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# Chinook habitat restoration decision support tool- Identifying chinook salmon habitat restoration effectiveness based on temperature, flow, and bioenergetics models

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# Chinook Habitat Restoration Decision Support Tool:

## Identifying Habitat Restoration Effectiveness by Linking Physical And Biological Models.

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**Presented by Andrew Spanjer, 4/5/2018, 30th Annual Salish Sea Conference in Seattle, WA**

# The Need for Linked Mechanistic Models to Improve Chinook Salmon Habitat

Energy is the growth "currency" for fish and restoration actions can change available energy by :

- Altering flow: changes in prey quality/availability and physiological energy costs (swimming costs)
- Adding large woody debris (LWD): energetic benefit from slowed river flow
- Riparian changes that influence energetic benefits/costs through temperature and prey availability/quality

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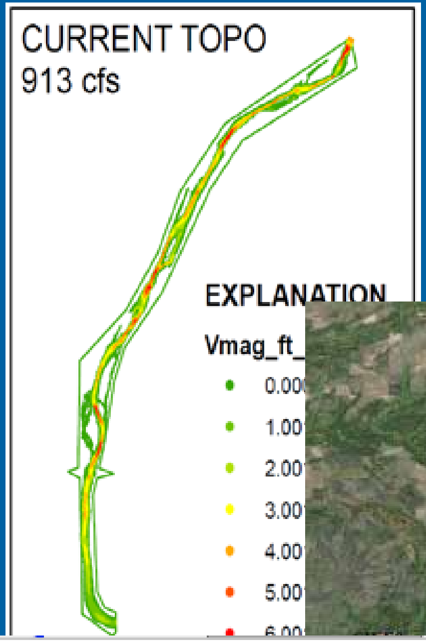
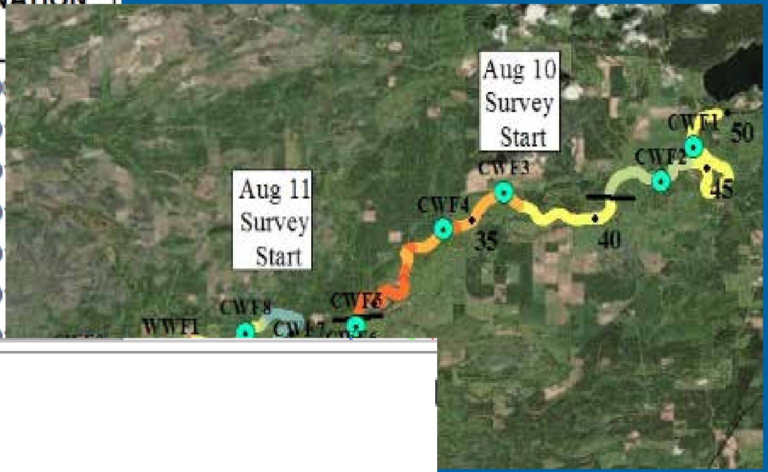
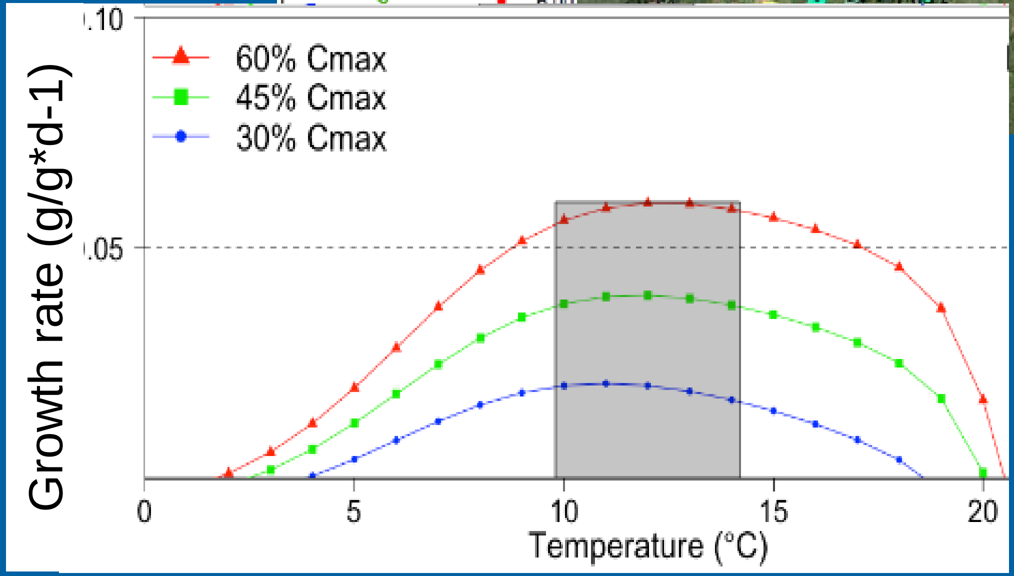
# Linking Mechanistic Models

Current developed physical models include:

- FaSTMECH or River2D
- SNtemp (river temperature model)




Wisconsin Bioenergetics Model : A well established growth model that uses energy assimilation and cost to predict growth rates in fish

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# Conceptual Diagram of Chinook Restoration Decision Support Tool

**Flow models: FaSTMECH or River2D**

- Prediction of velocity conditions for river reach under different flow conditions
- Allows for the modeling of woody debris input and velocity change (Hafs et. al 2014)

**SNtemp**

- Reach long predictions of stream temperature
- Daily time-step (mean daily temperature)
- Consideration of riparian canopy cover

**Wisconsin Bioenergetics Model:** Prediction of Chinook growth given the output of SNtemp and FaSTMECH under different management scenarios

**Visualization of competing restoration actions:** Creation of R shiny app to visualize scenarios along the range of potential restoration and management actions.

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# Hydraulic Modeling

- Flow and Sediment Transport Morphological Evolution of Channels (FaSTMECH) and River 2D module within the International River Interface Cooperative (iRIC) modeling framework (McDonald, Nelson, Smith et al. 2010)

- Used to simulate water velocity and depth for current and future conditions.

- Terrain mesh for current conditions based on topographic surveys

- Hypothetical terrain mesh for future conditions based on existing topographic data and expert judgment.

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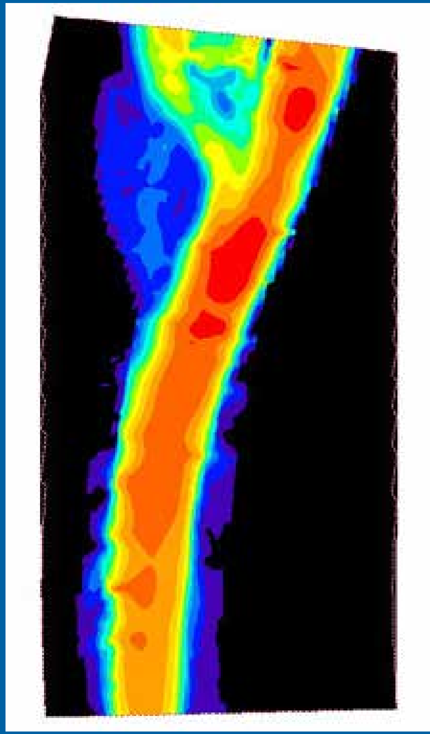
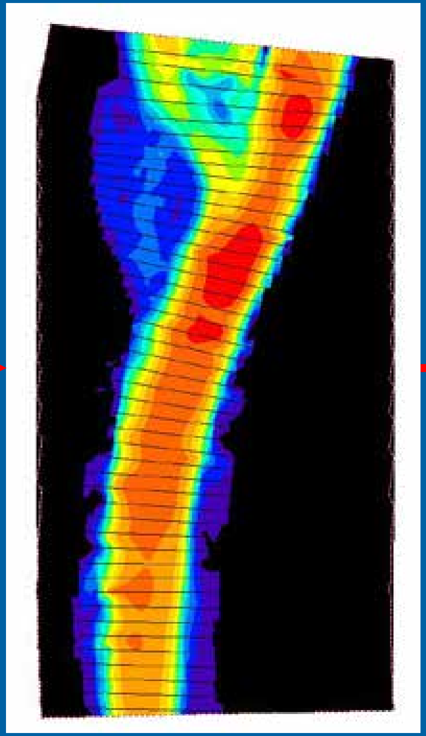
# Hydrologic Flow Model

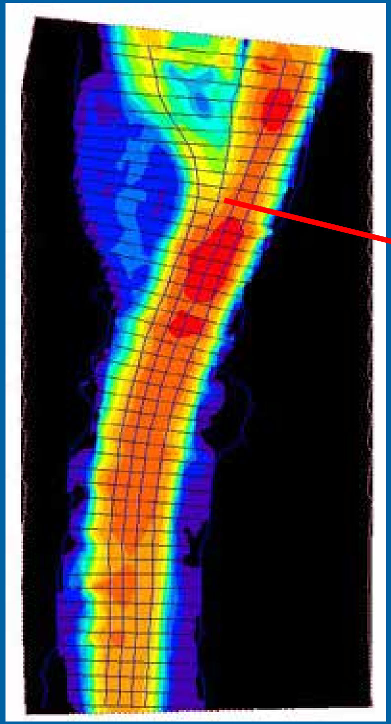
Velocity / depth from hydraulic model



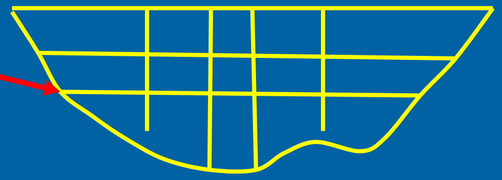
Transects perpendicular to max. velocity.



Horizontal tubes of equal discharge



Horizontal tubes vertically divided into
5 cells of equal discharge



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# SNtemp: Mechanistic Temperature Model

**Inputs:**

- Inflow/Outflow (cfs)
- Inflow temperature
- Simple stream geometry (elevation and length/average width of model segments)
- Atmospheric conditions
- Shading variables (topographic and vegetation)

Influenced by LWD addition in flow model

Manipulate based on proposed riparian changes

Output:

- Daily mean temperature per model segment (user defined)
- Feeds into daily time-step of Wisconsin bioenergetics model

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# Assessment of Individual Salmonid Growth Using Bioenergetics

Consumption - Metabolism - Waste = Specific Growth Rate

Inputs:

- Prey Quality ← Addition of energetically rich terrestrial taxa from riparian vegetation additions
- Prey Quantity ← Prey delivery and visual foraging success based on flow velocity
- Temperature ← Temperature from SNtemp model, cell dependent on location in reach
- Swimming cost ← Each modeled cell has varying energetic cost due to differences in velocity

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# Packaging and Dissemination of Decision Support Tool

**2D Flow Models: FaSTMECH and River2D**

Use existing software, output to R readable format

**SNtemp Temperature Model**

Re-coded into a standalone R package

**Wisconsin Bioenergetics Model**

**Visualization Of Competing Restoration Actions**

Temperature and bioenergetics within their own “Chinook Decision Tool” R package that can import flow model output

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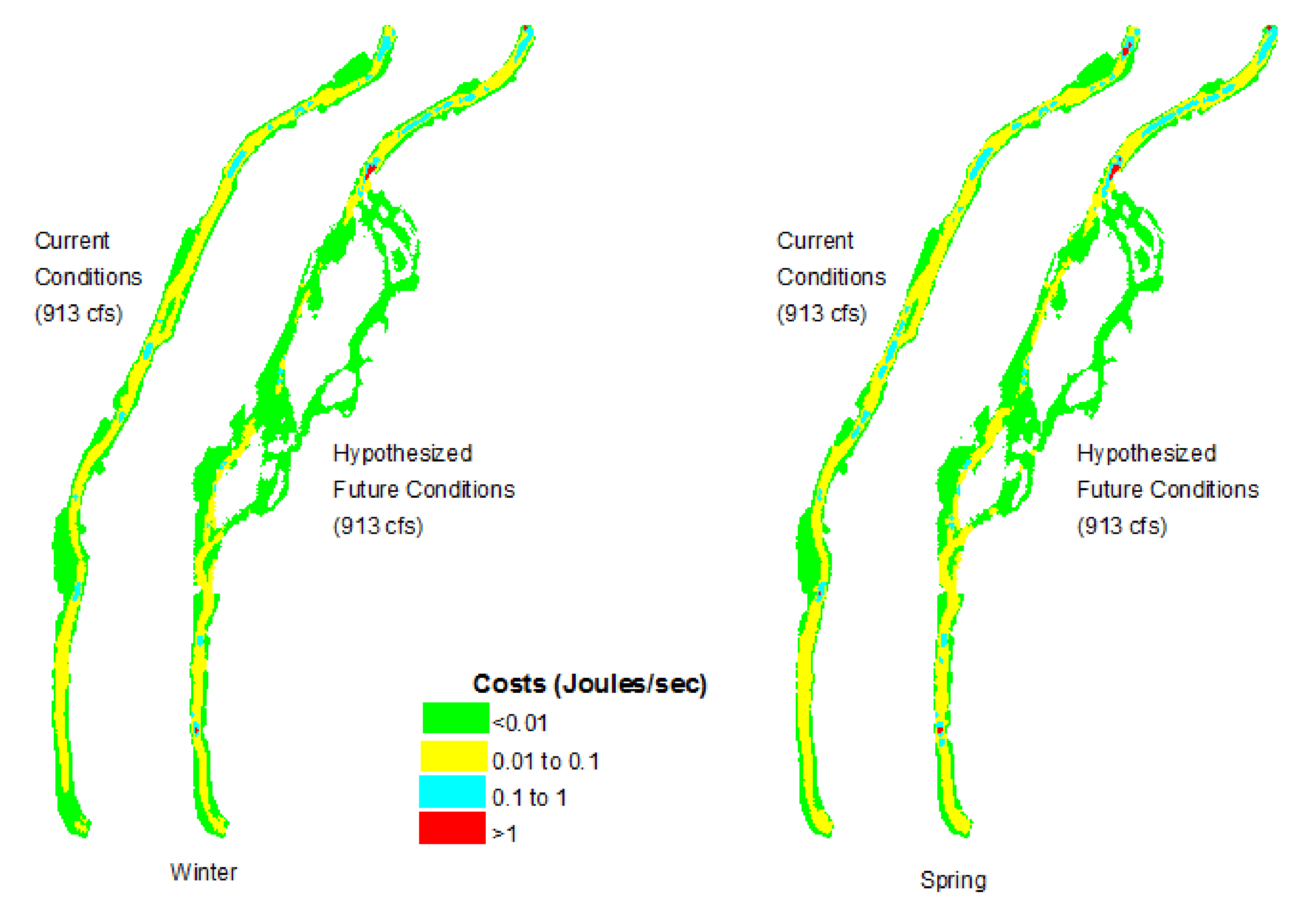
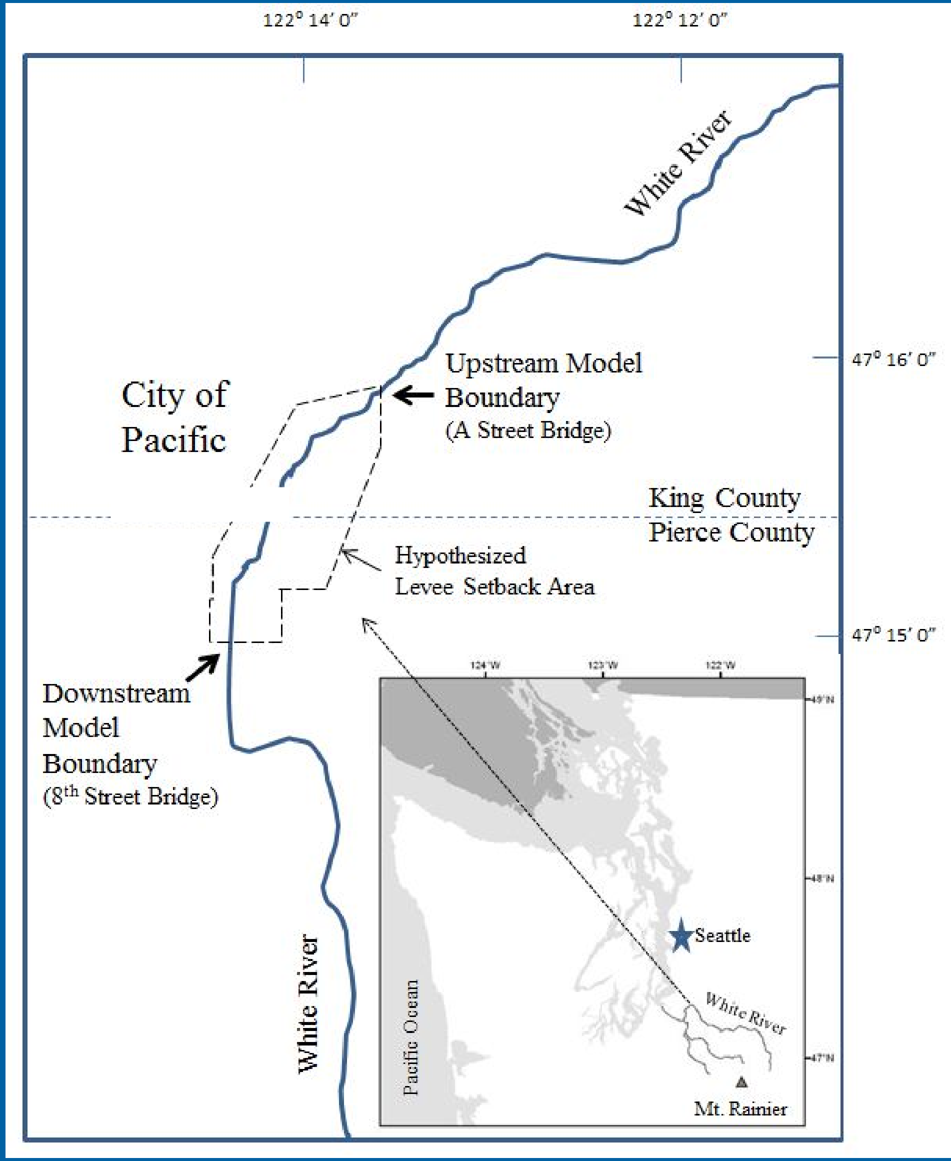
# Using Model Output to Visualize Outcomes of Different Restoration Actions



# Proof of Concept Study: King Co. Levee Setback 2016

- Historic spawning river for 6 anadromous salmonids
- 3 Federally listed salmonids
- Levees currently on both banks
- ~3,475 m
- Mean flow = 913cfs (19 years)
- Mean flow after 2003= 1740 cfs

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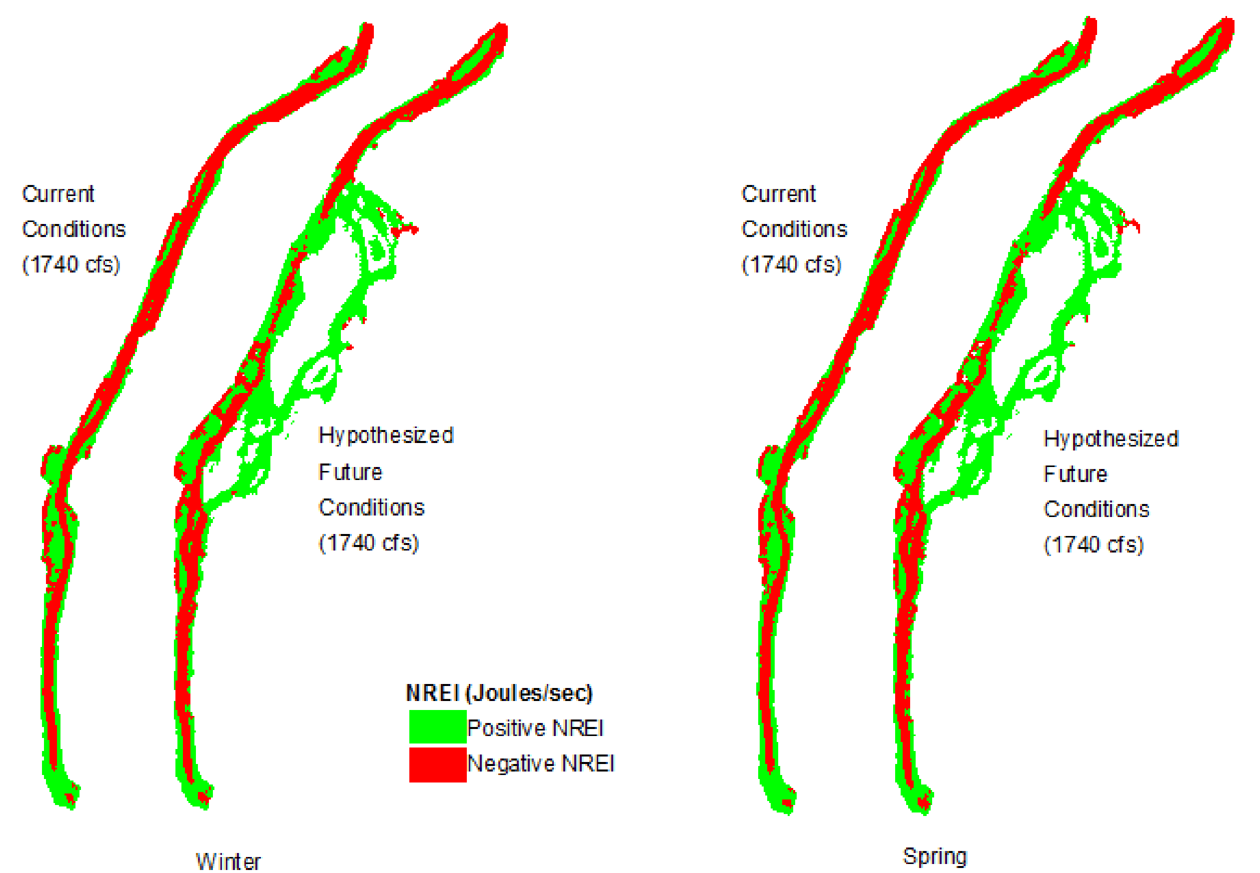
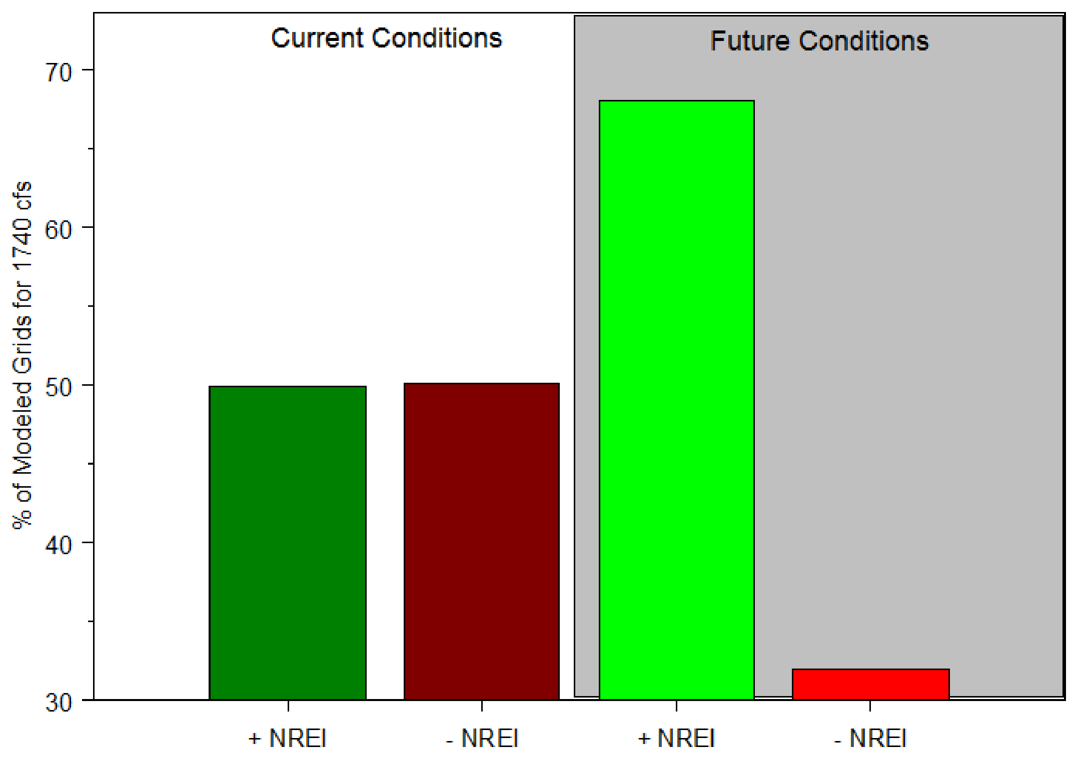
# Proof of Concept Study: King Co. Levee Setback 2016, Cont.




>18% increase in positive net rate of energy intake (NREI) for chinook salmon after levee setback

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# Next Steps

Use of SNtemp and Energetics model on Quinault River

- Evaluation of riparian shading
- Consideration of channel orientation (north/south and east/west)

Seeking funding for R package and proof of concept study on the Sauk-Suiattle

# Questions

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