Apr 5th, 2:45 PM - 3:00 PM

An integrated environmental and human systems modeling framework for Puget Sound restoration planning

Robert McKane
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Bradley Barnhart
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Allen Brookes
U.S. Environmental Protection Agency, United States, brookes.allen@epa.gov

See next page for additional authors

Speaker

Robert McKane, Jonathan Halama, Paul Bryce Pettus, Bradley Barnhart, Allen Brookes, Kevin Djang, Tarang Khangaonkar, Isaac Kaplan, Christopher James Harvey, Emily Howe, Phillip S. Levin, Michael W. Schmidt, and Raphael Girardin

An integrated environmental and human systems modeling framework for Puget Sound restoration planning

Bob McKane[1], Brad Barnhart[1], Paul Pettus[1], Jonathan Halama[1],
Allen Brookes[1], Kevin Djang[2], Tarang Khangoankar[3],
Chris Harvey[4], Isaac Kaplan[4], Hem Nalini Morzaria Luna[4],
Michael Schmidt[5], Emily Howe[6], Phillip Levin[6]

[1]U.S. Environmental Protection Agency, and [2]CSRA, Corvallis, OR
[3]Pacific Northwest National Laboratory, Seattle
[4]National Oceanic and Atmospheric Administration, Seattle
[5]Long Live the Kings, Seattle
[6]The Nature Conservancy, Seattle

Puget Sound Basin

Land area: ~13,000 mi^2

Water area : ~1,000 mi^2

http://staff.wwu.edu/stefan/SalishSea.htm

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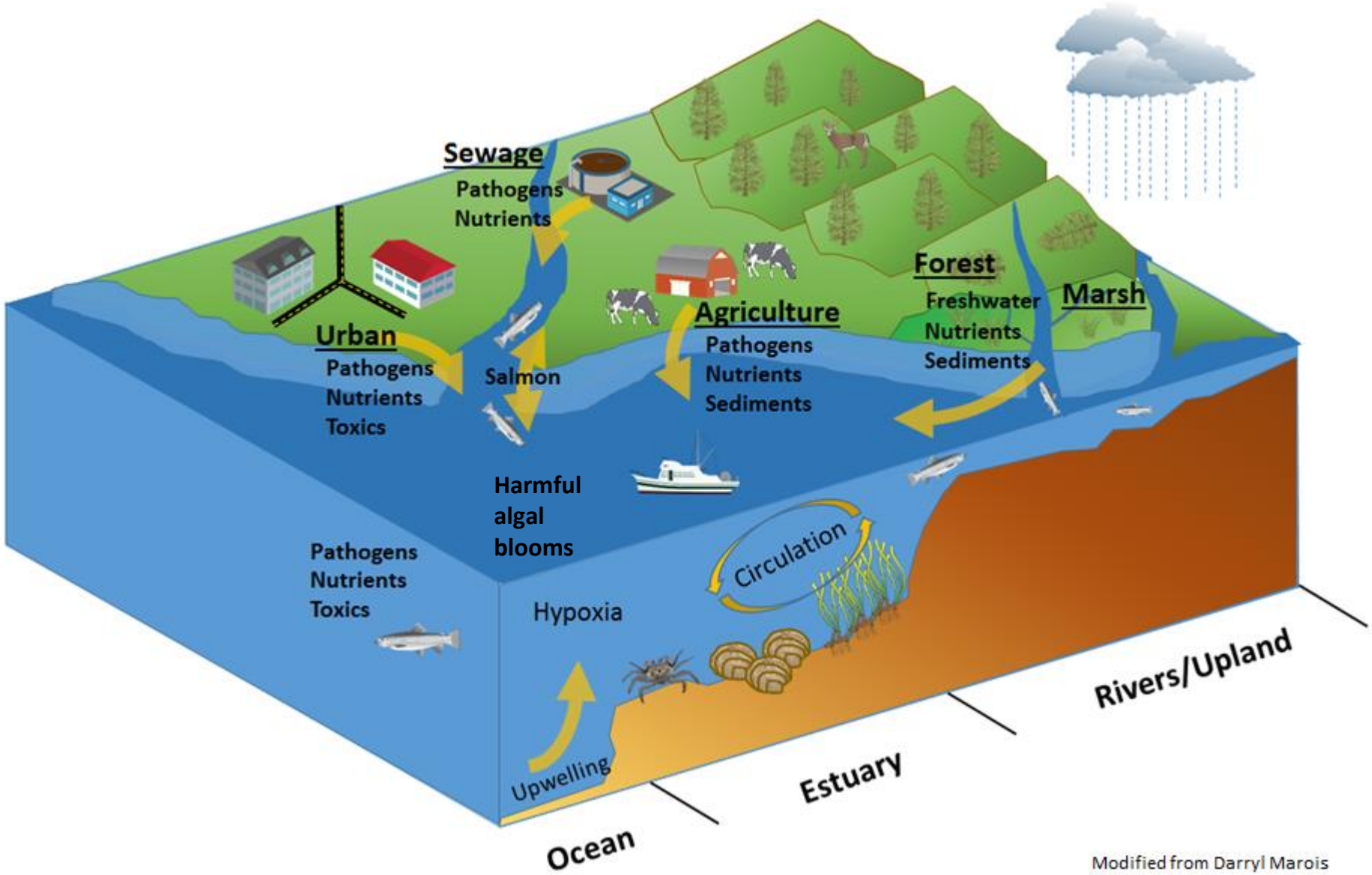
Puget Sound Land-Water Interactions



Modified from Darryl Marois

25 Vital Signs to help identify whether Puget Sound recovery targets are being met

Puget Sound Partnership
http://www.psp.wa.gov/vitalsigns/

PUGET SOUND VITAL SIGNS

Water Quantity
- Summer Stream Flows

Water Quality
- Marine Water Quality
- Freshwater Quality
- Marine Sediment Quality
- Toxics in Fish

Healthy Human Population
- Onsite Sewage
- Shellfish Beds
- Outdoor Activities
- Local Foods
- Air Quality
- Drinking Water

Quality of Life
- Sound Stewardship
- Economic Viability
- Good Governance
- Sense of Place
- Cultural Practices

Species and Foodweb
- Chinook Salmon
- Orcas
- Pacific Herring
- Birds

Protect and Restore Habitat
- Estuaries
- Floodplains
- Land Cover and Development
- Eelgrass
- Shoreline Armoring

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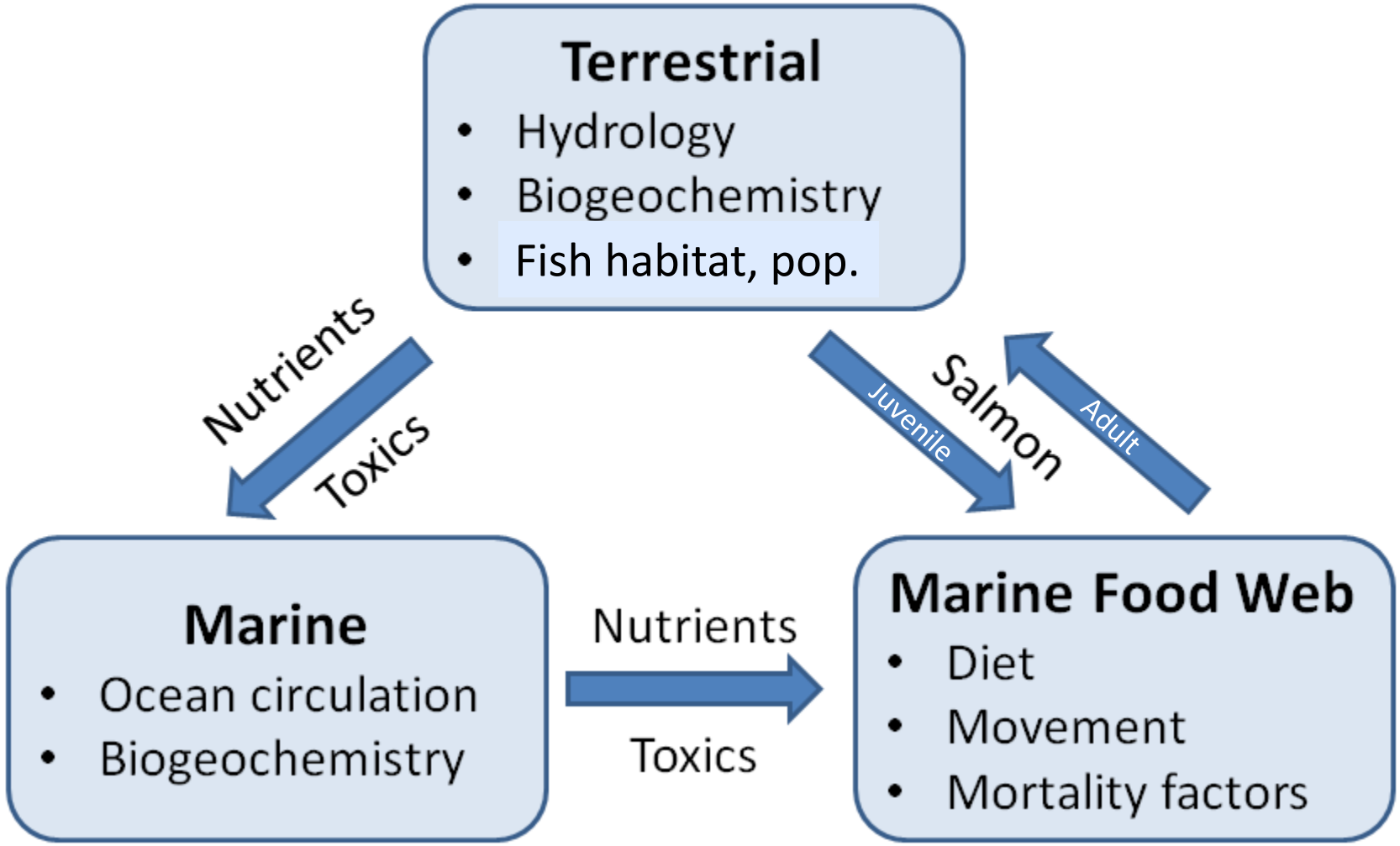
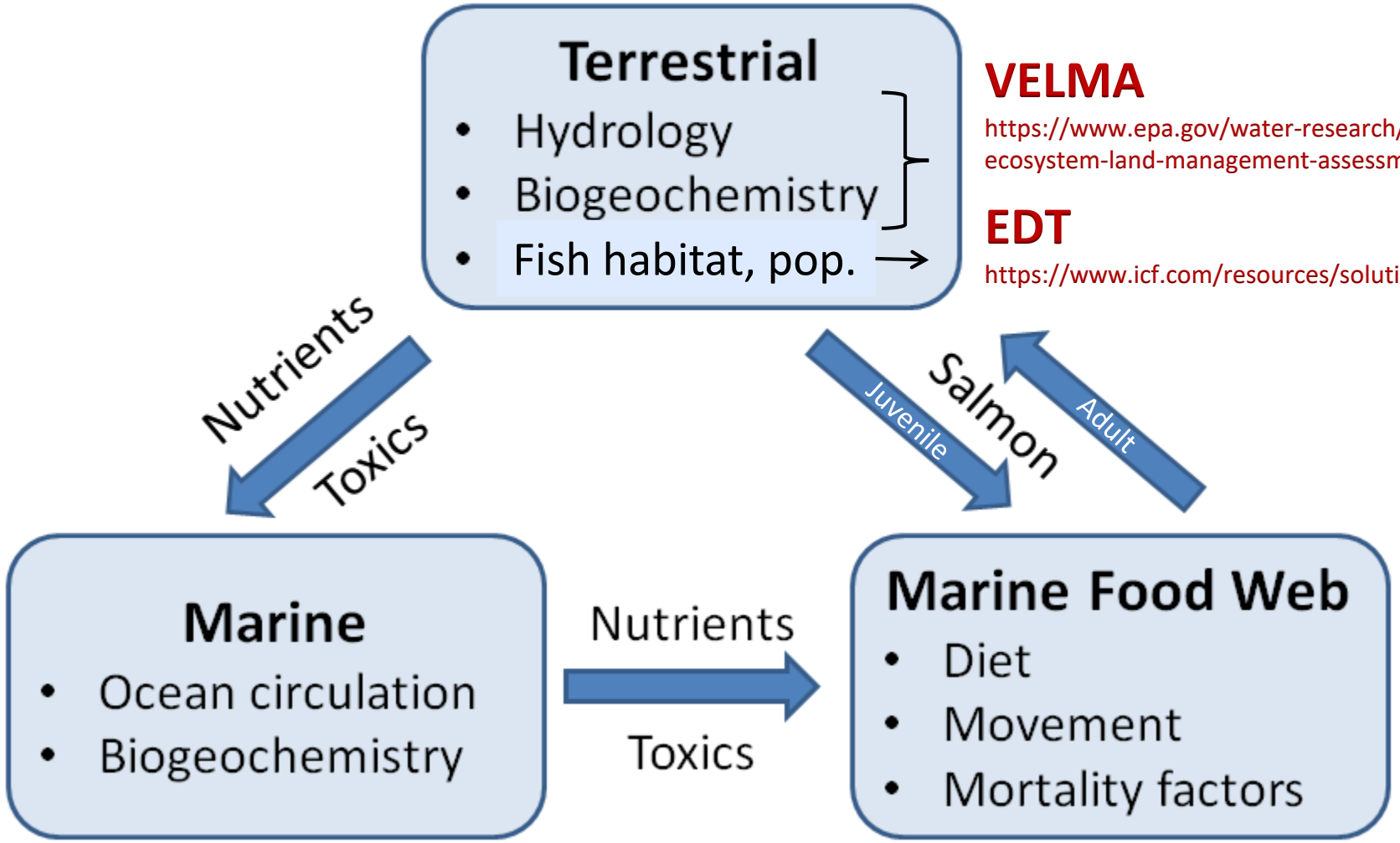
Integrated terrestrial-marine models are needed to

- Synthesize decades of terrestrial & marine data
- Identify comprehensive recovery solutions across habitats & scales…

Puget Sound Systems Modeling Framework



Puget Sound Systems Modeling Framework



VELMA

https://www.epa.gov/water-research/visualizing-ecosystem-land-management-assessments-velma-model-20

EDT

https://www.icf.com/resources/solutions-and-apps/edt3

Salish Sea Model

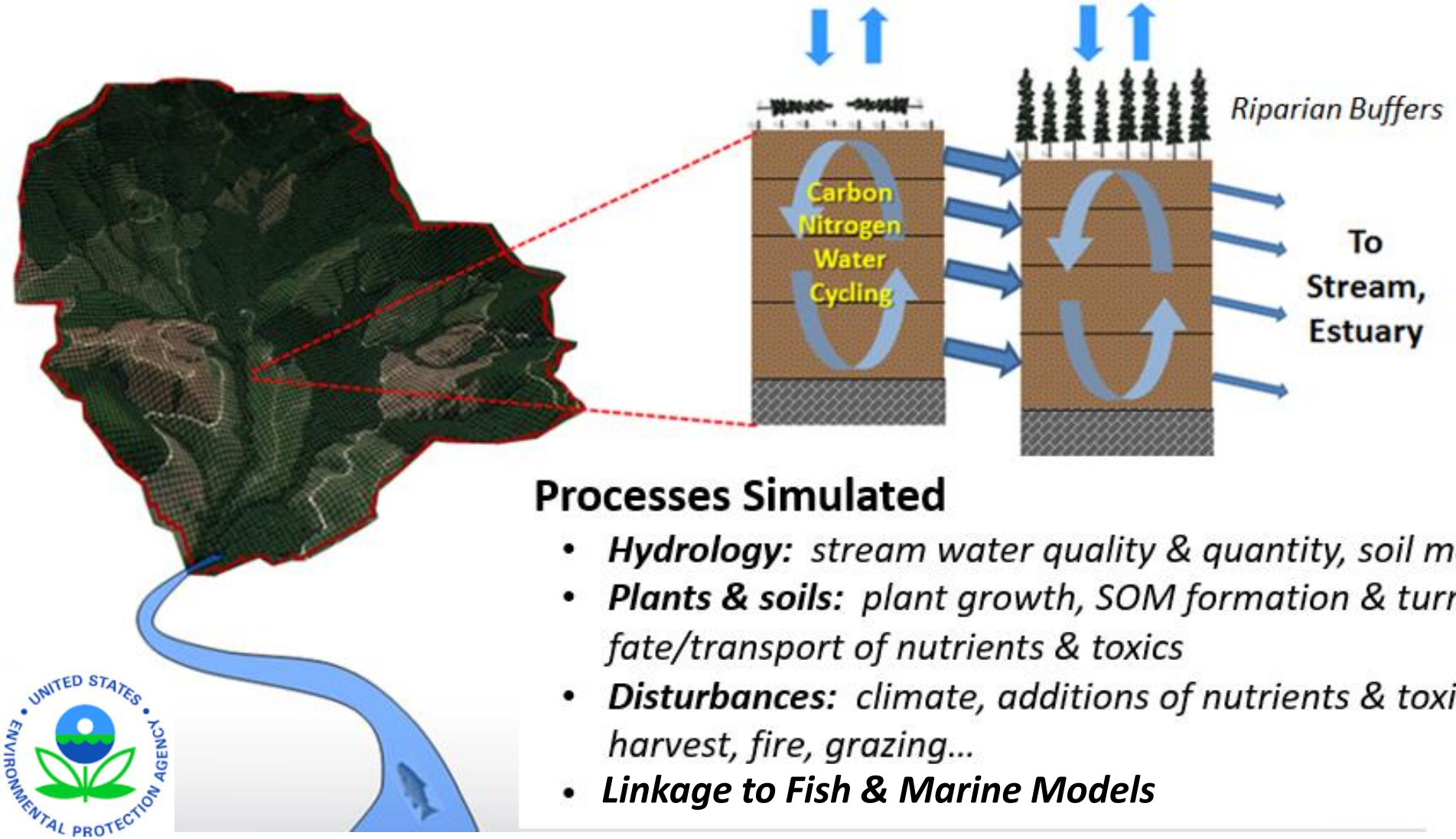
http://salish-sea.pnnl.gov/

Atlantis Model

https://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marineecology/aem.cfm

VELMA Watershed Model

Transport & fate of water, nutrients, toxics



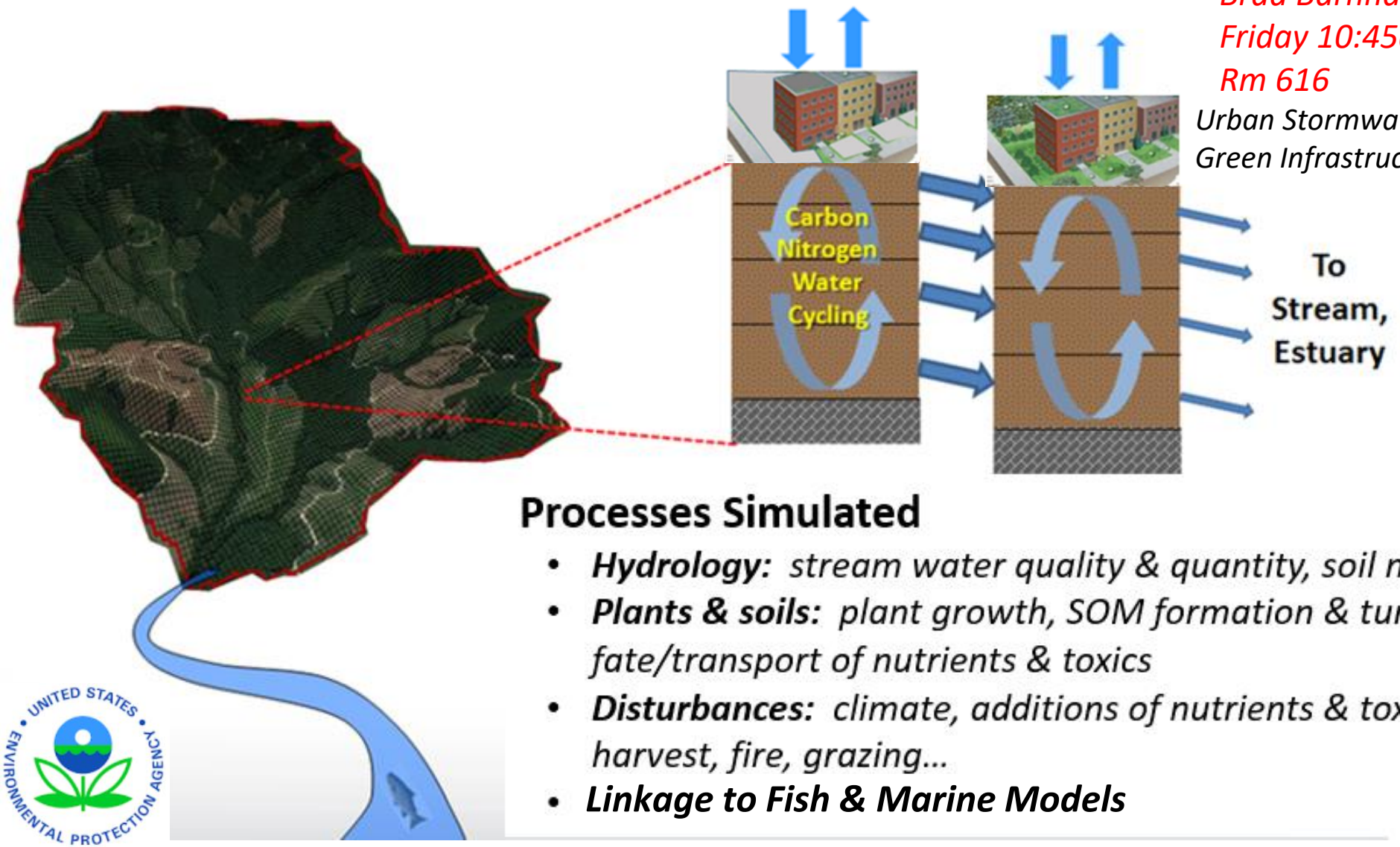
Processes Simulated

- ***Hydrology:*** *stream water quality & quantity, soil moisture*
- ***Plants & soils:*** *plant growth, SOM formation & turnover, fate/transport of nutrients & toxics*
- ***Disturbances:*** *climate, additions of nutrients & toxics, harvest, fire, grazing…*
- ***Linkage to Fish & Marine Models***

VELMA Watershed Model

Transport & fate of water, nutrients, toxics

Brad Barnhart
Friday 10:45am,
Rm 616
Urban Stormwater and Green Infrastructure



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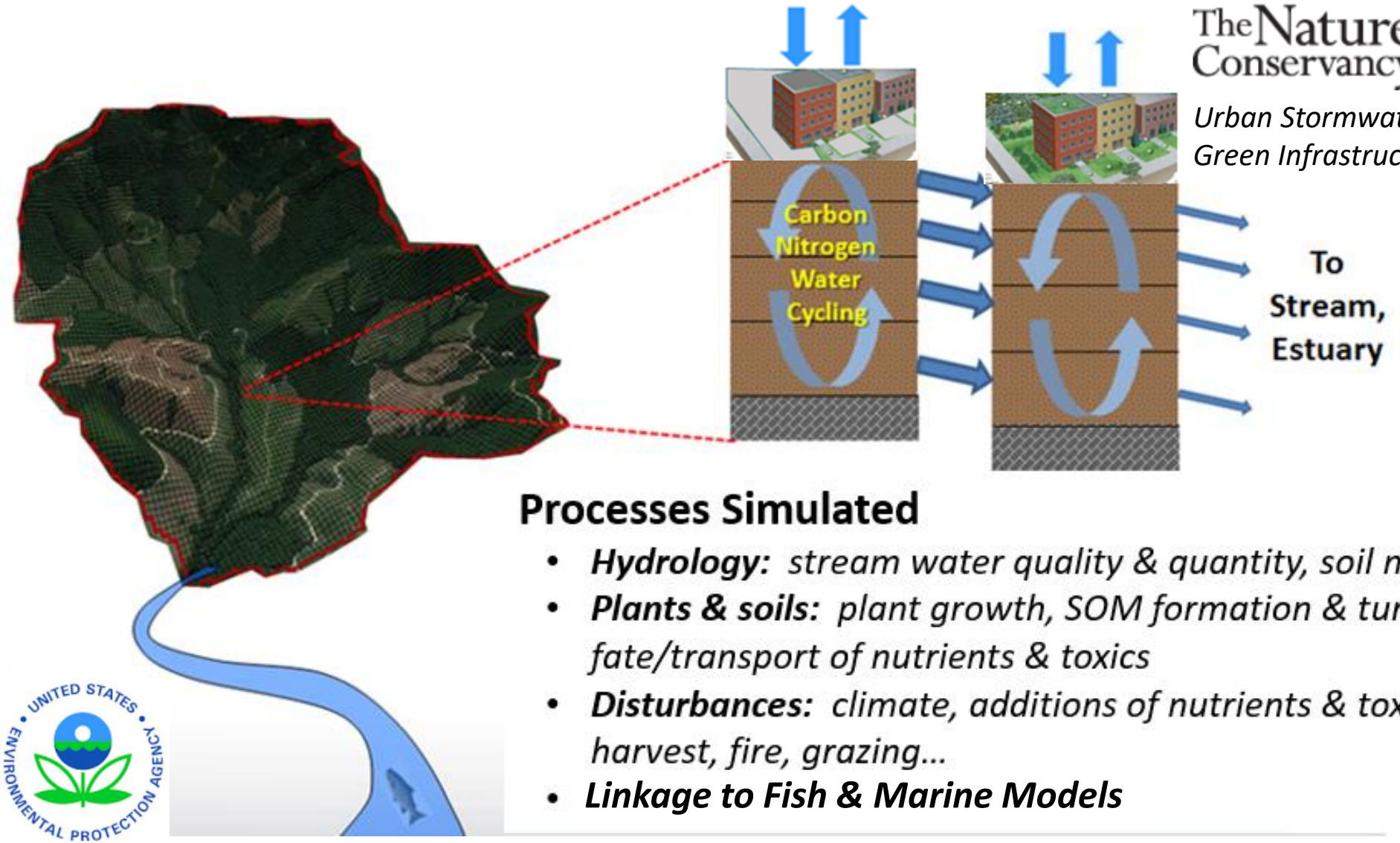

The Nature Conservancy

Urban Stormwater and Green Infrastructure

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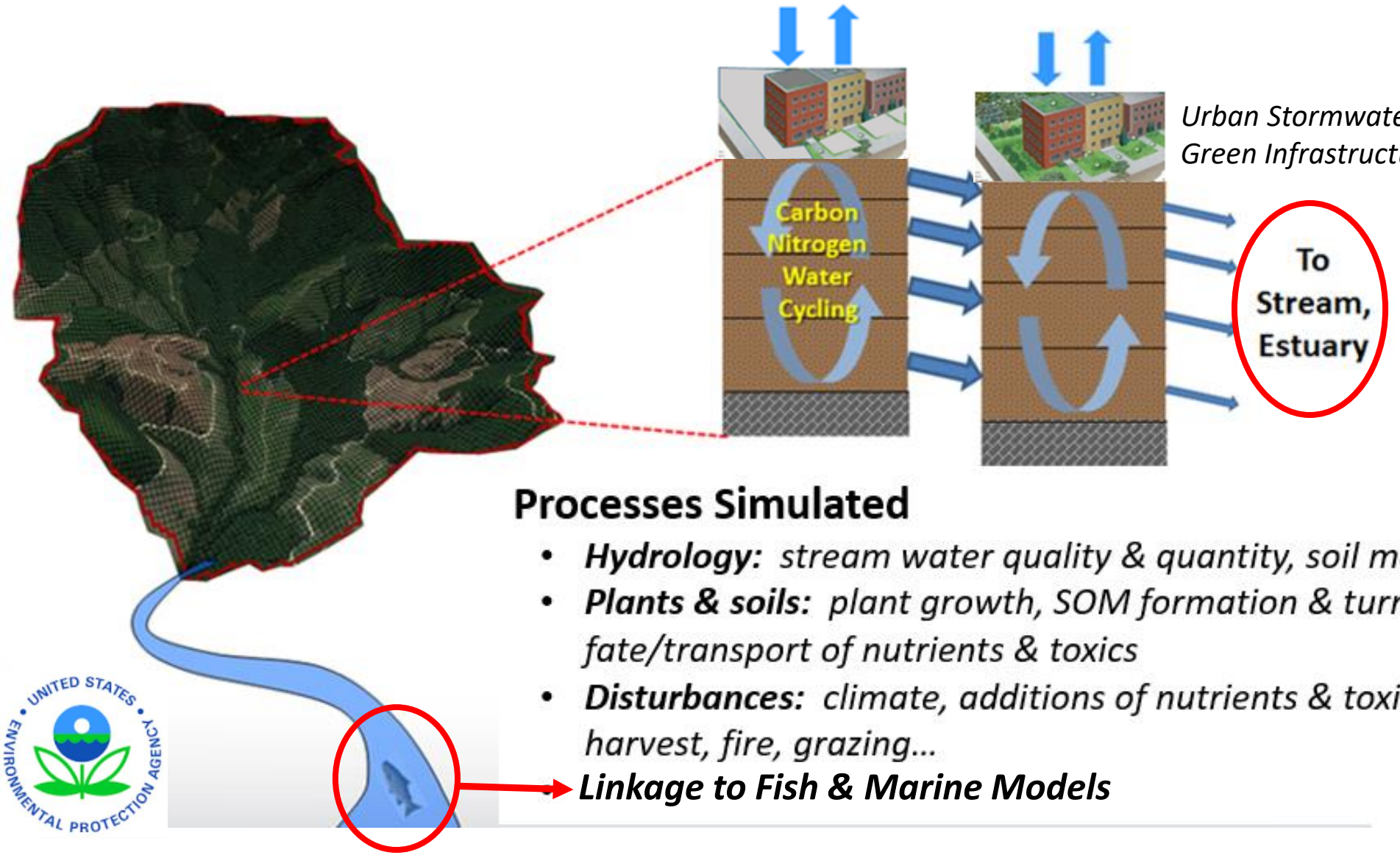

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PUGET SOUND VITAL SIGNS

Water Quantity
- ✓ **Summer Stream Flows**

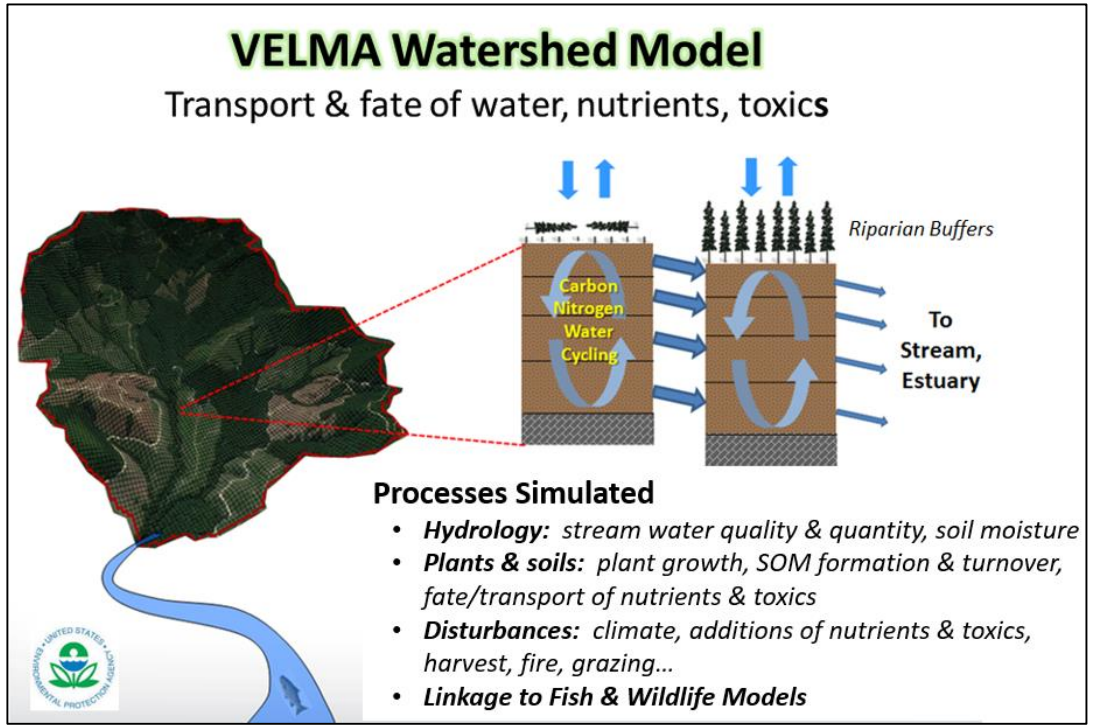
Water Quality
- Marine Water Quality
- ✓ **Freshwater Quality**
- Marine Sediment Quality
- Toxics in Fish

Healthy Human Population *
- ✓ **Onsite Sewage**
- Shellfish Beds
- ✓ **Outdoor Activities**
- ✓ **Local Foods**
- ✓ **Air Quality**
- ✓ **Drinking Water**

Quality of Life *
- ✓ **Sound Stewardship**
- ✓ **Economic Viability**
- ✓ **Good Governance**
- ✓ **Sense of Place**
- ✓ **Cultural Practices**

Species and Foodweb
- ✓ **Chinook Salmon***
- Orcas
- Pacific Herring
- ✓ **Birds***

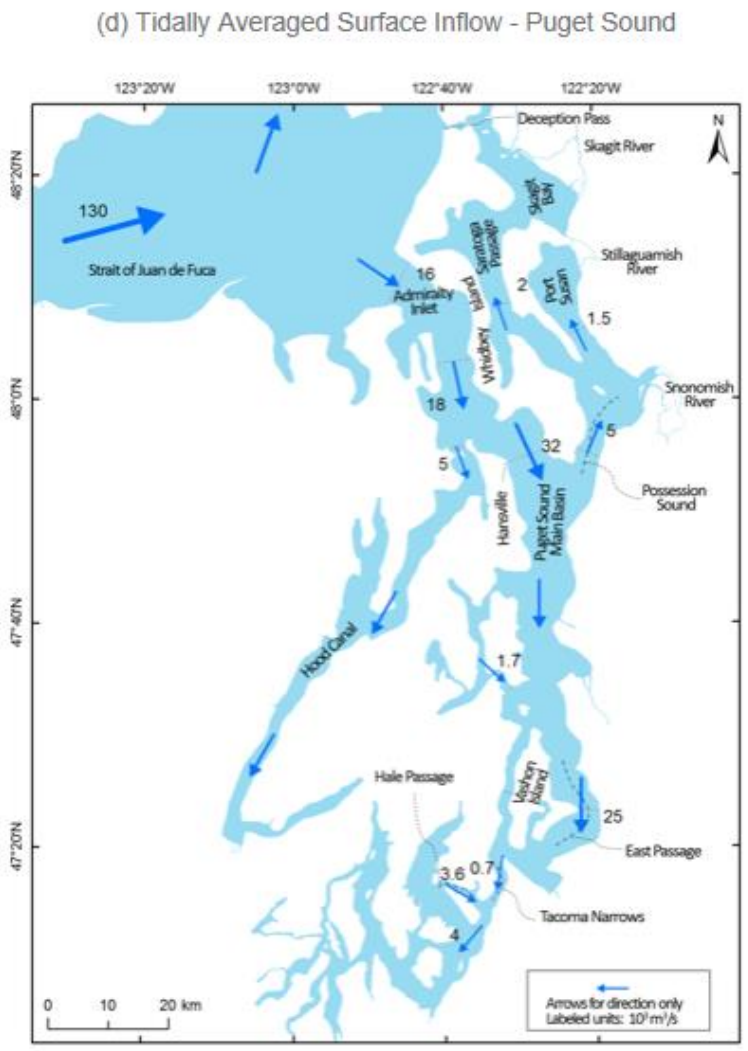
Protect and Restore Habitat
- ✓ **Estuaries (Salt Marshes)**
- ✓ **Floodplains ***
- ✓ **Land Cover and Development**
- Eelgrass
- Shoreline Armoring

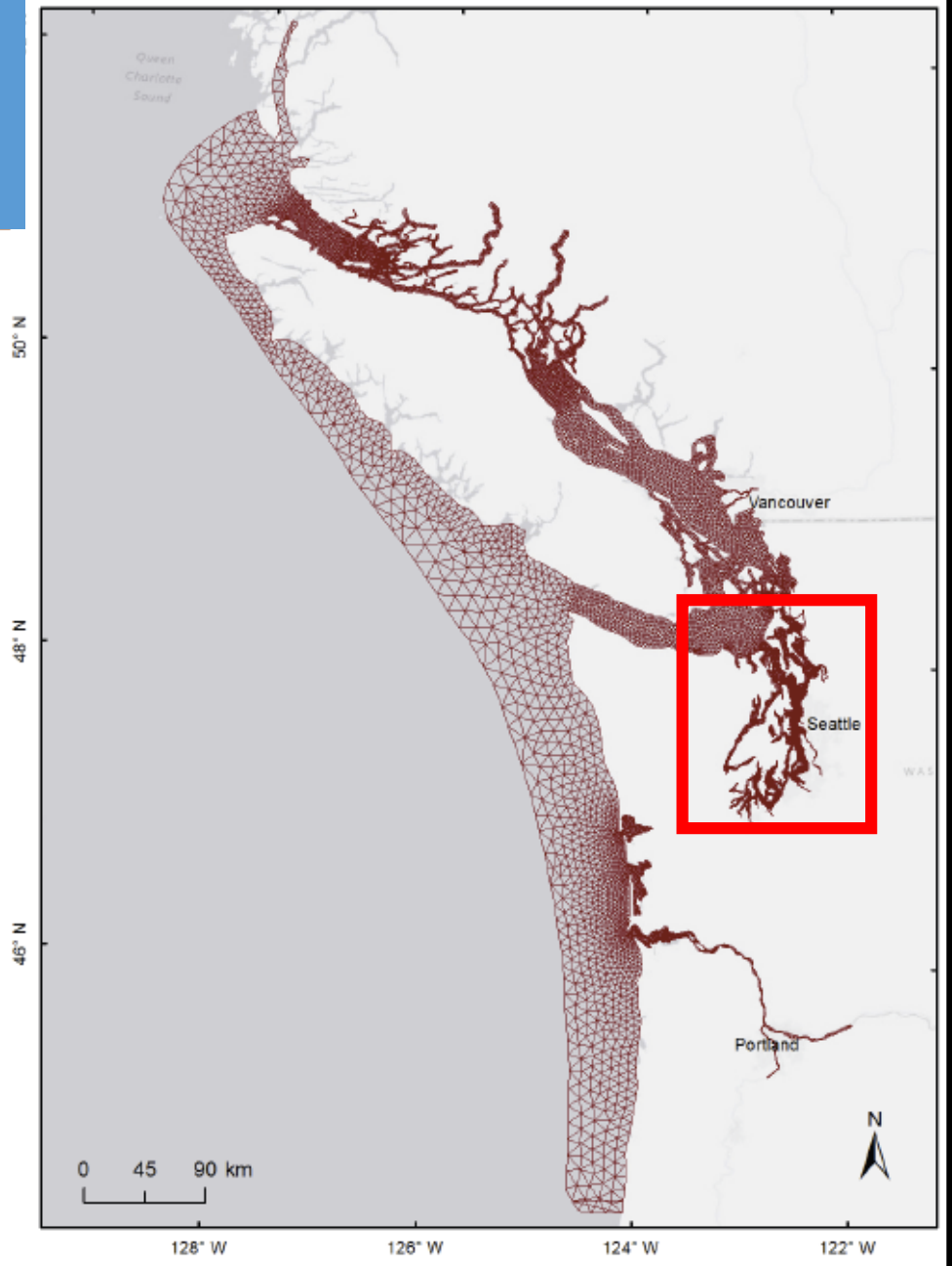


* With links to additional models or indicators

Salish Sea Model
Hydrodynamic Component

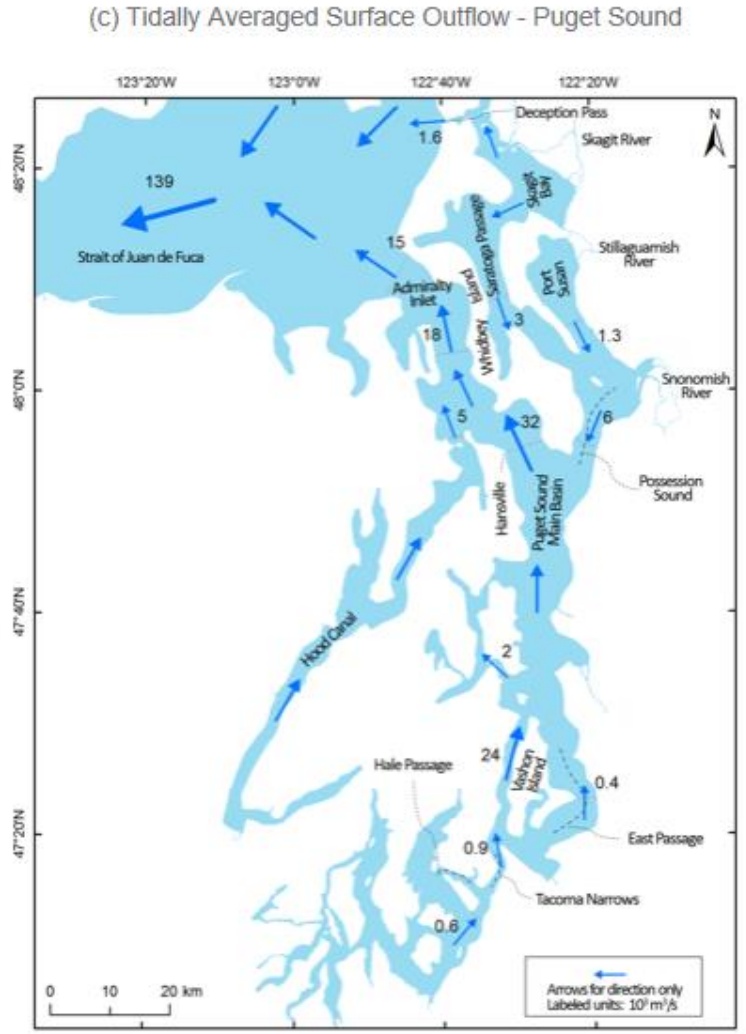
Pacific Northwest NATIONAL LABORATORY

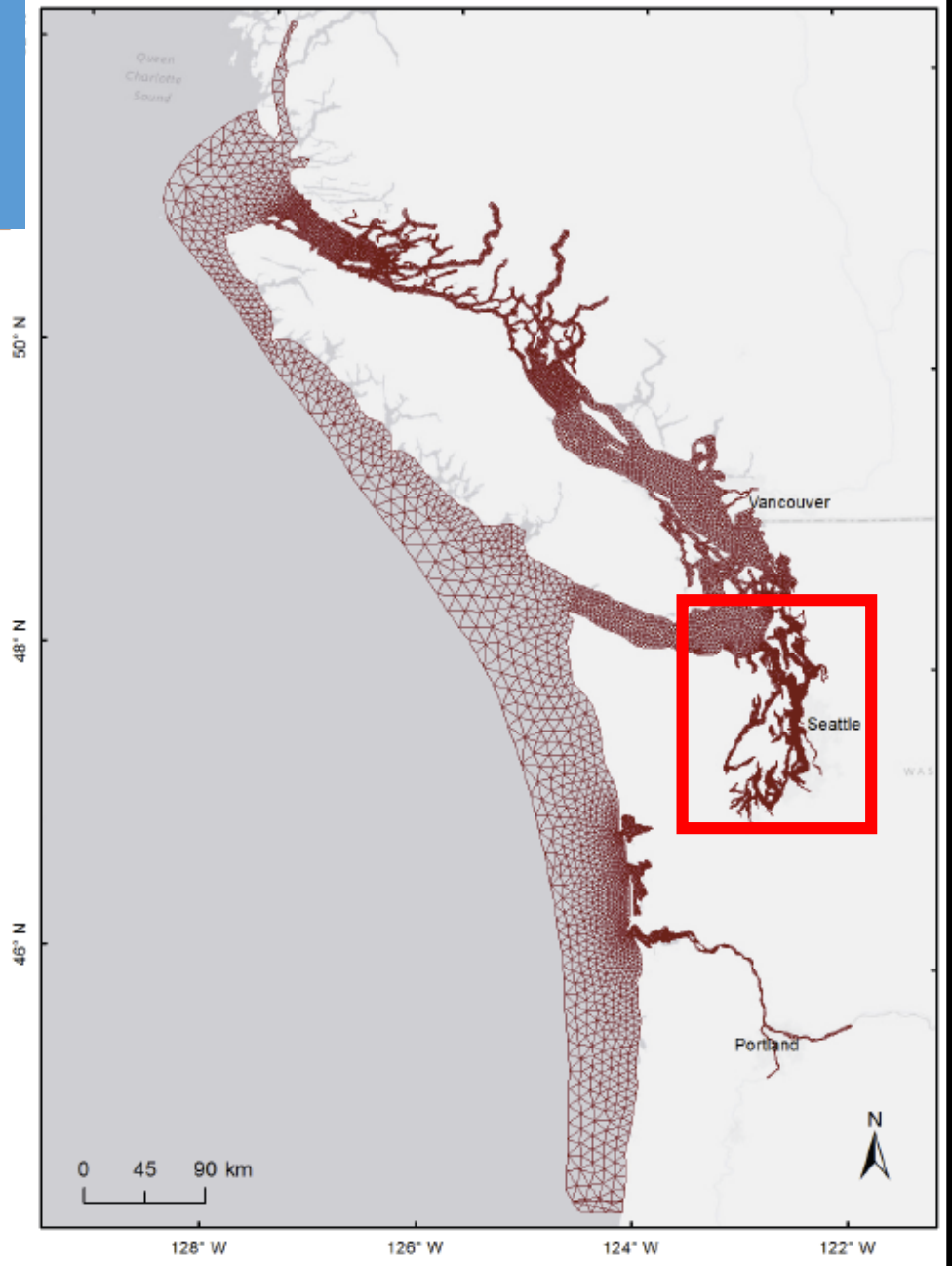




Salish Sea Model
Hydrodynamic Component

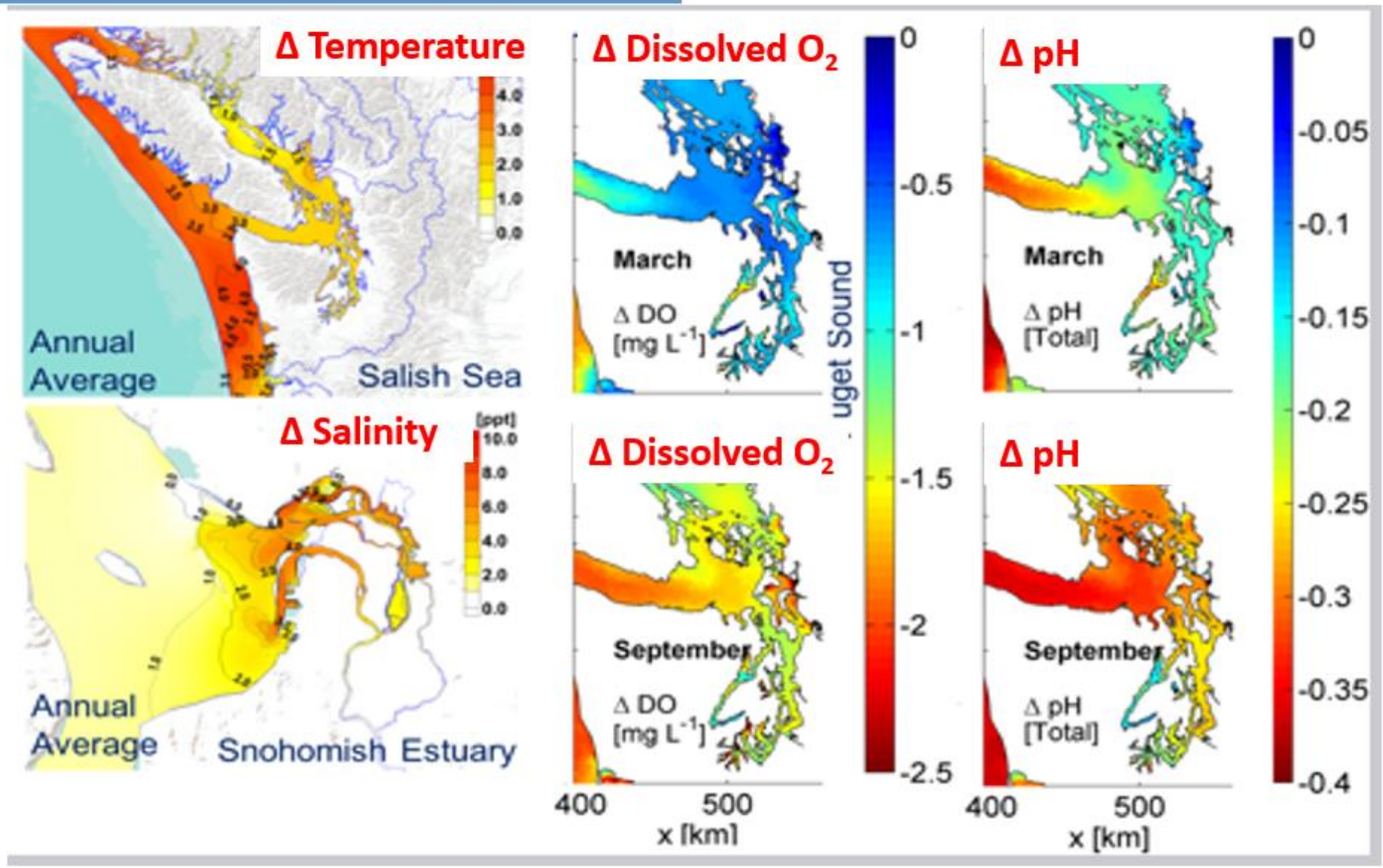
Pacific Northwest NATIONAL LABORATORY





Salish Sea Model
Biogeochemical Component

Pacific Northwest NATIONAL LABORATORY



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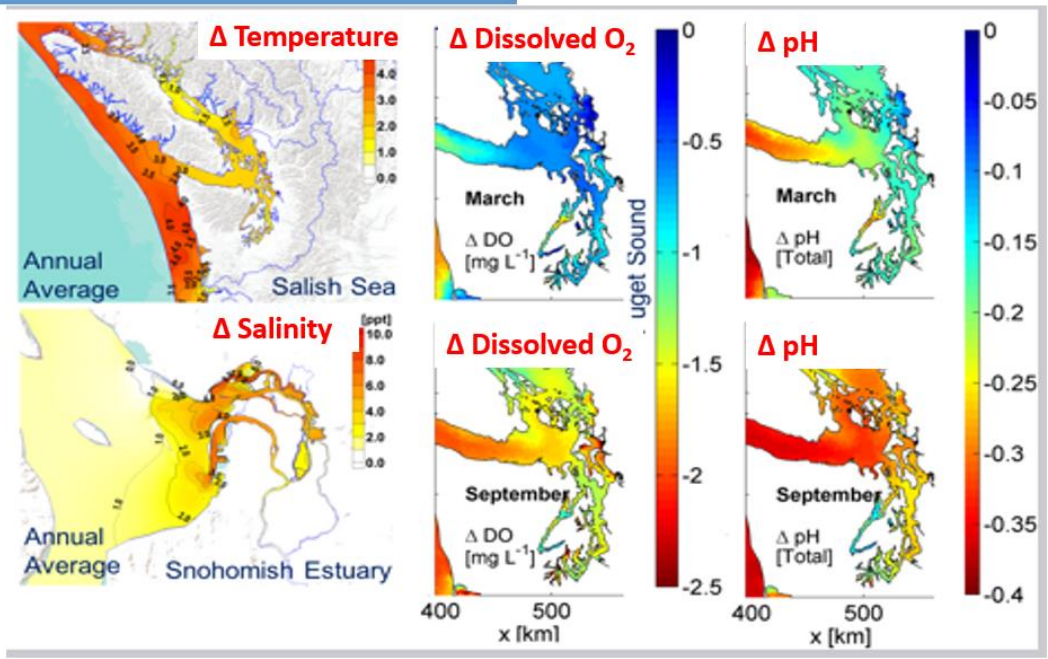
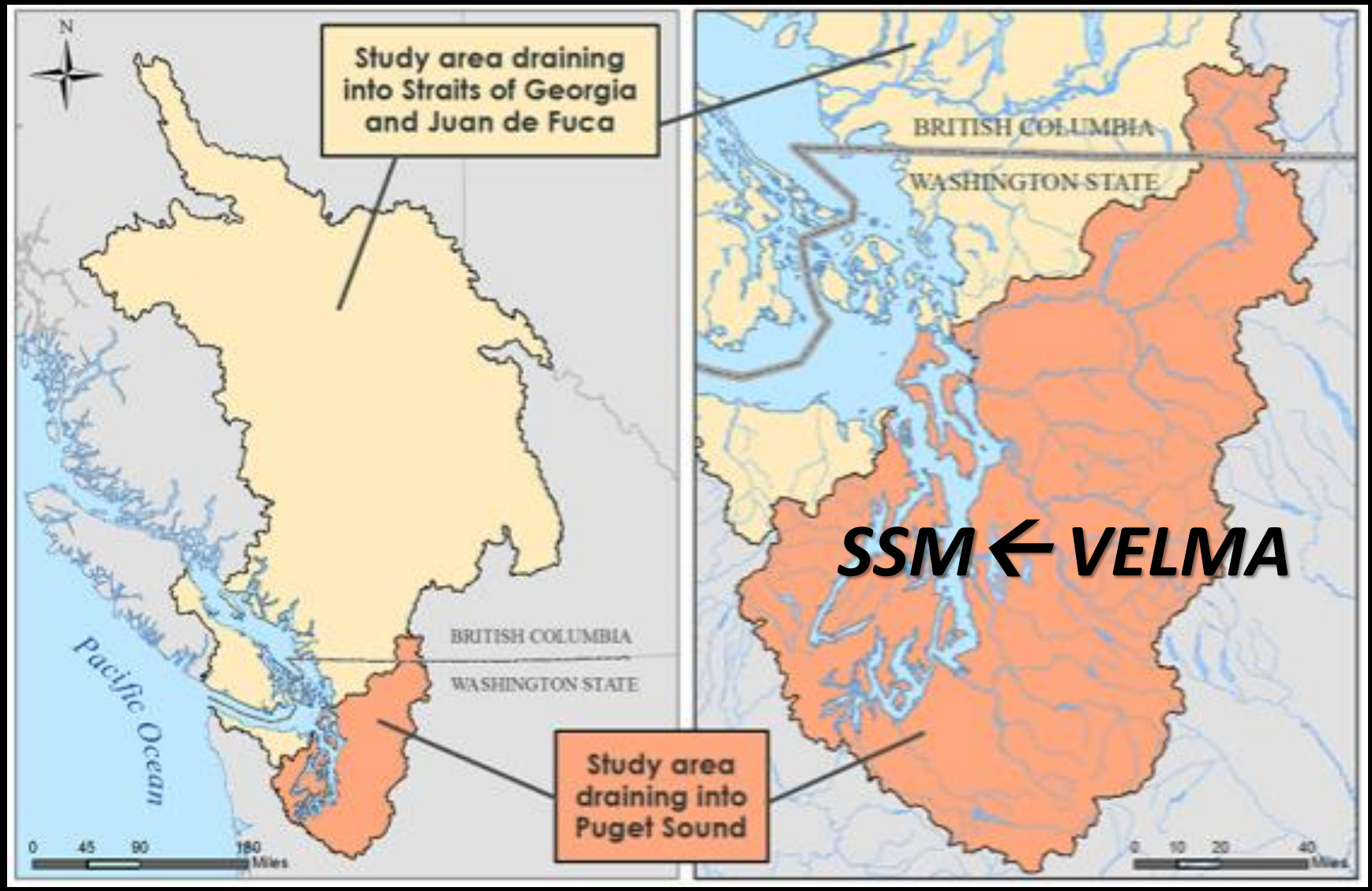
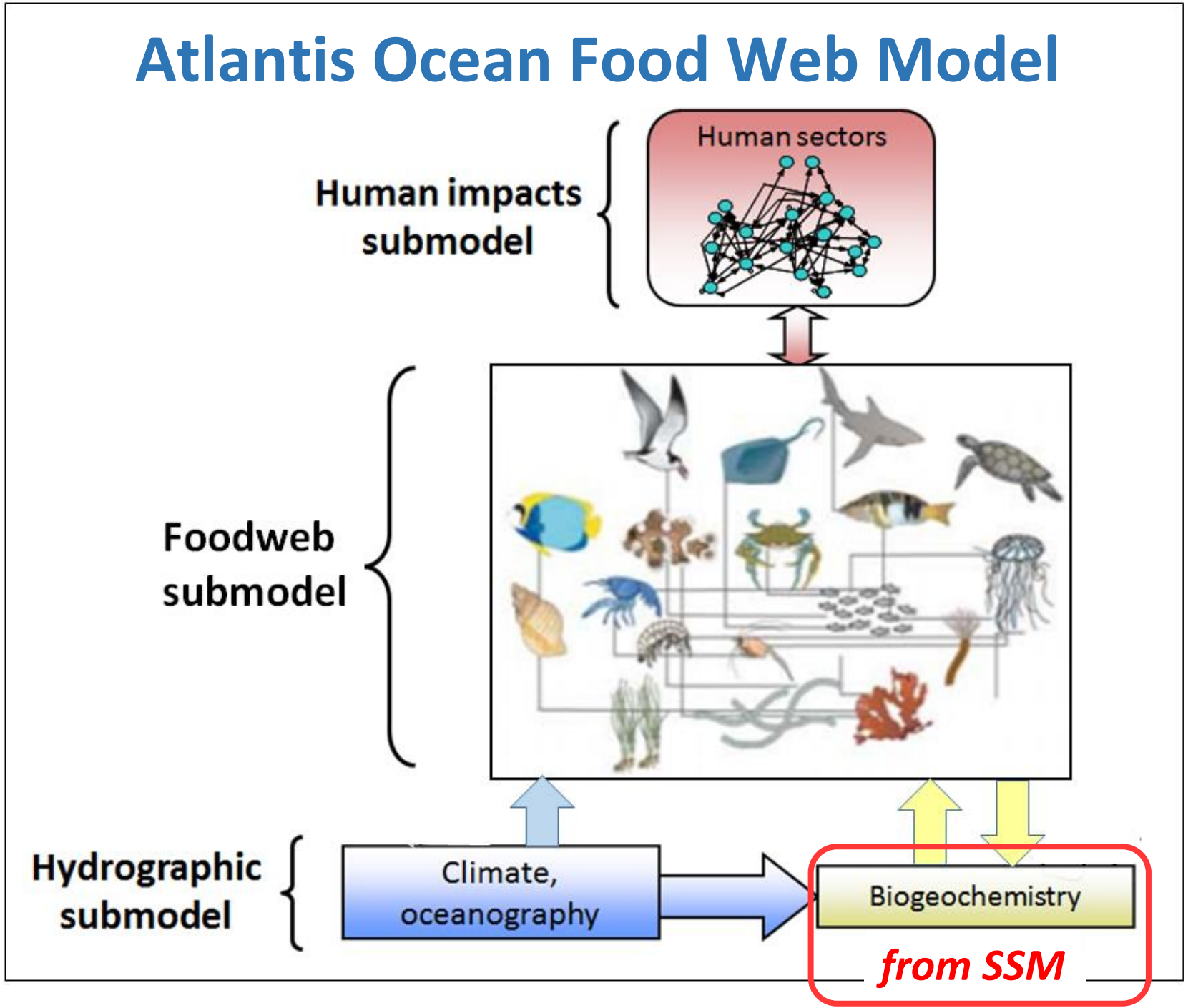


* With links to additional models or indicators

Salish Sea Model ← VELMA
Land-Water Interactions



Atlantis Ocean Food Web Model



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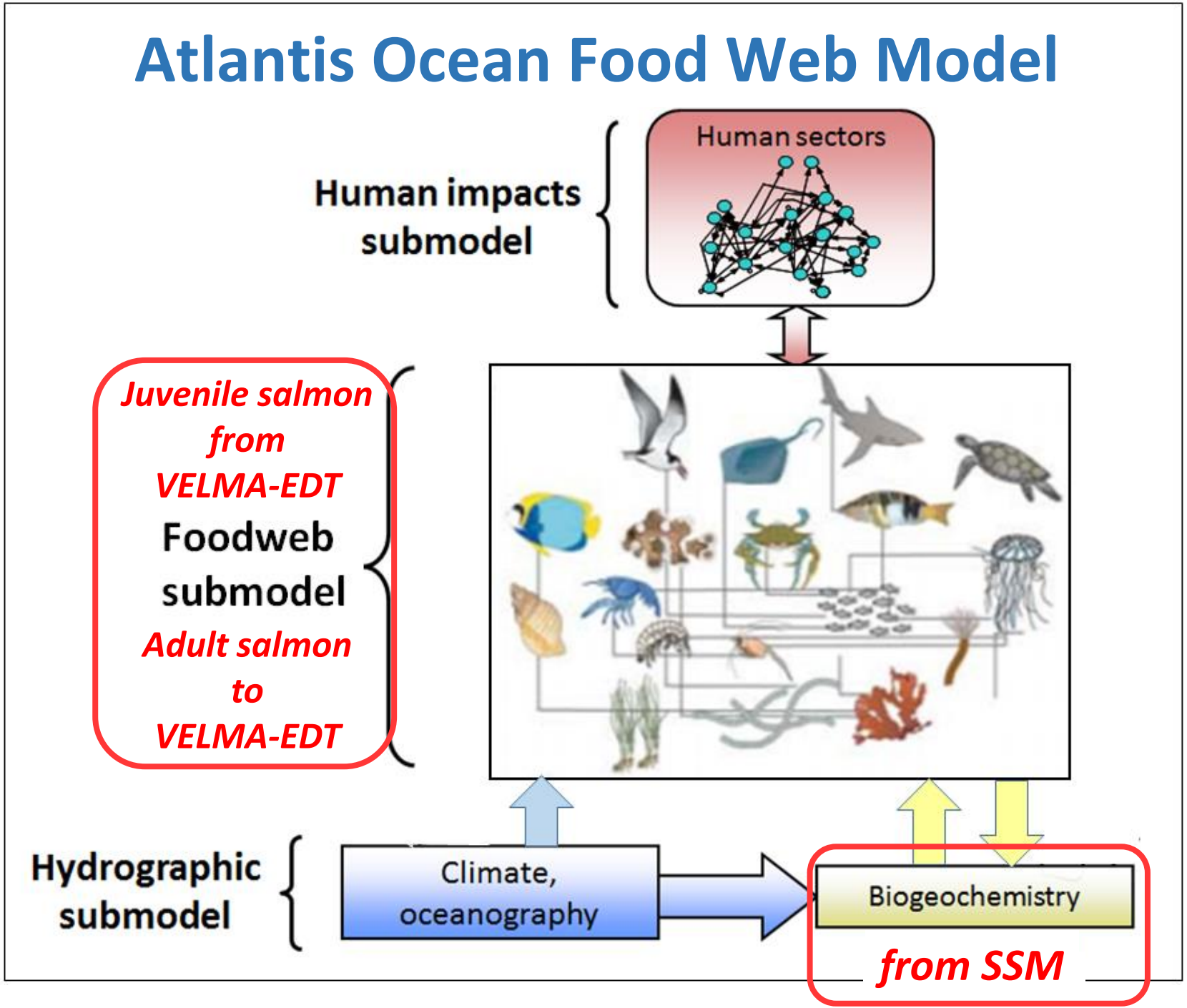

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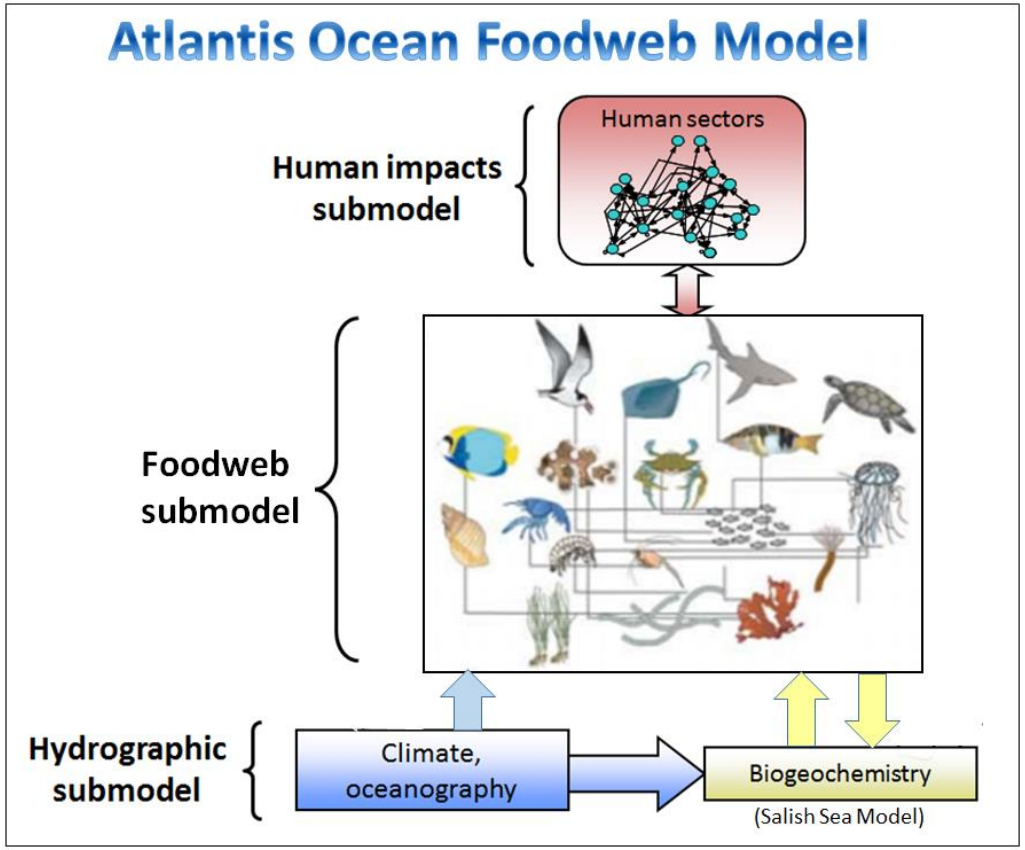

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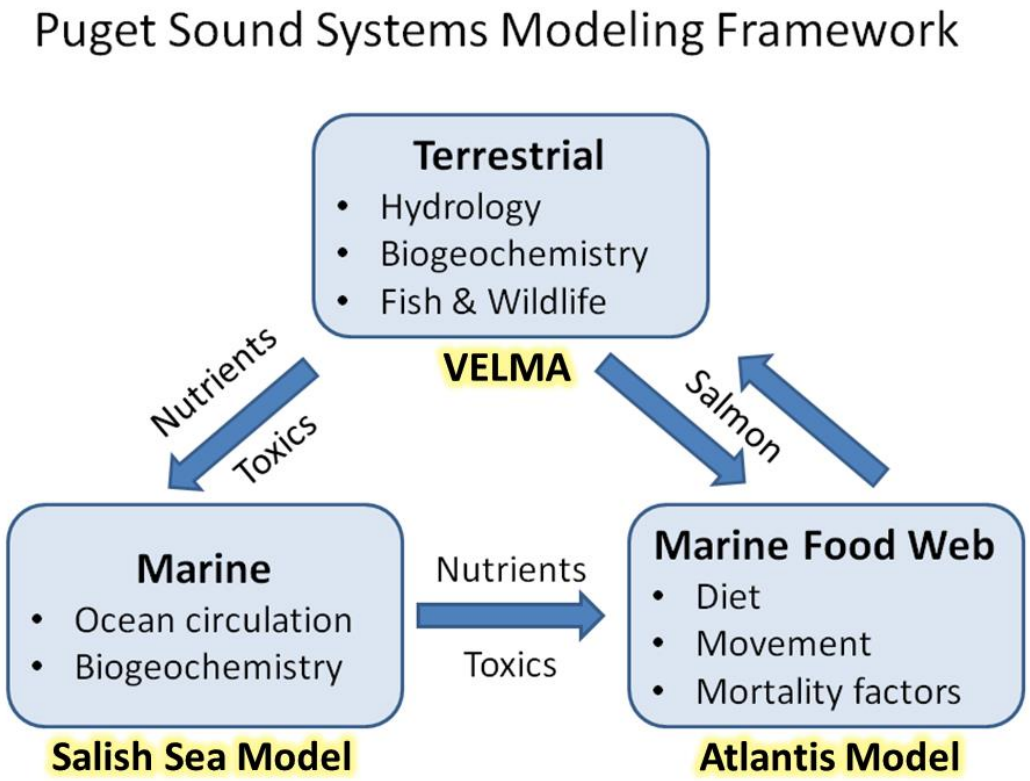

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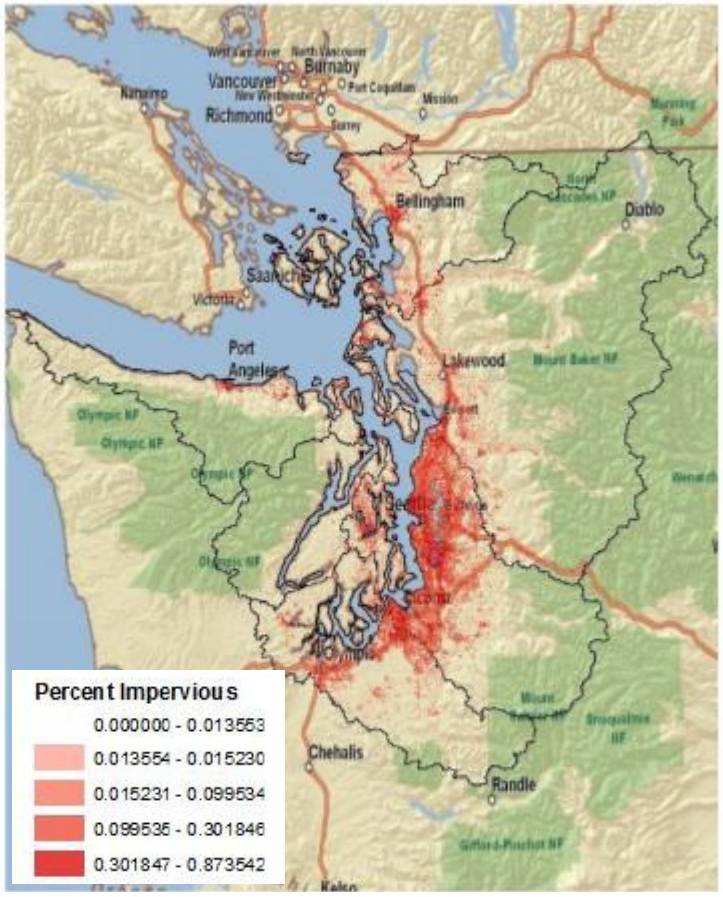
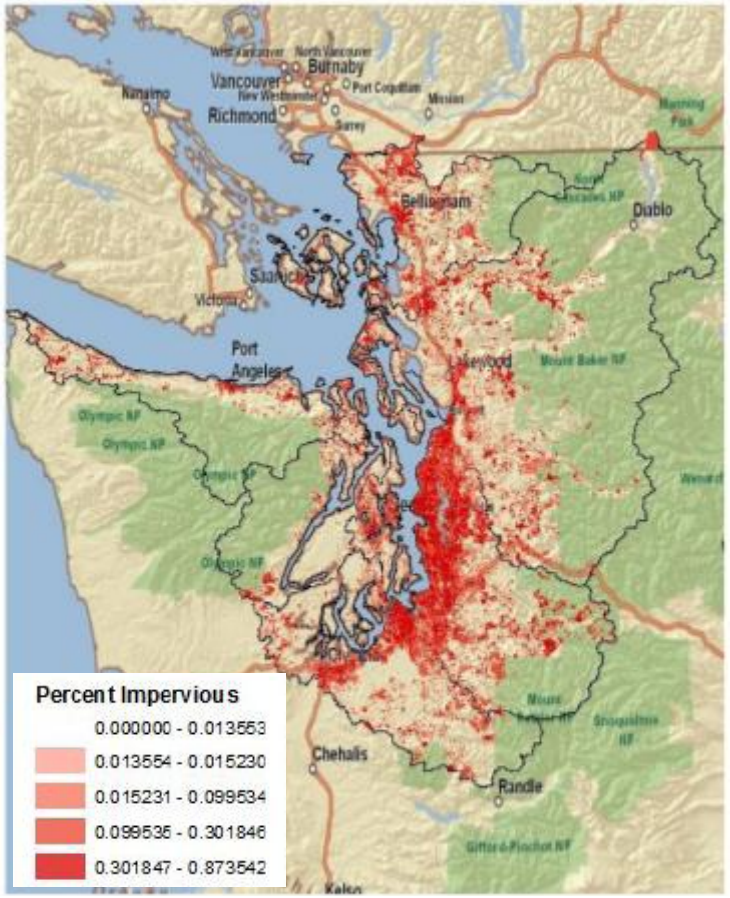
Major goal: Effects of alternative development scenarios on stormwater runoff to Puget Sound



Year 2000 % Impervious



Year 2060 % Impervious
Managed Growth Scenario

Bolte & Vache 2010: http://www.pugetsoundnearshore.org/supporting_documents/FRAP%20final%20report.pdf

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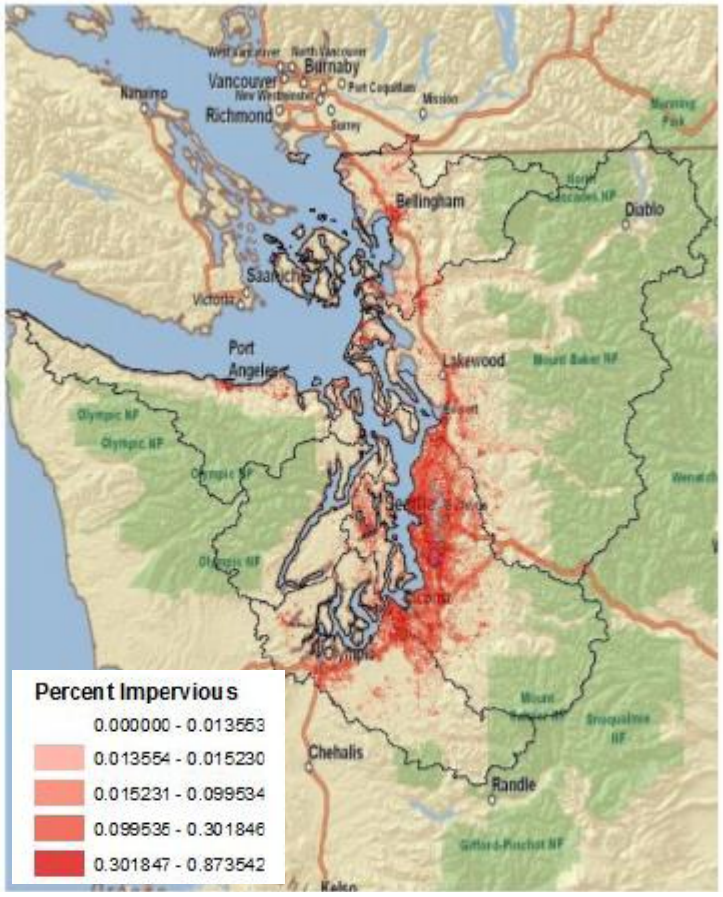

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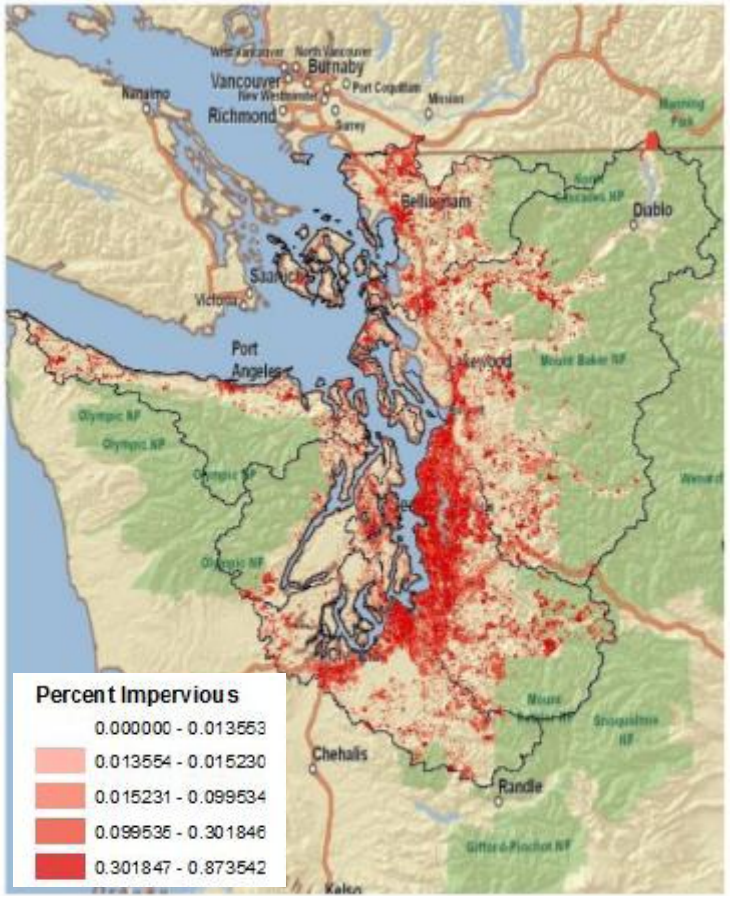

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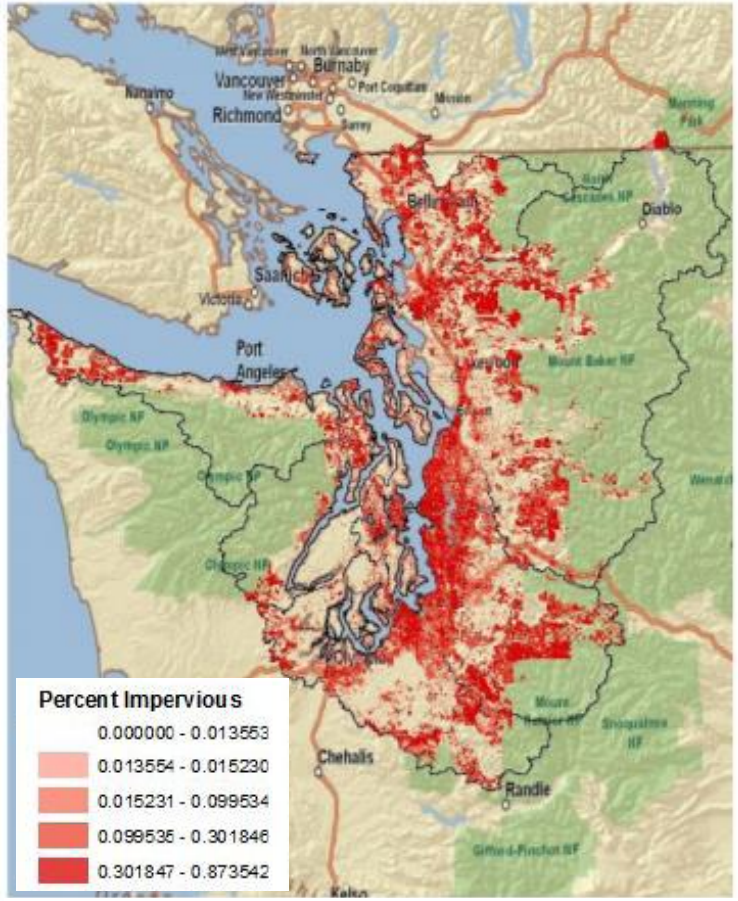


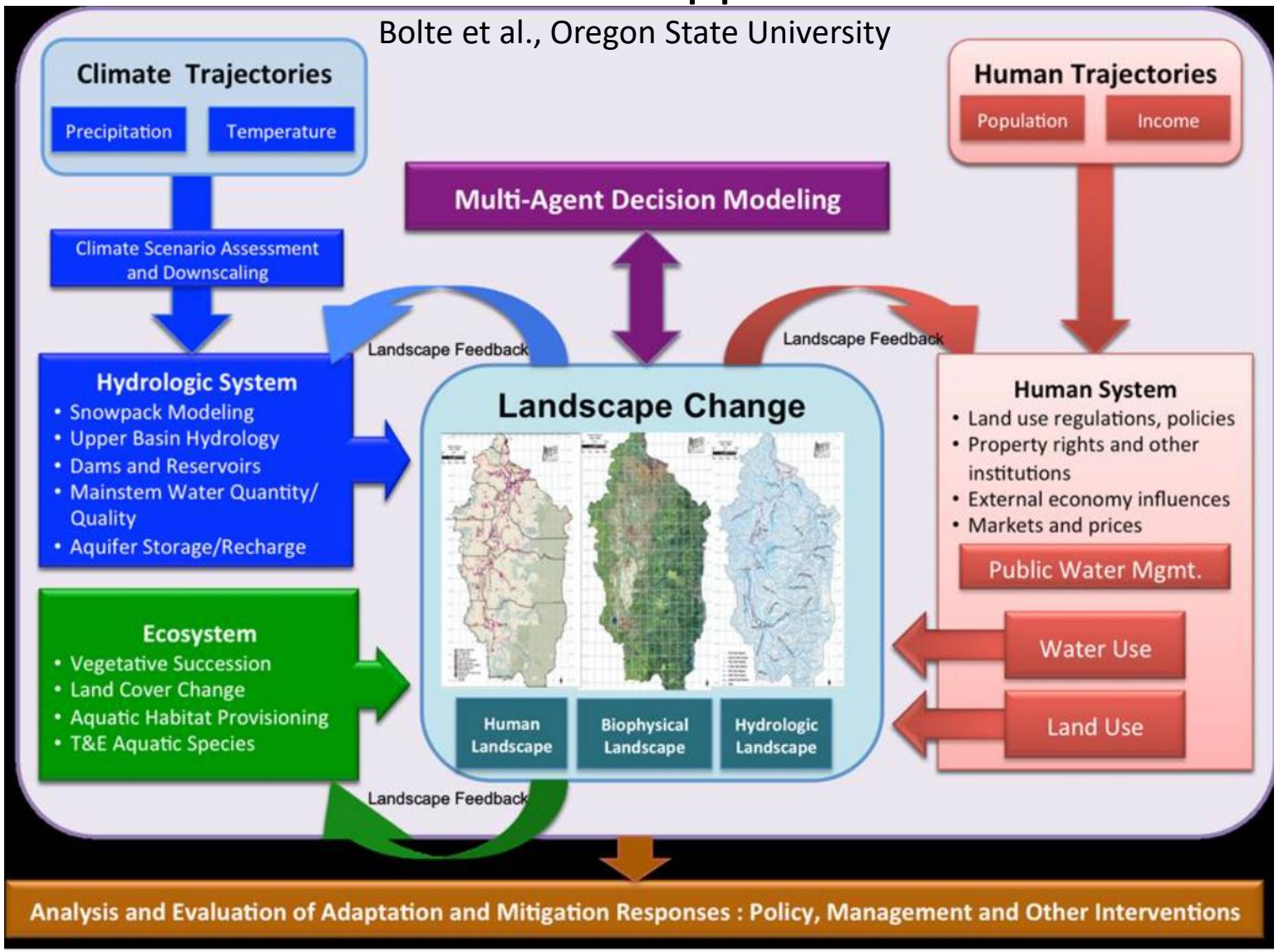
Year 2060 % Impervious
Unconstrained Growth Scenario

Bolte & Vache 2010: http://www.pugetsoundnearshore.org/supporting_documents/FRAP%20final%20report.pdf

Integrating environmental and human systems models

ENVISION Decision Support Framework

Bolte et al., Oregon State University



Left side: Environmental system models such as VELMA

Right side: Human system models (agent based)

Questions?

VELMA model: Bob McKane, Brad Barnhart, *EPA*
Salish Sea Model: Tarang Khangaonkar, *PNNL*
Atlantis model: Chris Harvey, Isaac Kaplan, Hem Nalini Morzaria Luna, *NOAA-NWFSC*; Michael Schmidt, *Long Live the Kings*
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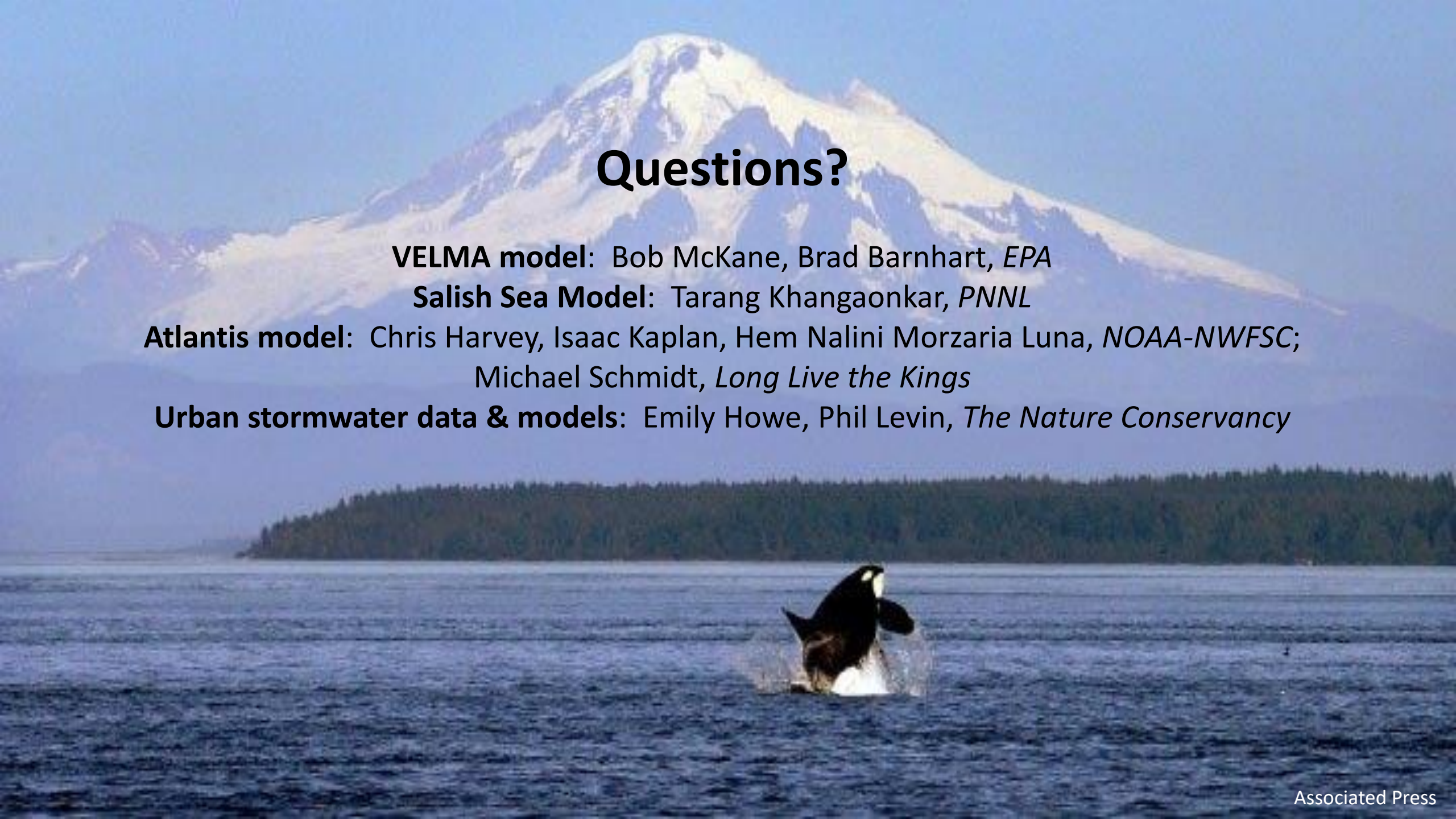

Associated Press