.5.4.6.1.2.4). Field personnel found it impracticable to attempt to accurately differentiate gravel composition into three size classes in turbid water conditions and used two instead (ISR Study 8.5, Section 4.5.2).
- The Study Plan indicated that location in water column, **focal point and mean column velocity** would be measured using a Price AA current meter (RSP Section 8.5.4.5.1.1.6.1). Most fish captures occurred using electrofishing, seining or a combination of the two methods which precluded the identification of fish focal point position within the water column (ISR Study 8.5, Section 4.5.2).
- The Study Plan indicated that **mesohabitat type** would be recorded for fish observation/capture points (RSP Section 8.5.4.5.1.1.6.1). However, this was not done during the field surveys but will be **completed after the mesohabitat mapping task is complete** by applying GIS data layers containing the location of HSC fish use observations (ISR Study 8.5, Section 4.5.2) to denote mesohabitat types

## Study 8.5 Variances

- The Study Plan indicated that field surveys would be conducted **at potential stranding and trapping areas on an opportunistic basis** following up to three flow reduction events during 2013 (RSP Section 8.5.4.5.1.2.2). The need for these studies will be discussed with the TWG.
- The Study Plan indicated that 2012-2013 winter study results would be distributed to the TWG by Q3 2013 (RSP Section 8.5.4.5.1.2.1). The results were presented and discussed during an IFS TT meeting in March 2014 (ISR Study 8.5, Section 4.5.2, Appendix L).
- The Study Plan indicated that macroinvertebrate sampling would occur at six stations, each with three sites (one mainstem site and two off-channel sites associated with the mainstem site), for **a total of 18 sites** (RSP Section 8.5.4.5.1.2.3). This sampling occurred at five stations on the Susitna River, each station with three to five sites (establishing sites at all macrohabitat types present within the station), for **a total of 20 sites** (ISR Study 8.5, Section 4.5.2).
- The Study Plan indicated the **Deshka River Chinook Salmon and Yentna River Sockeye Salmon** datasets would be examined for flow-dependent biological cues (RSP Section 8.5.4.5.1.3). Mainly due to lack of the necessary data, the Deshka River and the Yentna River were not used for this study. Through further discussions with ADF&G, the **Taku River and Stikine River Chinook Salmon** stocks were selected (ISR Study 8.5, Section 4.5.2).
- The Study Plan indicated that **additional variables would be compared to fish distribution and abundance**: surface flow and groundwater exchange fluxes, dissolved oxygen (intergravel and surface water), macronutrients, temperature (intergravel and surface water), pH, dissolved organic carbon, alkalinity, and Chlorophyll-a. Depending on these relationships, **additional HSC preference curves may be needed** (FERC 2013b [FERC April 1 SPD, page B-85]). Most of the data necessary to complete this analysis is still being processed and/or undergoing quality assurance checks and is not available at this time (ISR Study 8.5, Section 4.5.2, and Section 7.5.1.2.1).

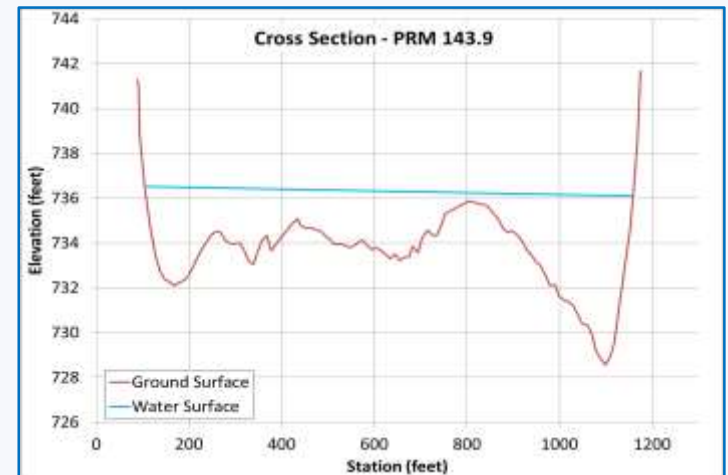


## Study 8.5 Variances

- The Study Plan indicated that **five tributary mouths**, including Sheep Creek and Caswell Creek, would be investigated as part of the Lower River studies (R2 2013b [Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014]). **Two of the five sites** identified for study in 2013 were not completed and were **deferred to the next study year** in order to evaluate the effectiveness of the model outputs from the other three sites and evaluate the need for additional sites (ISR Study 8.5, Section 4.6.2).
- The Study Plan indicated that an evaluation of the **representativeness of the Lower River study areas was to occur by Q4 2013** (R2 2013b [Technical Memorandum, Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014]). This task was **completed as part of the IFS TT POC Meetings, April 15-17, 2014**; ISR Study 8.5, Section 7.6.
- The Study Plan indicated that the final approach and details concerning methods for conducting **temporal analysis and Project operational scenarios would be discussed with the TWG in Q4 2013** (RSP Section 8.5.4.7.1.1). The general approaches to be used for the spatial analysis of the fish habitat models and the temporal analysis for the different resource models were discussed as part of the November 13-15, 2013 Instream Flow Study Technical Team Riverine Modelers meeting. More **details concerning these methods are provided in this ISR** and AEA is planning on finalizing the methods in 2014, in accordance with the Study Plan schedule; AEA demonstrate the application of the temporal methods and presented **options for the spatial analysis during the IFS TT POC Meetings, April 15-17, 2014** (ISR Study 8.5, Section 4.7.2, Section 7.7).

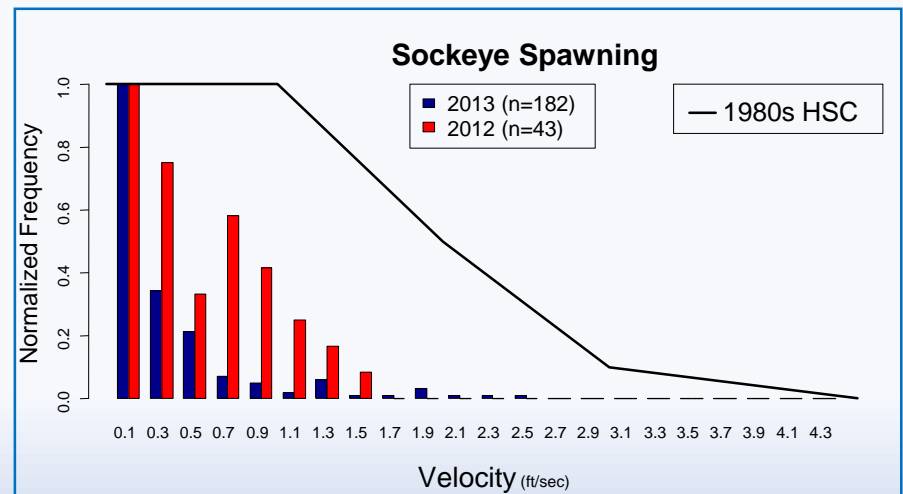
## Study 8.5 Summary of Results in ISR (ISR Study 8.5, Part A – Section 5)

- Mainstem open-water transects measured between PRM 187.2 and PRM 29.9 (Study 8.5 Appendices A, C, D)
- Ten tributary gaging stations with stage recorders, two tributary spot measurement stations (Study 8.5, Appendix E, F)
- Version 2 of the Open-water Flow Routing Model (see Study 8.5, Appendix K)
  - Version 1 (88 x-sections)
  - Version 2 (167 x-sections)
- 10 Middle River Focus Areas selected;  
7 measured in 2013
  - Bathymetry
  - Stage and flow
  - Surficial substrate and cover
- 5 tributary mouths and 6 mainstem sites selected in Lower River; 3 tributary mouths and 3 mainstem study sites measured in 2013.



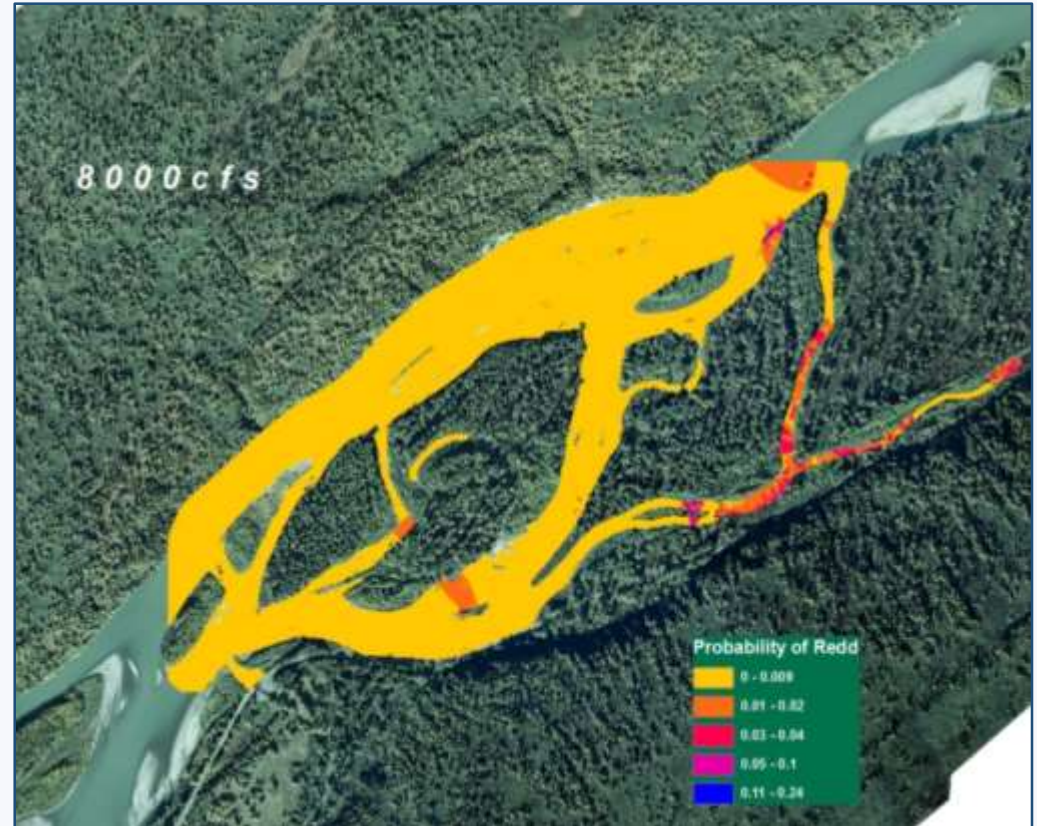
## Study 8.5 Summary of Results in ISR (ISR Study 8.5, Part A – Section 5)

- HSC sampling sites relied on stratified random sampling approach and areas of known fish use; 1,433 observations of habitat use collected for four lifestages of 12 species in 2013
- In response to suggestion in April 2013 FERC Study Plan Determination, micro-piezometer measurements routinely collected during HSC habitat use and availability observations
- Draft HSC histogram plots (Study 8.5, Appendix G)
- HSC data and fish distribution and abundance data (Study 9.6) used to develop periodicity tables (Study 8.5, Appendix H)
- Pilot Winter Studies (Study 8.5, Appendix L)



## Study 8.5 Summary of Results in ISR (ISR Study 8.5, Part A – Section 5)

- Riverine Modelers meeting held in November 2013
- Proof-of-Concept Meeting held in April 2014 (Study 8.5, Appendix N); FA-128 (Slough 8A) example
- Lower River Habitat Modeling (Study 8.5 Appendices I and O) ; Birch Creek tributary mouth example



Example GIS layer of salmonid spawning habitat FA-128 (Slough 8A)

# Study 8.5 Summary of Results since ISR

## IFS Analytical Framework (ISR Study 8.5, Part C, Appendix N (Proof of Concept))

- System Input
  - Mainstem and tributary gaging
- Reach Scale Modeling
  - Mainstem transects
- Focus Area Scale Modeling
  - 2-D computational mesh for 7 Focus Areas
  - Additional bathymetry, stage, and flow at Focus Area features
  - FA-151 (Portage Creek) bathymetry, stage, flow, substrate
- Fish Habitat Modeling
  - HSC in Lower River, FA-173 (Stephan Lake Complex), FA-184 (Watana Dam) and other Middle River sites
  - Measurement of groundwater/surface water features
  - Fish habitat model refined to integrate both SRH-2D (open-water) and River2D (ice) hydraulic data
  - Fish habitat model modified to integrate additional HSC parameters
- Decision Support System



# Study 8.5 Summary of Results since ISR

## September 2014 Technical Memorandum

### 2013-2014 Instream Flow Winter Studies



#### Field Study Results

- 2014 Sampling sessions:
  - February, March, and April
  - 4 Middle River Focus Areas below Devils Canyon
  - 28 Daytime electrofishing surveys (n=248 fish)
  - 16 Night electrofishing surveys (n=659 fish)
- HSC
  - 262 HSC observations
  - 8 species, fry and juveniles
  - Coho (120), Sockeye (68), chum (42)
- Water Quality
  - Intergravel water temps in main channel near 0°C
  - Intergravel water temps in sloughs 2-4 °C warmer
  - Dissolved oxygen levels drop to 4 mg/L depending on groundwater source and proportion of flow

# Study 8.5 Summary of Results since ISR

## HSC Curve Development



- Additional HSC data collection
  - Lower, Middle (above and below Devils Canyon)
  - Sampling sessions:
    - May 20-June 7
    - July 15-22
    - Sep 17-24
  - May-September 2014 Sampling
    - 1,465 habitat use measurements
    - 1,584 habitat availability measurements
    - Completed data entry – QC3
- **Technical Memorandum - Relationship Between Fish Abundance and Specific Microhabitat Variables**
  - Determine if “strong” relationships are present between fish abundance and 8 additional variables
    - HSC
    - HSI
    - Threshold
    - Not considered

# Study 8.5 Summary of Results since ISR

## HSC Curve Development

Species	Lifestage	Total Through July 2014	1980's Total
Chinook	Juvenile	218	
Chum	Fry	272	
	Spawning	348	333
Coho	Fry	280	
	Juvenile	84	
Pink	Fry	39	
	Spawning	59	NR
Sockeye	Fry	378	
	Spawning	181	81
Arctic Grayling	Fry	120	
	Juvenile	52	
	Adult	8	140



# Study 8.5 Summary of Results since ISR

## HSC Curve Development

Species	Lifestage	Total Through July 2014	1980's Total
Burbot	Juvenile	6	
	Adult	20	18
Dolly Varden	Fry	20	
	Adult	2	2
Longnose Sucker	Fry	87	
	Juvenile	79	
	Adult	73	157
Rainbow Trout	Juvenile	7	
	Adult	7	143
Whitefish	Fry	112	
	Juvenile	54	
	Adult	33	384

# Study 8.5 Summary of Results since ISR

## HSC Curve Development

Life Stage	Multivariate Preference Curve (2012-2015 data)	Univariate Utilization 2012-2015/1980's Data	Literature Based/ Prof. Opinion
<b>Spawning</b>	Chum		
	Pink		
	Sockeye		
<b>Fry</b>	Coho	Arctic Grayling	
	Chinook	Whitefish	
	Sockeye	Longnose Sucker	
<b>Juvenile</b>	Coho	Arctic Grayling	
	Chinook		
	Longnose Sucker		
<b>Adult</b>	Whitefish	Arctic Grayling	Bering Cisco
	Longnose Sucker	Rainbow	Eulachon
			Burbot

# *AEA Proposed Modifications to Study 8.5 in ISR (ISR Study 8.5, Part C – Section 7)*

## **7.1.1.2. IFS Analytical Framework**

- No modifications to the Study Plan are needed to complete this study component and meet Study Plan objectives

## **7.2.1.2. River Stratification and Study Area Selection**

- At this time, no modifications to the Study Plan are needed to complete this study component and meet Study Plan objectives

## **7.3.1.2. Hydrologic Data Analysis**

- Several hydrology stations established in 2012 will be discontinued in 2014
  - ESS60 (PRM 168.1) and ESS35 (PRM 102.1) not ideal for rating curve development
- At least 6 original hydrology stations will be maintained in 2014 for water level and temperature
  - ESS80 (PRM 225.0), ESS70 (PRM 187.2), ESS65 (PRM 176.5), ESS55 (PRM 152.1), ESS40 (PRM 107.1), ESS30 (PRM 98.4)
  - Remaining stations will be maintained for air temperature and camera images
  - Additional water-level recording stations will be installed and maintained as needed
    - Some of those include mainstem Susitna River near Sheep Creek (PRM 69.5) and Caswell Creeks (PRM 67)
- Hydrology gages will be installed at Fog Creek and Portage Creek (delayed from lack of land access)
- Three instead of five representative years were selected to represent wet/warm (1981), average (1985), and dry/cool (1976) conditions. The two additional years that were to represent warm and cold Pacific Decadal Oscillations were not included since analysis did not support this distinction. See Appendix J.
- Final metrics will be developed with input from the TWG and other resource disciplines after Version 3 of the Open-water Flow Routing Model is available in 2015

## **7.4.1.2. Reservoir Operations and Open-water Flow Routing Modeling**

- No modifications to the Study Plan are needed to complete the modeling for this study component and meet Study Plan objectives

# ***AEA Proposed Modifications to Study 8.5 in ISR (ISR Study 8.5, Part C – Section 7)***

## **7.5.1.2. Habitat Suitability Criteria Development**

- Initial analysis of microhabitat variables and fish abundance need to be finished in 2014 by AE. Depending on the results of the analysis, additional HSC/HSI variables may need to be included in the analysis.

## **7.6.1.2. Habitat-Specific Model Development**

- As described in ISR Section 4.6.2, AEA is deferring LR-2 field studies from 2013 to 2015. This schedule modification for completing the Study Plan for the Lower River Segment will not impact AEA's ability to meet the objectives of the Study Plan. All other methods for Lower River fish habitat modeling will remain unchanged from the methods described in RSP Sections 8.5.4.2 through 8.5.4.7).

## **7.7.1.3. Temporal and Spatial Habitat Analyses**

- Temporal analyses include extrapolating the results of 2-D modeling of Focus Area fish habitats from existing conditions (i.e., License Year 0) to future conditions (i.e. Years 25 and 50). Spatial analyses include applying 1-D and 2-D fish habitat model results from modeled to non-modeled areas. General approaches for temporal and spatial analysis were discussed during the November 13-15, 2013 IFS TT Riverine Modelers Meeting (AEA 2013), and were more specifically described during the IFS TT POC meeting on April 15-17, 2014 (AEA 2014b). The final approaches for both the temporal and spatial analysis were to be provided in the ISR (RSP Section 8.5.4.7.1.3); and while discussion occurred during implementation of the Study Plan in 2013 and early 2014, decisions on the final approaches were deferred to 2015.

## **7.8.1.3. Instream Flow Study Integration**

- No modifications to the Study Plan are needed to complete the study components and meet Study Plan objectives

# Current Status and Steps to Complete Study 8.5

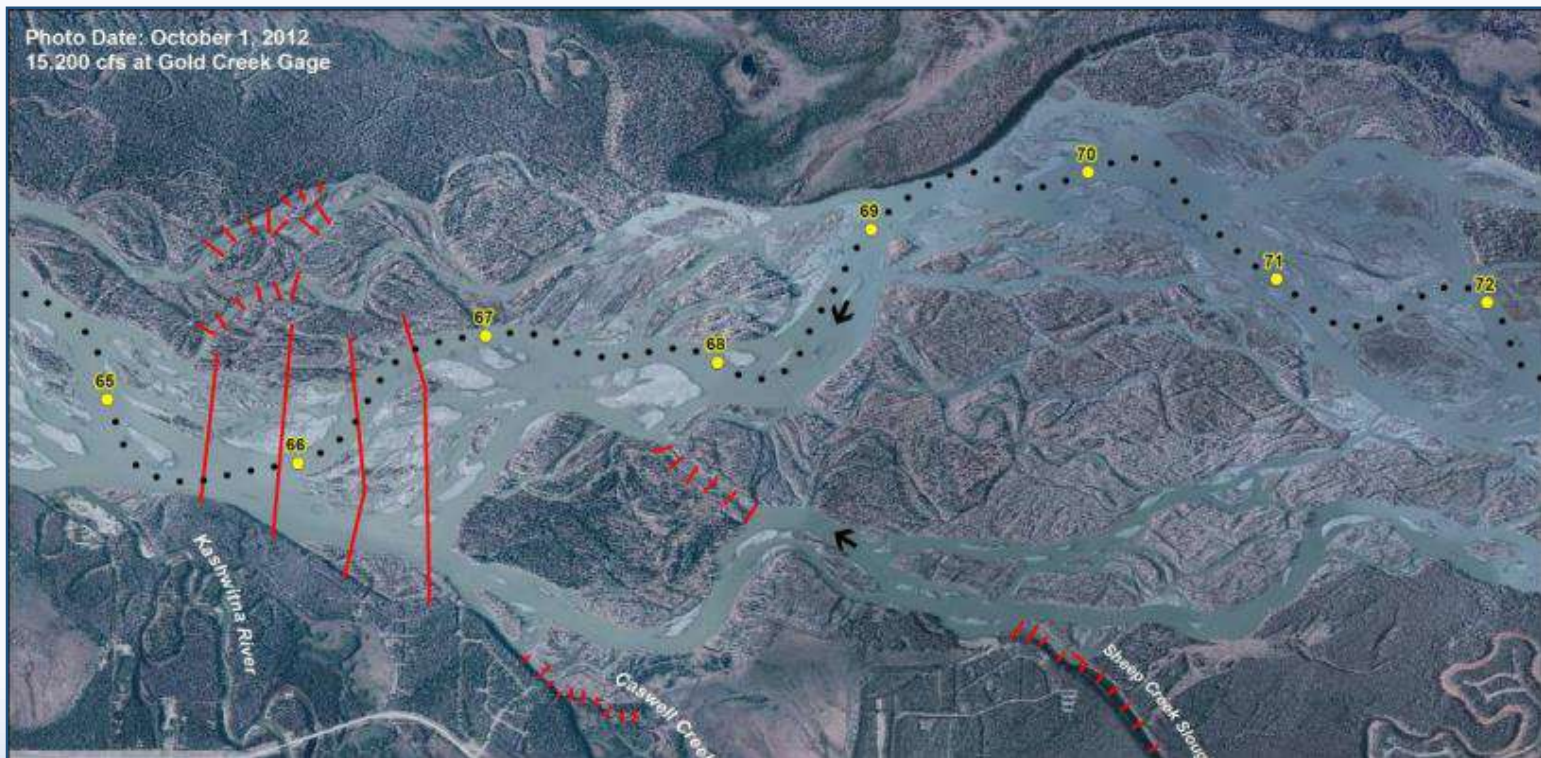
- **System Input**
  - Mainstem and tributary gaging (open-water and ice)
- **Reach Scale Modeling**
  - Mainstem transects (bathymetry, stage , and flow)
  - Version 3 Open-water Flow Routing Model
- **Middle River Focus Area Scale Modeling**
  - Measure FA-173 (Stephan Lake Complex), FA-184 (Watana Dam) bathymetry, stage, flow, substrate, and cover measurements
  - Maintain monitoring sensors (stage, water temp and DO) in FA-104 (Whiskers Creek), FA-128 (Slough 8A) and FA-138 (Gold Creek) during open-water and ice periods
  - Finalize SRH-2D (open-water) and River2D (ice) 2-D hydraulic modeling



# Current Status and Steps to Complete Study 8.5

- **Lower River Transect Modeling**

- Measure Lower River sites near PRM 67 (mainstem, side channel, Sheep and Caswell creeks) transect x-sections, stage, flow, substrate, and cover
- Finalize transect hydraulic modeling at six tributary mouths and six mainstem study sites



# Current Status and Steps to Complete Study 8.5

## Middle River Focus Area Habitat Modeling

- HSC measurements in Middle River with reduced emphasis on species/lifestages with large data sets
- Measurement of groundwater/surface water features at Focus Areas
- Finalize periodicity
- Finalize HSC
- Finalize Visual Basic and associated GIS tools to compute HSC/HSI metrics
- Ensure fish habitat models integrate additional HSC parameters as needed
- Conduct fish habitat modeling that integrates both SRH-2D (open-water) and River2D (ice) hydraulic data
- Develop varial zone models for Middle River Focus Areas
- Calculate breaching flow/habitat connectivity metrics
- Conduct effective spawning:incubation modeling at Focus Areas
- Conduct salmonid rearing habitat analyses
- Calculate Index of Hydrologic Alteration (IHA) and Environmental Flow Components (EFH) using Version 3 of Open-Water Flow Routing Model

# Current Status and Steps to Complete Study 8.5

- **Lower River Transect Habitat Modeling**
  - HSC measurements in Lower River
  - Adjust periodicity and HSC for Lower River as needed
  - Calculate fish passage and habitat connectivity metrics
  - Calculate Weighted Usable Area for target species for open-water period
  - Calculate Weighted Usable Area time series for open-water period
- **Decision Support System**
  - Finalize temporal and spatial habitat extrapolation process
  - Finalize process for evaluating uncertainty in evaluation metrics
  - Finalize integration process for fish habitat metrics
    - Matrix Method
      - Multiple Criteria Decision Analysis
      - Focus on KEY metrics
      - Large matrix
  - Finalize integration process for other riverine and reservoir related interests



# *Licensing Participants Proposed Modifications to Study 8.5?*

- Agencies
- CIRWG members and Ahtna
- Public