Apr 4th, 2:30 PM - 2:45 PM

Skagit Delta alternatives analysis: using output from the Salish Sea hydrodynamic model to quantify benefits and impacts of restoration project concepts

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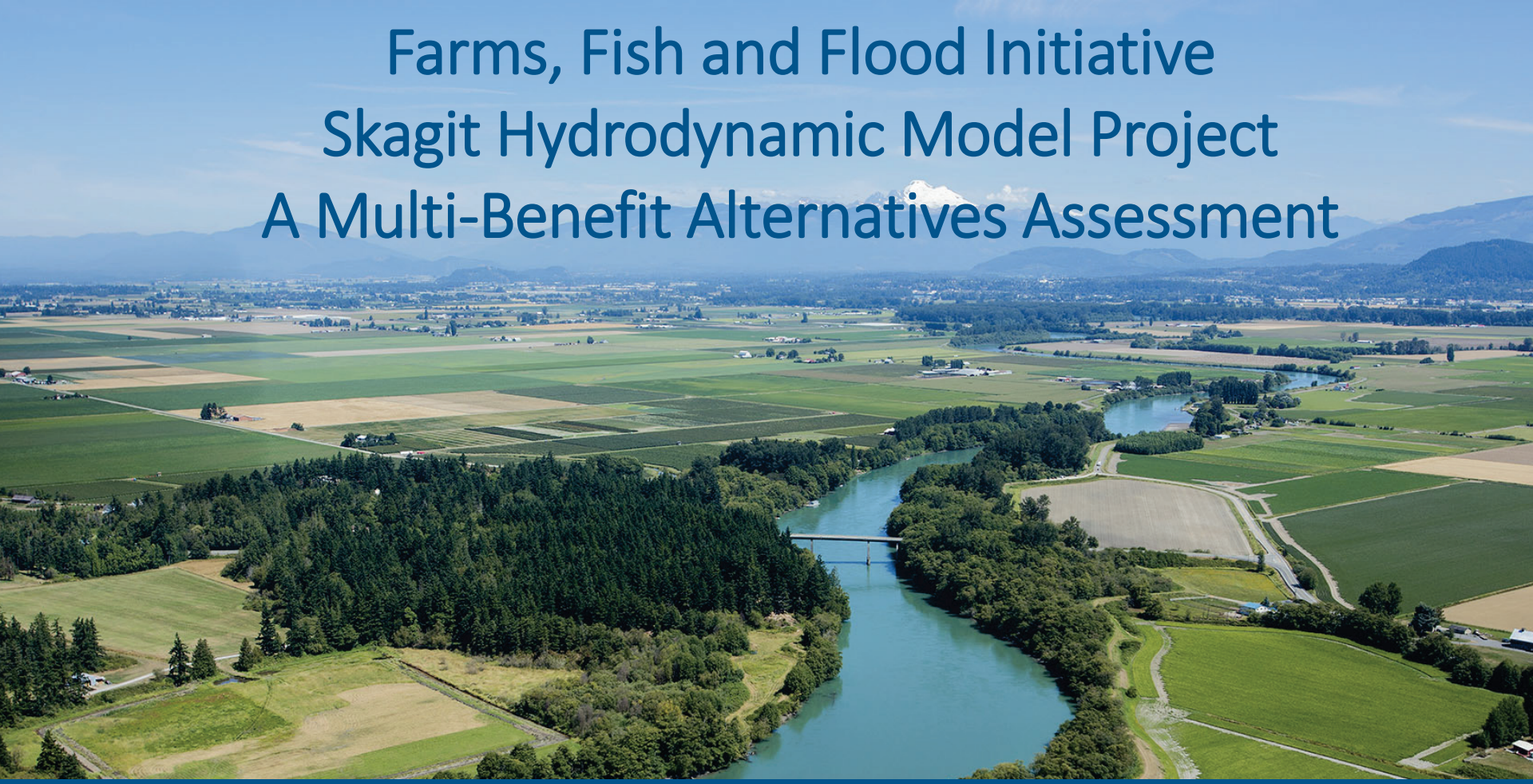
Farms, Fish and Flood Initiative
Skagit Hydrodynamic Model Project
A Multi-Benefit Alternatives Assessment



Salish Sea Conference
April 4, 2018

SHDM Co-Leads
Jenny Baker The Nature Conservancy
Jenna Friebel Wa. Dept. Fish and Wildlife
Polly Hicks NOAA Restoration Center

Skagit Hydrodynamic Model Project

"Using an alternatives analysis, develop a suite of projects that are well supported to achieve the long-term viability of Chinook salmon tidal delta habitat and community flood risk reduction in a manner that protects and enhances agriculture and drainage."

This is a tool developed through the 3FI process that provides **transparency** about the **benefits and impacts** from estuary restoration concepts

Selecting the right tools to inform analyses of objectives and indicators

Models

- 3-D Hydrodynamic Modeling (PNNL)
- Channel Development Model (Greg Hood)
- Chinook Model (Eric Beamer)

Non-Model Analysis

- GIS
- Change in Channel Cross-section Analysis
- Vegetation community predictions

PNNL SHDM Model Output and Indicators Supported

Output description	Objectives/indictors supported
★ Area subject to tidal & riverine processes (high tide/low flow or Q2/low tide)	Restore tidal and riverine processes (Fish) Support regulatory agreements (Farm)
Depths of inundation within a project concept (May Mean Flow and Spring High Tide)	Restore diverse habitat types (Fish)
★ Duration of WSE over a 3 month period	Increase suitable channel habitat (Fish)
Changes in WSE during flood events	Reduce floodwater elevations (Flood)
★ Changes in flow balance between forks	Minimize loss of existing habitat (Fish)
Climate Change	Not used in alternatives analysis, but provided as additional information for consideration in future phases
Changes in salinity	

Model Domain and Grid

Skagit Delta

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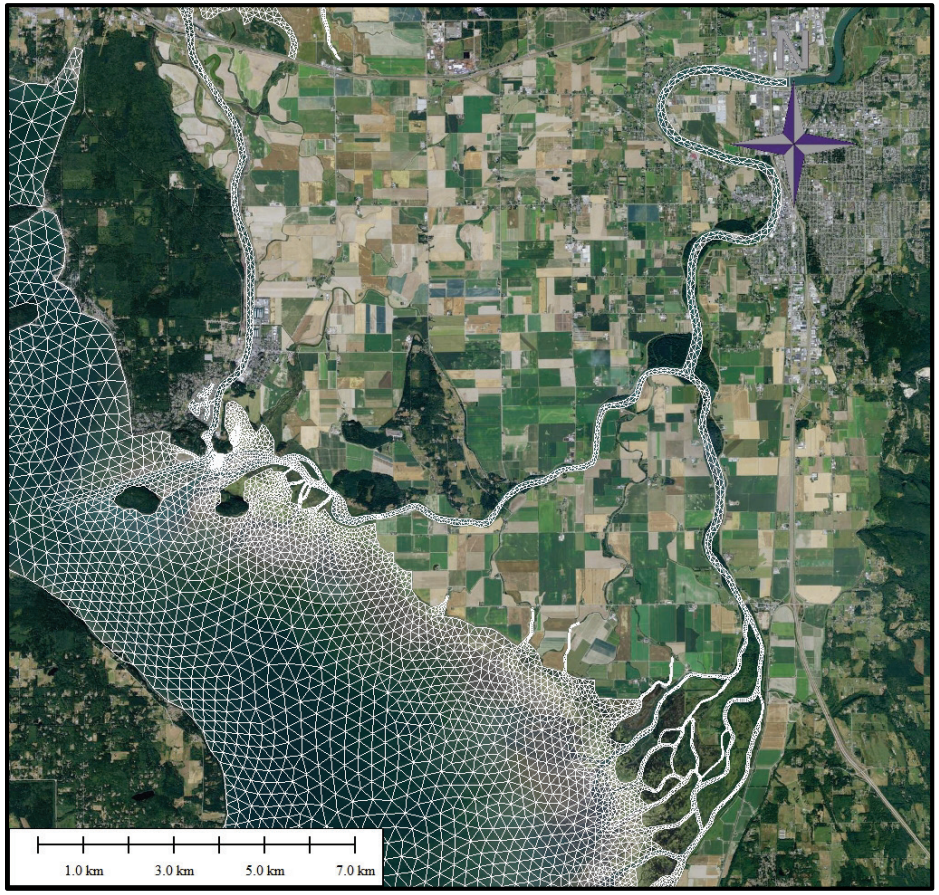
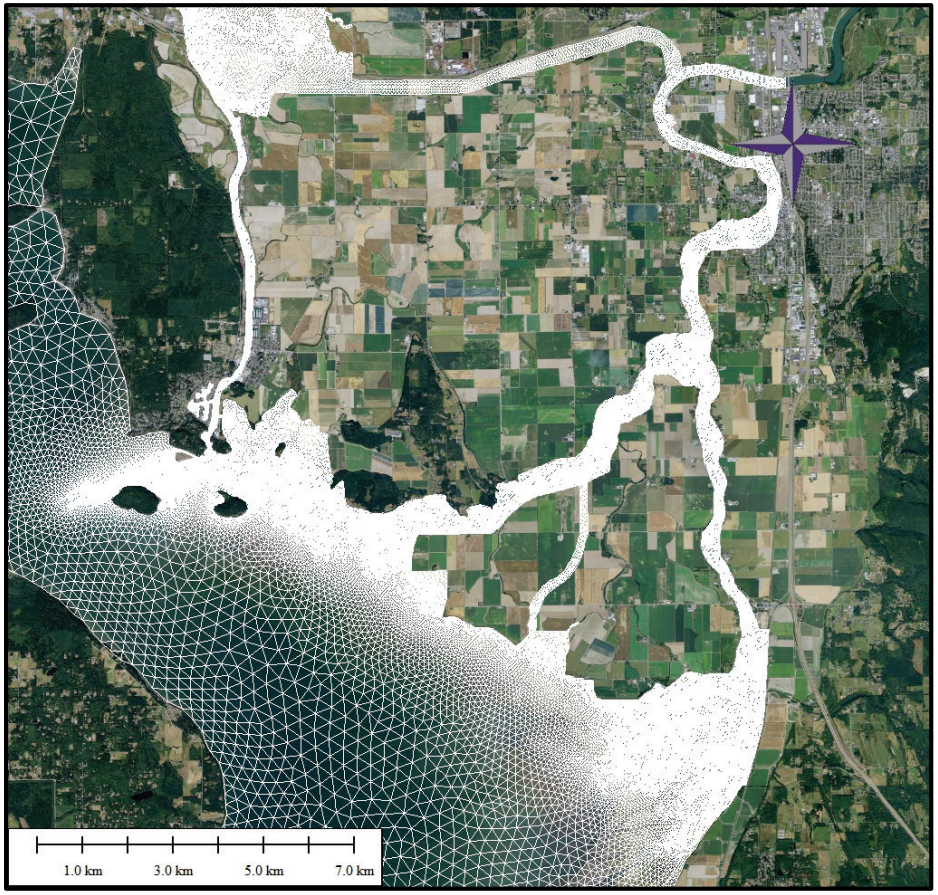
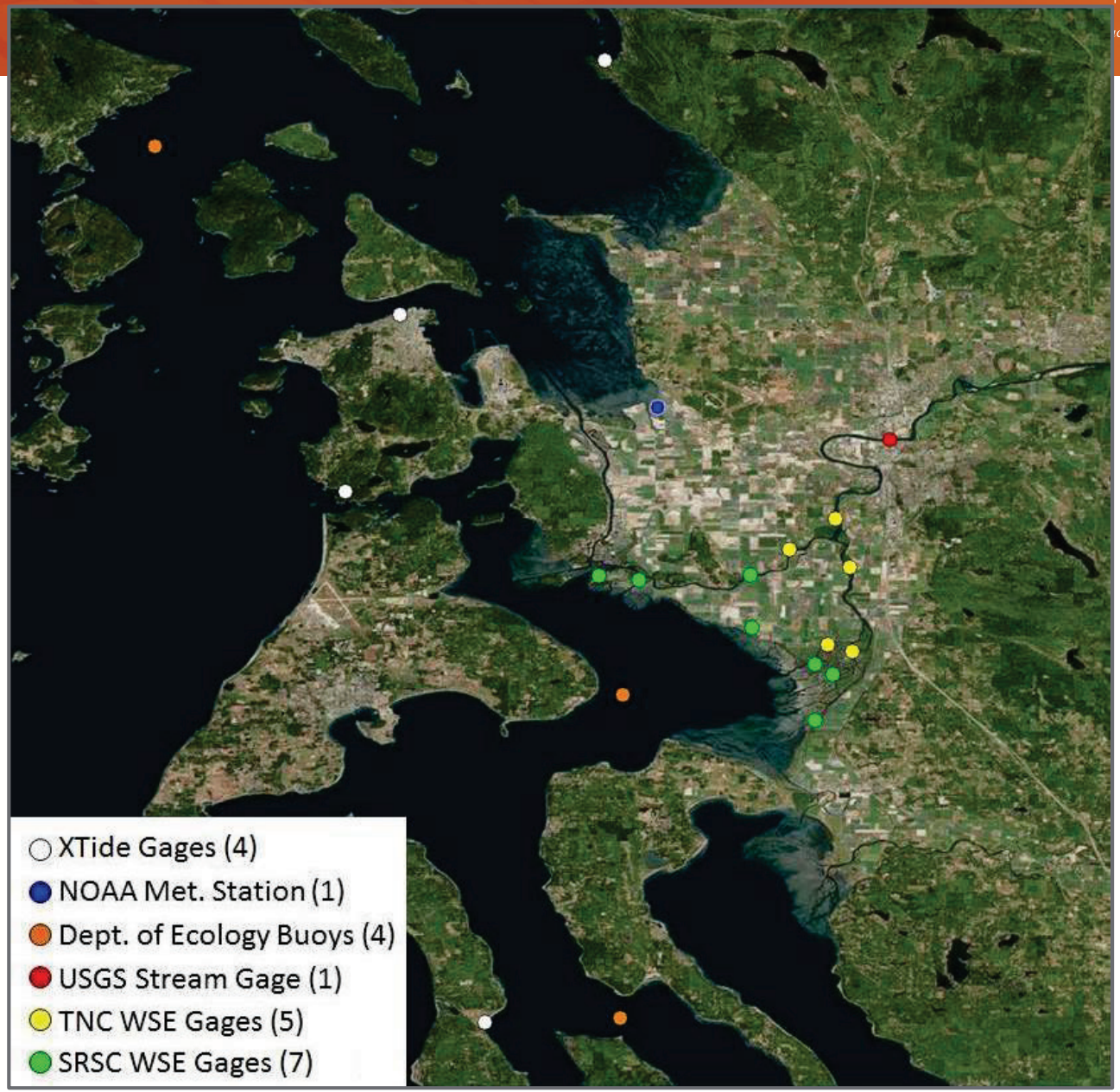




Existing Skagit Bay Model
19,576 elements

Updated Grid
127,184 elements

Available Monitoring Data



WDFW – Water Level Loggers

Model Setup and Validation – 11/14 – 6/15

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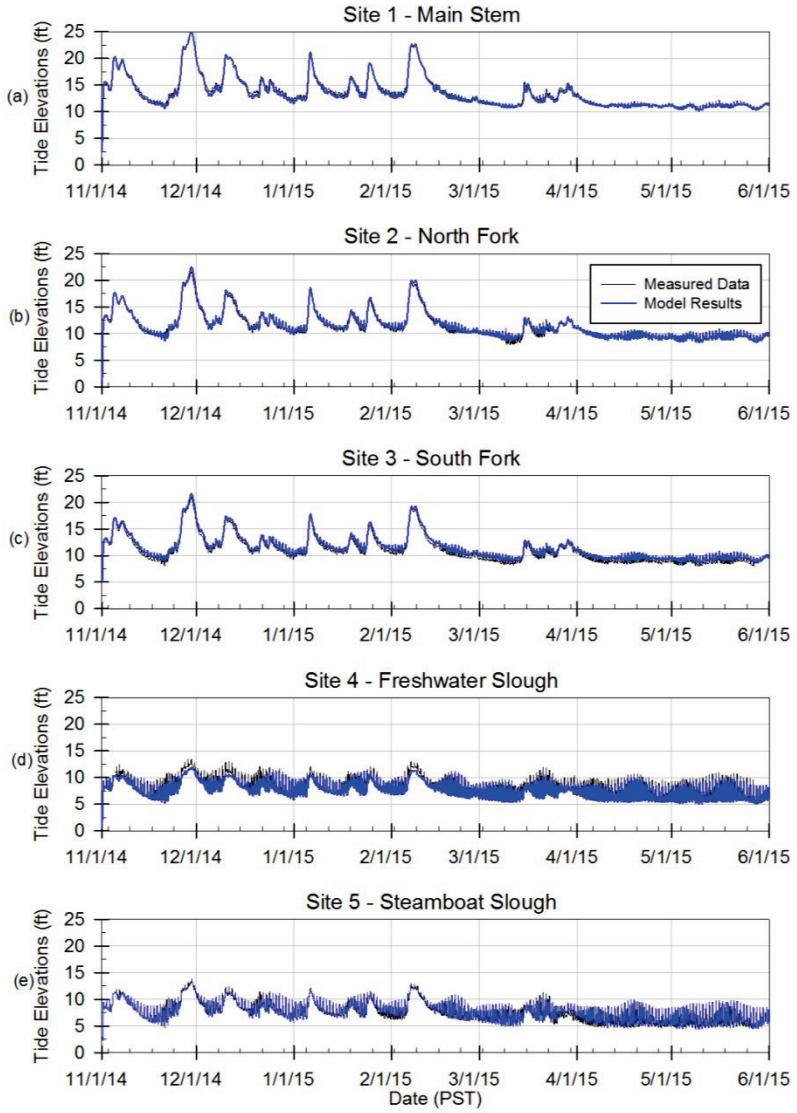
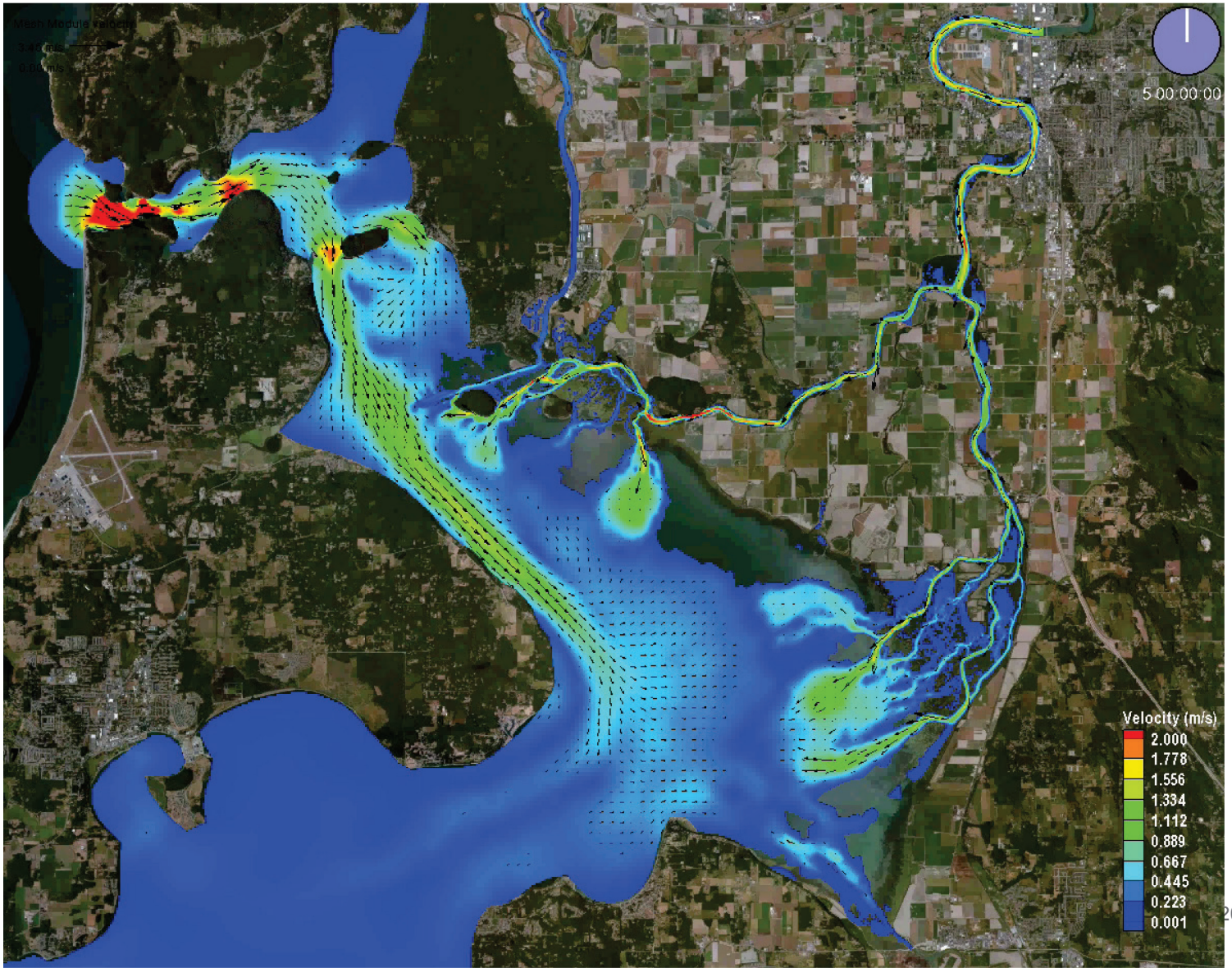


- Model sites calibrated within 1.4%, 1.0%, 2.8%, 9.6% and 2.3% relative error, respectively

Animation: Velocity



Grouped Project Runs

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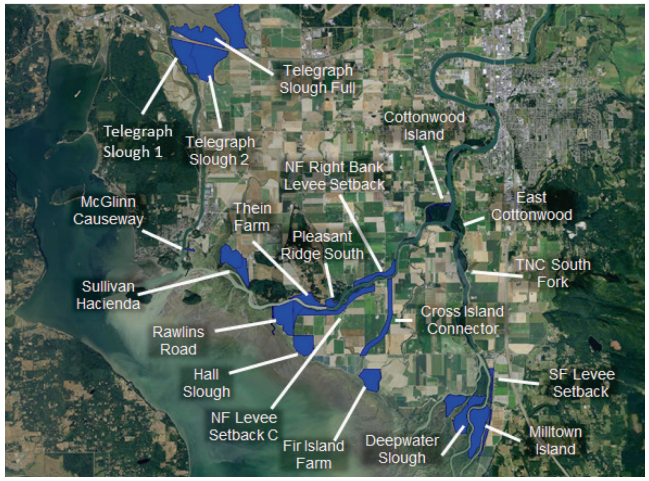
Simulation 1: Small Projects

Simulation 6: Moderate Influence #1

Simulation 7: Moderate Influence #2

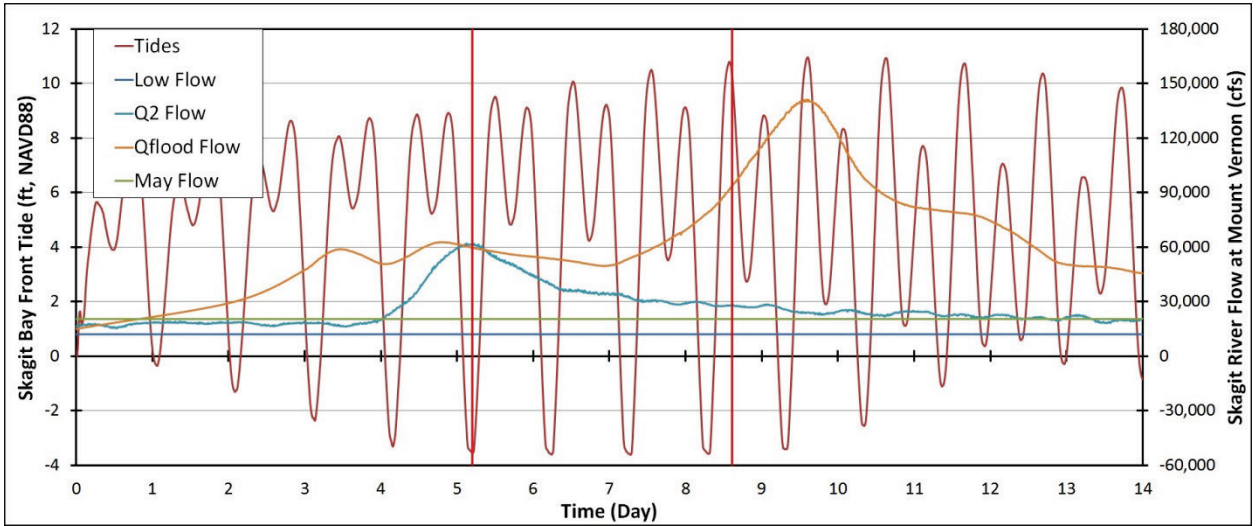
Simulations 8 & 10: Selected Projects



- Blue polygons are projects
- Simulations 1-7 isolate project effects
- Simulation 8 shows cumulative effect
- Simulations 9-10 show effects of climate change

Model Runs per Scenario

- Full model simulation from **Nov 1, 2014 – May 22, 2015** using historic hydrographs and tide charts
- Two-week design runs to isolate effects of riverine, tidal, flood, etc.
  - Tidal: Low flow (12,000 cfs) and high Spring tide (10.8 ft NAVD88)
  - Riverine: Q2 flow (62,000 cfs) and low Spring tide (-3.3 ft NAVD88)
  - Flood: Qflood (93,200 cfs) and high Spring tide (10.4 ft NAVD88)
  - Mean May flow (20,400 cfs) and high Spring tide (10.8ft NAVD88)
  - Feb. to May Juvenile Outmigration



Fish Objective: Increased area subject to tidal & riverine processes

Analysis Method:

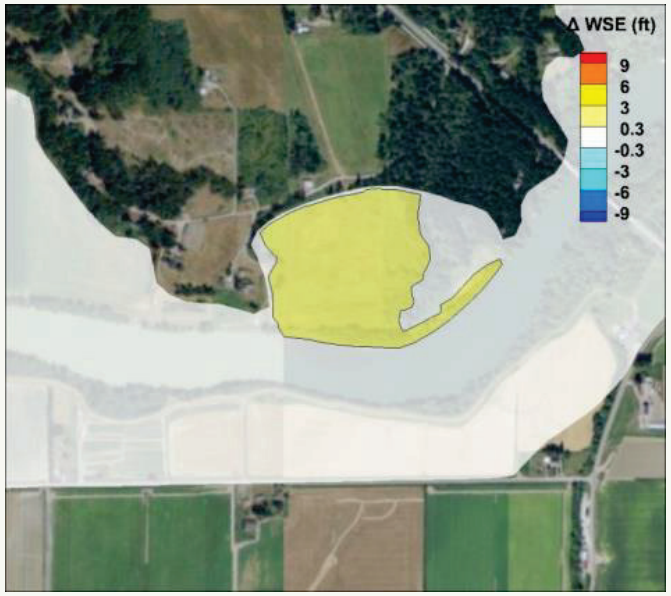
1. Determine if project was tidal, riverine or a combination of the two
2. Calculate within project concept footprint with wetted area increase

   For tidal sites use high tide scenario, for riverine Q2.

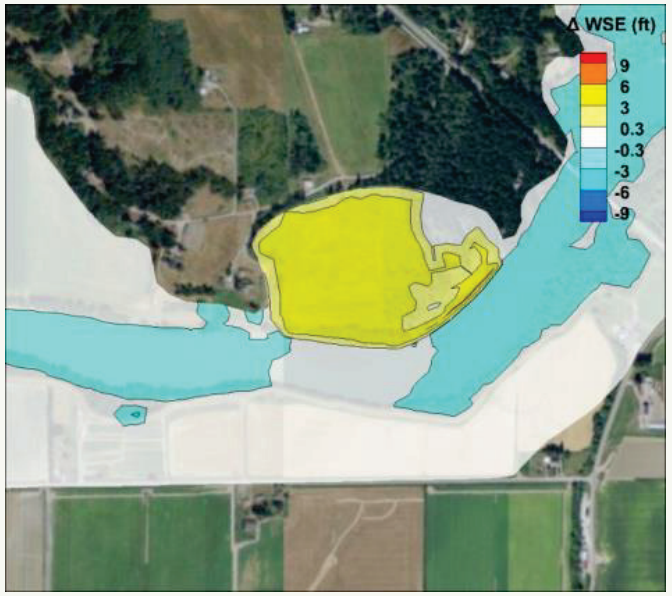
   For tidal and riverine, sum the areas accounting for overlap.

High Tide/ Low Flow	Pleasant Ridge South
Baseline	0.0
Small Projects	22.3
Increase in Area	22.3

Q2 Flow/ Low Tide	Pleasant Ridge South
Baseline	0.4
Small projects	27.8
Increase in Area	27.4



Low Flow (12,000 cfs)
High Spring Tide (10.8 ft)



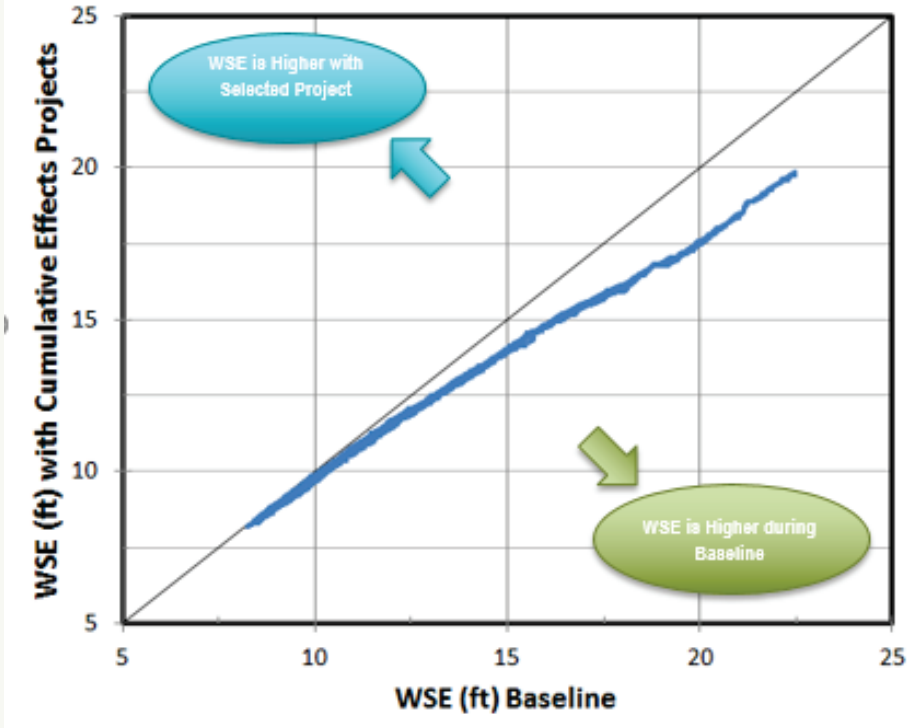
Q2 Flow (62,000 cfs)
Low Spring Tide (-3.3 ft)

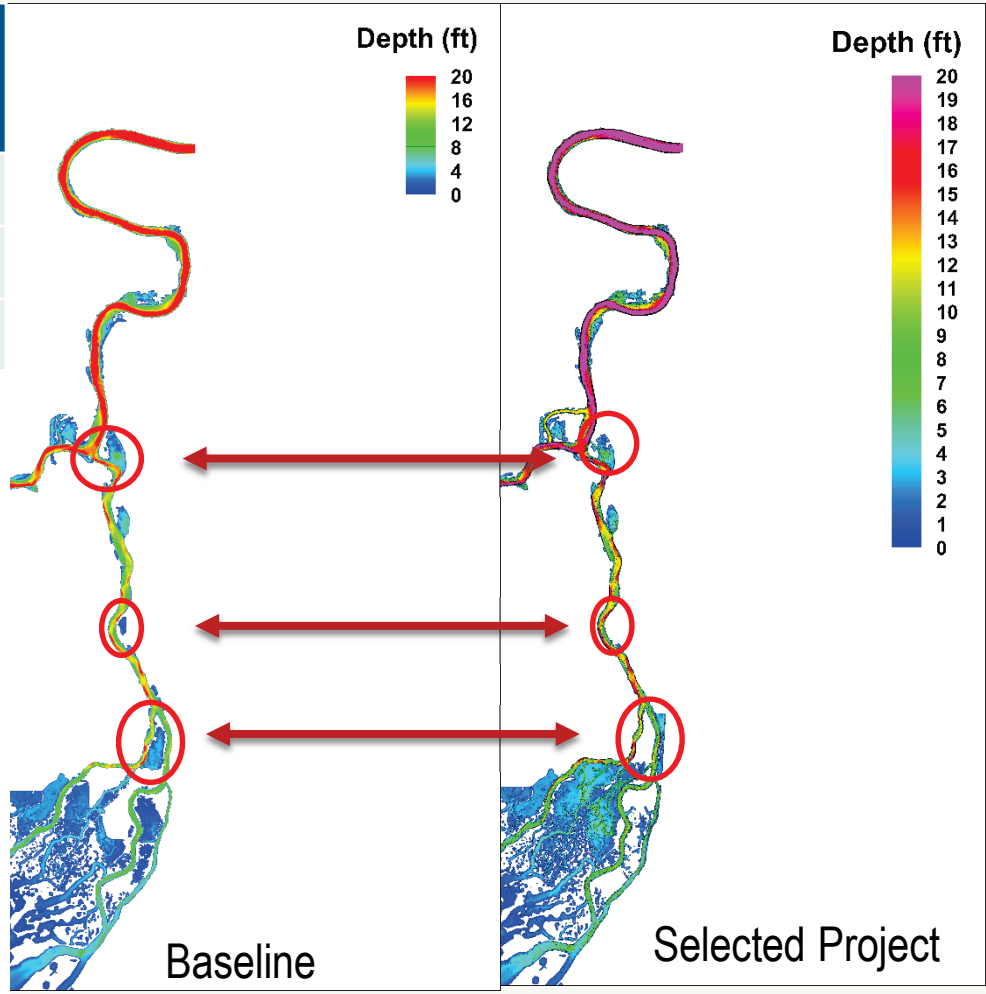
Fish Objective: minimize impacts to offsite habitat

Effect of change in flow and WSE between forks on existing habitat

- Examined for areas outside of project footprints that are inundated during Q2 Baseline and not during Q2 with selected project run (see red circled areas)

Project Concept	Net Off-site Loss (acres)
Avon-Swinomish By-pass	336.4
NF Levee Setback A	132.5
NF Levee Setback B	68.3





Q2 Flow (62,000 cfs)/Low Spring Tide (-3.3 ft)

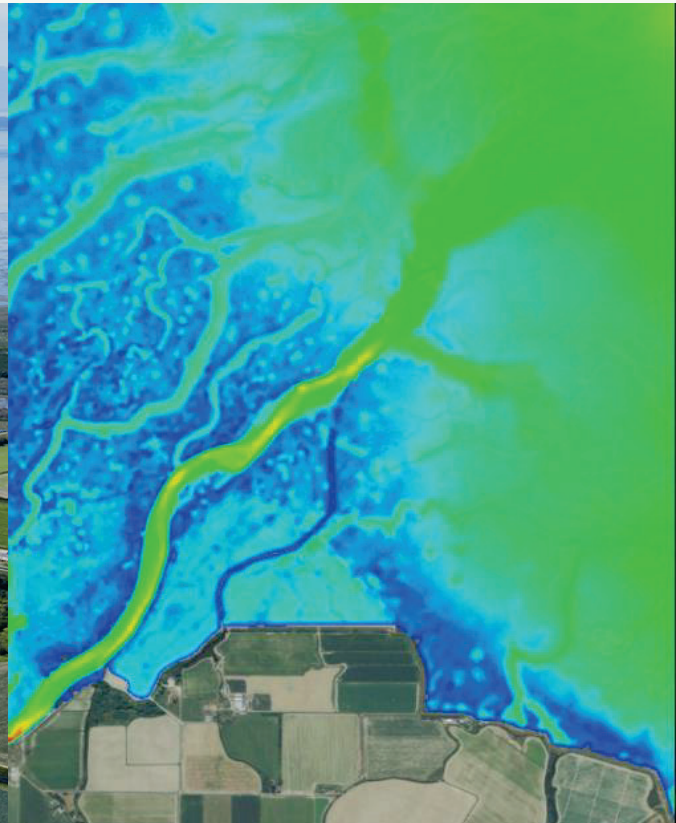
Fish Objective: Increase Area of Tidal and Riverine Channels Suitable To Chinook Rearing Fry

Indicator: Total number of acre-hour suitable habitat predicted

Method:

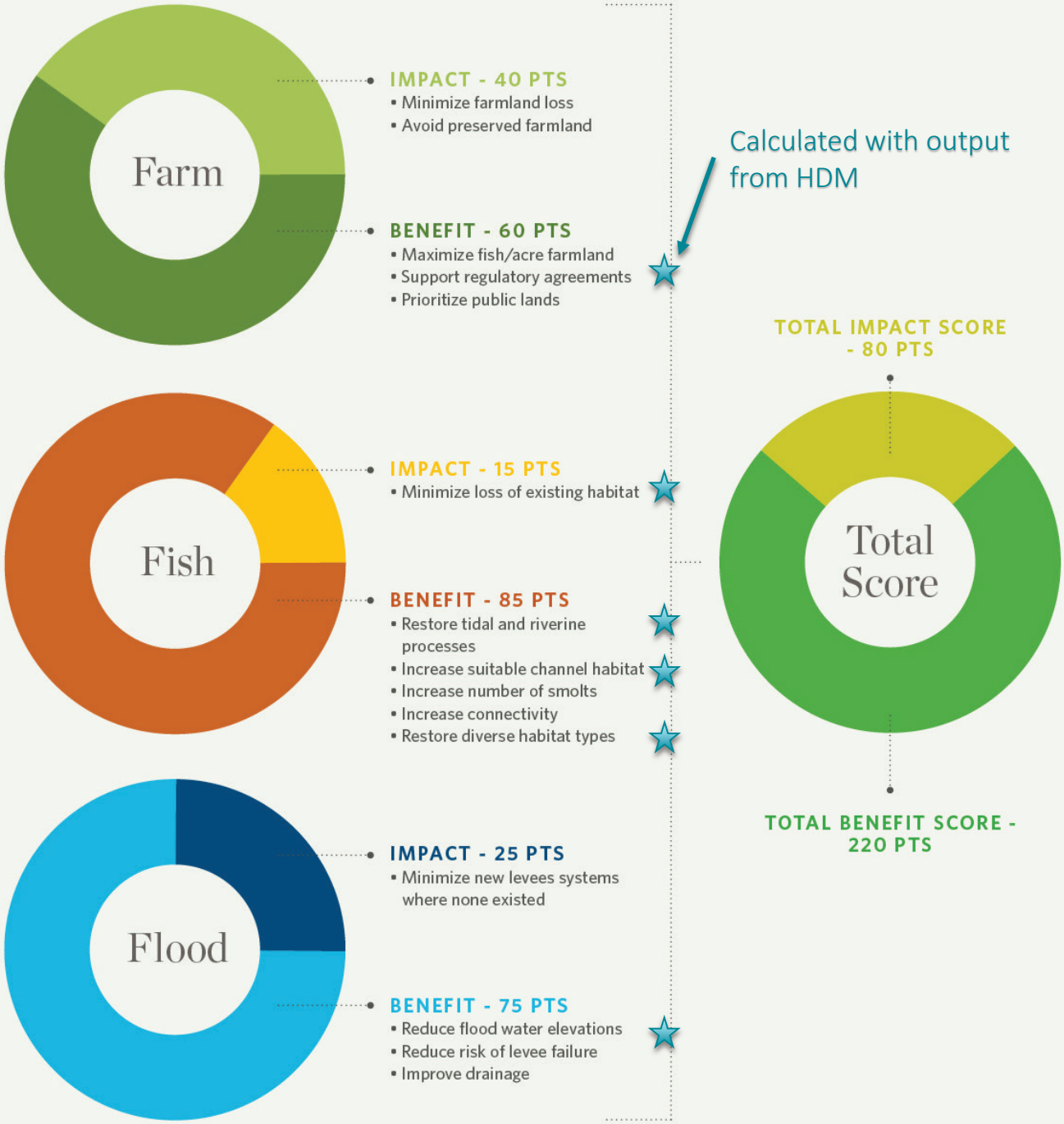
$$\sum_{elevationx}^{elevation\ z} (hours\ inundated\ (_{x\ to\ x\ +\ 6ft_{)}}\ *\ areax)$$

Elevation	Hrs water depths suitable for smolts	Acres at elevation	Acre*hrs
-3	0	4.8	0
-2	728	7.8	5,666
-1	996	8.7	8,655
0	1,351	14.7	19,915
1	1,680	48.4	81,422
2	1,936	87.0	168,438
3	1,977	92.8	183,426
4	1,248	190.5	237,851
5	980	306.4	300,383
6	625	167.9	105,018
7	296	37.1	10,982
8	40	18.0	727
9	0	15.9	0
10	0	15.5	0
11	0	13.7	0
12	0	8.1	0
13	0	4.3	0
		Total acre*hours	**1,122,486**



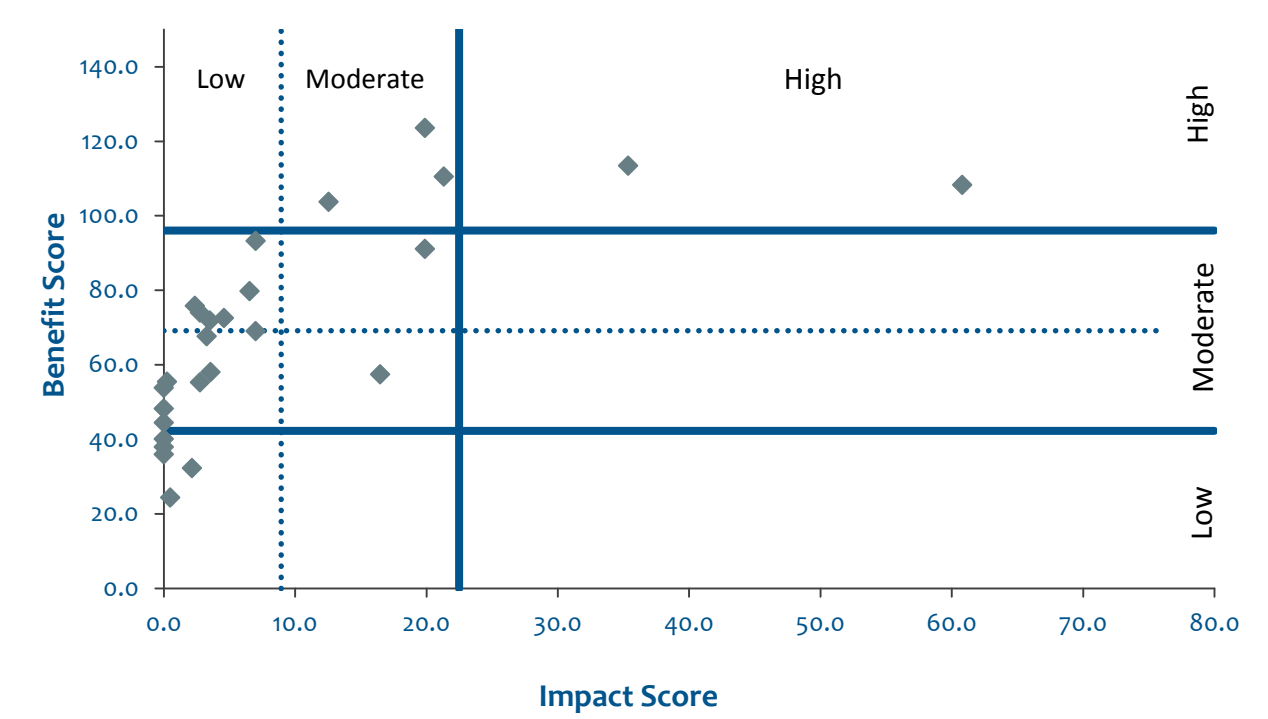
SHDM
Logic Framework

Scores for each indicator were normalized and weighted



SHDM Multiple Interest Score

- Total Benefit and Impact Scores for each project concept were plotted



- The plotted scores were then used to identify distinct groups of project concepts

Current 3FI Partners

Dike District #17/Dike District Partnership
NOAA Restoration Center
Skagitonians to Preserve Farmland
WA Dept. of Agriculture
WA Dept. of Fish and Wildlife
Western WA Agricultural Association

HDM Working Group

Dike District #3
Dike District #17/Dike District Partnership
Dike & Drainage District #22
NOAA Restoration Center
Seattle City Light
Skagit Conservation District
Skagitonians to Preserve Farmland
Skagit Watershed Council
The Nature Conservancy
Upper Skagit Tribe
US Geological Survey
WA Dept. of Fish and Wildlife
Western WA Agricultural Association

Technical Analyses

Pacific Northwest National Laboratory
Skagit River System Cooperative
The Nature Conservancy
US Geological Survey

Funding Organizations

EPA/National Estuary Program
NOAA Restoration Center
Private Donors
SRFB/RCO/Skagit Watershed Council