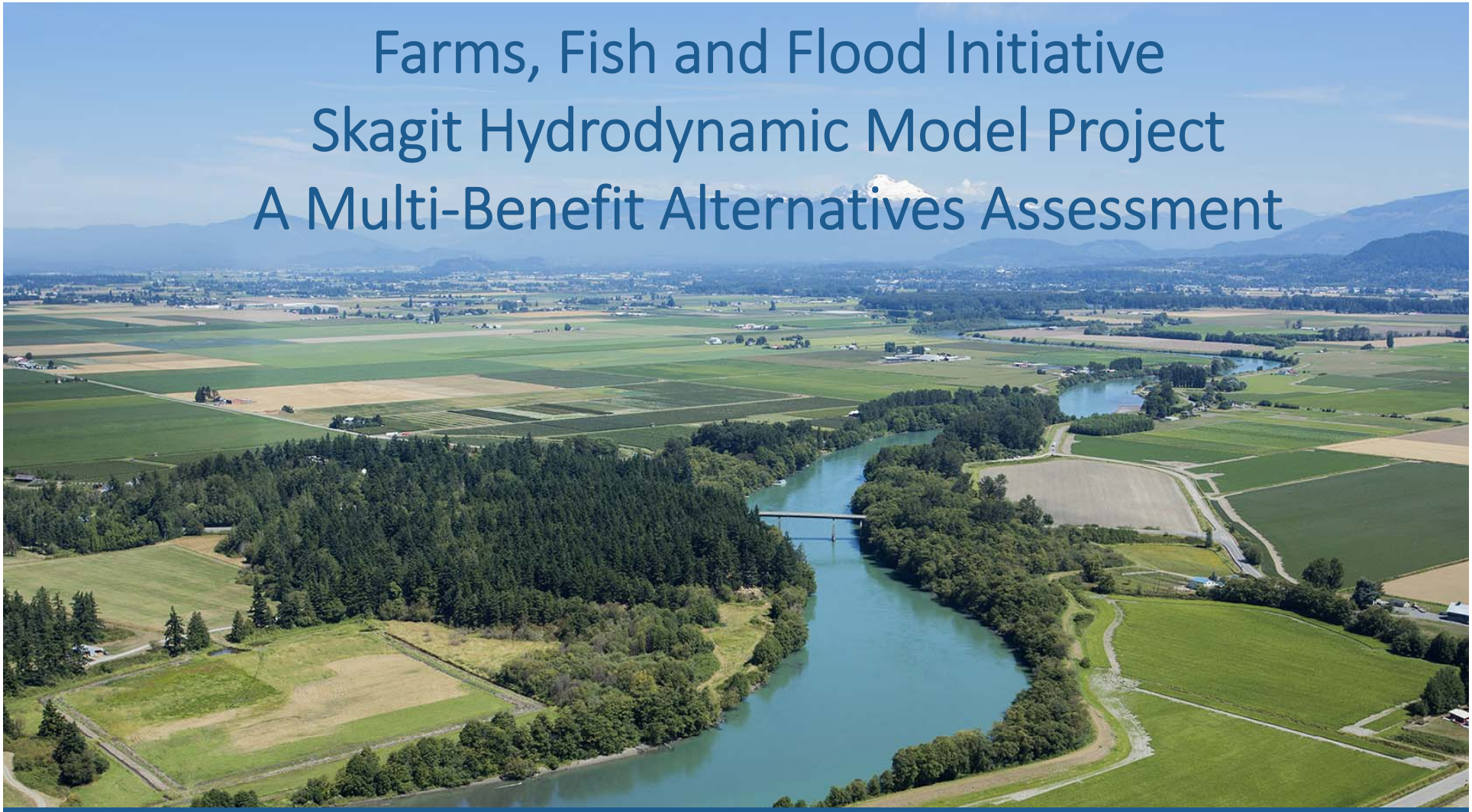
Farms, Fish and Flood Initiative
Skagit Hydrodynamic Model Project
A Multi-Benefit Alternatives Assessment



RRNW Conference
February 2018

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

PNNL 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) Minimize loss of existing habitat (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	

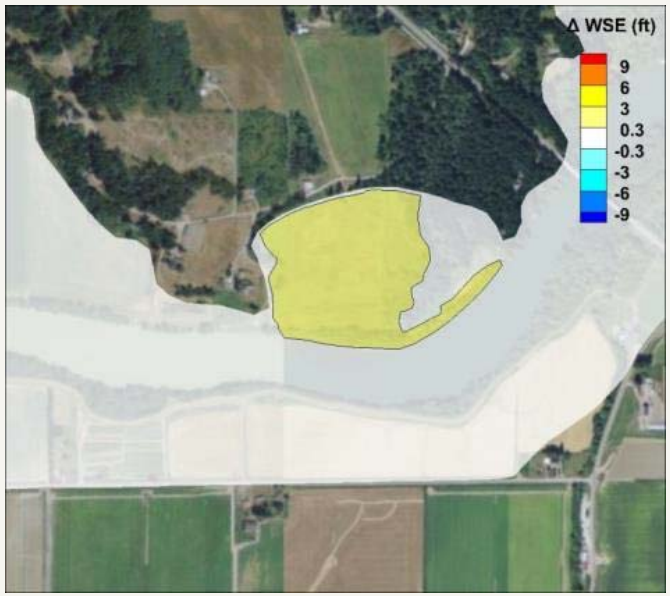
Fish Objective 1: Increased area subject to tidal & riverine processes

Analysis Method calculate within project concept footprint with wetted area increase

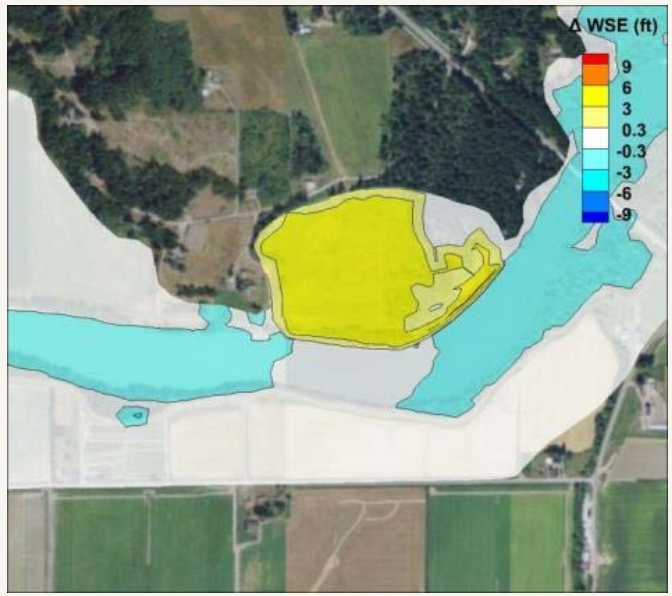
- For tidal sites use high tide scenario/low flow, for riverine Q2/low tide.
- For tidal and riverine, sum the areas accounting for overlap.

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)



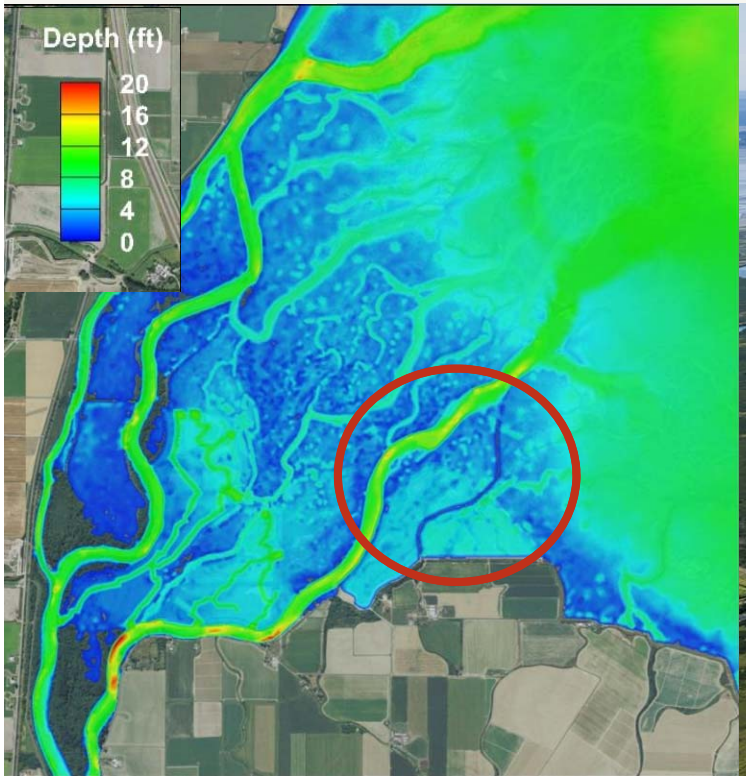
Q2 Flow (62,000 cfs)
Low Spring Tide (-3.3 ft)

Fish Objective 3: Increase Area of Tidal and Riverine Channels Suitable To Chinook Rearing Fry

Total number of acre-hour suitable habitat predicted

Wiley Slough Restoration Project Example

38,500 smolts predicted in Skagit Chinook Recovery Plan
Up to 70,000 smolts based on monitoring of tidal channels
Up to 240,000 if monitoring data from ponded areas are included
(Beamer et al 2011, 2012)



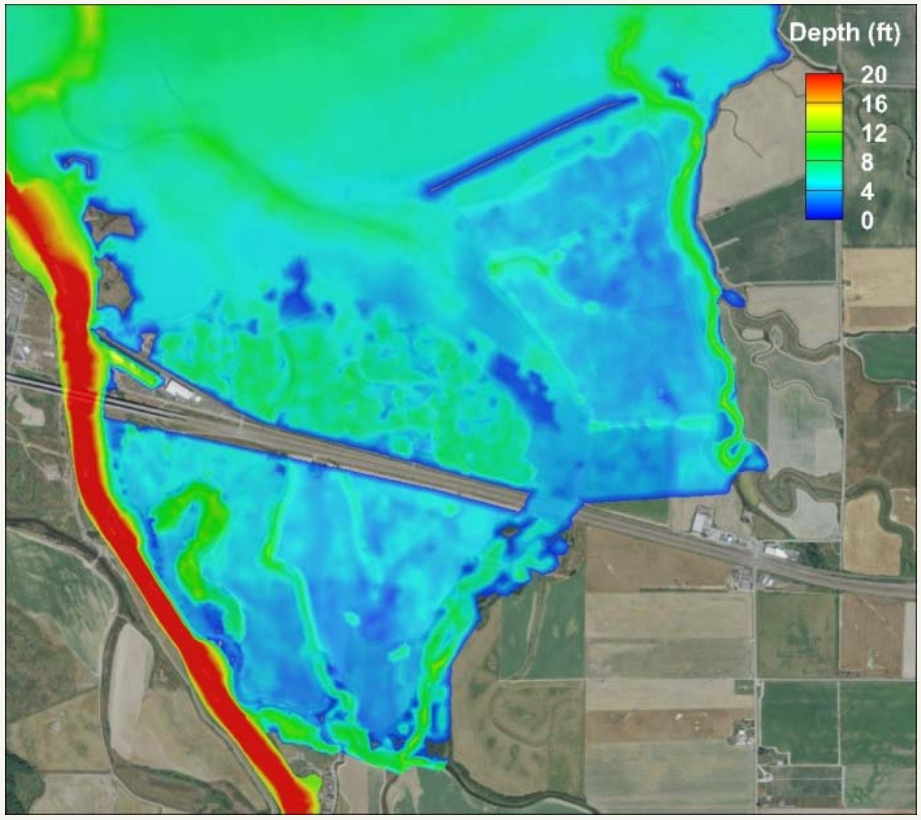
Fish Objective 3: Increase Area of Tidal and Riverine Channels Suitable To Chinook Rearing Fry

Indicator: Total number of acre-hour suitable habitat predicted

Method:

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

Telegraph Slough Full			
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**

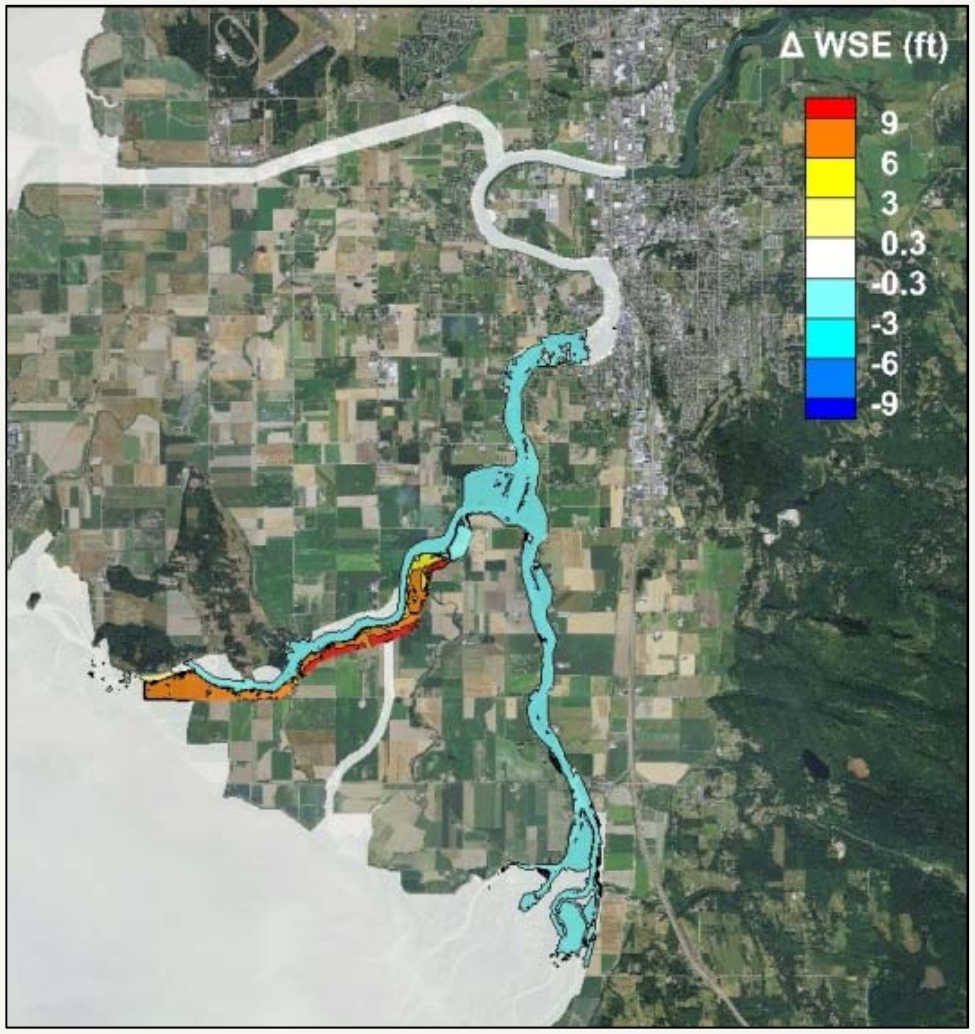


Flood Objective 1: Flood stage relative to existing conditions
Example: Project with high flood benefit (NF Levee Setback A)

Indicator: Reduced flood stage

Analysis Method:

1. Calculate change in water surface elevation
2. Evaluate change relative to 0.0
3. Estimate length of river with significant change

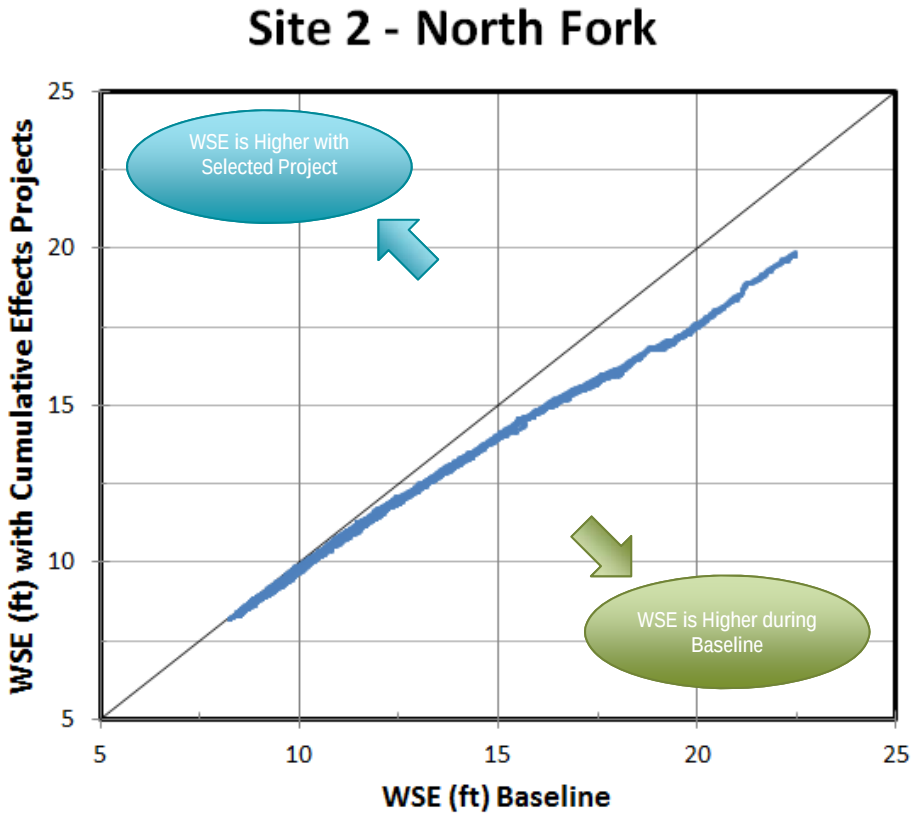


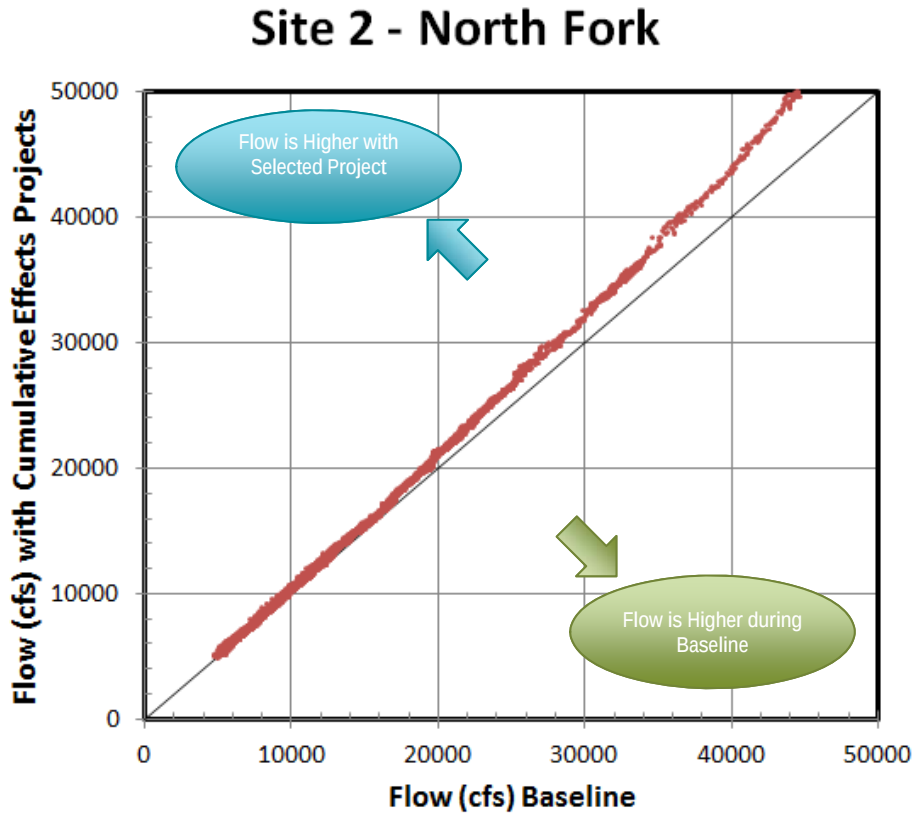
Qflood (93,200 cfs)
High Spring Tide (10.4 ft)

Fish Objective 2: minimize impacts to offsite habitat

Evaluate change in the distribution of flow and WSE: North Fork Skagit River

- Reduce WSE in the North Fork Skagit
  - Results from increased storage and conveyance capacity due to project implementation
- More flow in the North Fork Skagit as compared to baseline



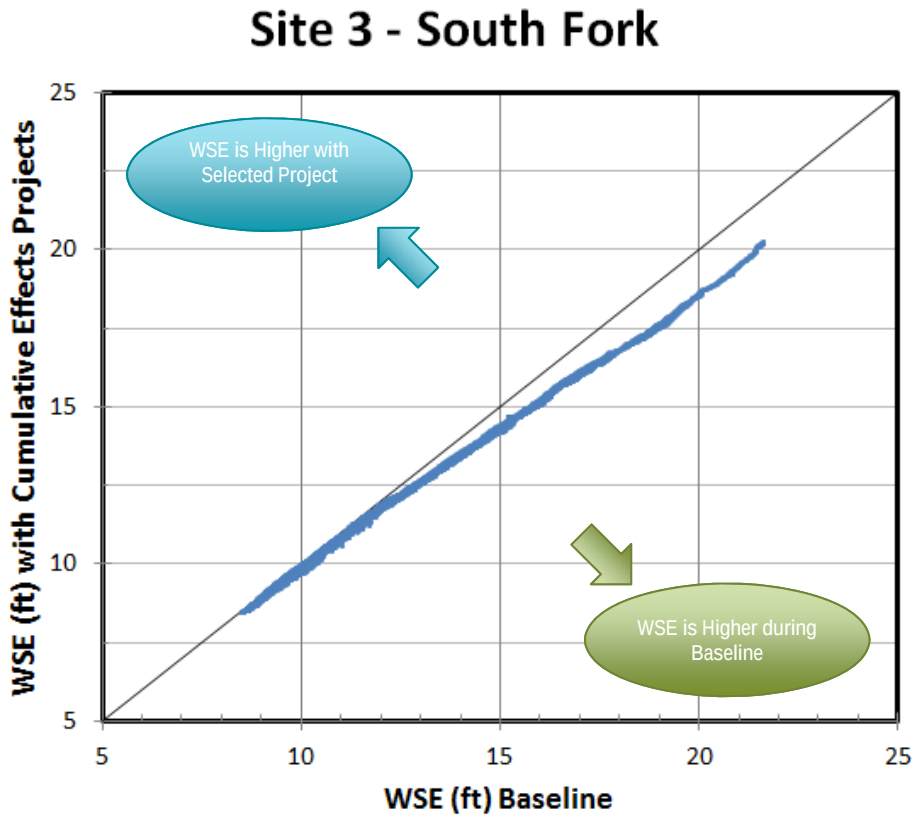


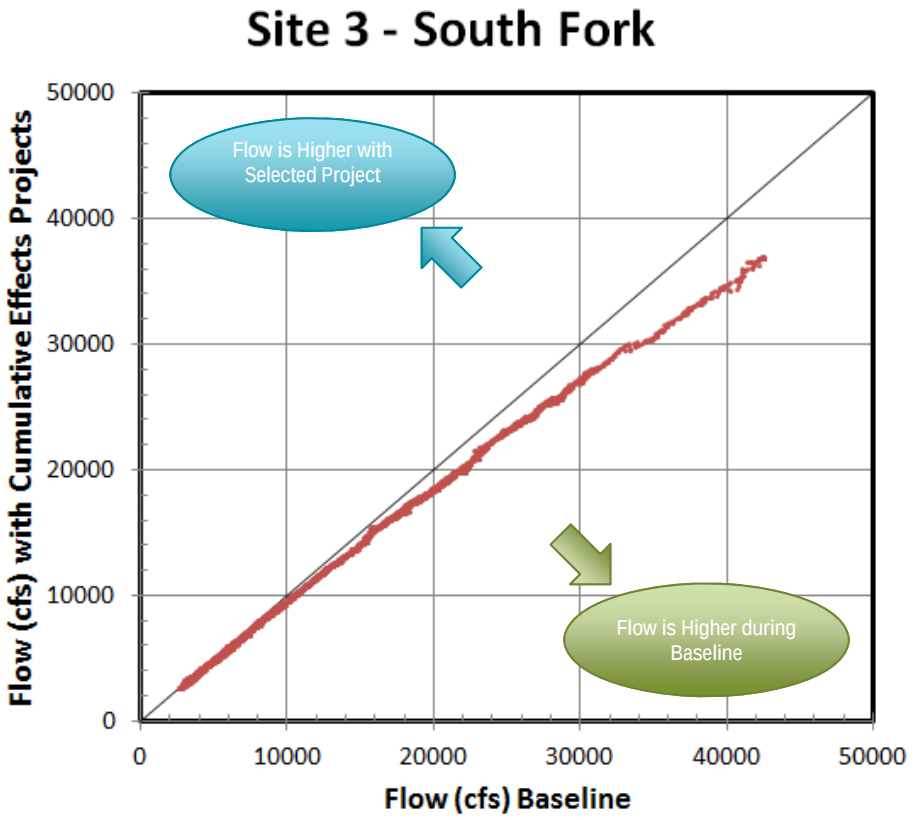
Full Simulation: November 2, 2014 – May 29, 2015

Fish Objective 2: minimize impacts to offsite habitat

Evaluate change in the distribution of flow and WSE: South Fork Skagit River

- Reduce WSE in the South Fork compared to baseline
  - Due to more storage and conveyance capacity in the North Fork Skagit as a result of project implementation
- Less flow in the SF Skagit compared to baseline





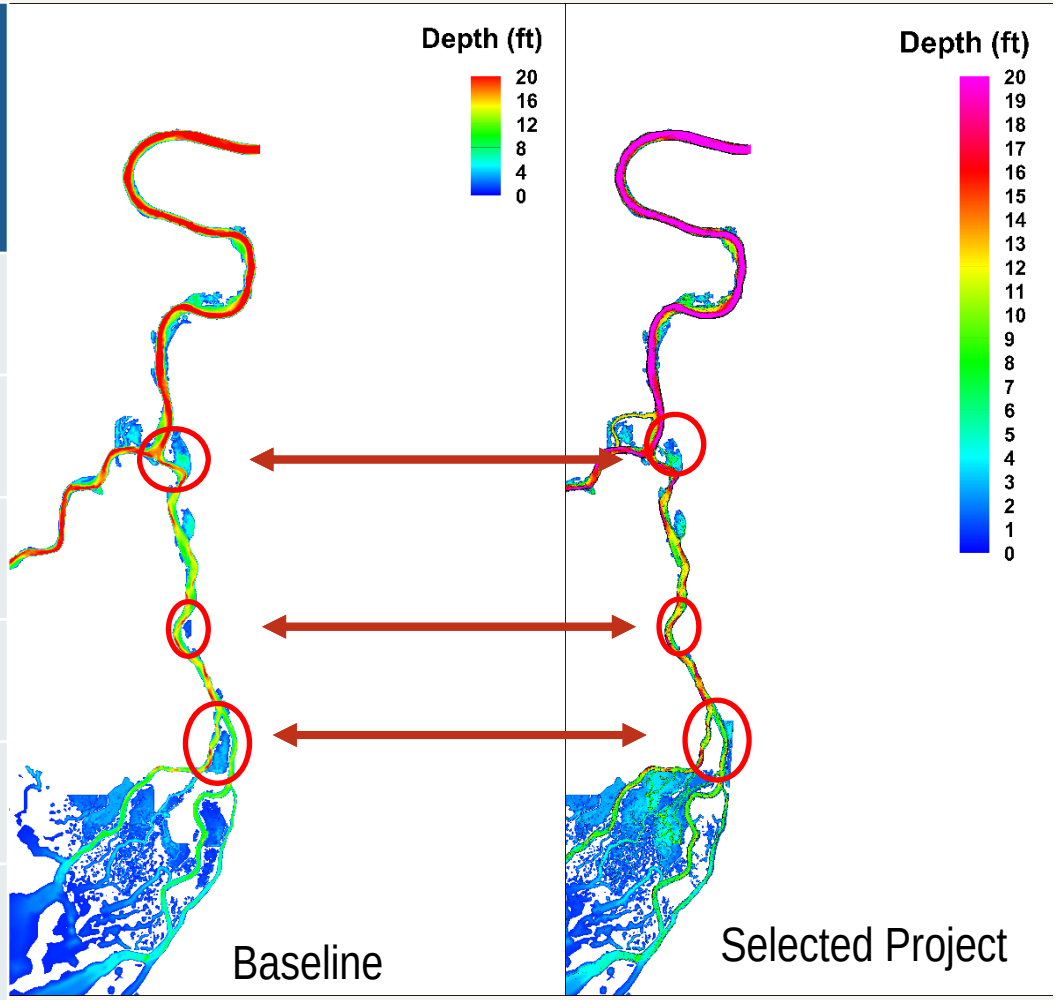
Full Simulation: November 2, 2014 – May 29, 2015

Fish Objective 2: minimize impacts to offsite habitat

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

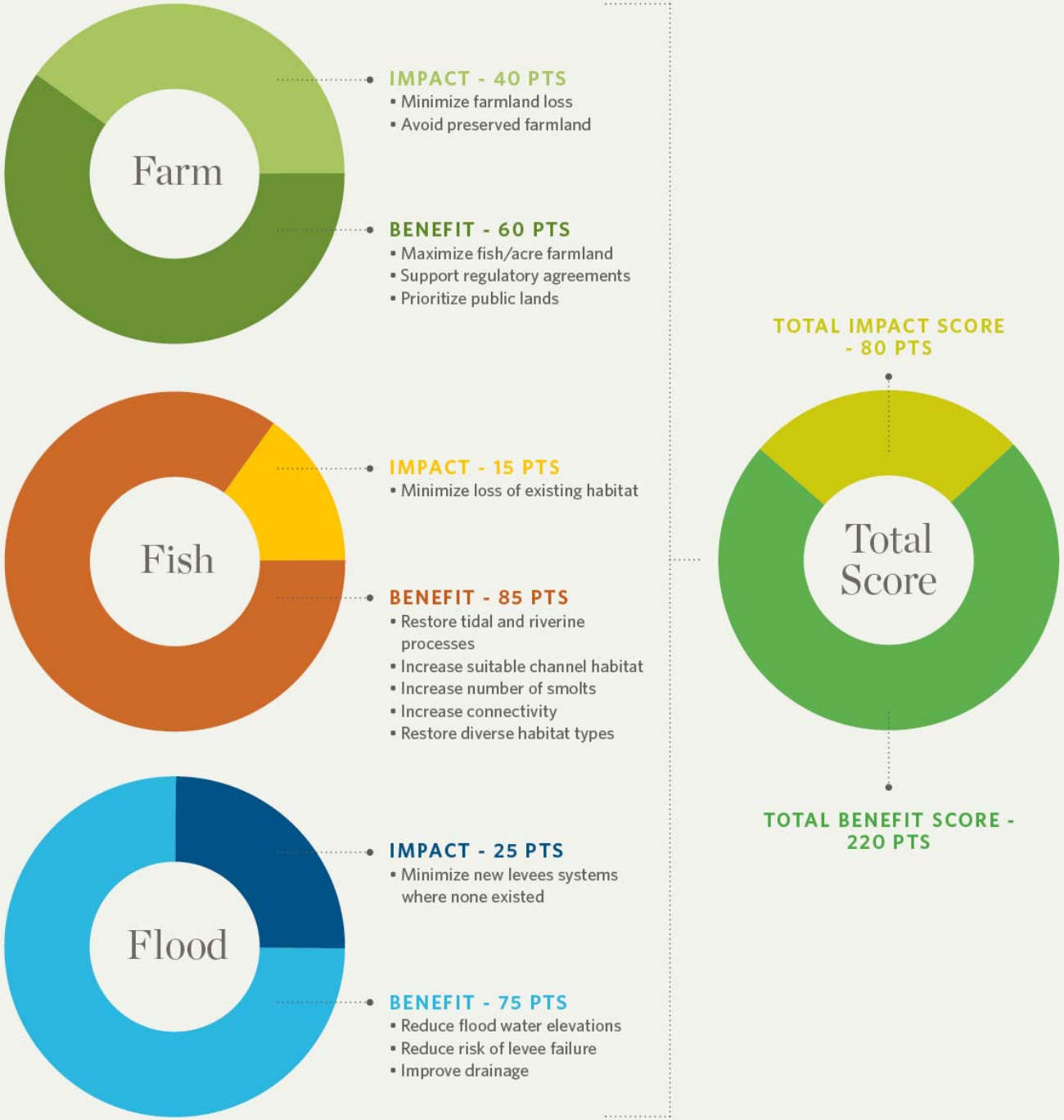
- Examined for areas outside of project footprints that are inundated during Q2 Baseline and not during Q2 with selected project run (see red circled areas)

Project	Net Off-site Loss (acres)
Avon-Swinomish By-pass	336.4
NF Levee Setback A	132.5
NF Levee Setback B	68.3
NF Levee Setback C	40.8
Cross Island Connector	97.6
Thein Farm and NF RB Levee Setback	47.0



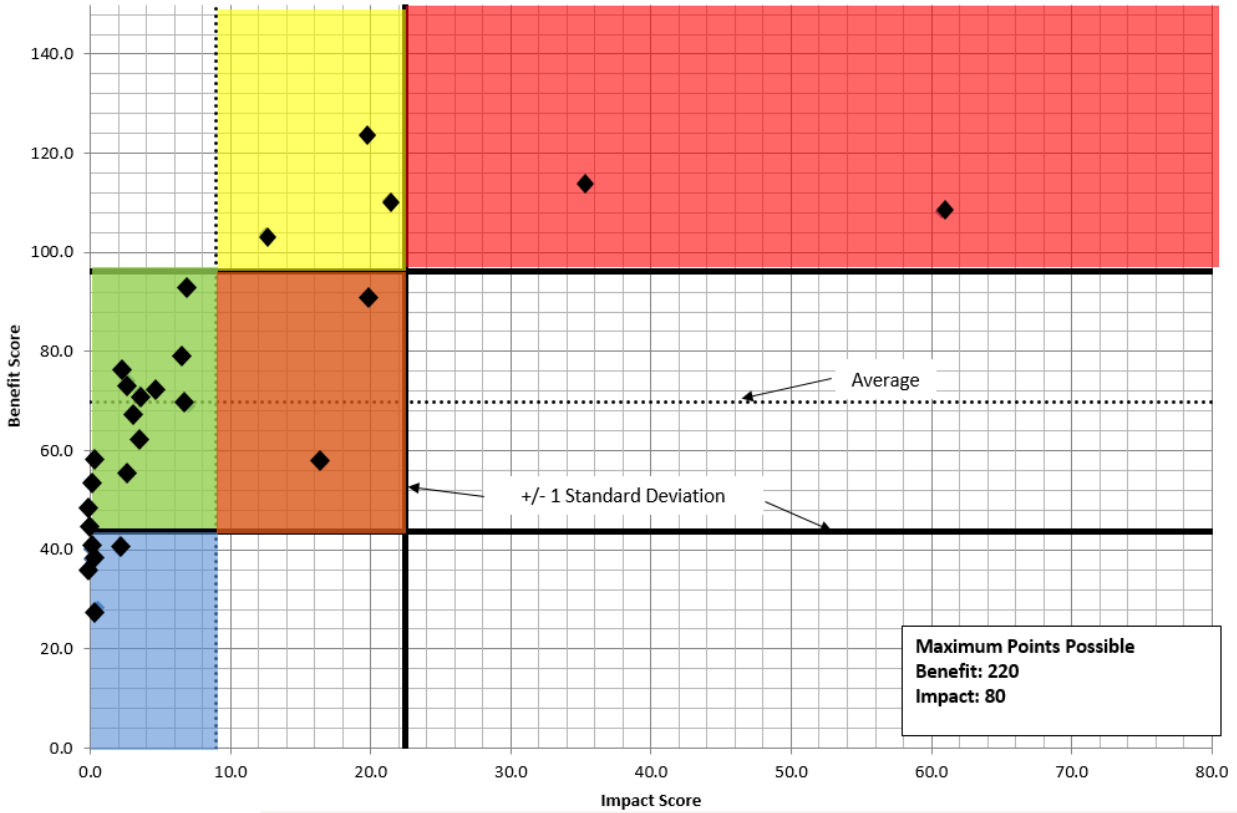
Q2 Flow (62,000 cfs)/Low Spring Tide (-3.3 ft)

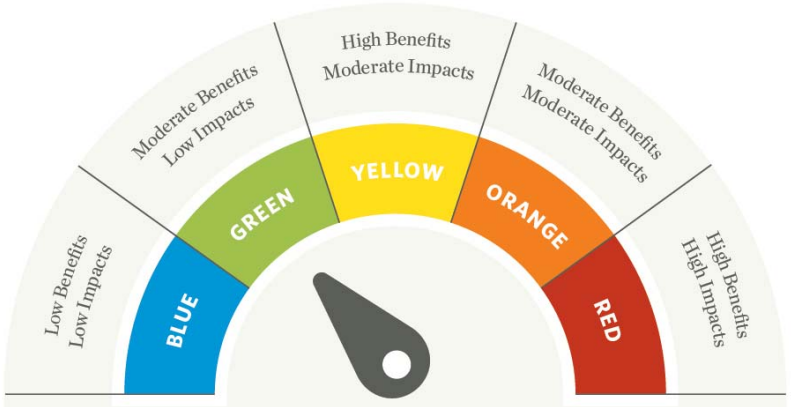
SHDM
Logic Framework



SHDM Multiple Interest Score

- Total Benefit and Impact Scores for each interest group were plotted
- The plotted scores were then used to identify distinct groups of project concepts





Five distinct management groups

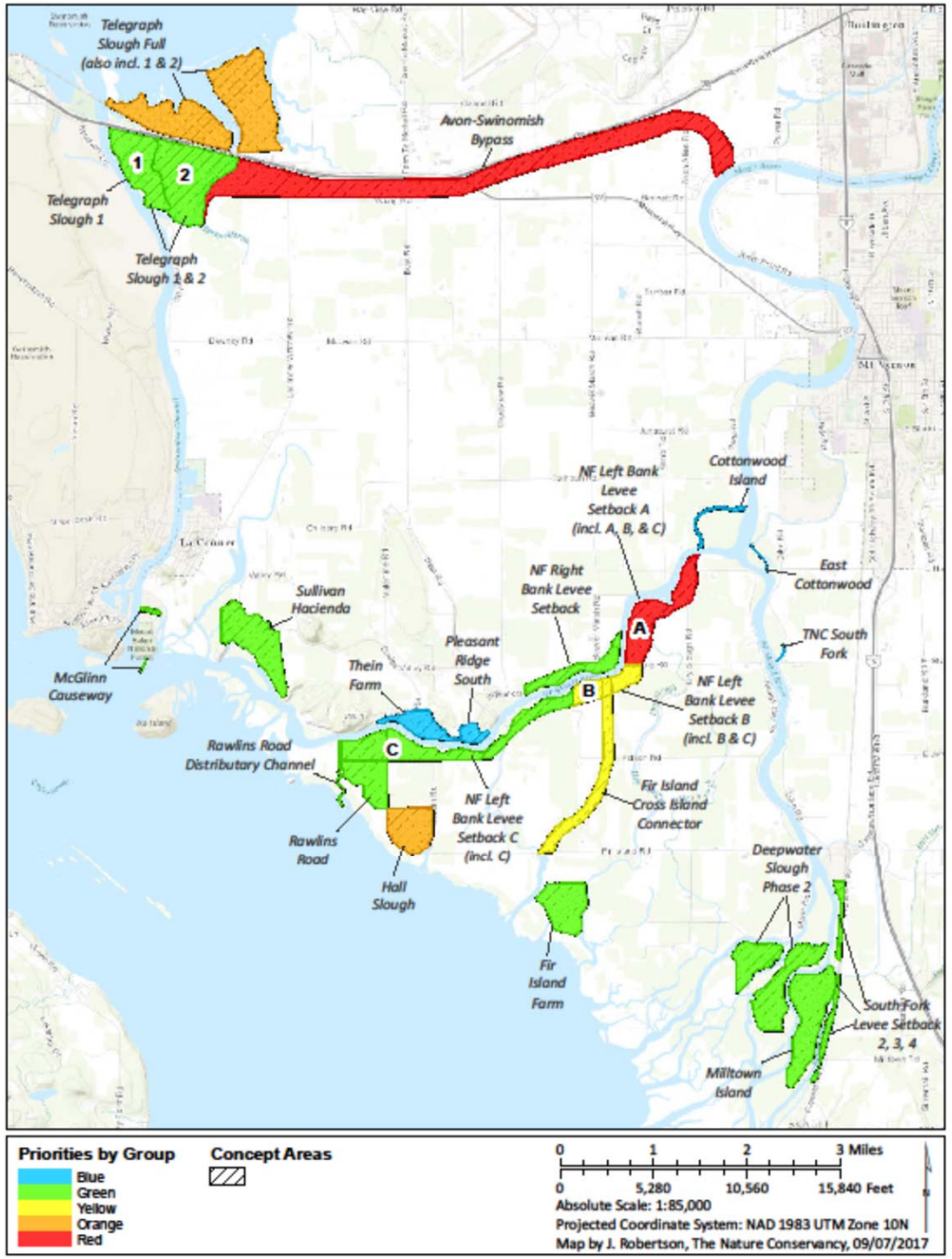
- Outreach Plan and Timeline Developed for each management group

Going forward….

- Cumulative Effects Analyses
- Climate Change Analyses
- Salinity Analyses

- Continue to evaluate projects in terms of multiple benefits
- Accountability and monitoring of implemented restoration projects
- Continued community outreach

….this is a tool to support continued collaborations



Climate Change Analysis: Effect on Inundation

How does increased Q2 and SLR effect inundation during a high tide or Q2 in a future baseline (w/o projects) condition?

- Comparing inundated areas between current baseline and future baseline during a high spring tide
- Comparing inundated areas and WSE during current Q2/low tide and future Q2/low tide.

Run	Discharge (cfs)	Tide (ft)
R0: Existing Baseline	Low Flow Q = 12,000	High Spring Tide = 10.8
R9: Future Baseline SLR	Low Flow Q = 12,000	High Spring Tide = 12.7
R0: Existing Baseline Q2	Q2 = 62,000	Low Tide = -3.3
R9: Future Baseline Q2	Q2 = 103,237	Low Tide = -1.4

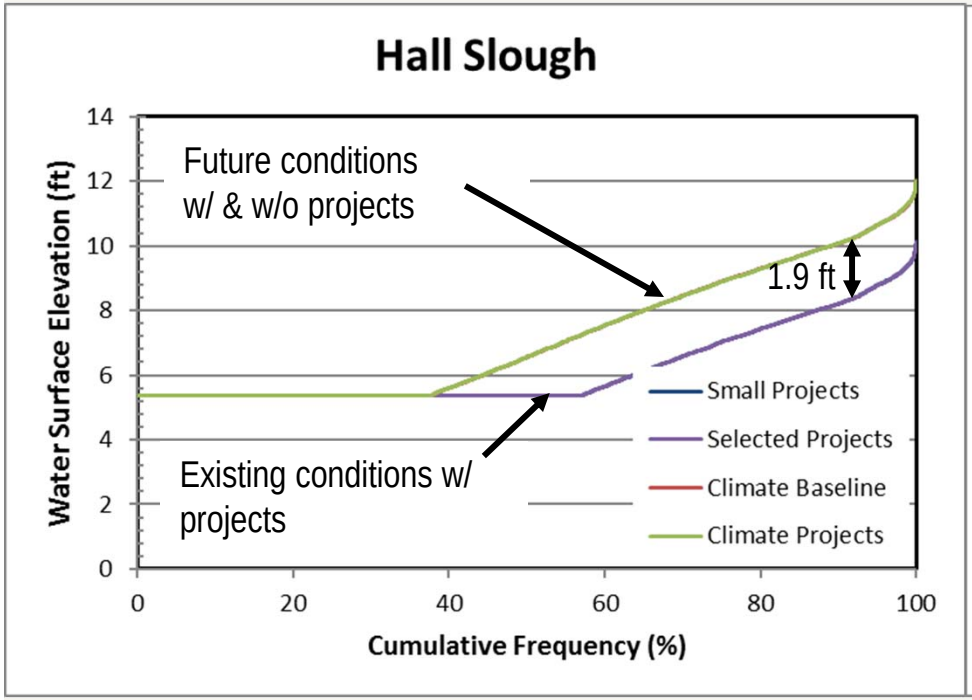
Lee, Hamlet, Grossman. 2016.

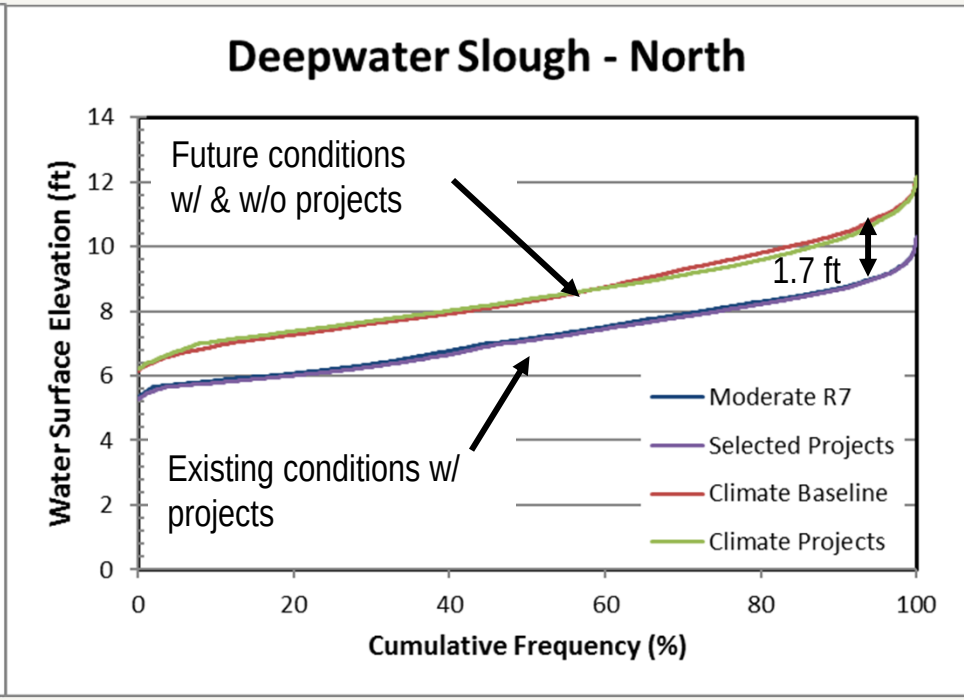
Climate Change Analysis: Affects on WSE and Habitat

Does climate change have the potential to affect WSE and habitat potential of project concepts?

Project Concepts: Hall Slough and Deepwater Slough

- *Very little change in WSE due to projects*
- *Still have an increase in WSE from SLR of ~1.9ft.*
- *Increase in WSE is slightly less than 1.9 ft as move upstream*





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