The Aquatic Trophic Productivity Model: Incorporating Food Web Dynamics into River Restoration

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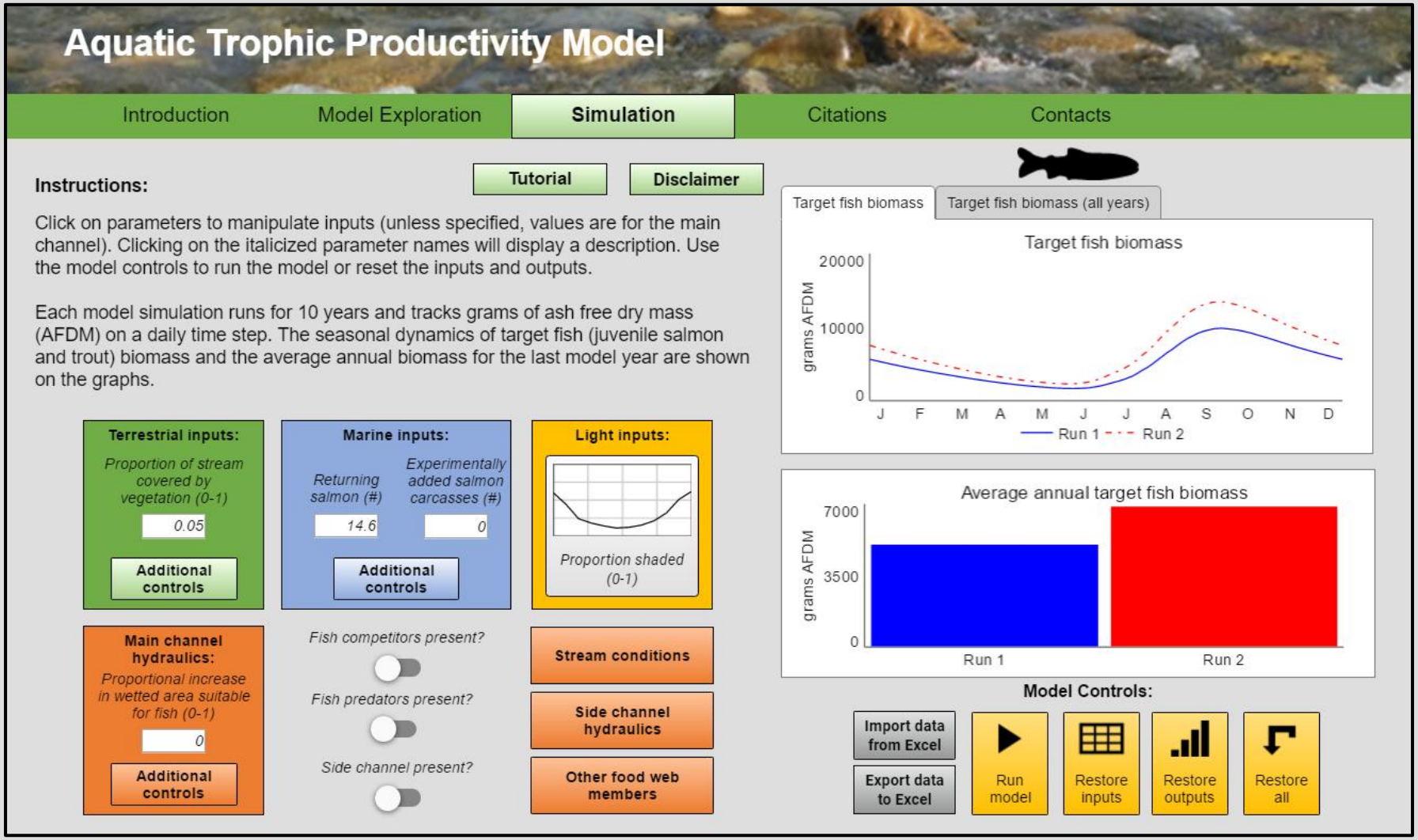
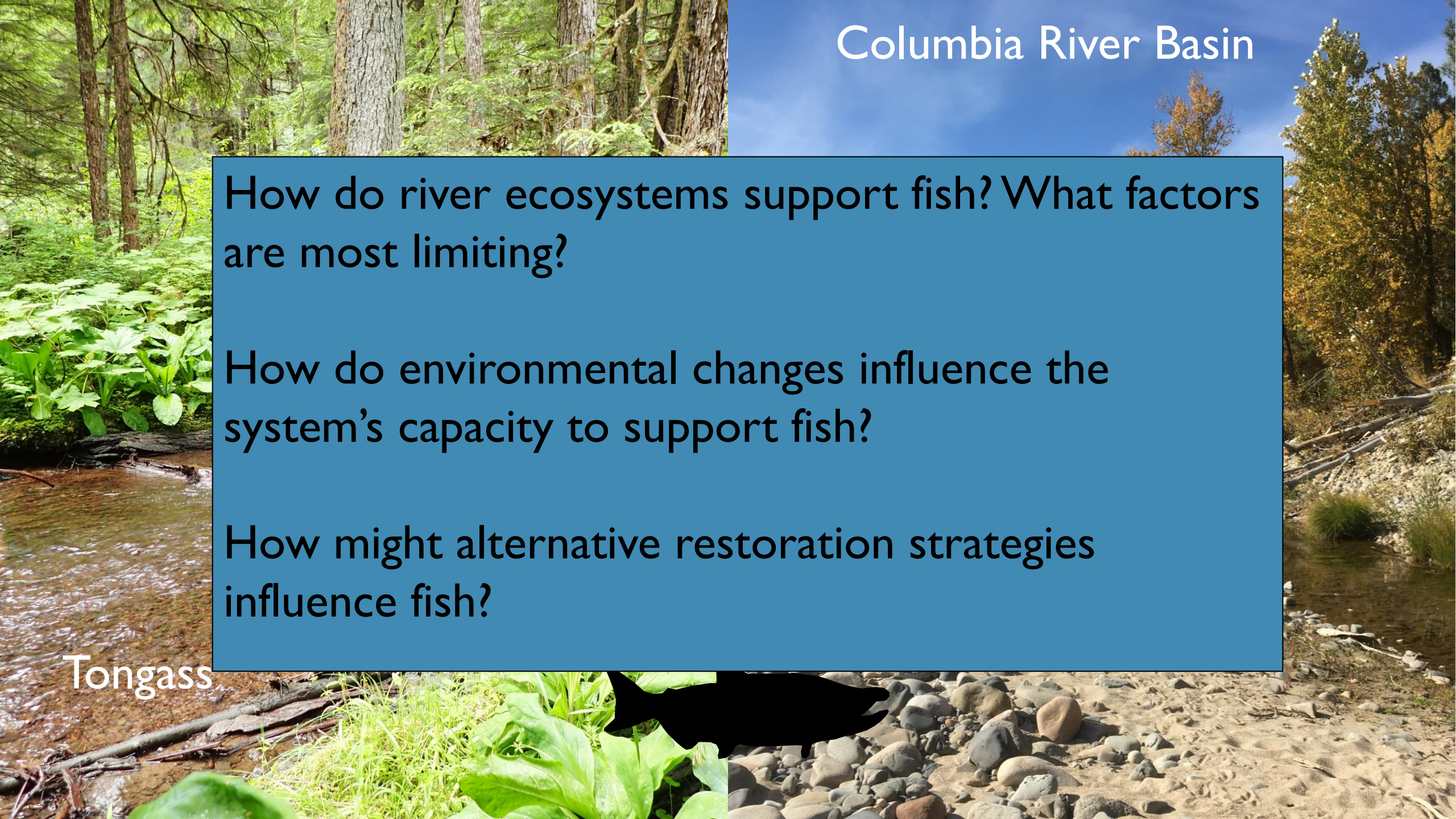
Photo: Ryan Bellmore

AQUATIC TROPHIC PRODUCTIVITY MODEL: ONLINE INTERFACE



Aquatic Trophic Productivity Model:

- Food web model
- Tool to guide salmon recovery actions
- Developed in the Columbia River Basin, WA



How do river ecosystems support fish? What factors are most limiting?

How do environmental changes influence the system's capacity to support fish?

How might alternative restoration strategies influence fish?

INTRODUCTION

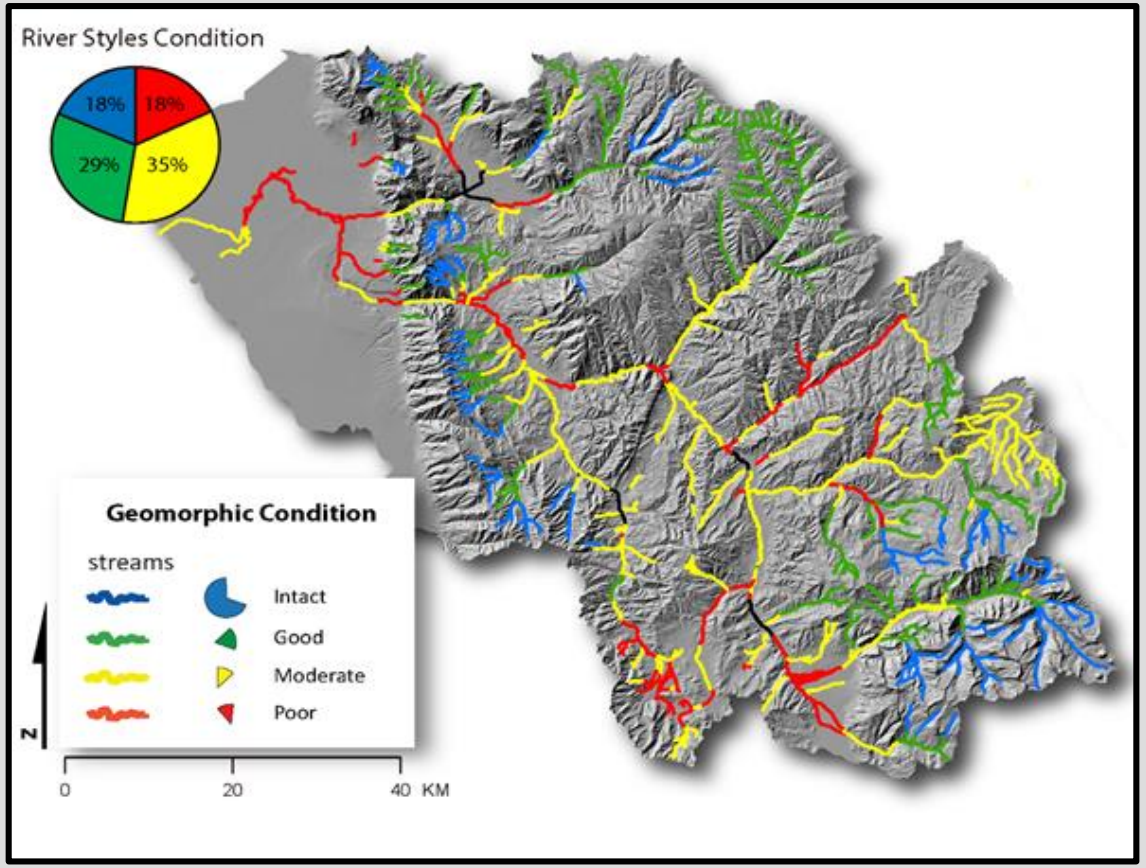
The "sticks and stones" approach

Paradigm: fish production is controlled by the quantity and quality of in-stream *physical habitat*.

INTRODUCTION

Implications. . .

Restoration prioritization based on geomorphic assessments



Wheaton et al. River Styles Assessment

INTRODUCTION

Implications. . .

Restoration design based on local habitat features and channel hydraulics

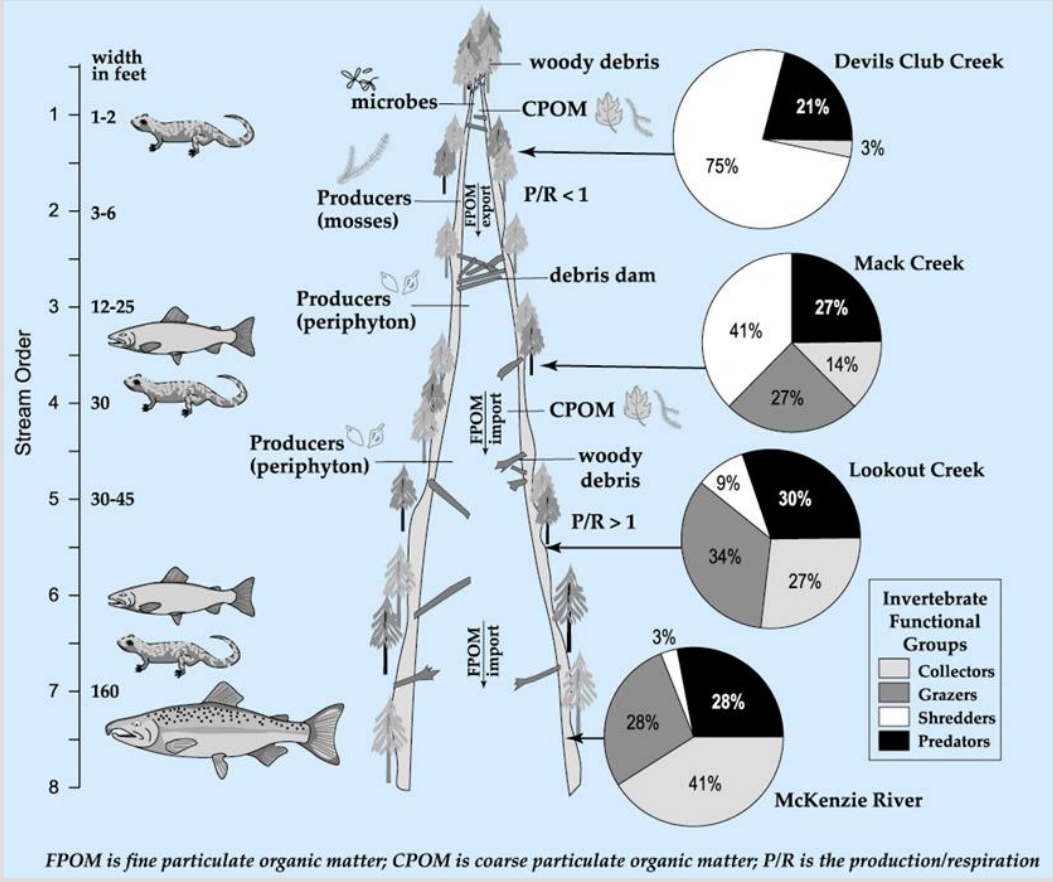
Photo: Estuary Partnership

INTRODUCTION

What are we leaving out?

The "ECO" part of the ecosystem.

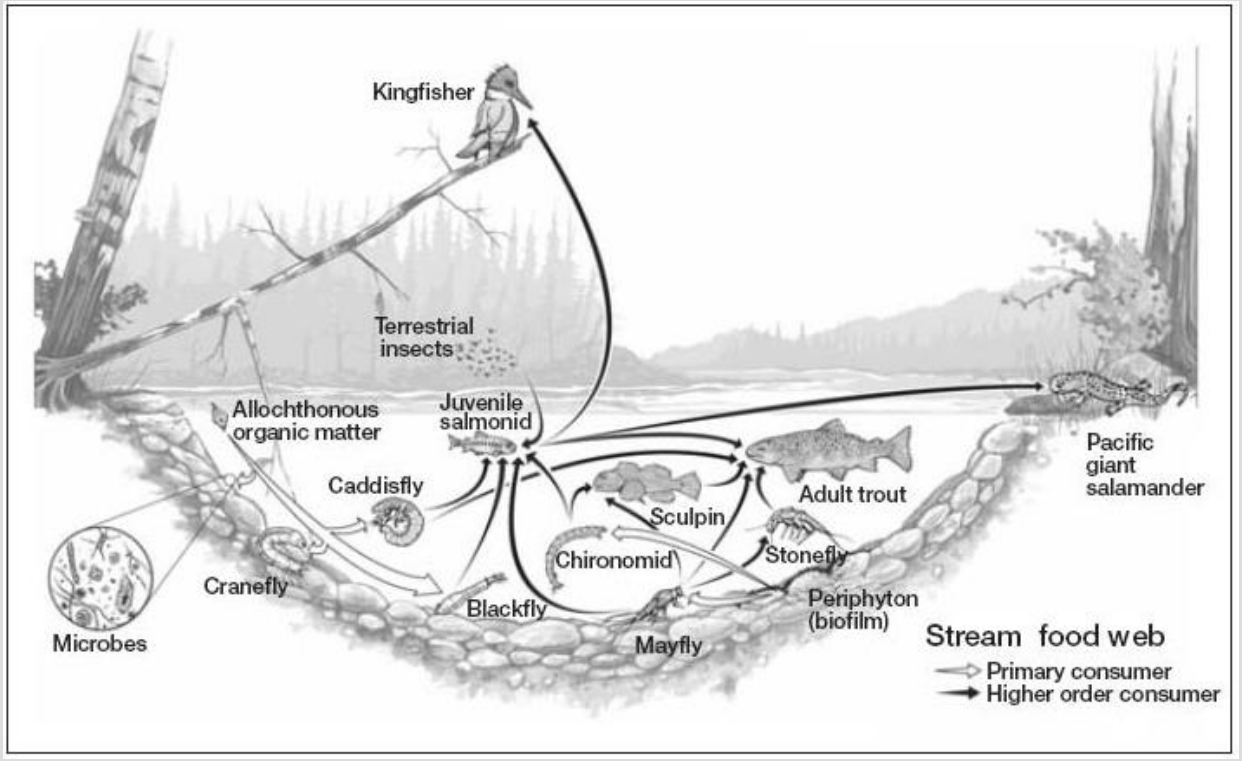
- Organic matter and nutrient availability (what are energy resources?)



River Continuum Concept, Vannote et al. (1980)

INTRODUCTION

What are we leaving out?

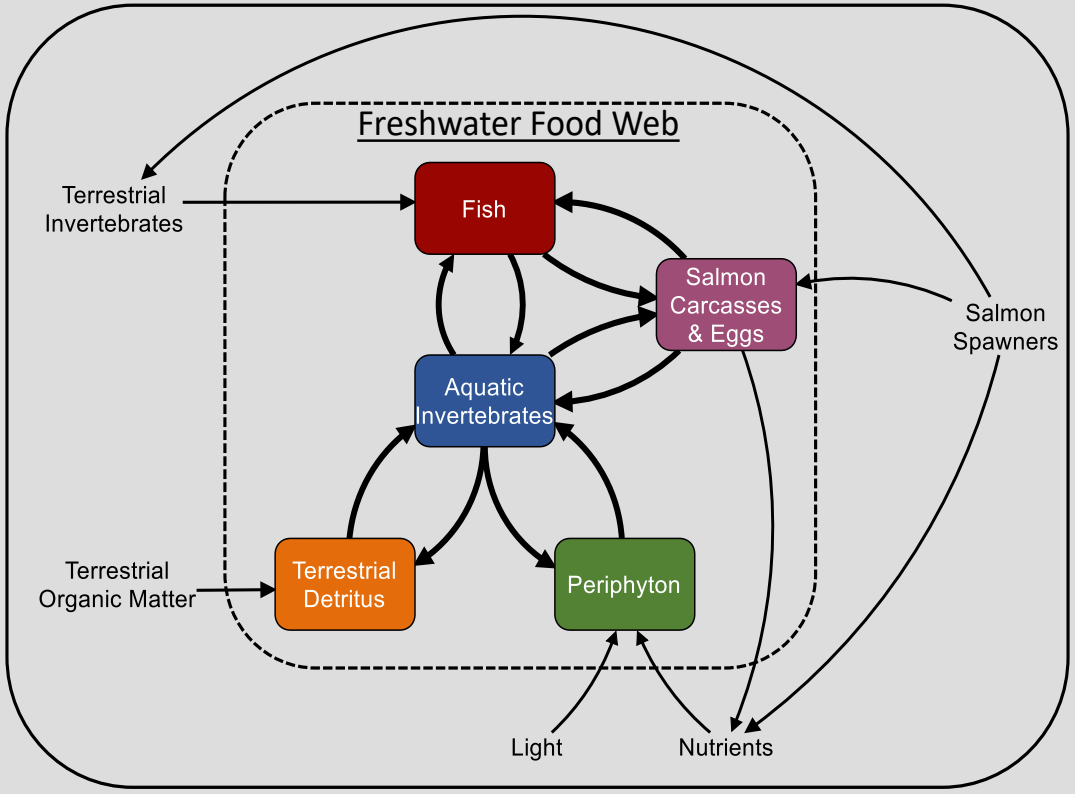


Macneale et al. 2010

- Community and food web structure (who is there and how do they interact?)

THE AQUATIC TROPHIC PRODUCTIVITY MODEL

Developed to help incorporate these complexities into river restoration prioritization and planning.



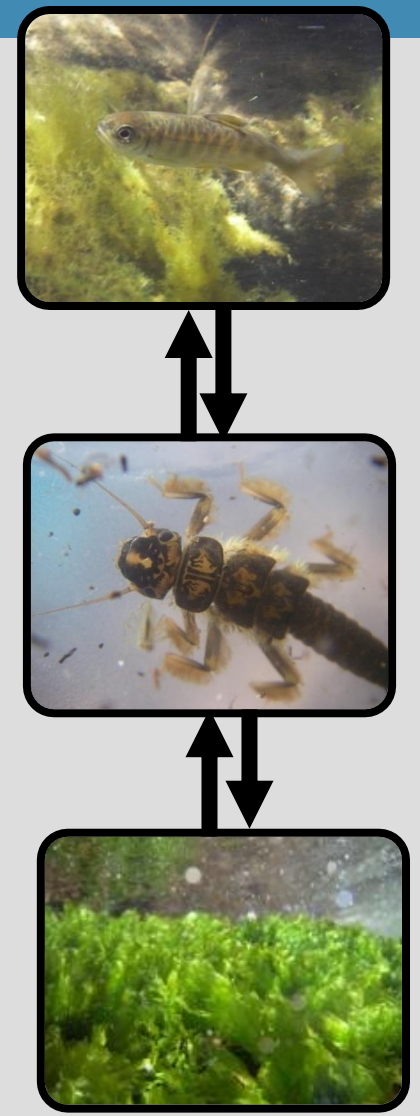
Bellmore et al. 2017
Ecological Applications

AQUATIC TROPHIC PRODUCTIVITY MODEL

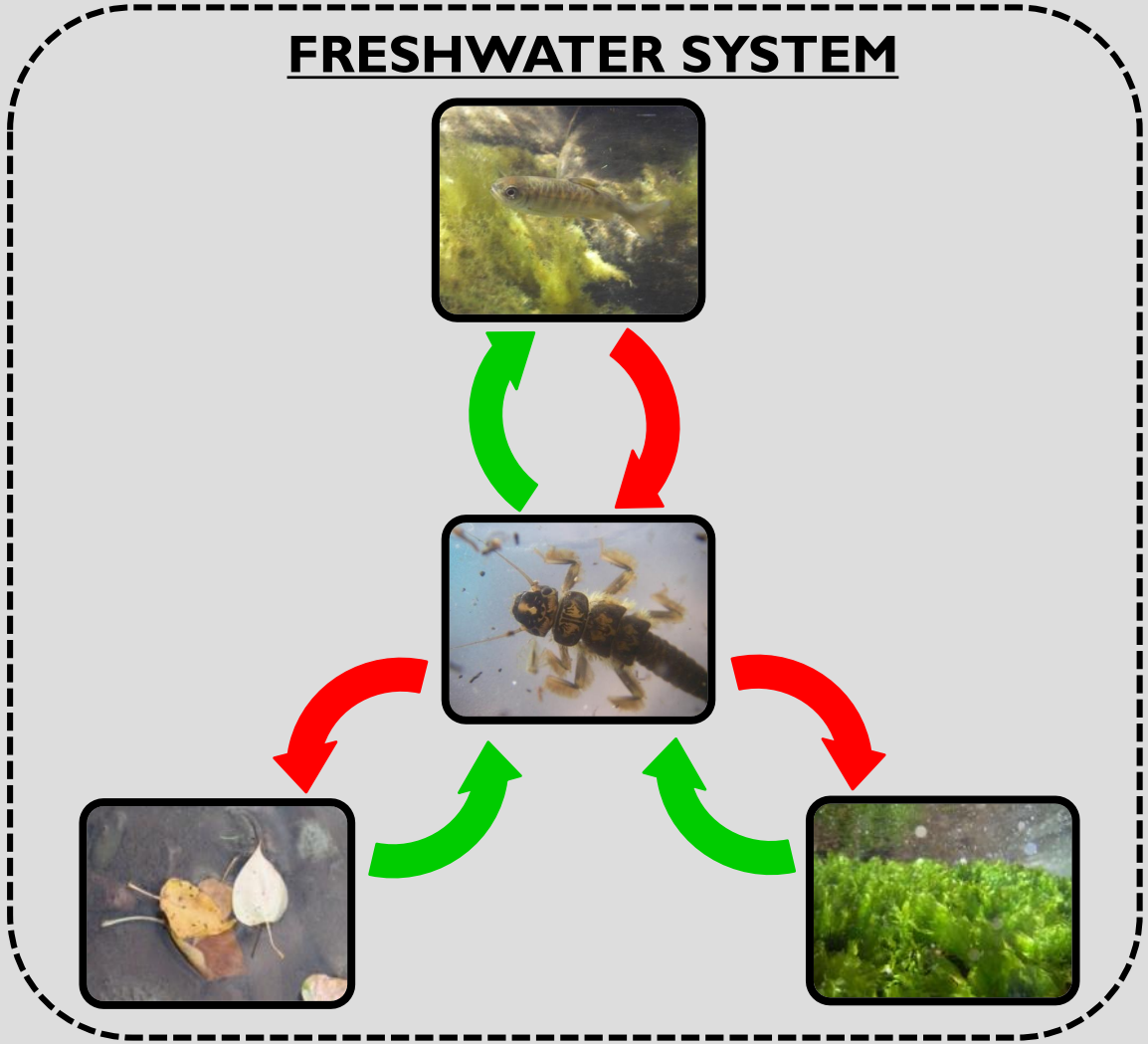
What is the ATP Model?

A food web simulation model, whereby fish production is explicitly tied to the flows of energy through the food web.

- Links food webs to physical habitat, riparian conditions, and marine derived organic matter subsidies
- Simulates how the biomass of aquatic organisms changes through time



MODEL STRUCTURE



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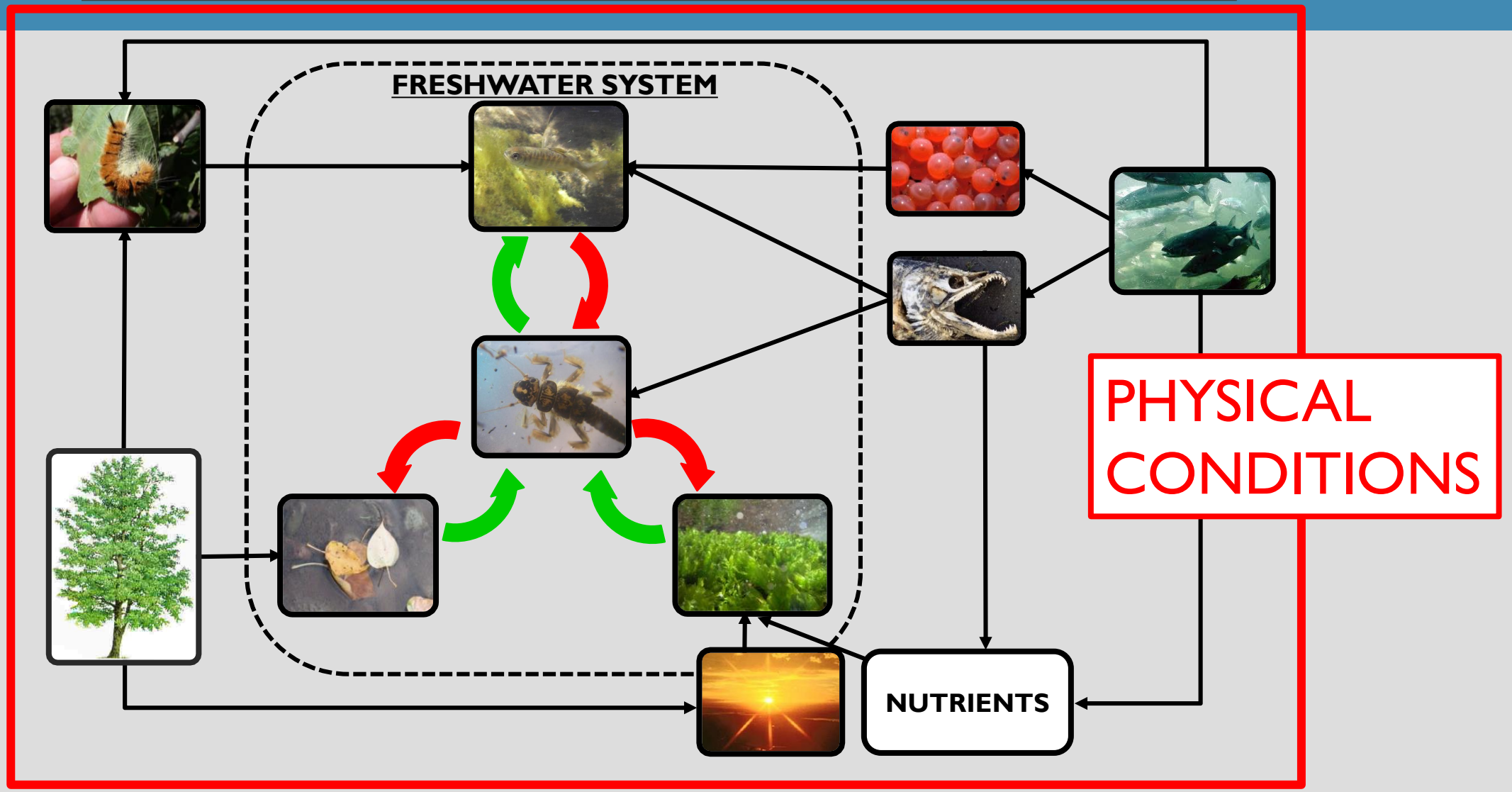

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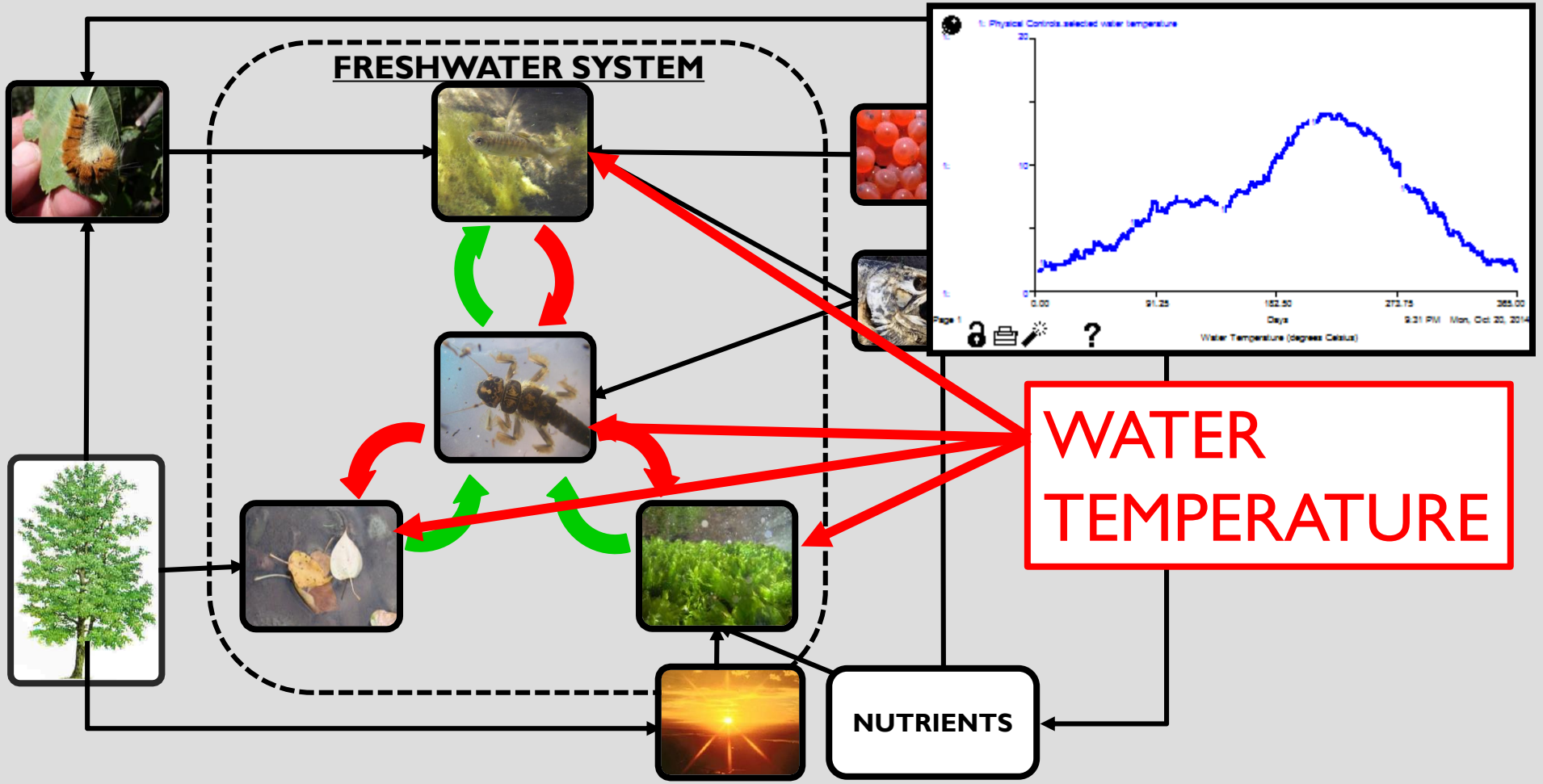

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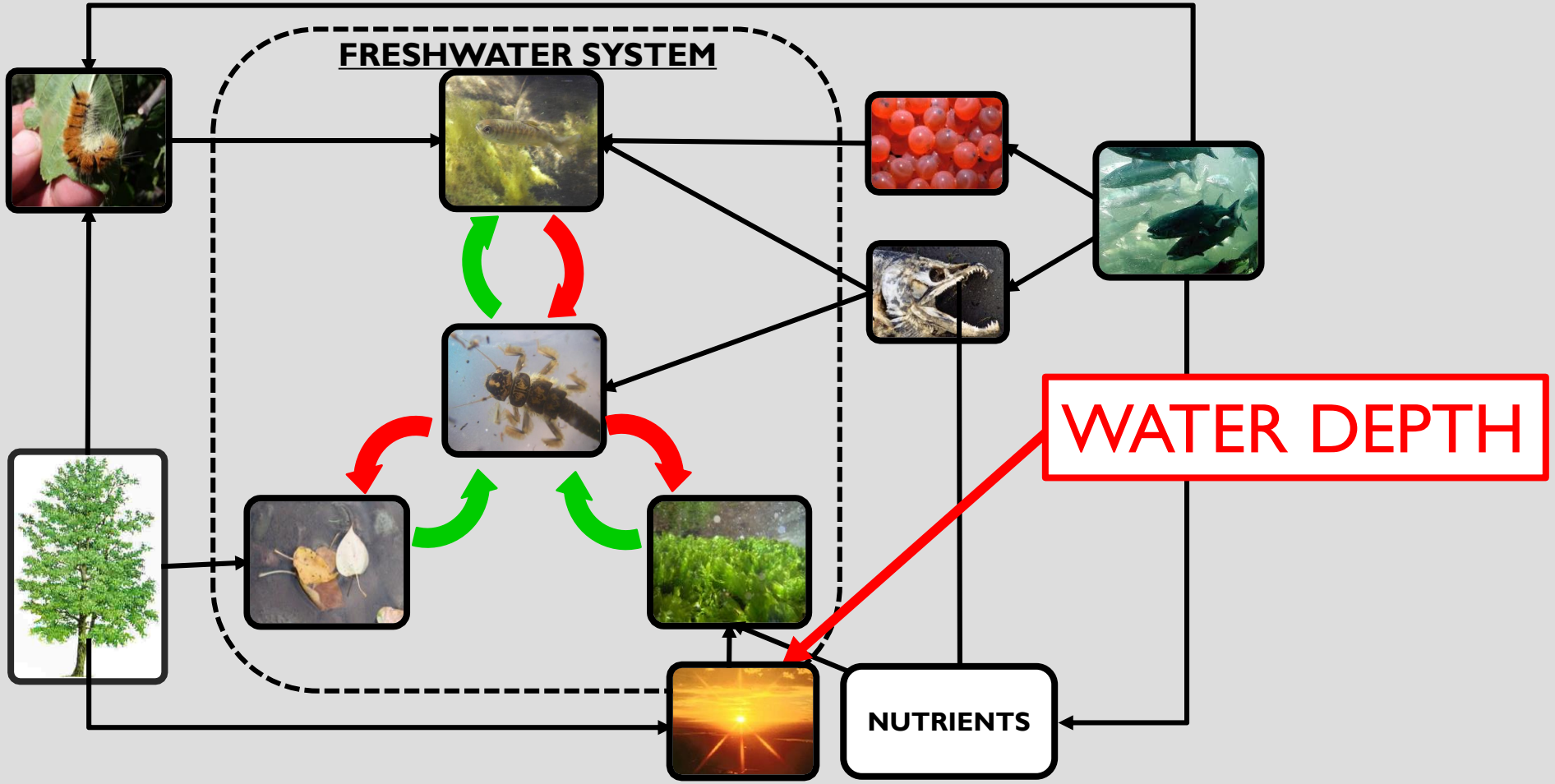
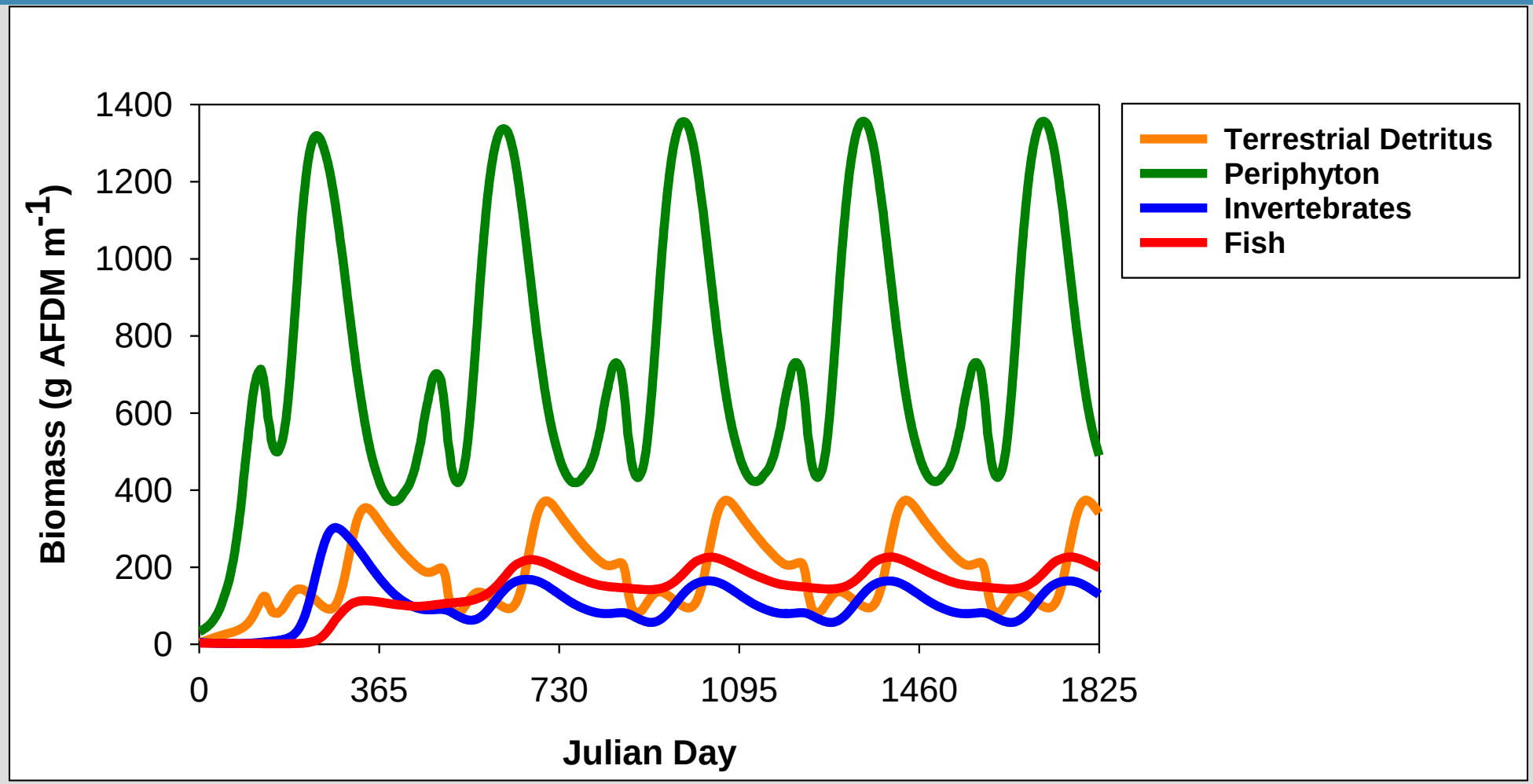


MODEL STRUCTURE

Site Specific Environmental Inputs

- Annual hydrograph (flow regime)
- 1-D channel hydraulics (summarized from 2D model)
- Habitat suitability index
- Channel gradient
- Benthic substrate size
- Water temperature profile
- Riparian cover & shading
- Water turbidity
- Nutrient concentrations (NO_3, NH_4, SRP)

MODEL STRUCTURE



INTERFACE DEMONSTRATION

Aquatic Trophic Productivity Model

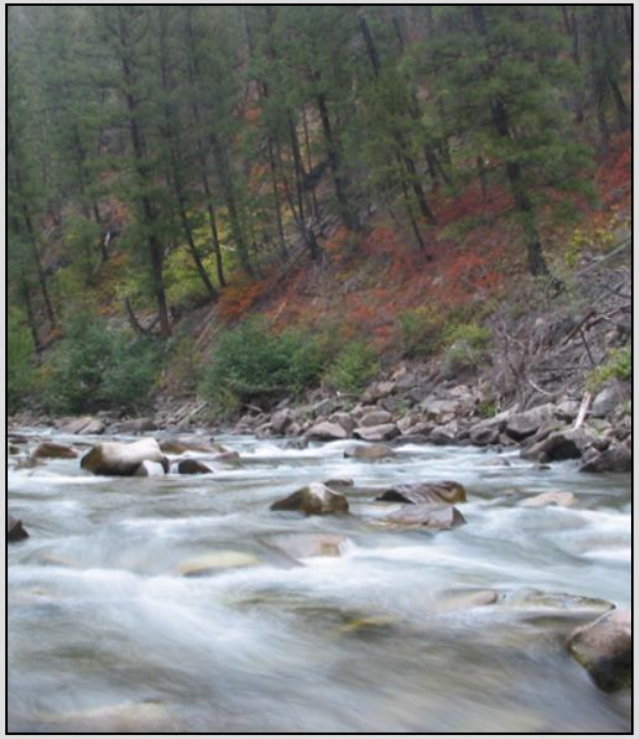
Introduction | Model Exploration | Simulation | Citations | Contacts

Aquatic Trophic Productivity (ATP) Model

The ATP model is a dynamic food web simulation model. The model links the dynamics of river food webs to: (1) the physical and hydraulic conditions of stream habitats, (2) the structure and composition of riparian zones, and (3) nutrient subsidies delivered by adult salmon. This version of the model can be used to explore how alternative restoration or management actions affect periphyton, terrestrial detritus, aquatic invertebrates, and ultimately, juvenile salmon and trout biomass.

Click through the tabs above to explore the model and conduct manipulative simulations. Note: The model runs best in Google Chrome.

For illustrative purposes, the model is already parameterized with environmental conditions for a reach of the Chewuch River, a tributary to the Methow River in northcentral Washington, USA.



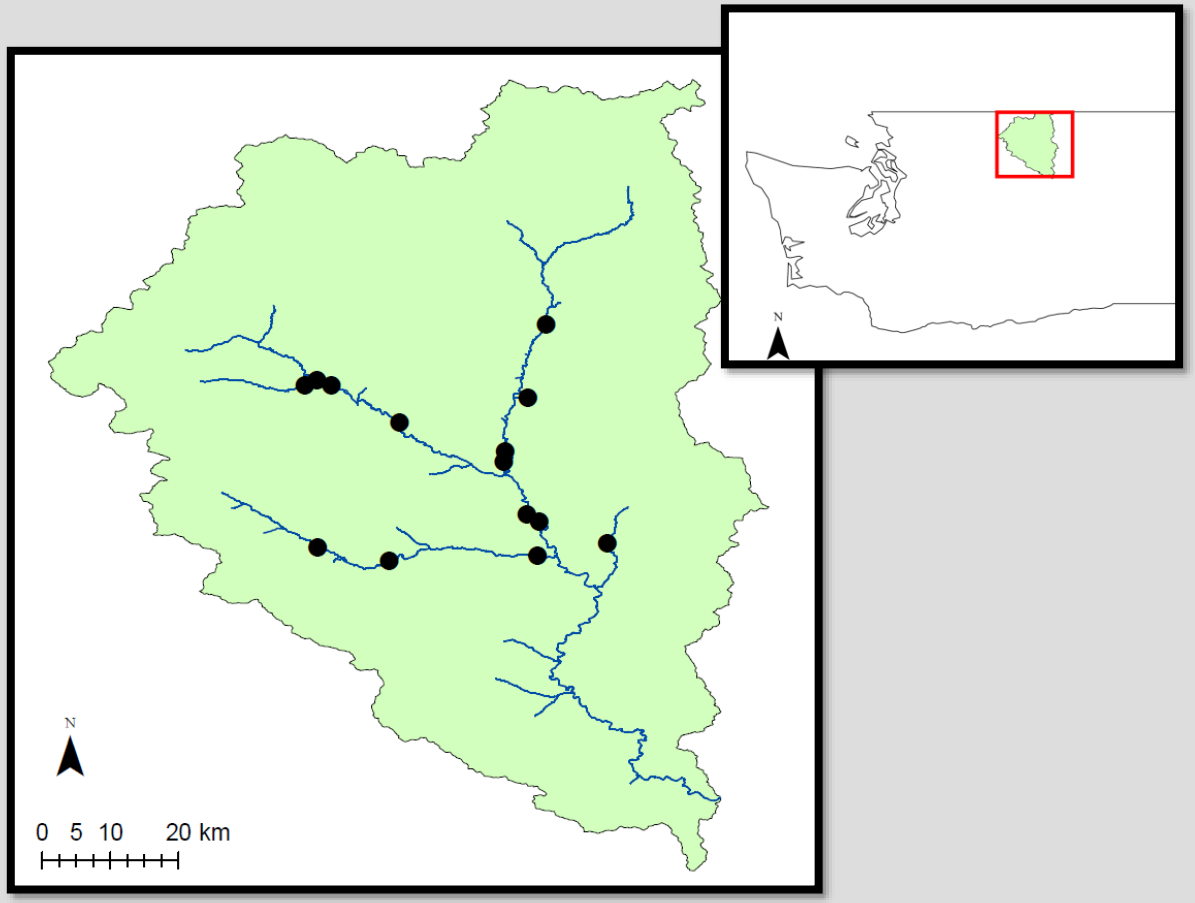
Version 3.2; Updated 11-27-17

EXPLORING ENVIRONMENTAL VARIATION ACROSS SITES

How does variation in environmental conditions within a watershed affect local fish response to restoration strategies?

FISH BIOMASS ACROSS THE WATERSHED

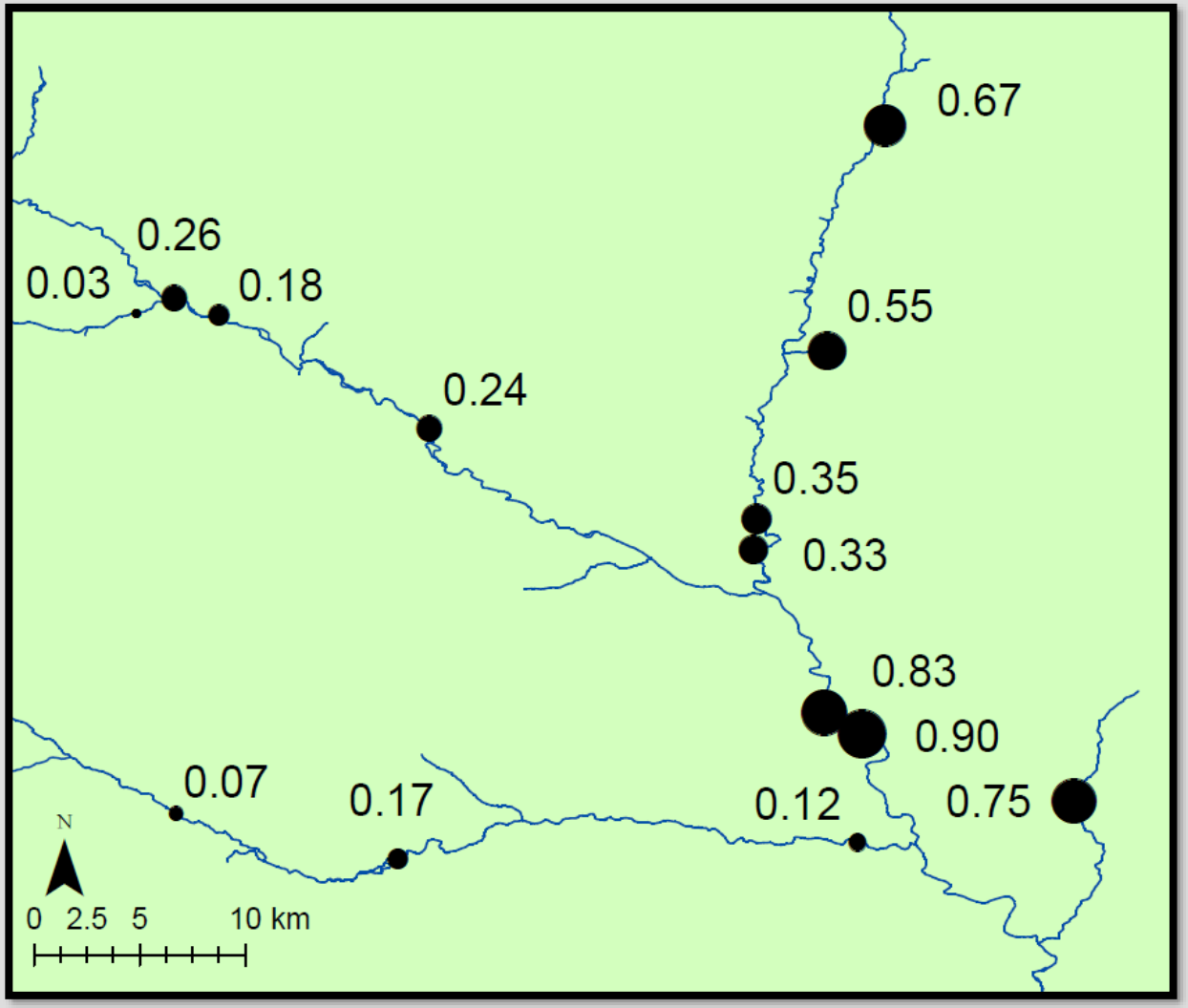
- Modeled 14 sites in the Methow watershed using empirical data from each of the sites



Methow River watershed in Washington state

FISH BIOMASS ACROSS THE WATERSHED

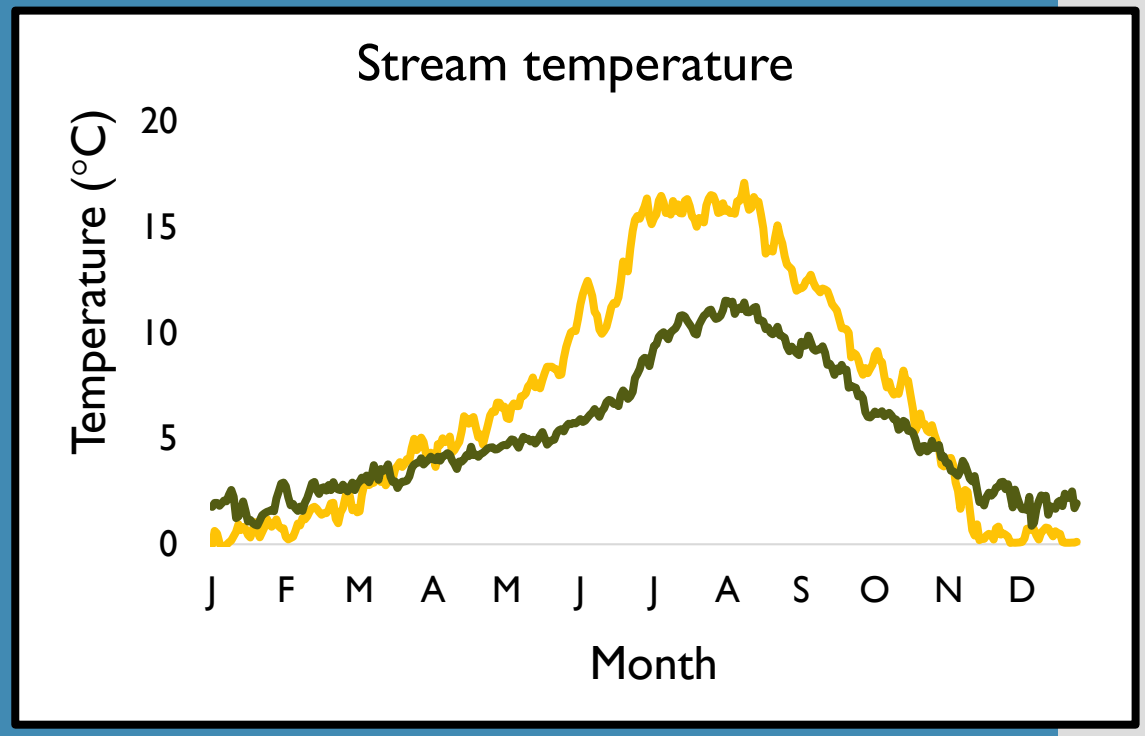
- Modeled 14 sites in the Methow watershed using empirical data from each of the sites
- Sites differ in their capacity to sustain fish populations

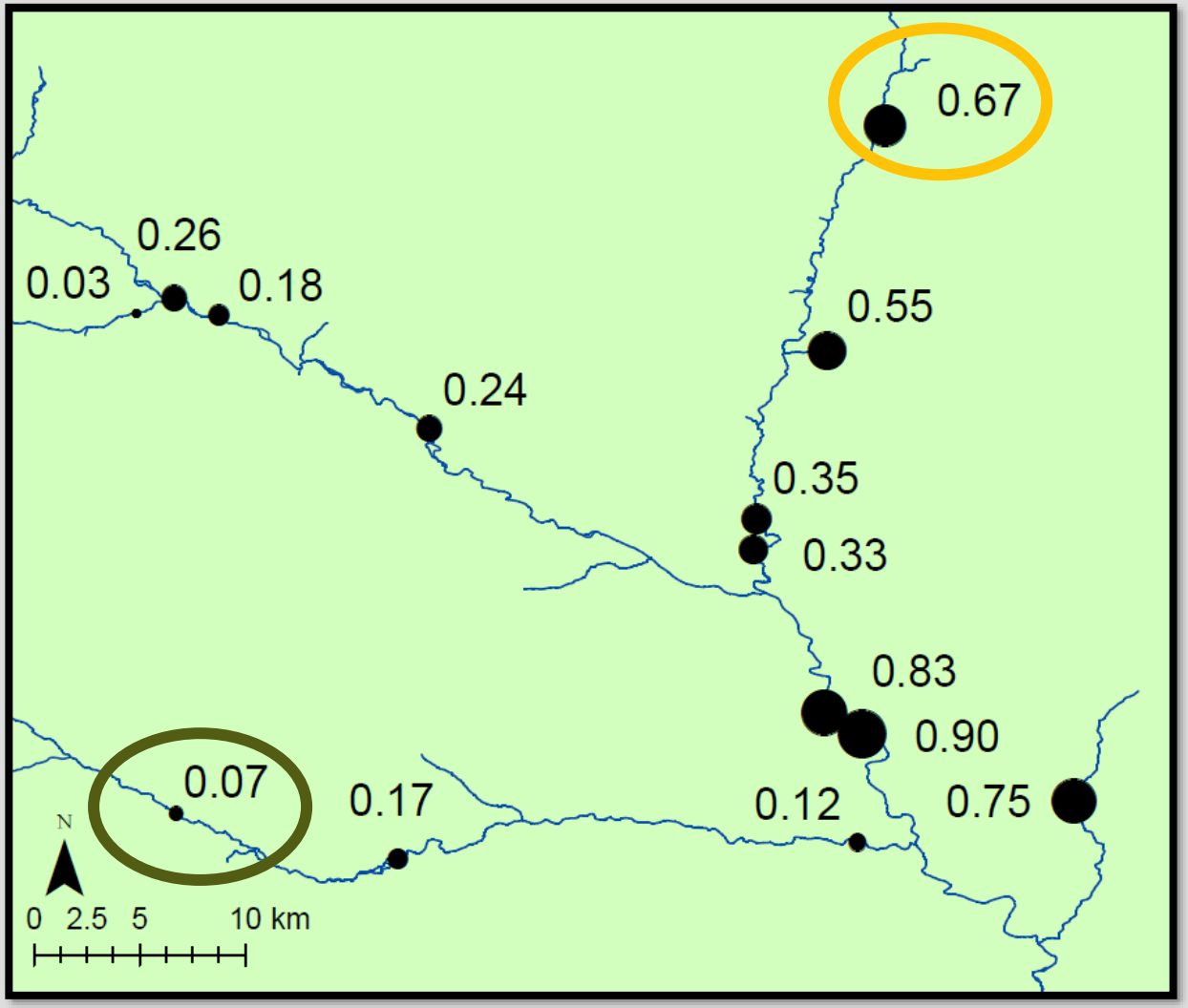


Average fish biomass (g AFDM/m^2)

0.5

FISH BIOMASS ACROSS THE WATERSHED





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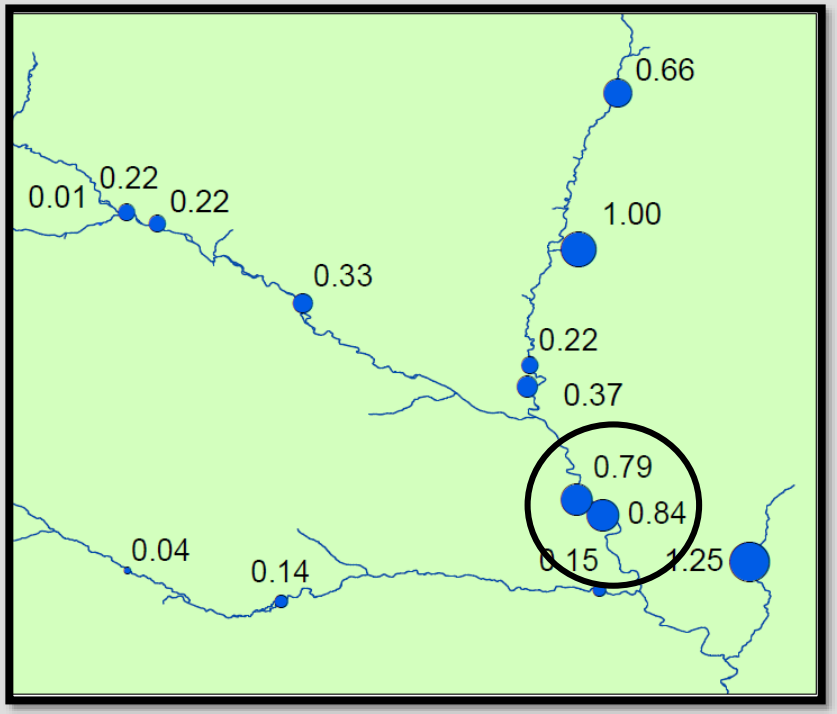
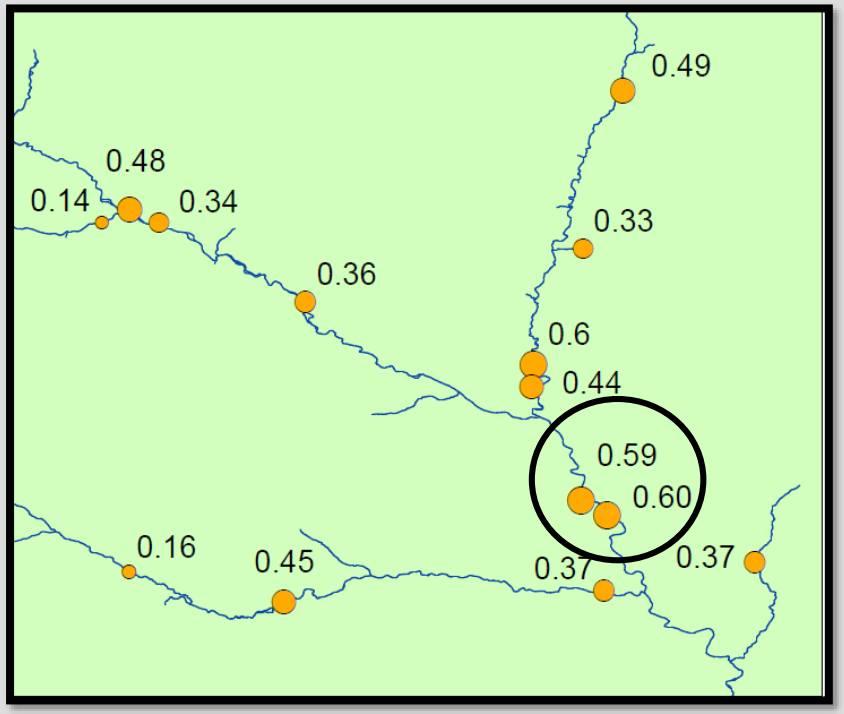
COMPARISON ACROSS STRATEGIES

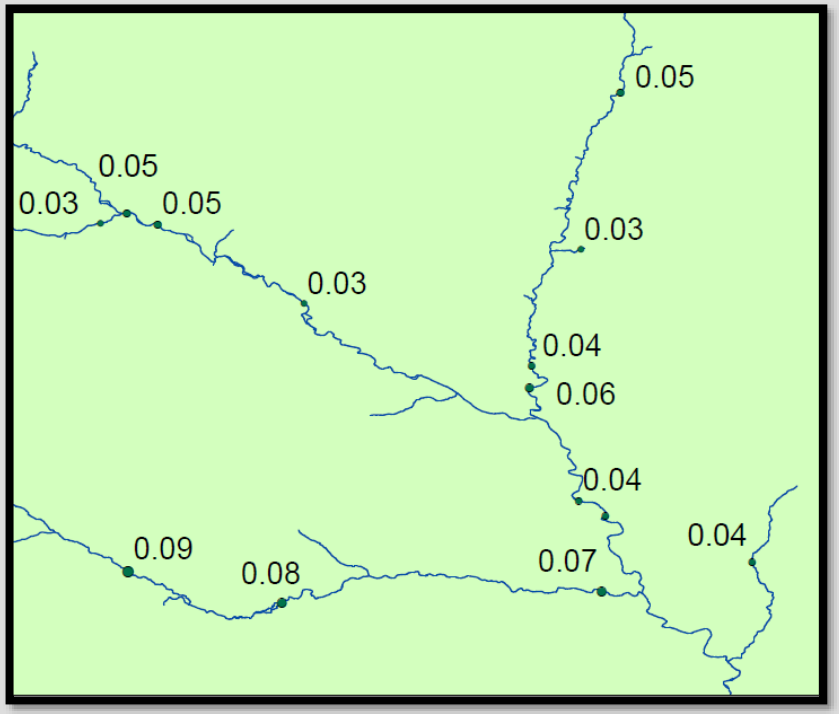
HSI Increase

Carcass Augmentation

Riparian Vegetation Increase







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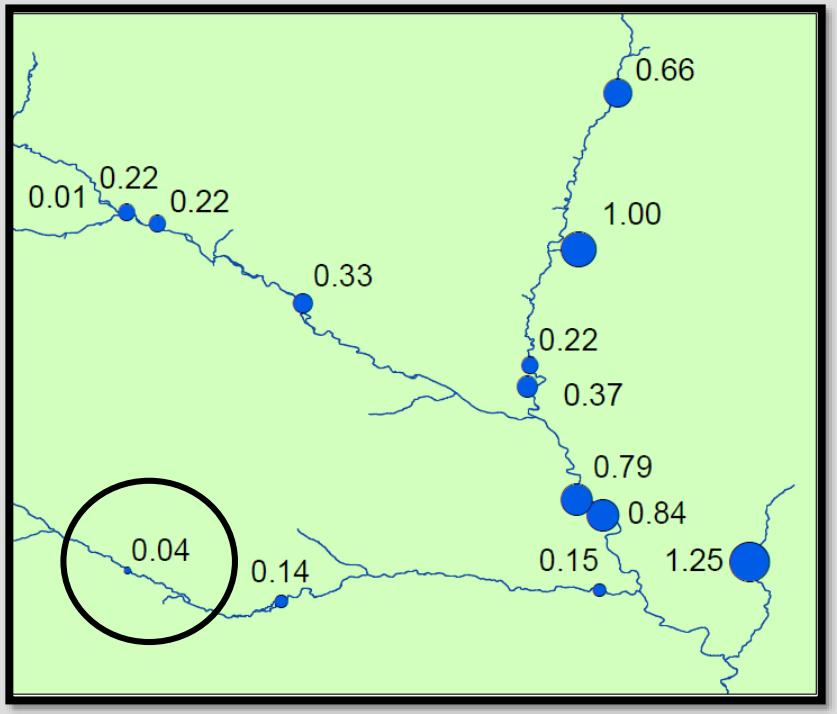

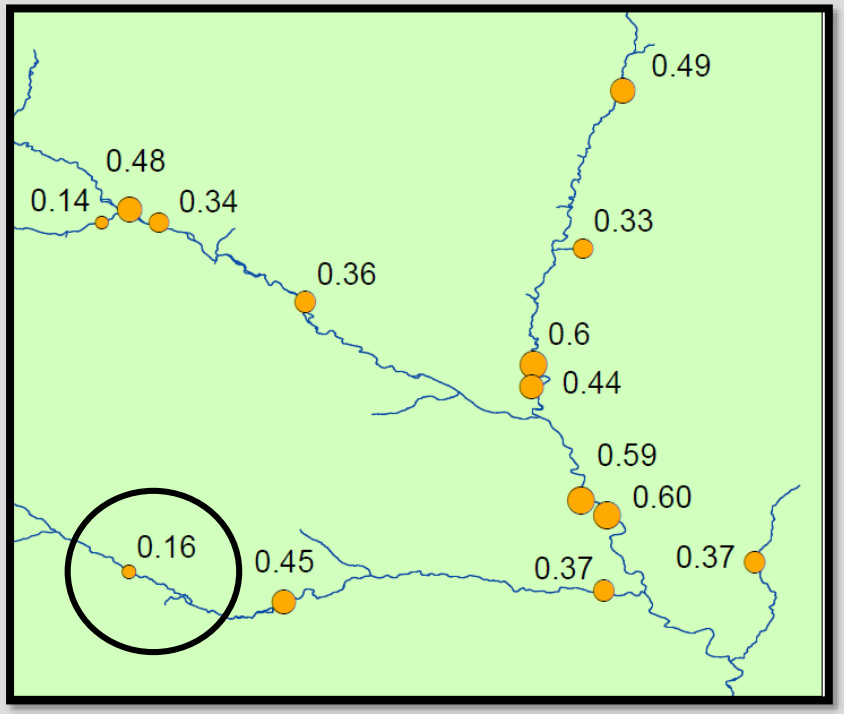

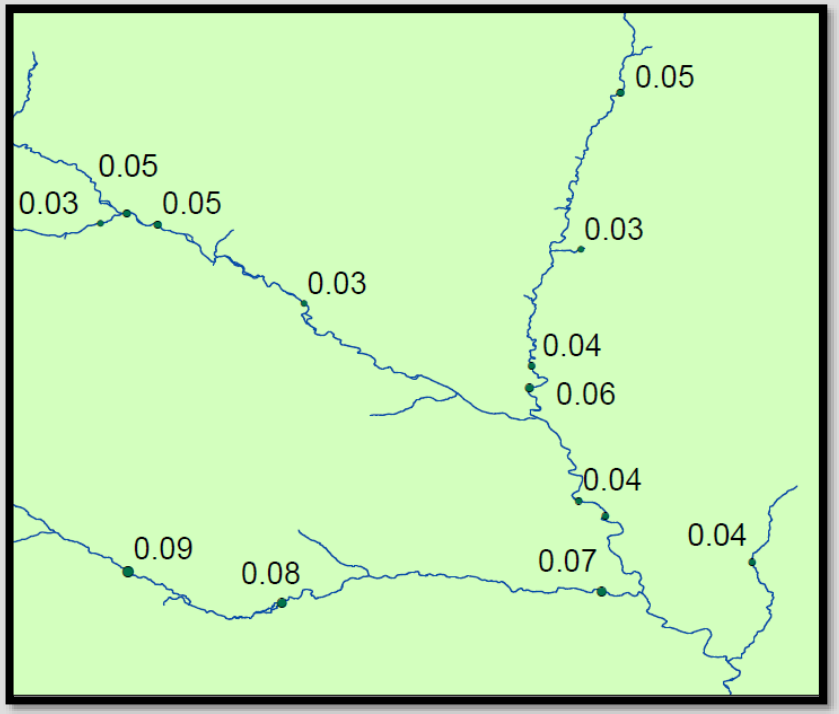

CONCLUSION

The ATP model:

Incorporates food web dynamics into restoration planning and prioritization

- Identify sites that may be most responsive to restoration

Can be used in Southeast Alaska to explore...

- Habitat restoration (e.g., floodplain reconnection, large wood additions)
- Riparian management (e.g., thinning/logging in riparian zones)
- Climate change impacts on flow and temperature
- Invasive species
- Marine derived nutrients

Is an interactive tool

- Managers and practitioners can run live simulations

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FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

USGS

QUESTIONS?

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ATP Model Interface:
https://exchange.iseesystems.com/
Search by keyword “ATP”