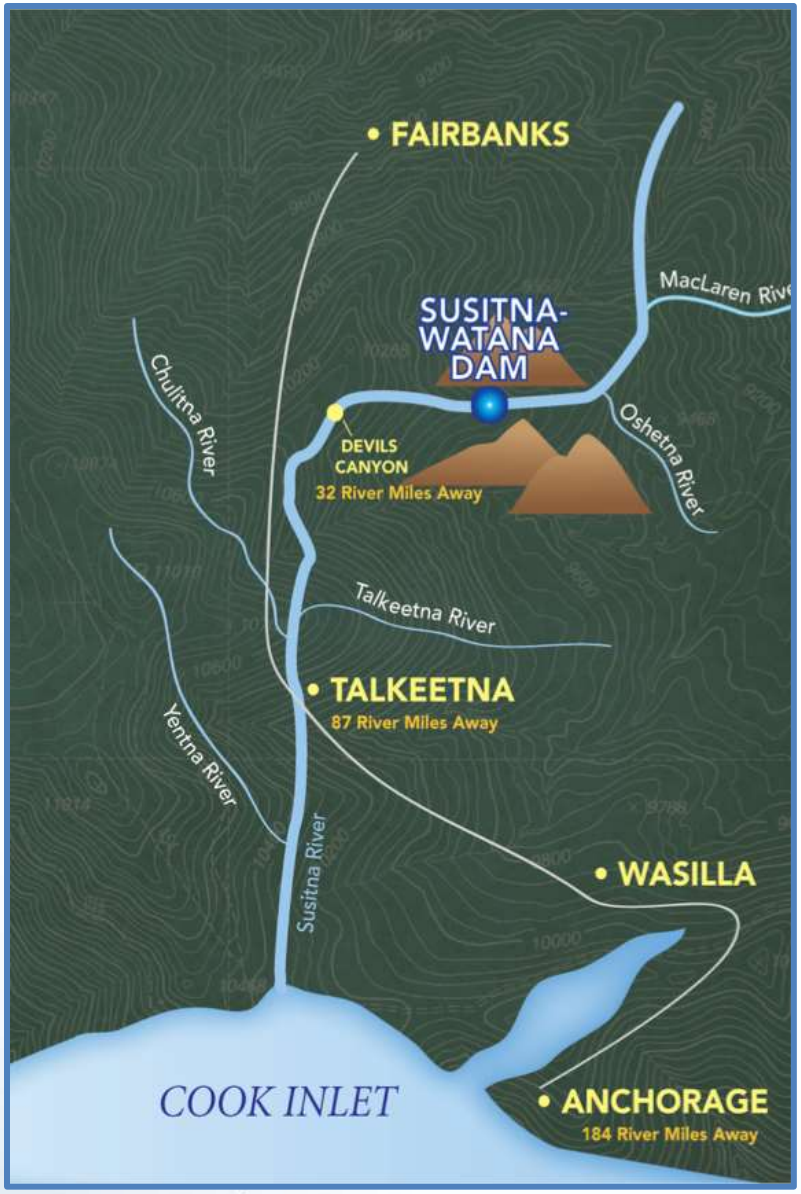

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Technical Team Meeting

Proof of Concept Meeting

2-D Fish Habitat Salmonid Rearing FA 128 Middle River Focus Areas

April 15-17, 2014

Prepared by Miller Ecological Consultants and R2 Resource Consultants

Overview

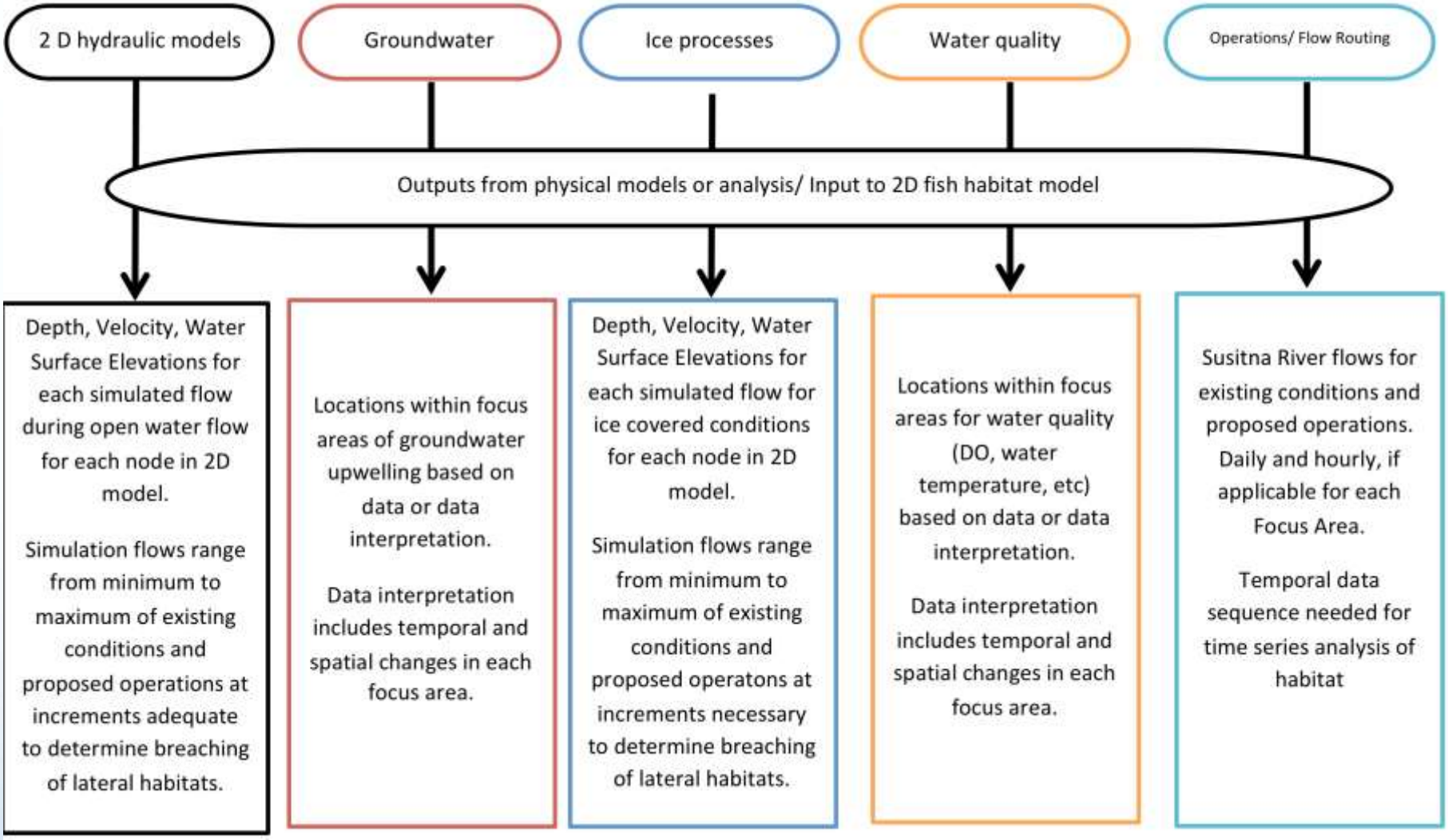
- Presentation overview:
  - Describe the 2-D habitat objectives
  - Describe the modeling approach
  - Present the work flow process and interdependencies to other models
  - Present metrics for salmonid rearing
- Note: The examples shown are for illustration of the process and model inputs and outputs. Any reference to specific life stage requirements or site locations are used to illustrate the steps that will be taken in the habitat modeling not actual conditions.

Objectives

- Compute usable area (square feet) for current conditions
  - Salmonid Rearing Habitat (open water and under ice)
  - Connection between main channel and lateral habitats under ice (flooding of lateral habitat under ice)
  - Usable area for other free swimming life stages as a function of flow (open water and under ice)
- Compute usable area for project operation conditions
  - Same as above
- Compare project operation to current conditions to determine change

Review of 2-D Based Habitat Model

- Incorporates concepts from traditional PHABSIM/IFIM
  - Hydraulics and suitability criteria
  - Calculates usable area
- Habitat area calculated from 2-D hydraulic model using GIS tools to combine hydraulic output data or other parameters (e.g. groundwater, water quality)
- Model uses HSC and HSI analysis for evaluation
- Data dependencies from the following: hydraulic models for open water and ice processes, substrate and cover data from field data collection, groundwater data, water quality data, HSC and HSI analysis
- Provides visual and quantitative result for decision framework


2 D hydraulic models
Groundwater
Ice processes
Water quality
Operations/ Flow Routing
Outputs from physical models or analysis/ Input to 2D fish habitat model
Depth, Velocity, Water Surface Elevations for each simulated flow during open water flow for each node in 2D model.
Simulation flows range from minimum to maximum of existing conditions and proposed operations at increments adequate to determine breaching of lateral habitats.
Locations within focus areas of groundwater upwelling based on data or data interpretation.
Data interpretation includes temporal and spatial changes in each focus area.
Depth, Velocity, Water Surface Elevations for each simulated flow for ice covered conditions for each node in 2D model.
Simulation flows range from minimum to maximum of existing conditions and proposed operatons at increments necessary to determine breaching of lateral habitats.
Locations within focus areas for water quality (DO, water temperature, etc) based on data or data interpretation.
Data interpretation includes temporal and spatial changes in each focus area.
Susitna River flows for existing conditions and proposed operations. Daily and hourly, if applicable for each Focus Area.
Temporal data sequence needed for time series analysis of habitat

POC – Salmonid Rearing Habitat Analysis

- **Identify potential use of discrete channel areas suitable for salmonid rearing and track the area (hourly) through the subsequent rearing period:**
  - ✓ **Dewatering**
  - ✓ **Cover**
  - ✓ **Depth**
  - ✓ **Velocity**

POC – Salmonid Rearing Habitat Analysis

- **Data Needs:**
  - ✓ Salmonid juvenile rearing habitat suitability & distribution*
  - ✓ Substrate composition*
  - ✓ Juvenile rearing periodicity*
  - ✓ Water surface elevation (dewatering)*
  - ✓ Depth*
  - ✓ Velocity*
  - ✓ Cover*

*Available for Proof of Concept

POC – Salmonid Rearing Habitat Analysis

HSC Salmonid Rearing Model – Best Fit

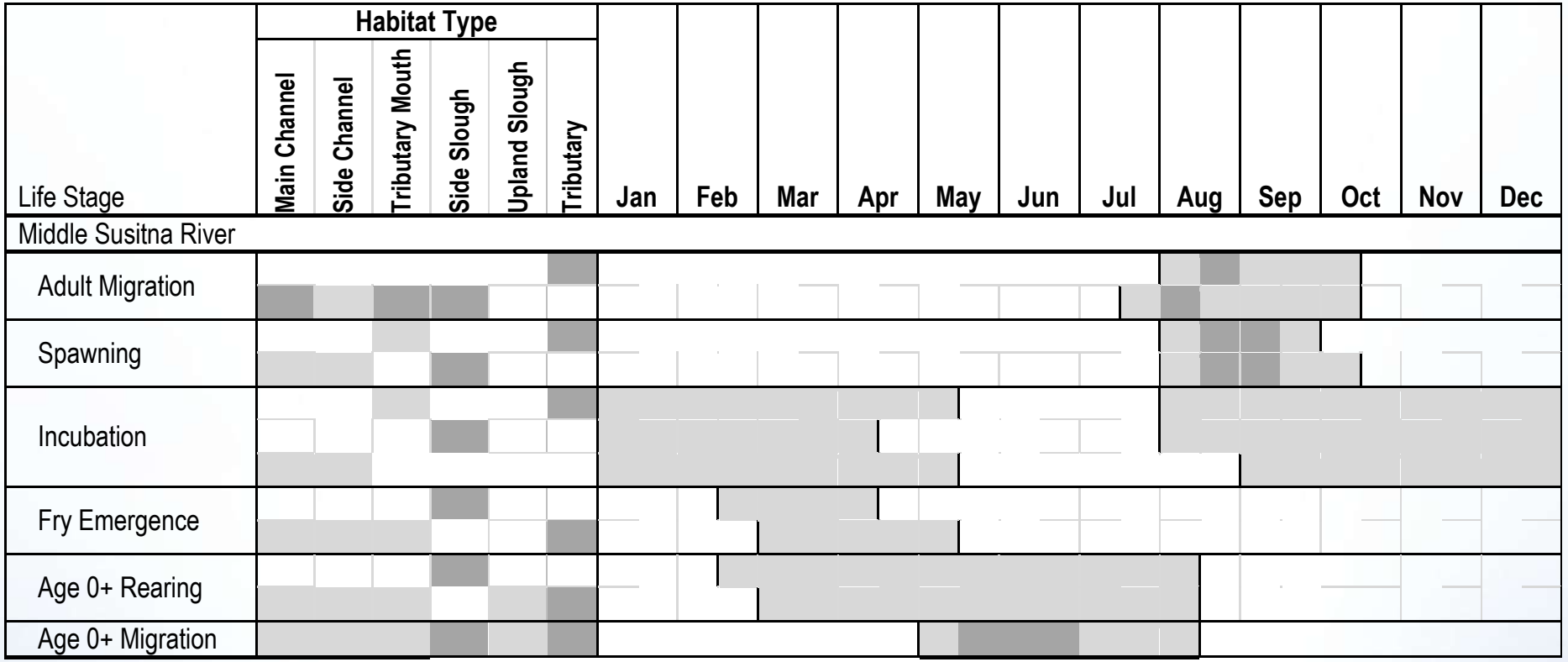
$$\log\left(\frac{p}{1-p}\right) = a_k + 2.7depth - 0.83depth^2 + b_k vel - 24vel^2 + 18vel^3 - 4.2vel^4,$$

where the following are the intercept and velocity slope estimates for each cover/turbidity group:

	a_k	b_k
Not Turbid/Cover	-3.8	11
Not Turbid/No Cover	-4.2	8.4
Turbid (>50 NTU)	-5.6	9

POC – Salmonid Rearing Habitat Analysis

Periodicity of chum salmon utilization among macro-habitat types in the Middle River Segment (PRM 187 – 102) of the Susitna River by life history stage.



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POC – Salmonid Rearing Habitat Analysis

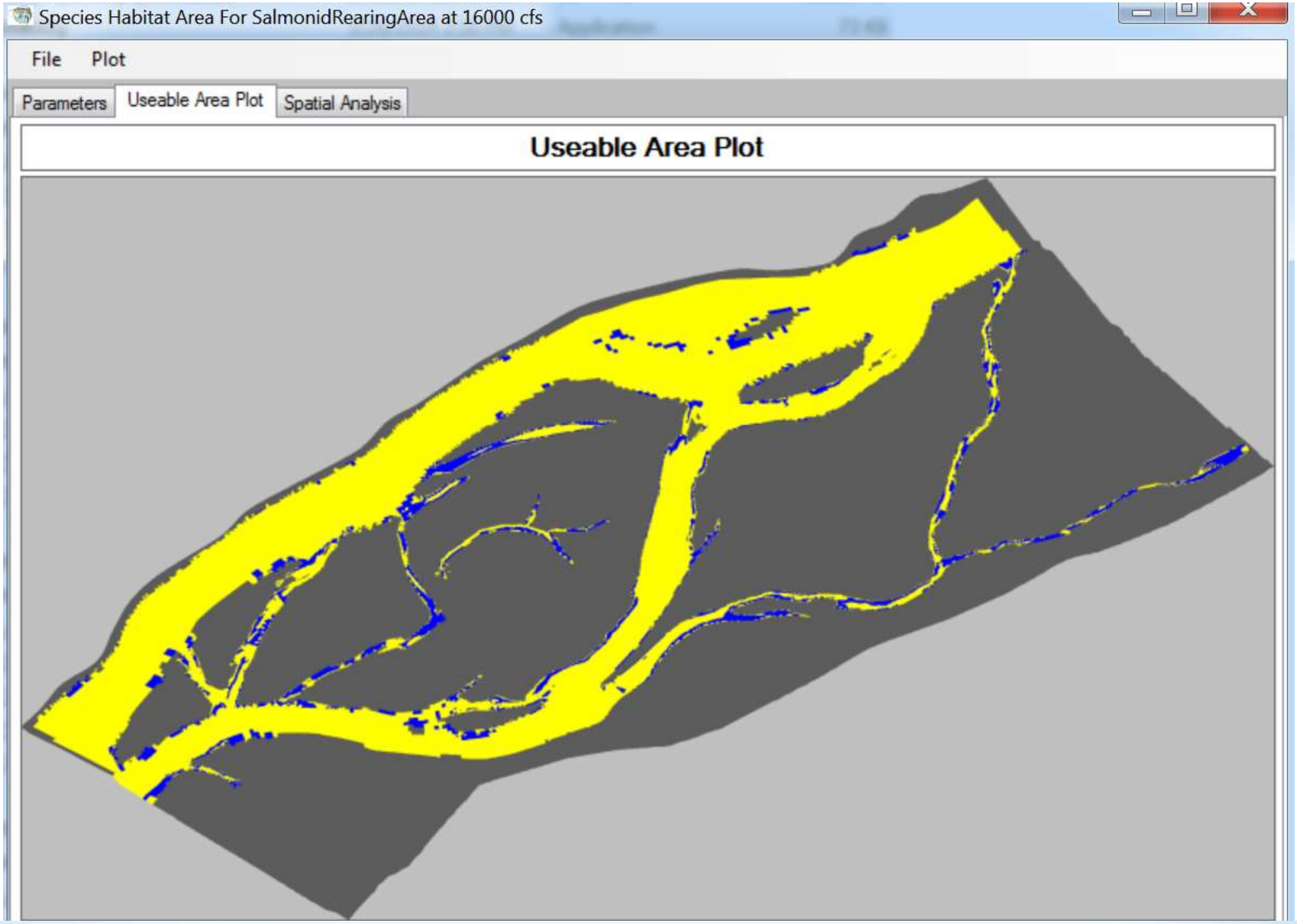
Rearing Period

- Define potential rearing areas using site-specific HSC preference for salmonid rearing
- Define periodicity based on 1980s and 2012/2013 data

2-D Fish Habitat Spatial Analysis

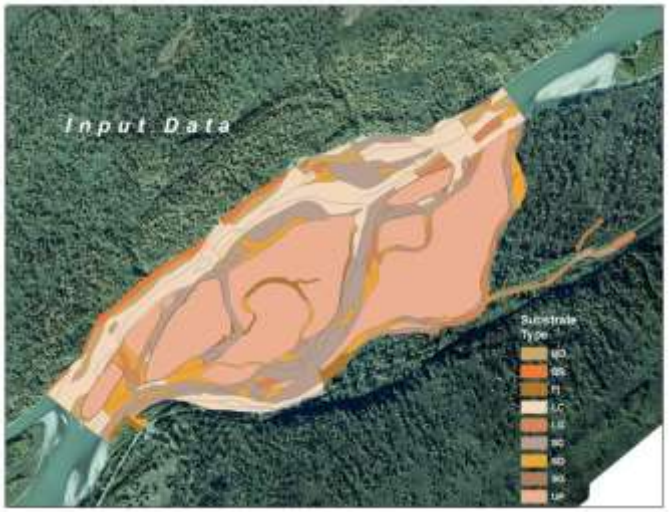
- Process Hydraulic Flow Data
  - CSV file geo-referenced data x,y,z, velocity, depth, channel index
- Create spatial data layers for each flow
- Conduct the Usable Area Modeling/HSI modeling
  - Combine spatial data and habitat equations
- Produce habitat graphics and CSV files with habitat values at each node
- Produce habitat versus discharge response functions

Example of VB visualization



GIS Model Flow Chart

Input Data
- Cover
- Substrate
- Groundwater
- Hydraulic



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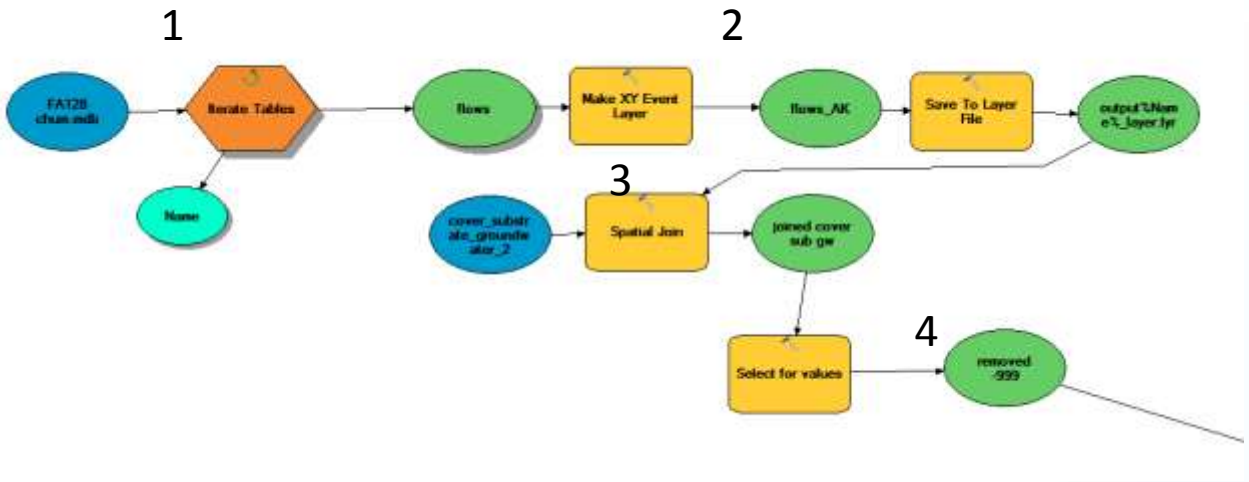
GIS Model Flow Chart

1. Import hydraulic data
2. Convert to spatial setting and project to AK State Plane
3. Join input data with substrate, cover and ground water data and clips data
4. Remove illogical values



Blue= input
Yellow= tool
Orange=repeat
Green=output

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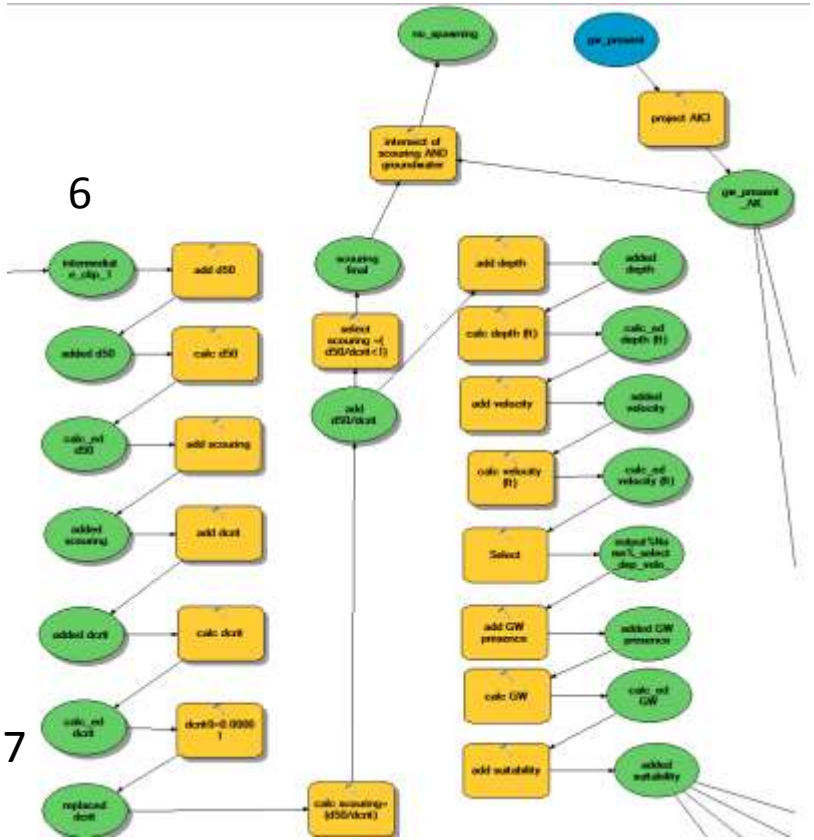
GIS Model Flow Chart

6. Add fields and populate fields in float data format: D50, Scouring

7. Eliminate 0 values, needed for step 8

8. Compare D50/D critical as a ratio for scouring



Blue= input
Yellow= tool
Orange=repeat
Green=output

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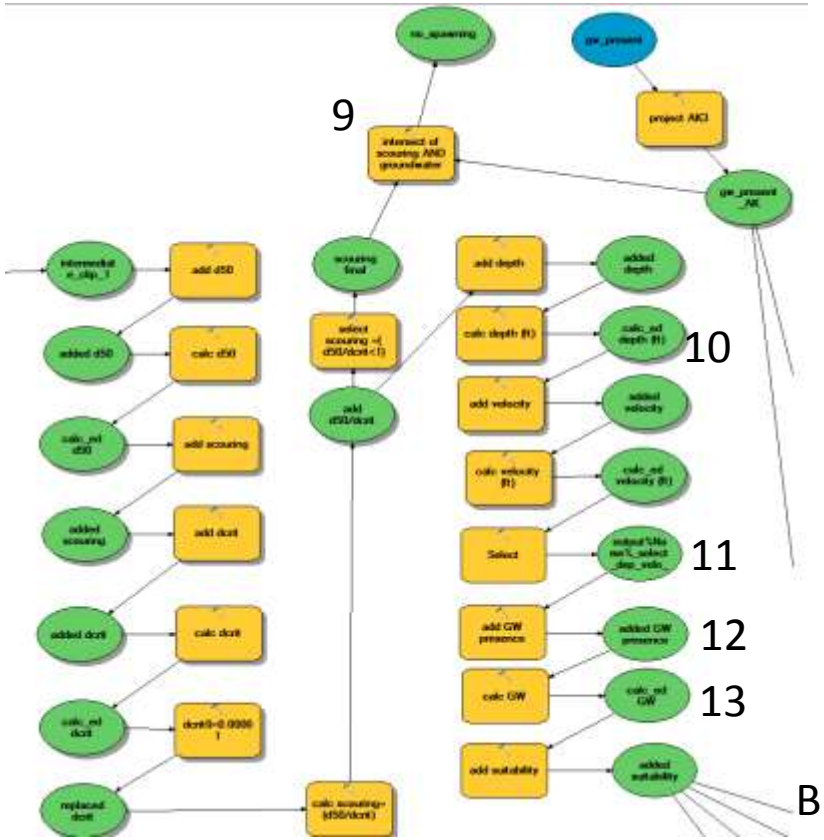
GIS Model Flow Chart

9. Selecting for D50/Scouring <1 and intersecting with groundwater
10. Add field and populate field in float data format: depth, velocity
11. Select for habitat requirements for depth, velocity
12. Add field and populate field in presence absence format: groundwater
13. Add field for suitability calculation



Blue= input
Yellow= tool
Orange=repeat
Green=output

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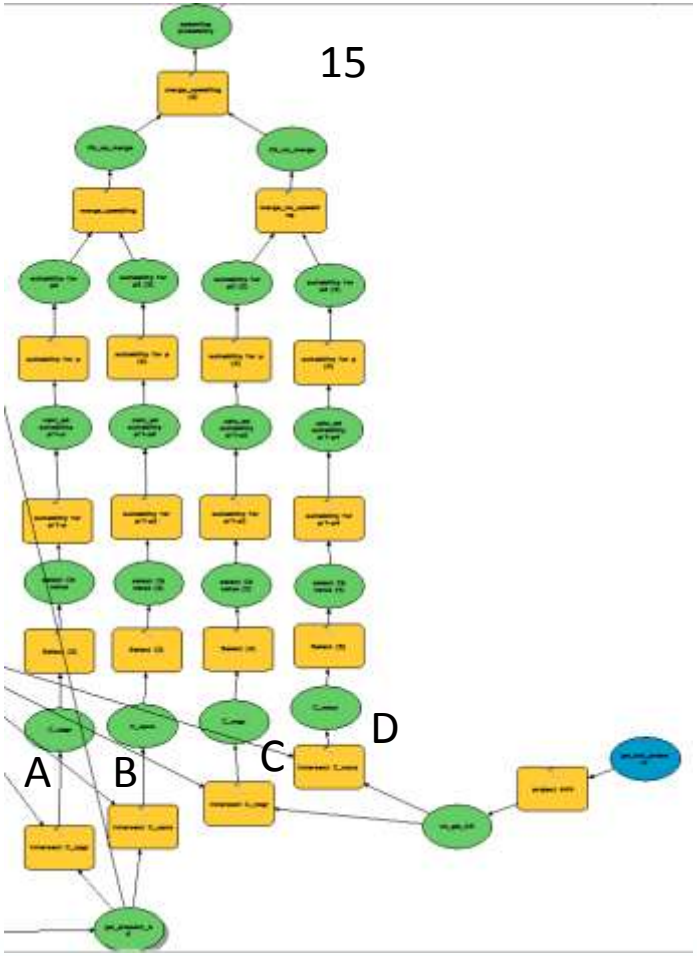
GIS Model Flow Chart

14. Calculate Habitat Suitability for 4 different criteria
    A. Upwelling + gravel
    B. Upwelling + cobble
    C. No upwelling + gravel
    D. No upwelling + cobble
15. Merge the data back together into one Habitat Suitability field



Blue= input
Yellow= tool
Orange=repeat
Green=output

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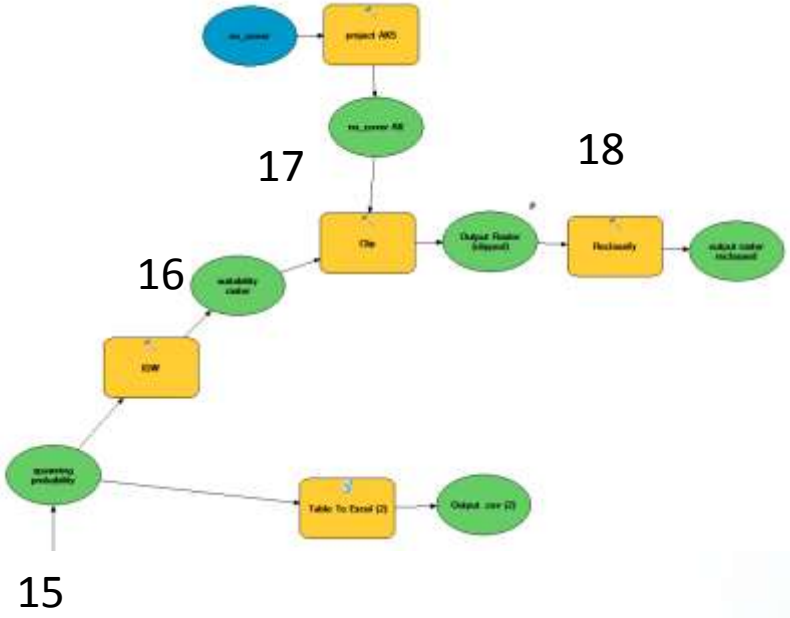
GIS Model Flow Chart

15. From previous slide
16. Convert Suitability output to raster data type using Inverse Distance Weighting method
17. Clip the boundaries to rivers edge
18. Reclassify to count pixels (area) representing each habitat suitability



Blue= input
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Green=output

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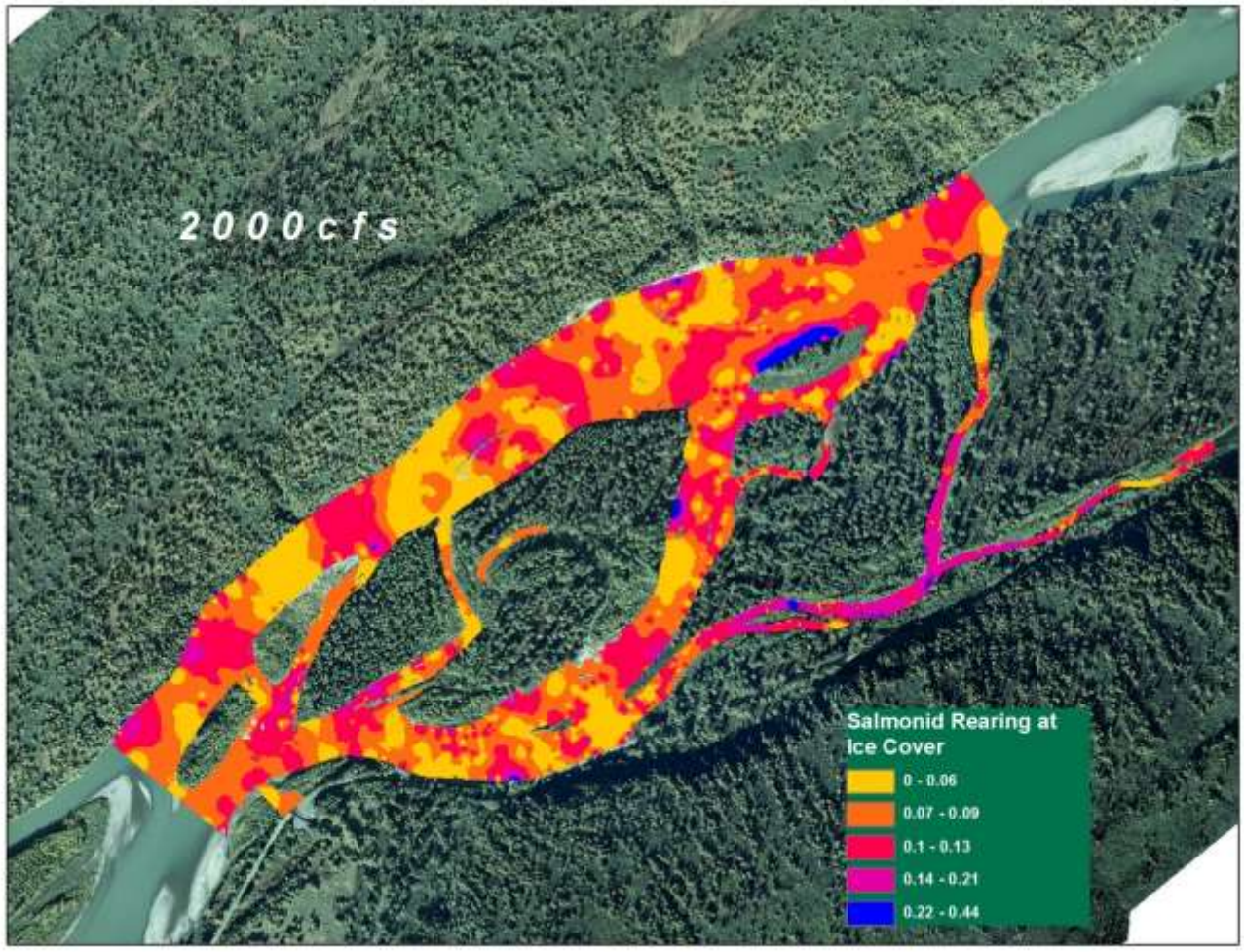
FA-128 (Slough 8A) Ice Cover Salmonid Rearing 2,000 cfs simulation



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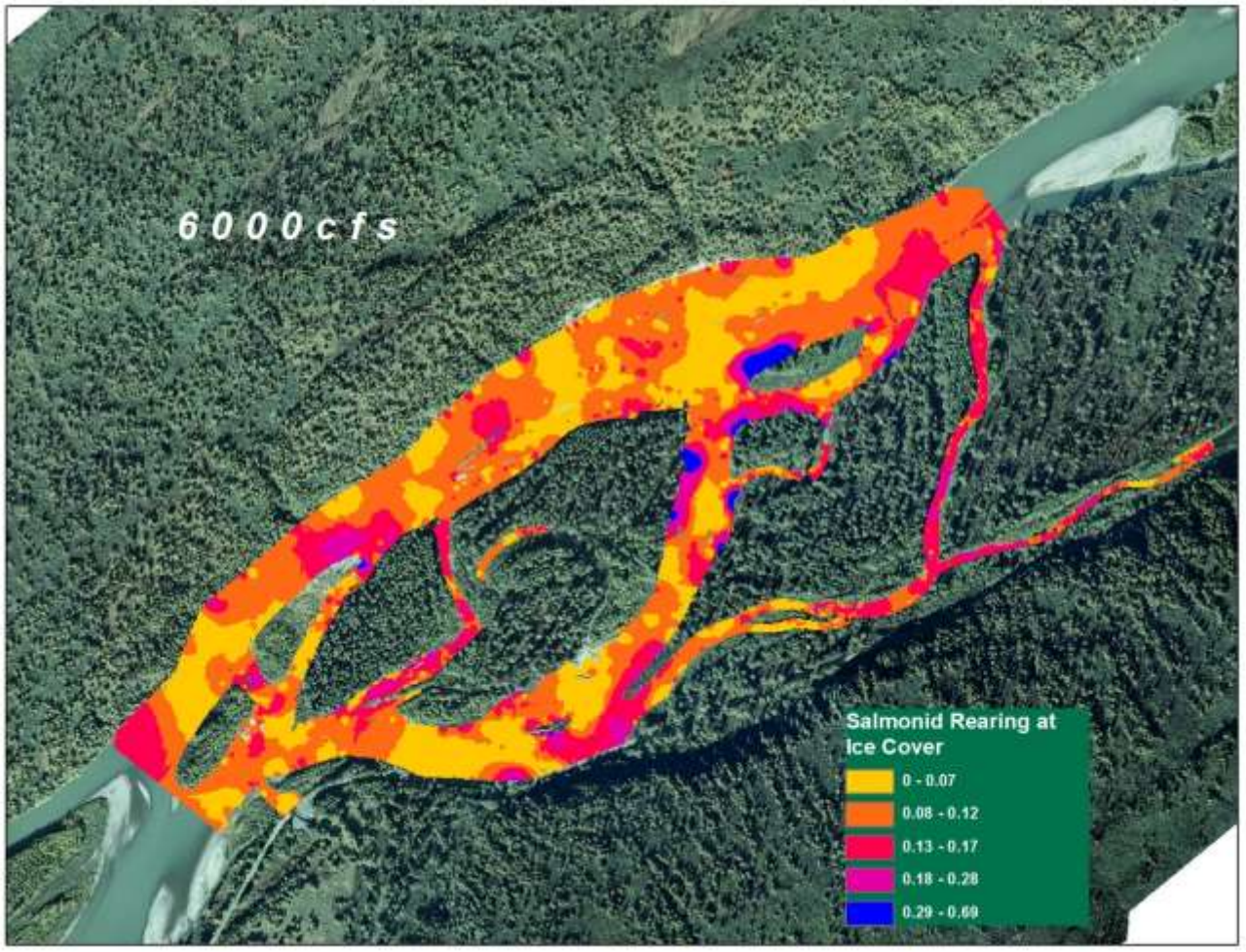
FA-128 (Slough 8A) Ice Cover Salmonid Rearing 6,000 cfs simulation



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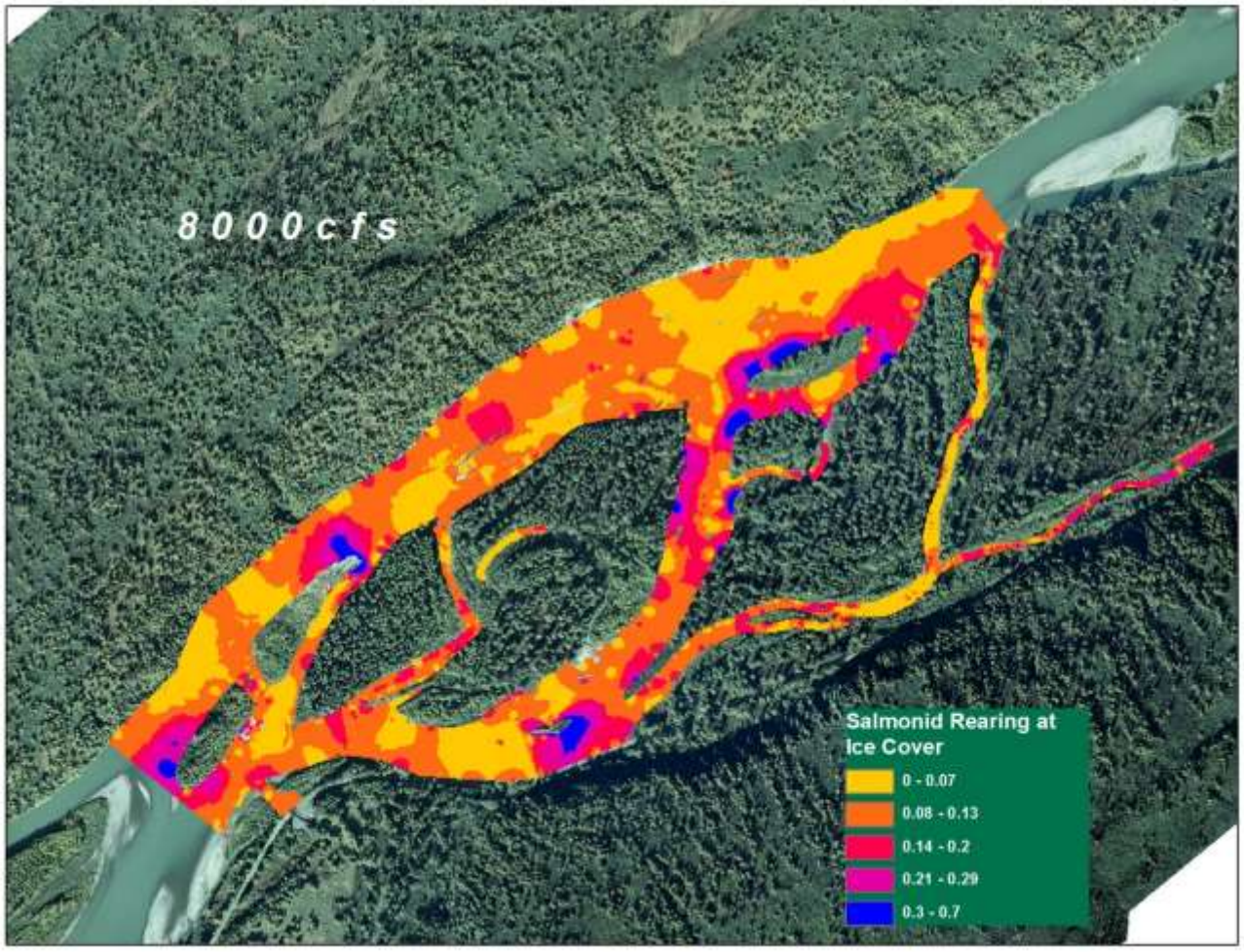
FA-128 (Slough 8A) Ice Cover Salmonid Rearing 8,000 cfs simulation



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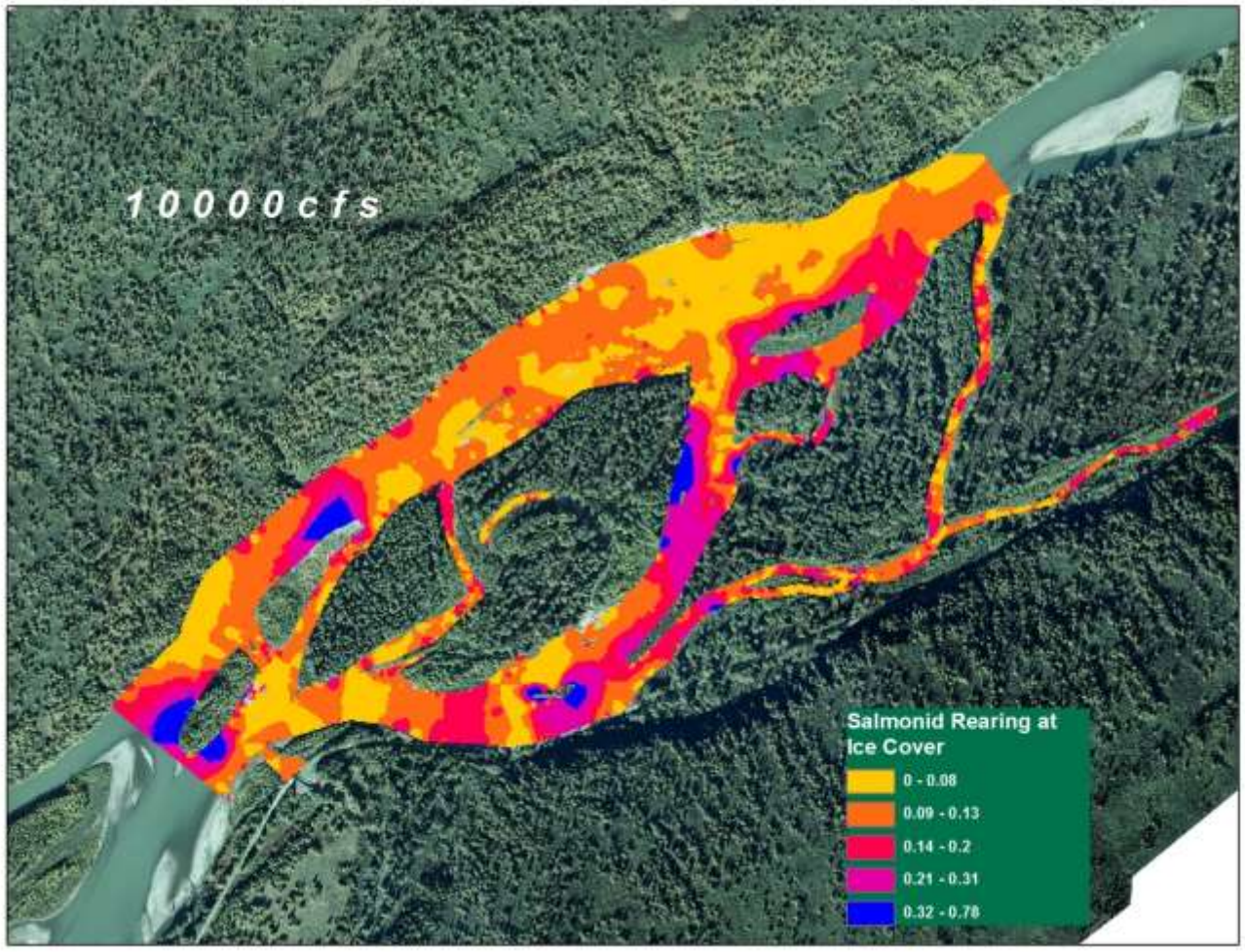
FA-128 (Slough 8A) Ice Cover Salmonid Rearing 10,000 cfs simulation



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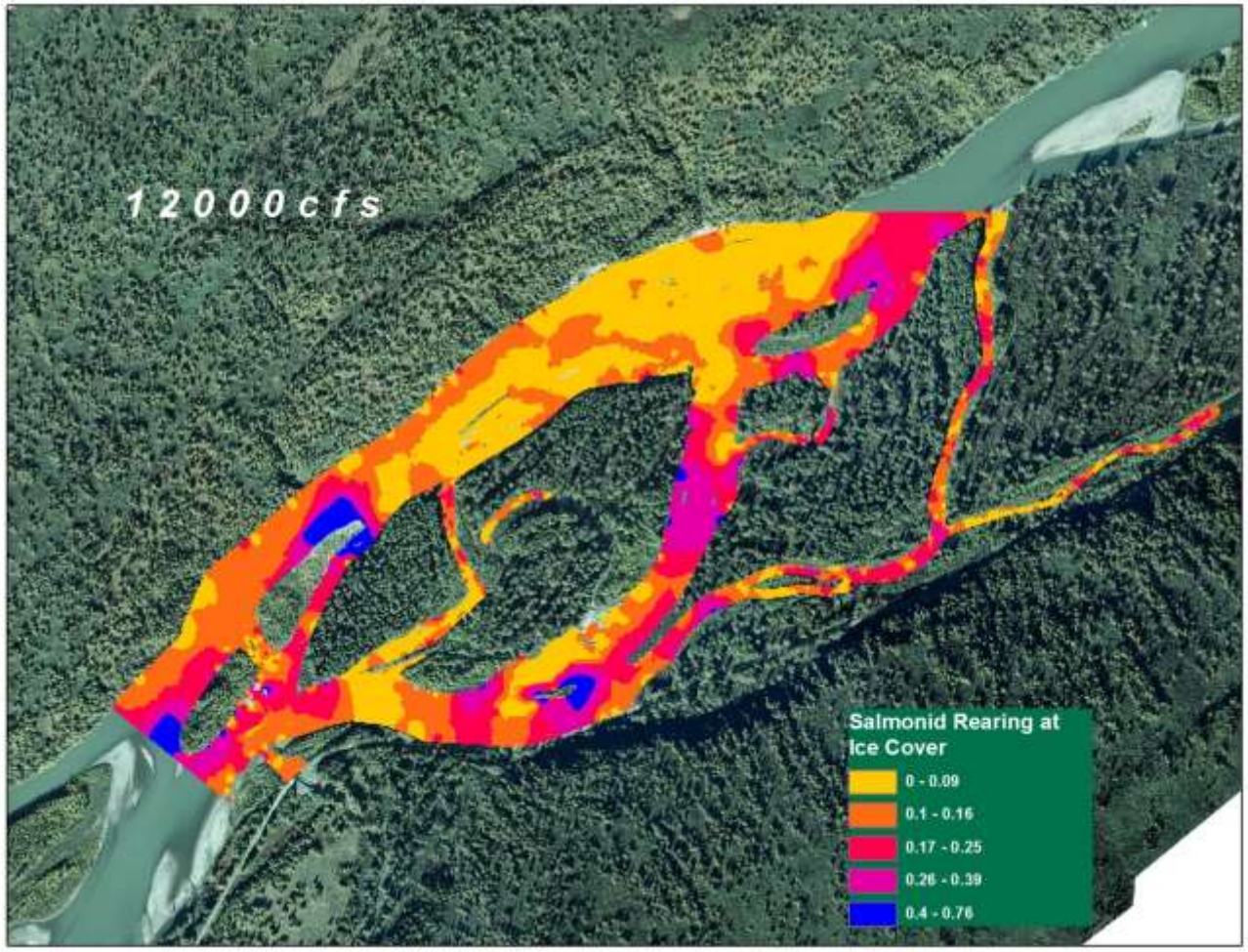
FA-128 (Slough 8A) Ice Cover Salmonid Rearing 12,000 cfs simulation



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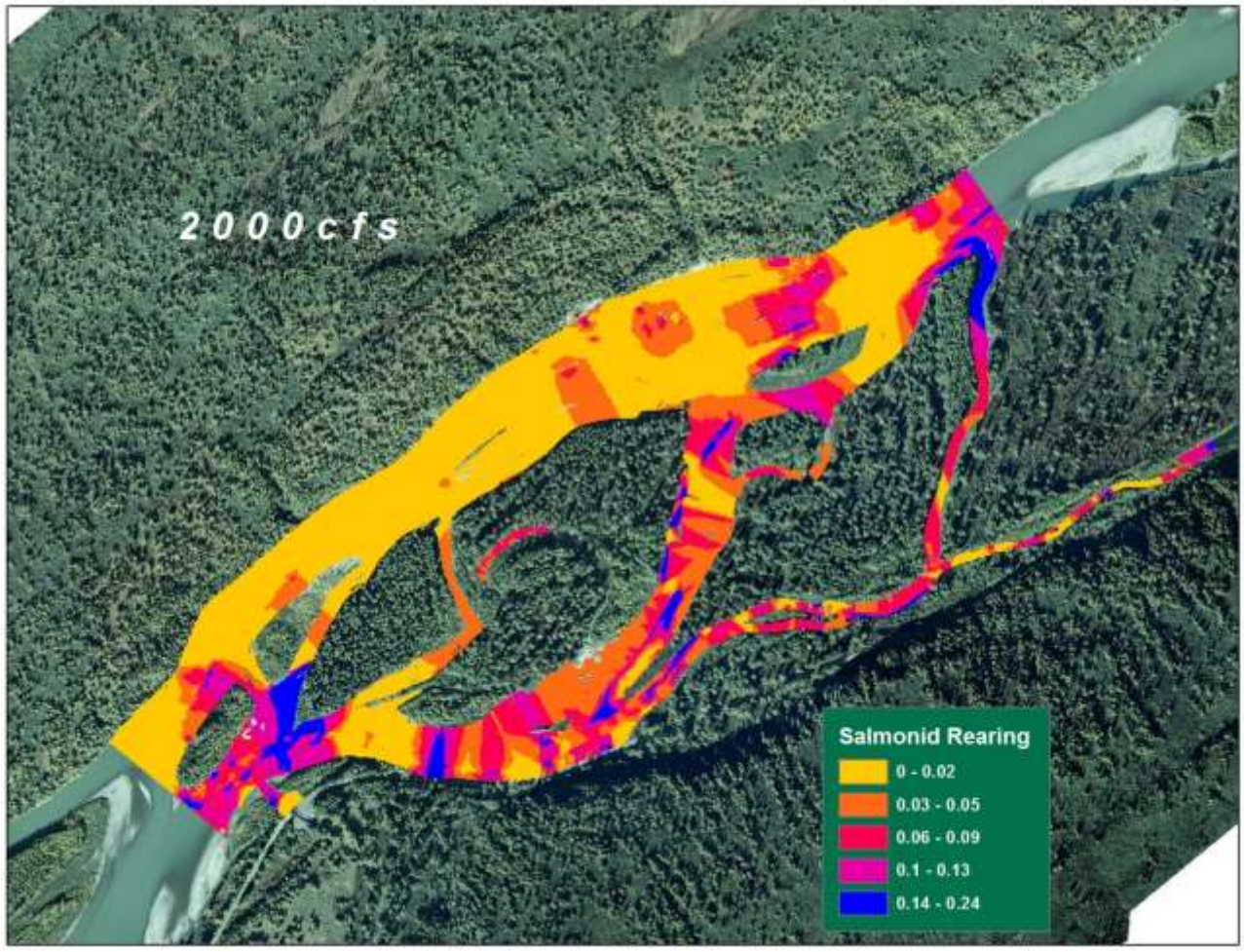
FA-128 (Slough 8A) Salmonid Rearing 2,000 cfs simulation



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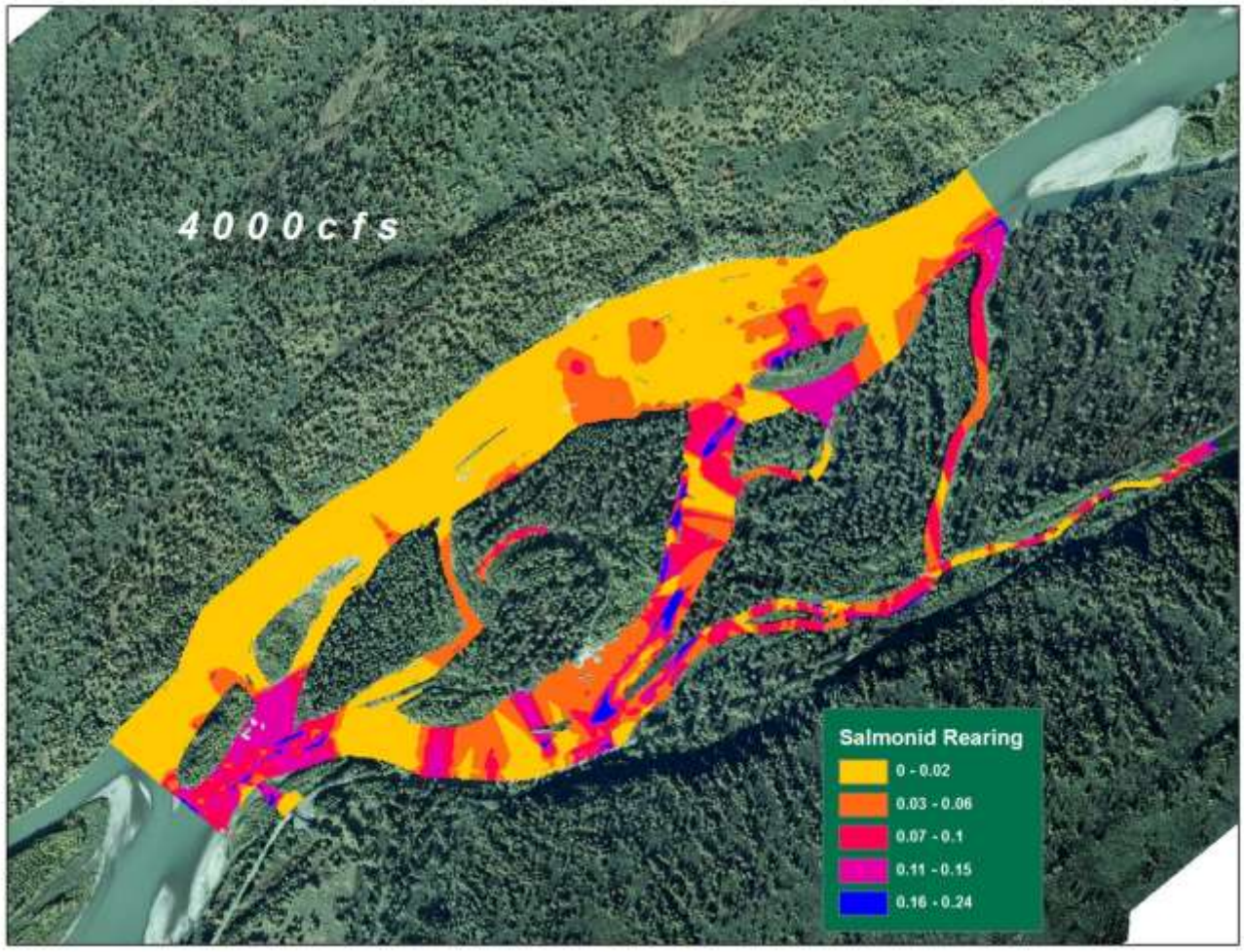
FA-128 (Slough 8A) Salmonid Rearing 4,000 cfs simulation



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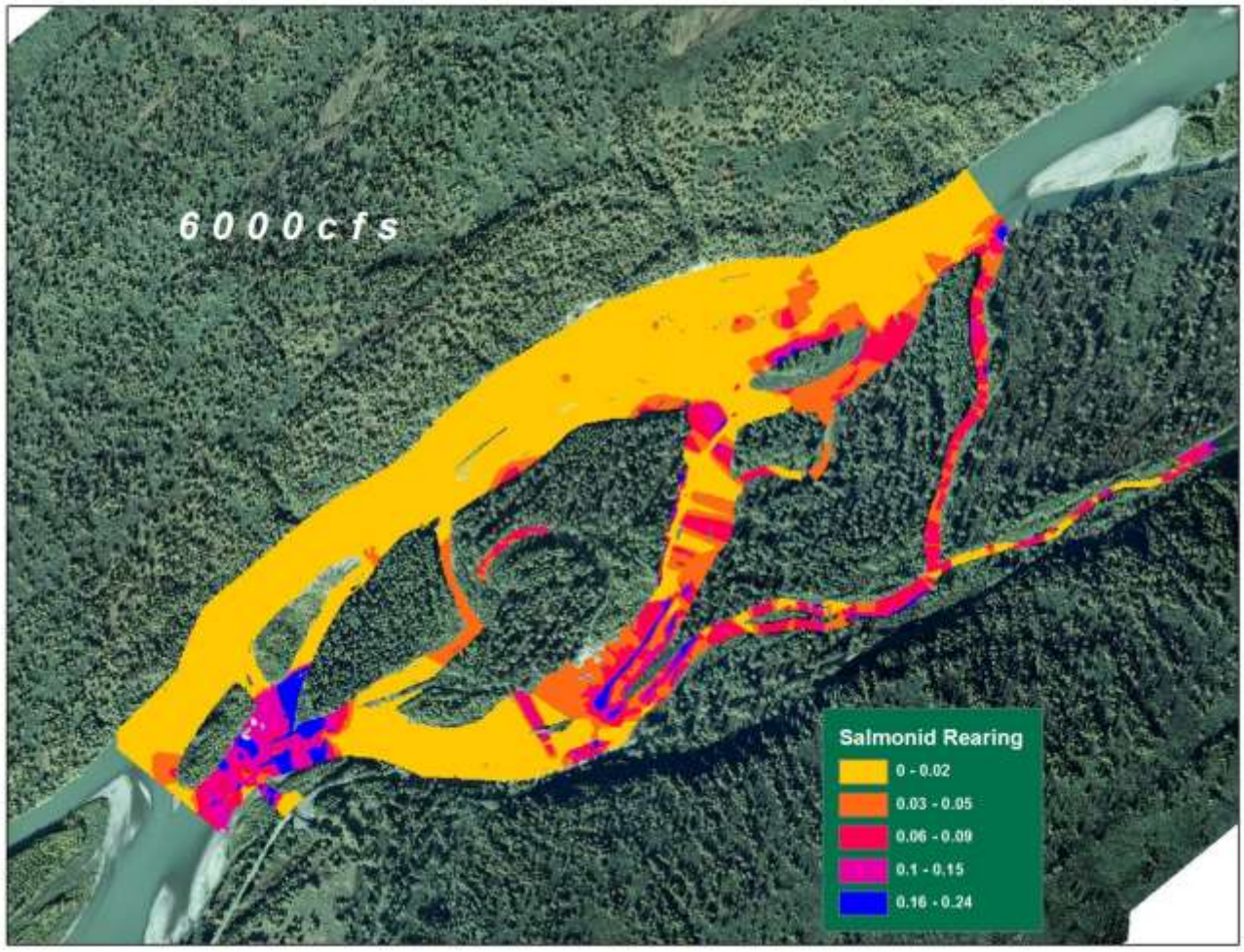
FA-128 (Slough 8A) Salmonid Rearing 6,000 cfs simulation



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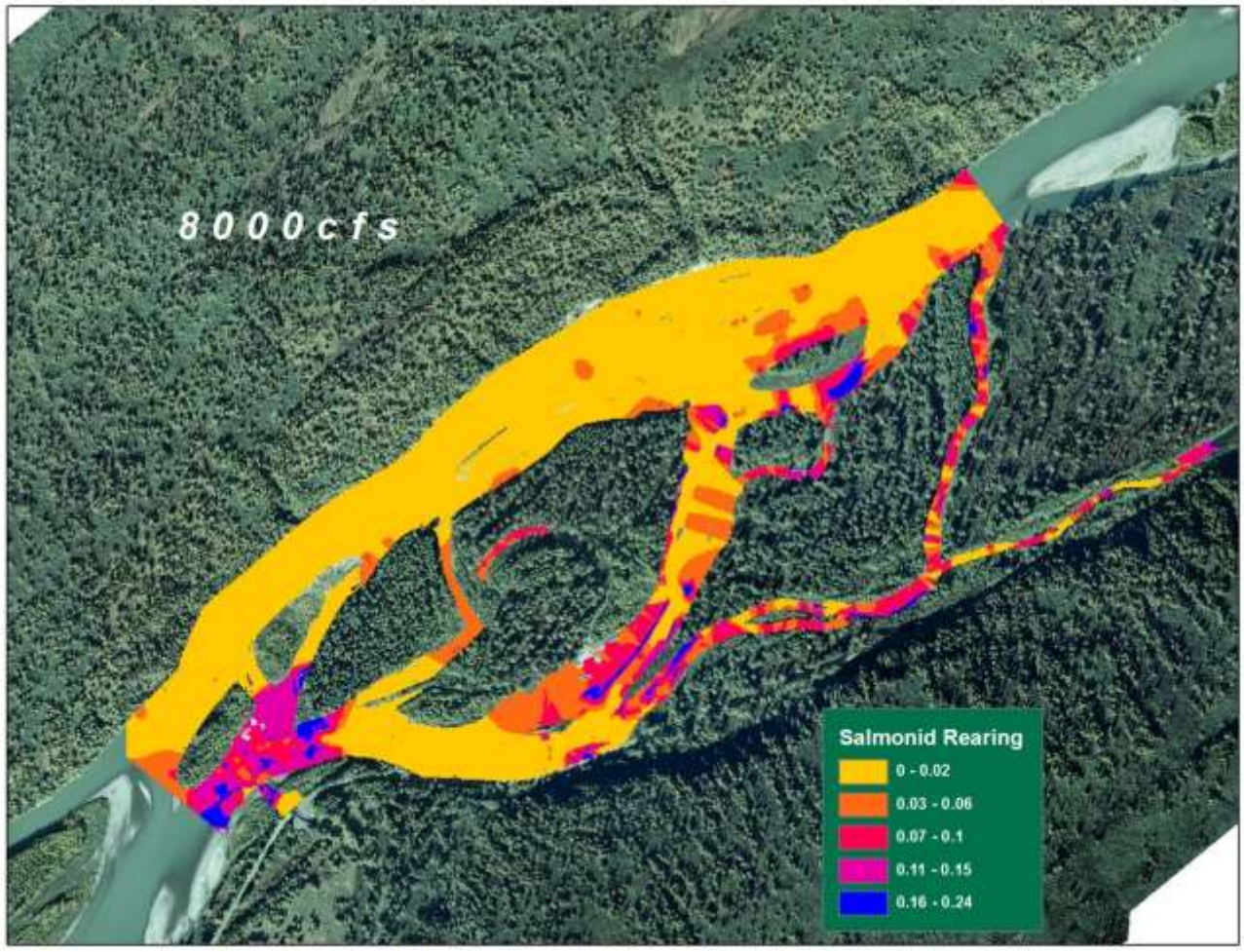
FA-128 (Slough 8A) Salmonid Rearing 8,000 cfs simulation



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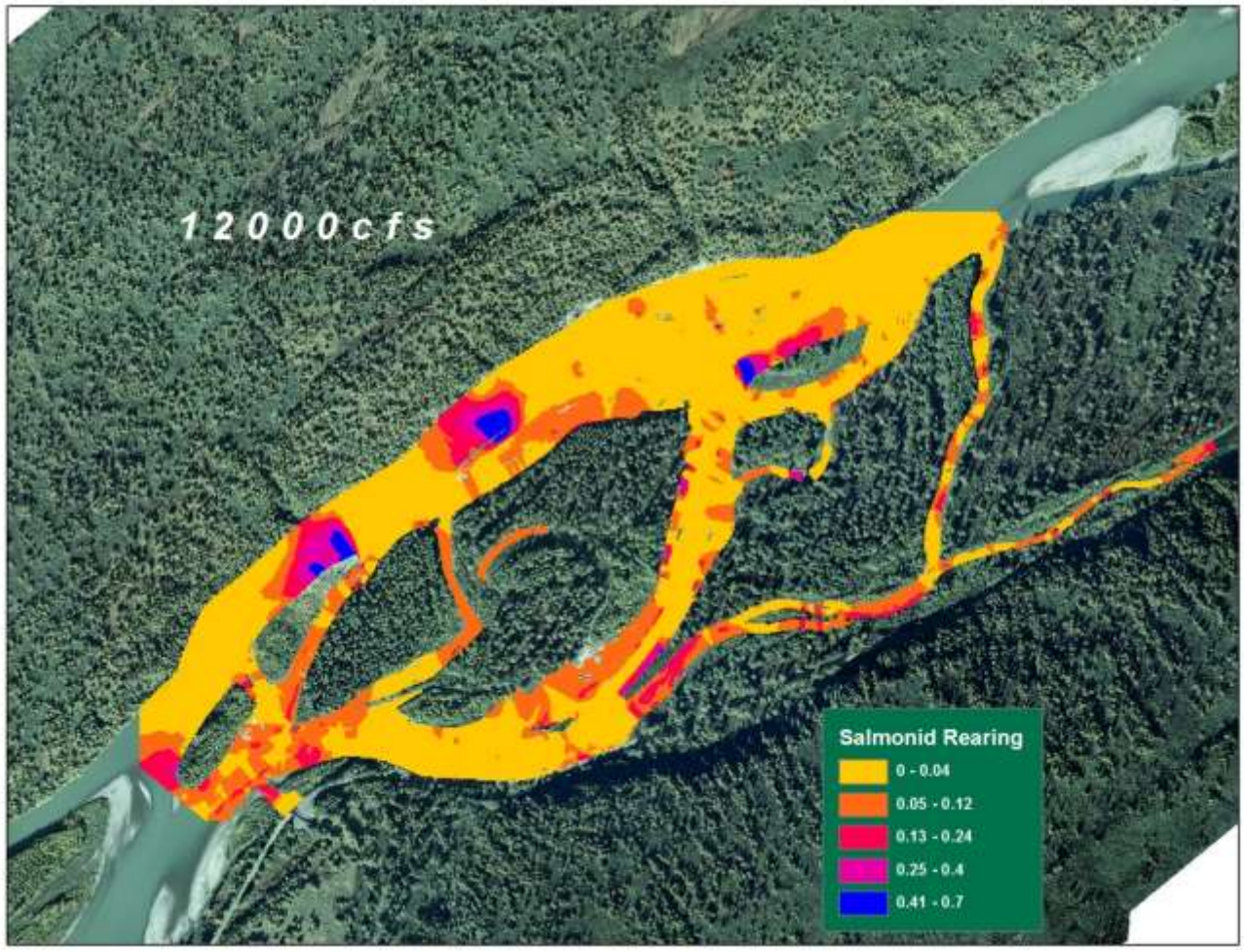
FA-128 (Slough 8A) Salmonid Rearing 12,000 cfs simulation



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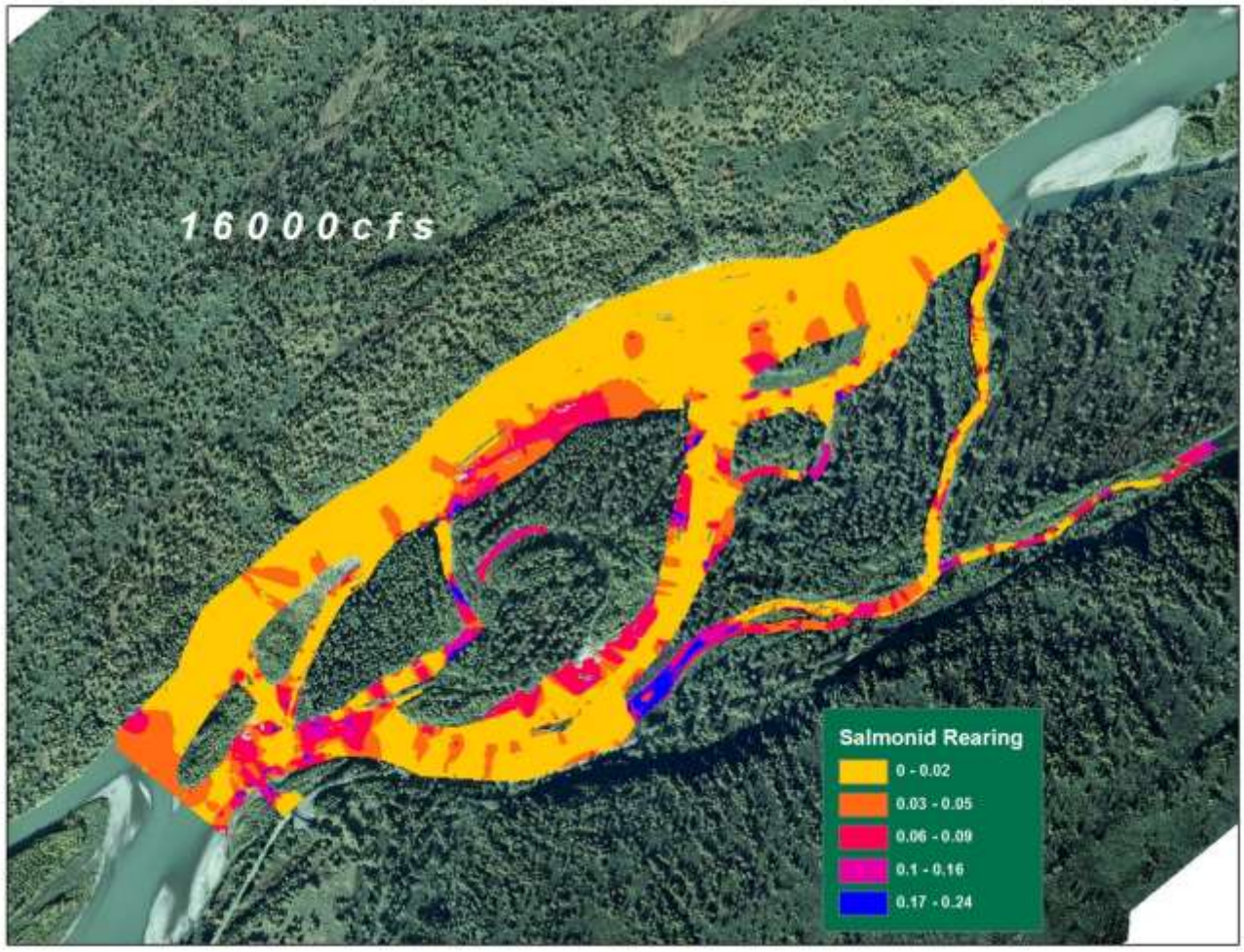
FA-128 (Slough 8A) Salmonid Rearing 16,000 cfs simulation



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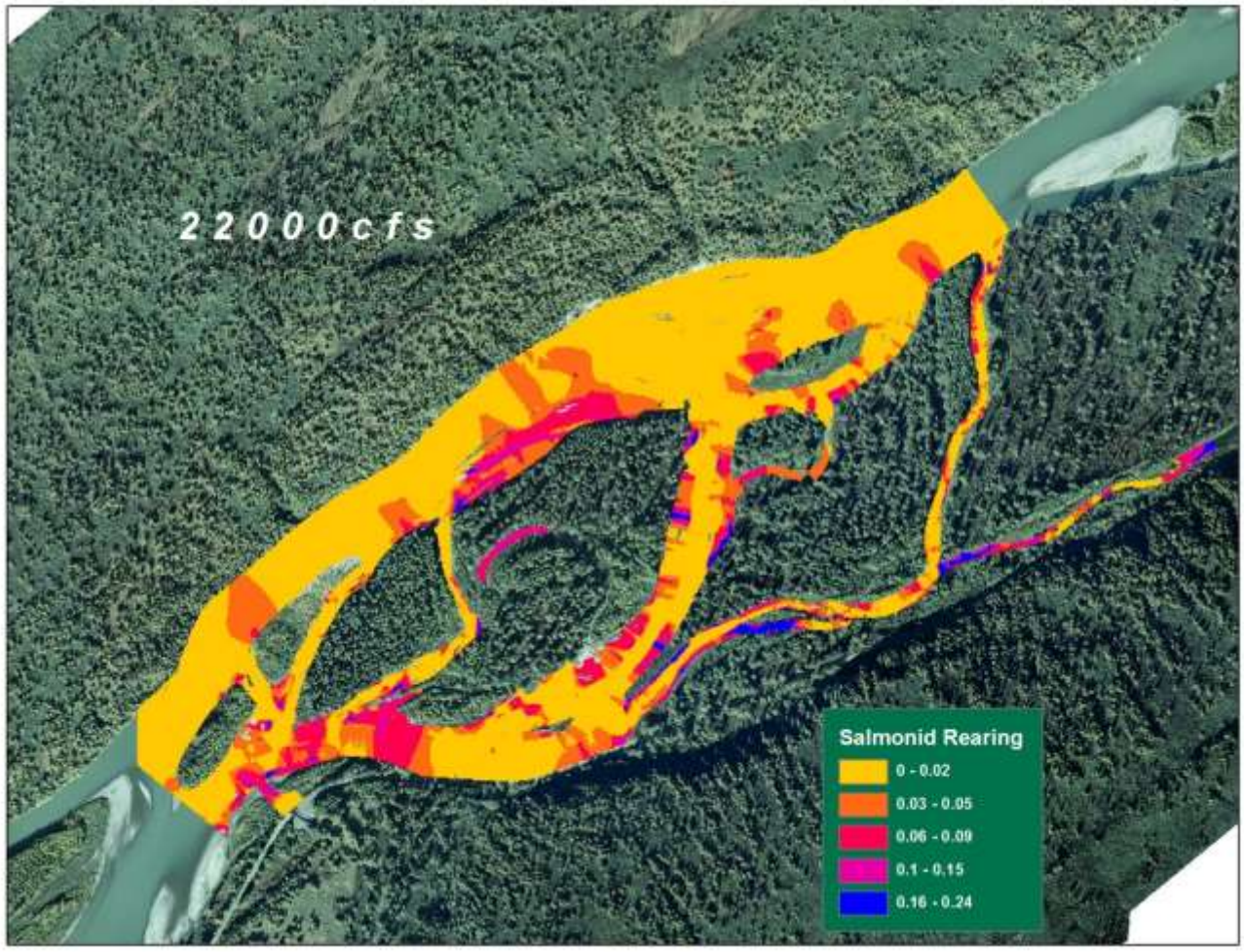
FA-128 (Slough 8A) Salmonid Rearing 22,000 cfs simulation



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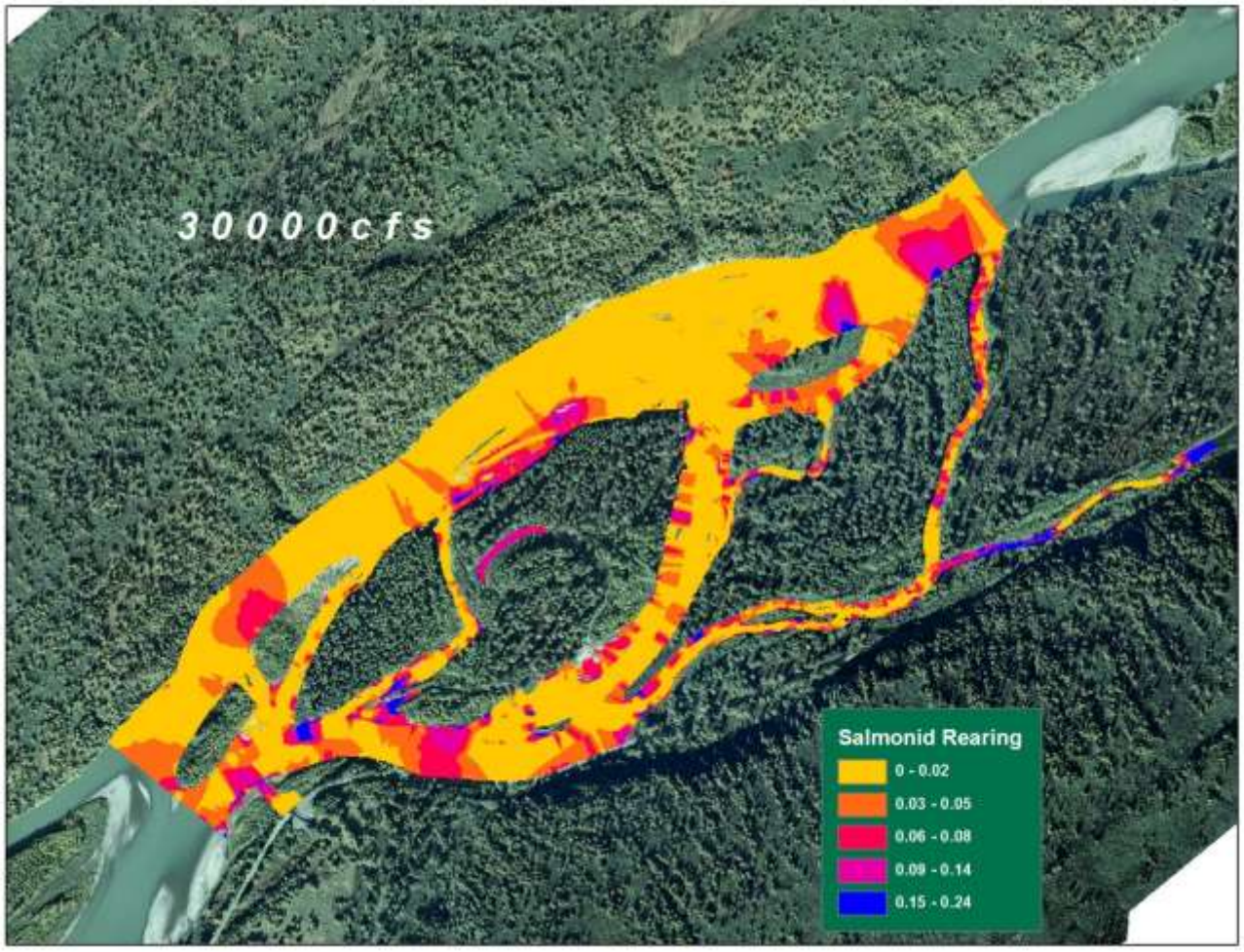
FA-128 (Slough 8A) Salmonid Rearing 30,000 cfs simulation



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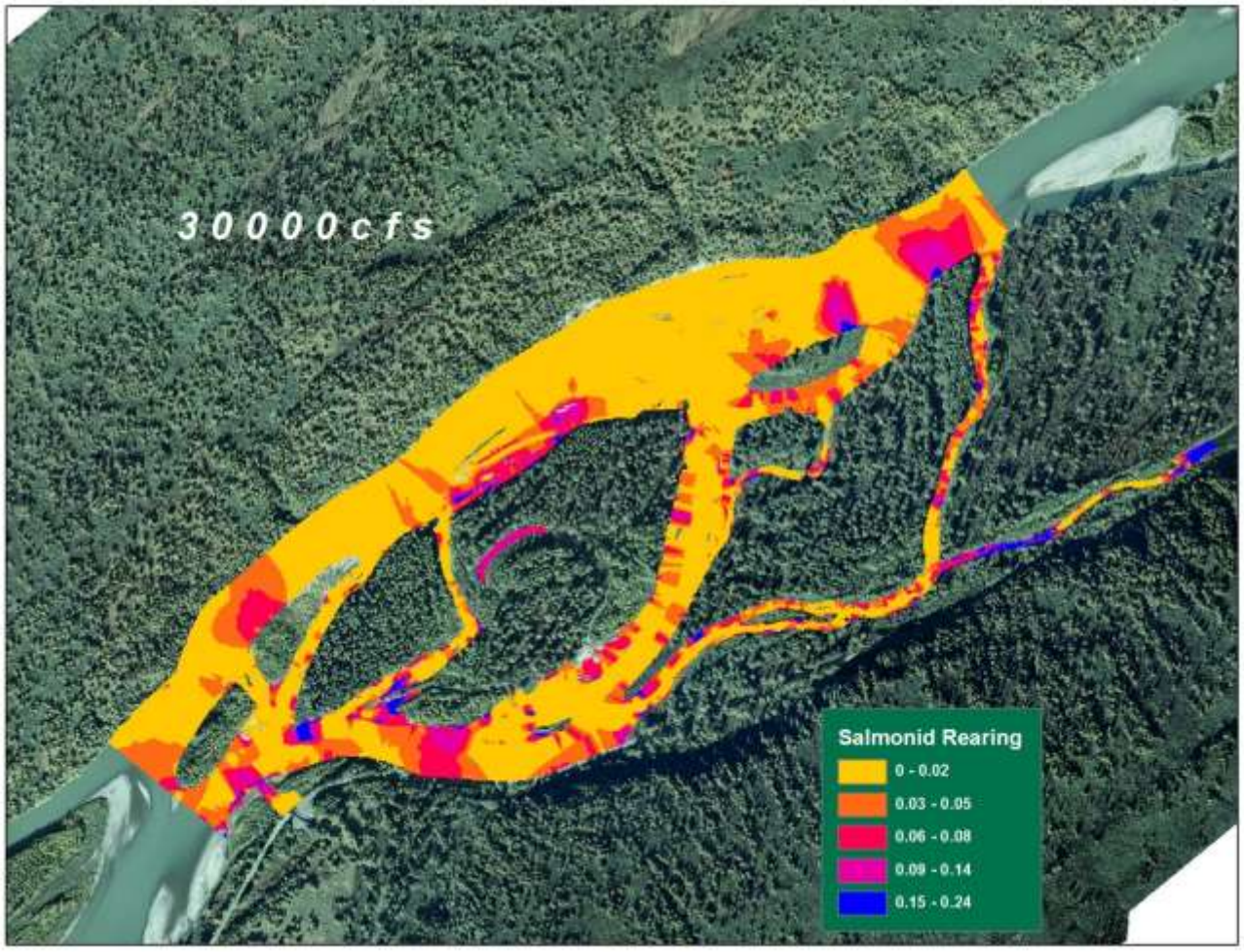
FA-128 (Slough 8A) Salmonid Rearing 50,000 cfs simulation



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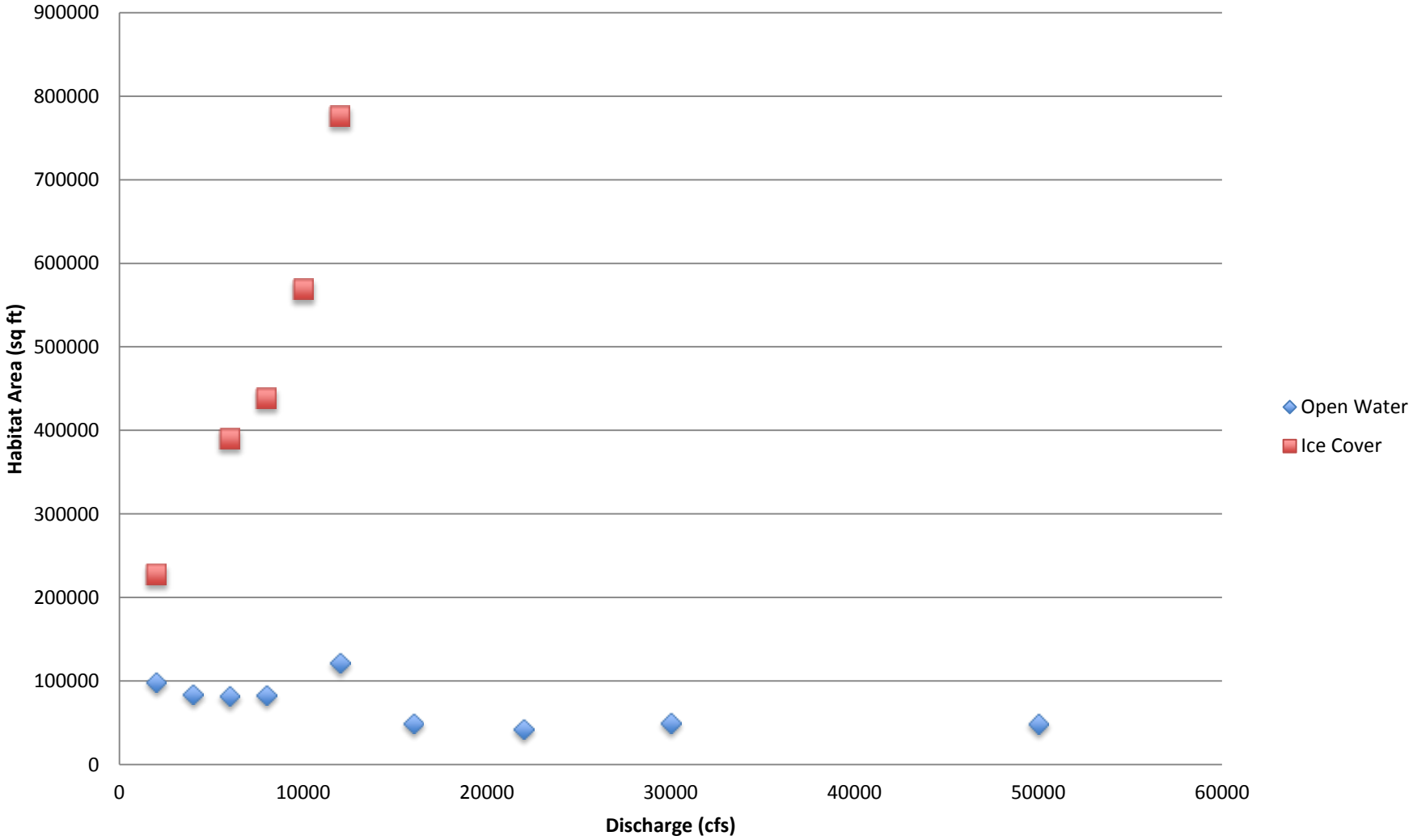
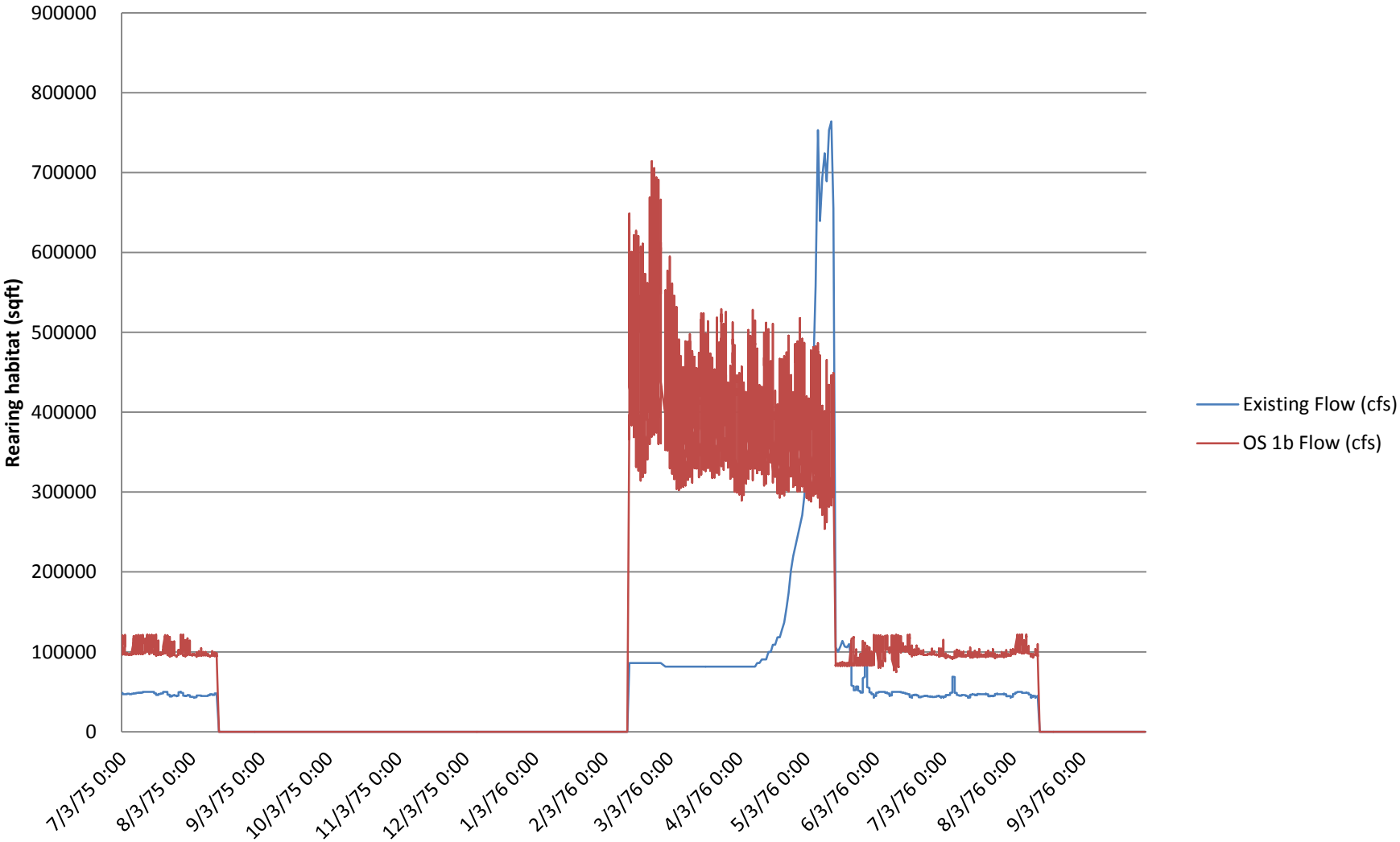
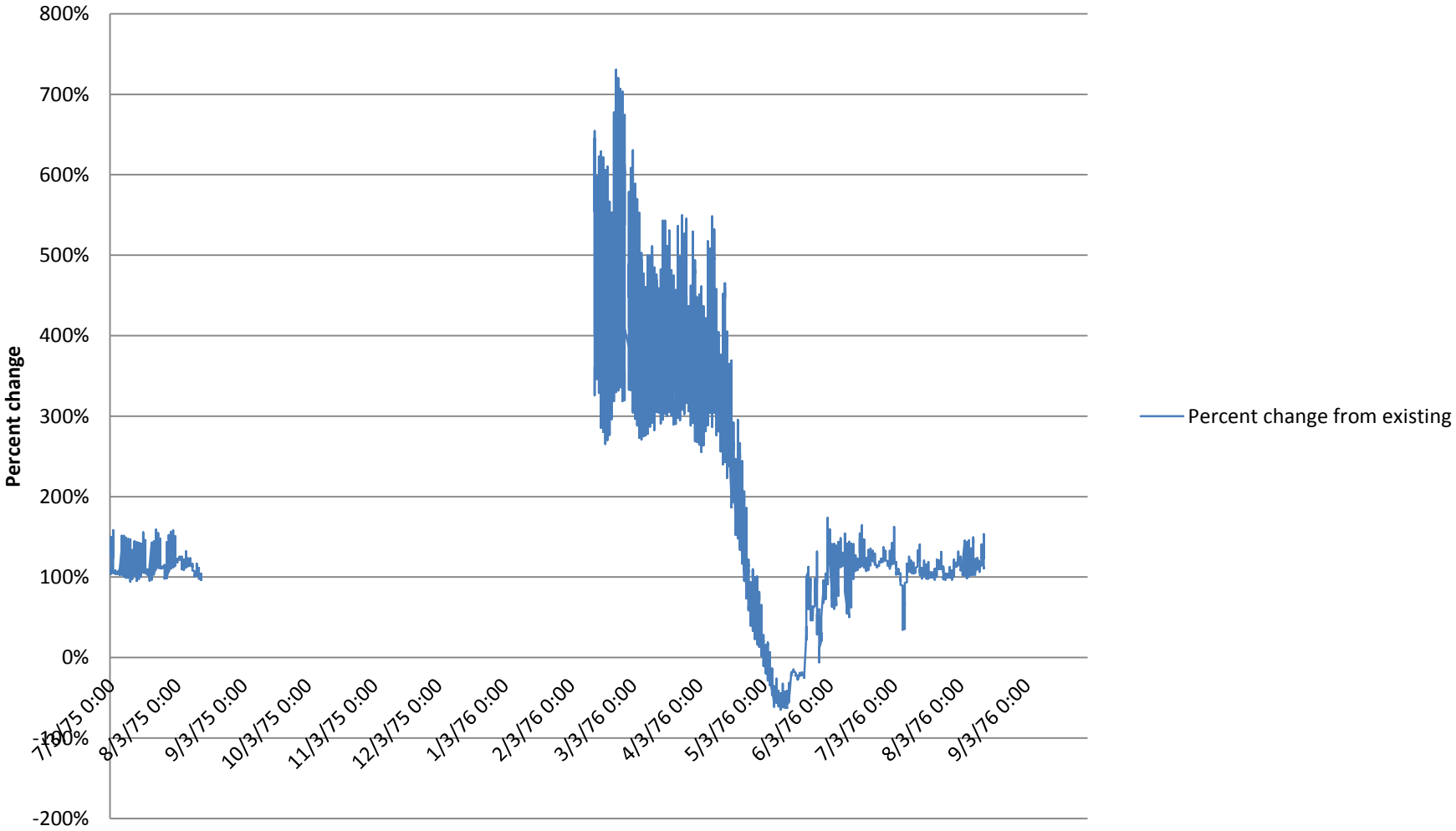
FA-128 (Slough 8A) Salmonid Rearing Usable Habitat versus Flow
Open Water and Ice Cover



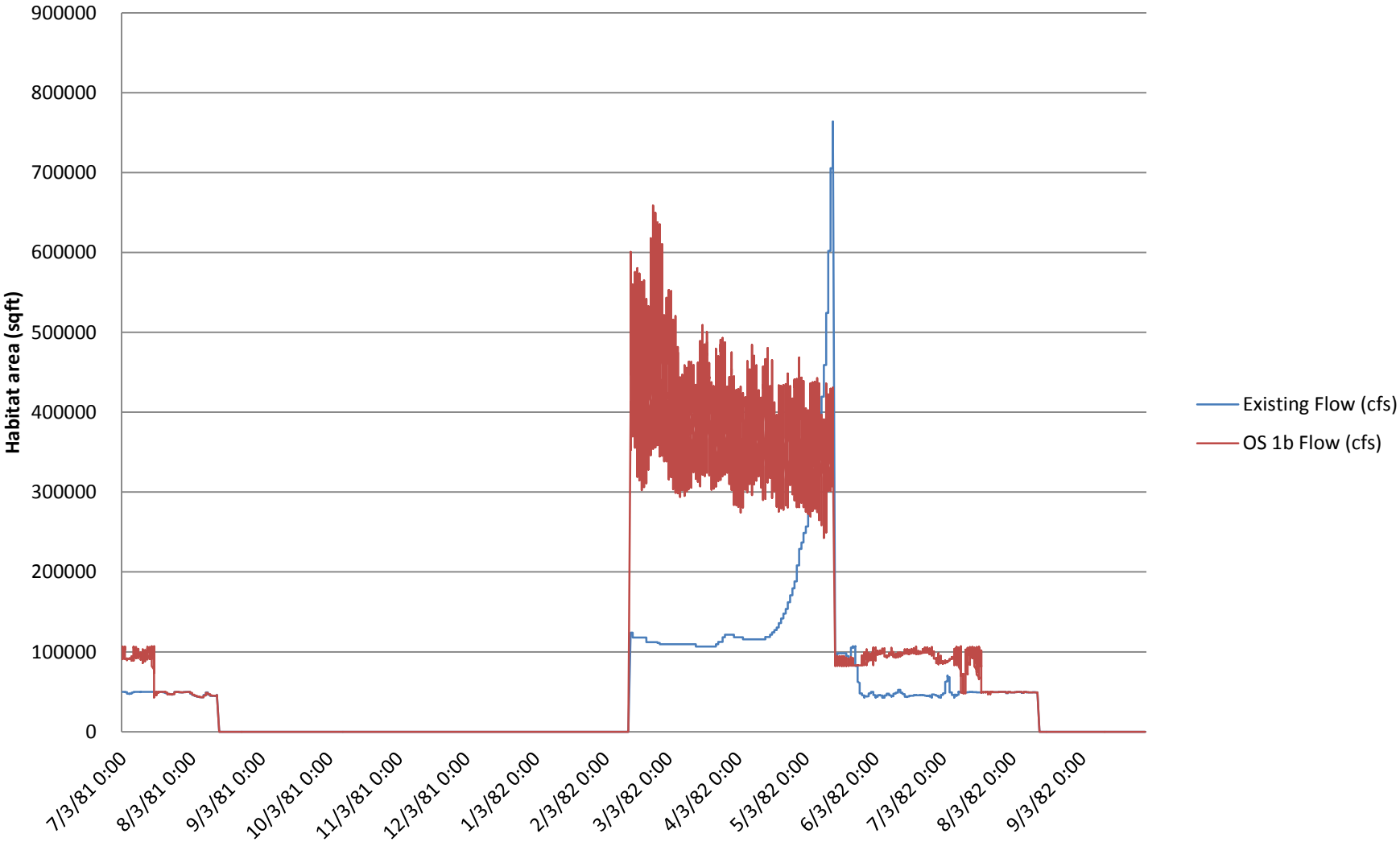
FA-128 (Slough 8A) hourly salmonid rearing habitat
1976 dry year



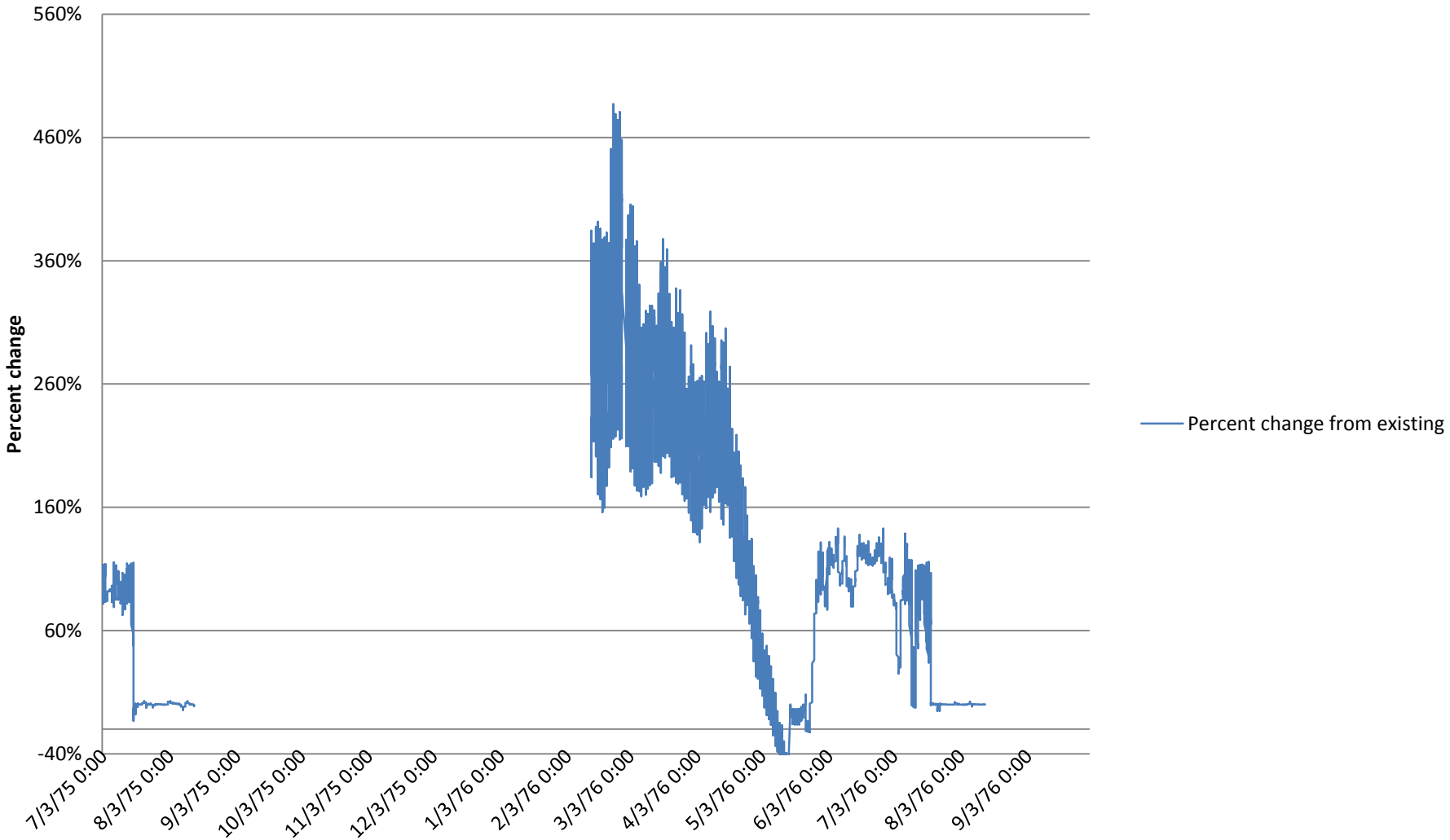
FA-128 (Slough 8A) hourly salmonid rearing percent change from existing conditions 1976 dry year



FA-128 (Slough 8A) hourly salmonid rearing habitat
1981 wet year

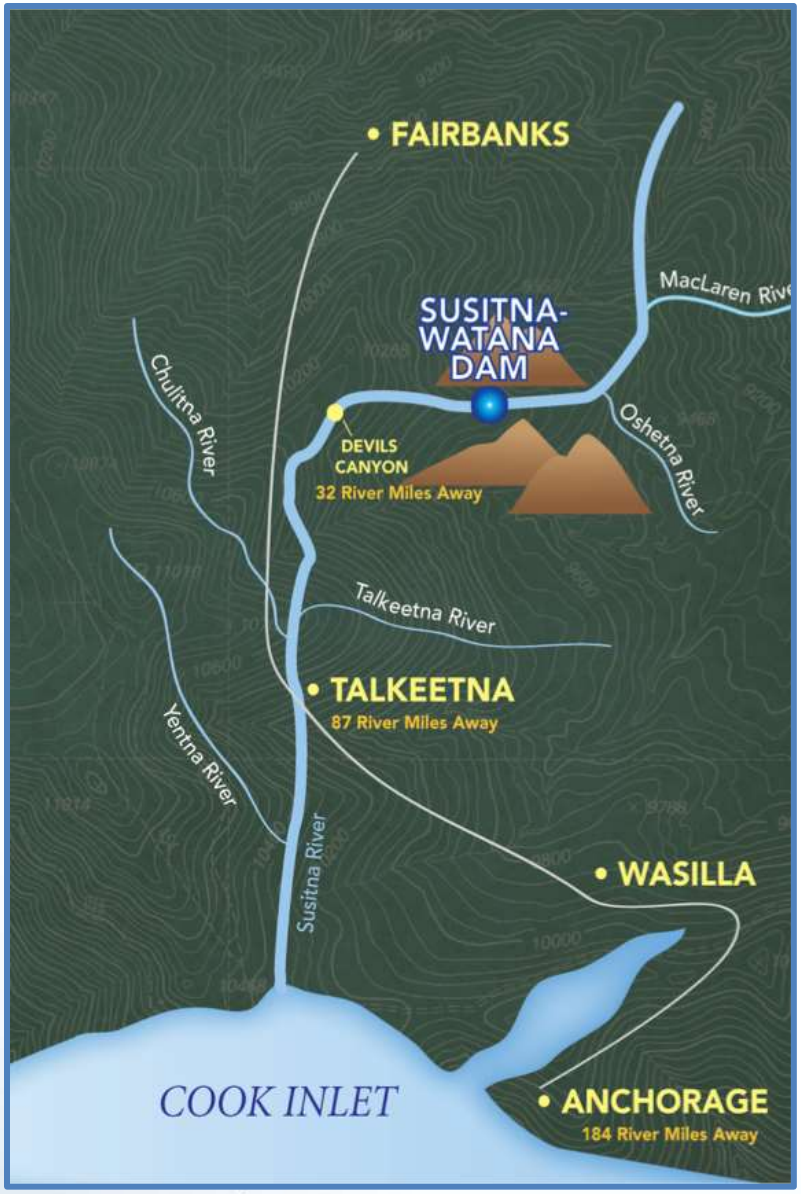


FA-128 (Slough 8A) Hourly Salmonid rearing habitat
Percent change from existing conditions
1981 wet year



Summary

- Approach provides tabular and graphical data outputs for input to DSS or other decision processes.
- The analysis sequence is similar to other 2-D habitat analysis with the addition of explicit inclusion of ground water conditions, breaching in lateral habitats, and water quality.
- A similar approach will be used on other species and life stages of interest.



2-D Fish Habitat Middle River Focus Areas

Questions

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