Models facilitate comparison of the social-ecological tradeoffs among Puget Sound management alternatives

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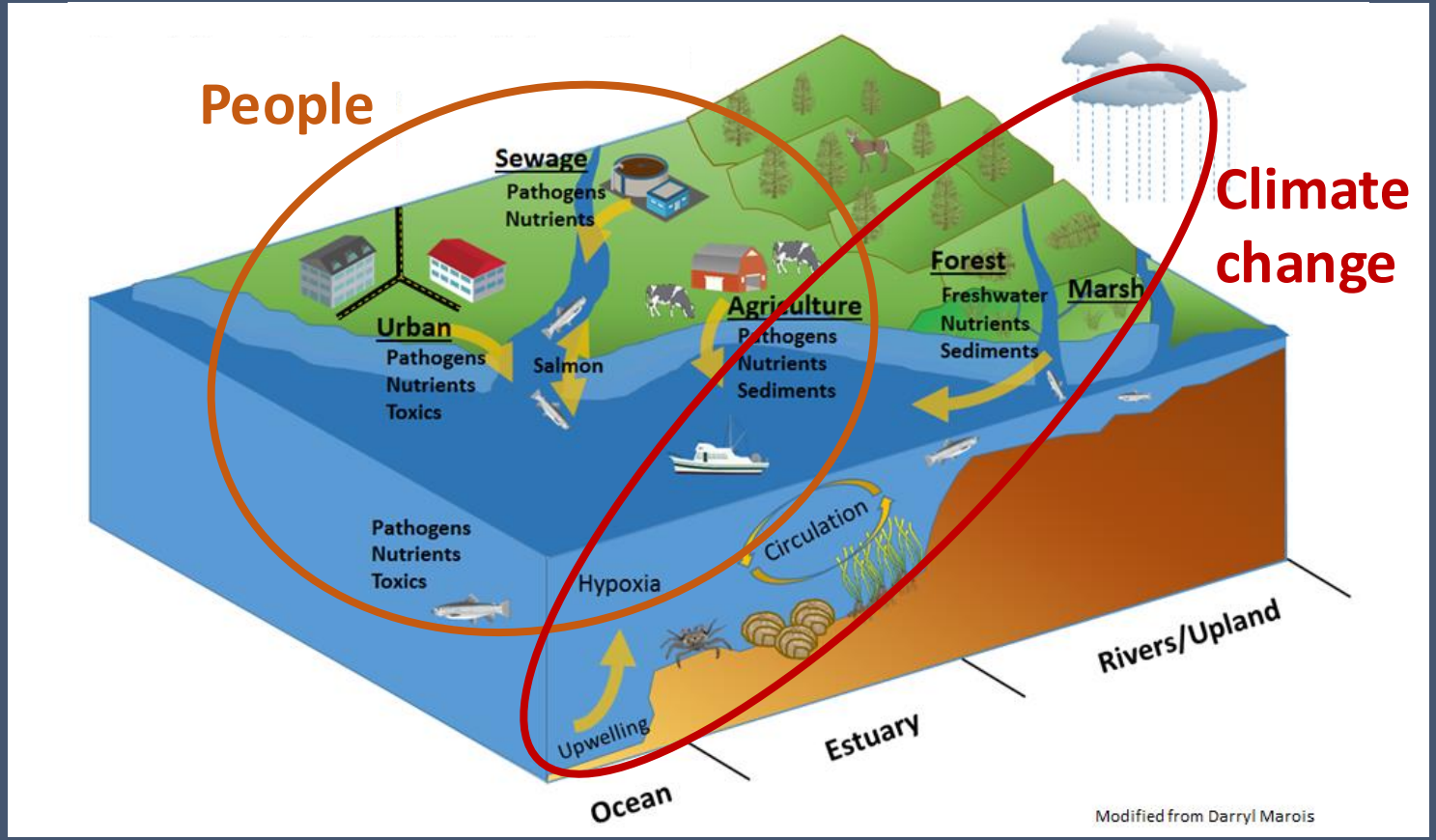
Pacific Northwest National Laboratory, University of Wash

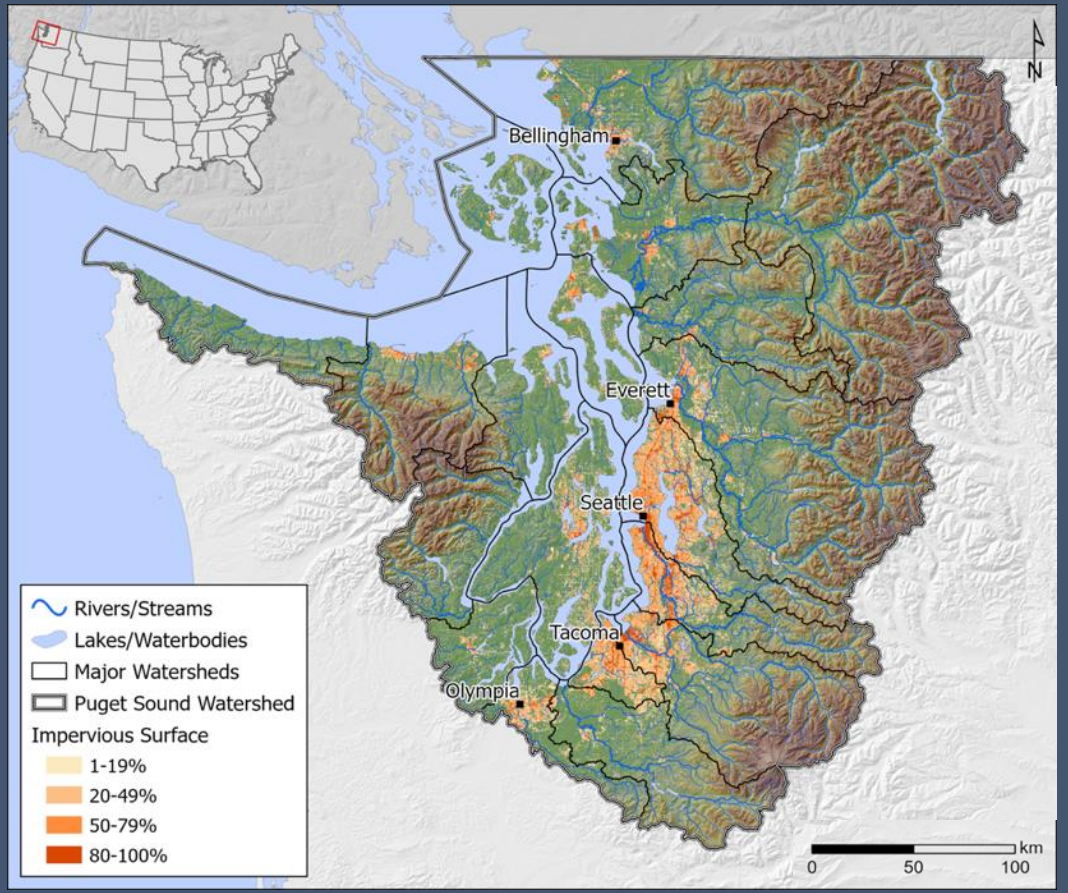
Wicked Problems



Puget Sound, Washington

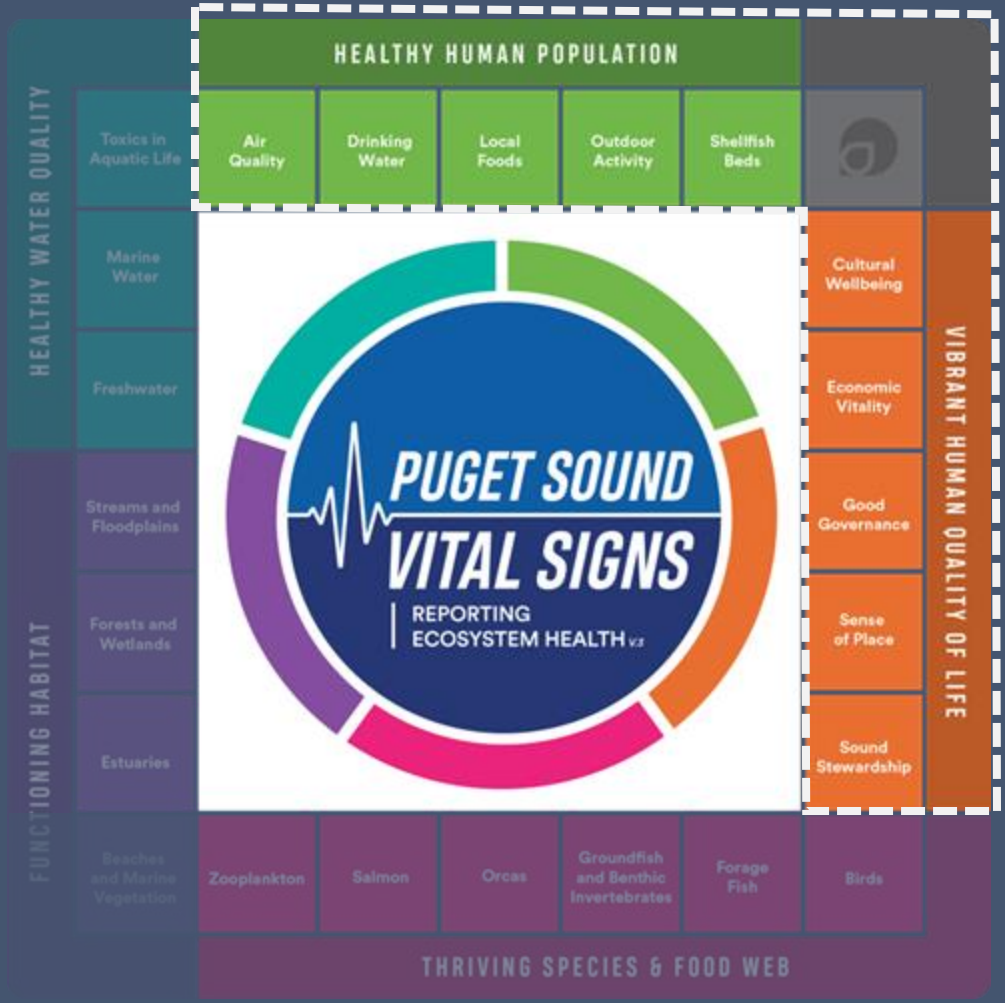

Candice Emmons, NOAA


Marlin Greene, One Earth



Recovery Objectives

Number of indicators making progress:



PUGET SOUND National Estuary Program

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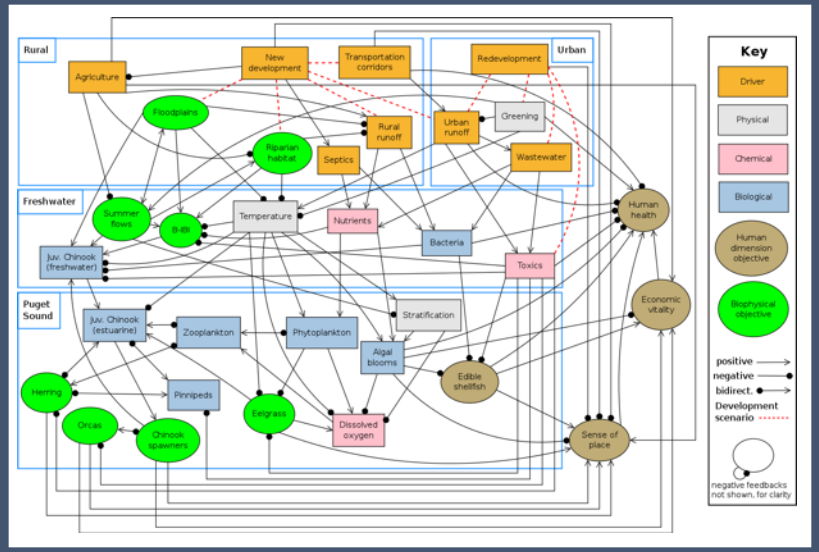
Decision Support Modeling

Qualitative

Network Model (QNM)



Magel & Francis 2022, *Front. Mar. Sci.*

Quantitative

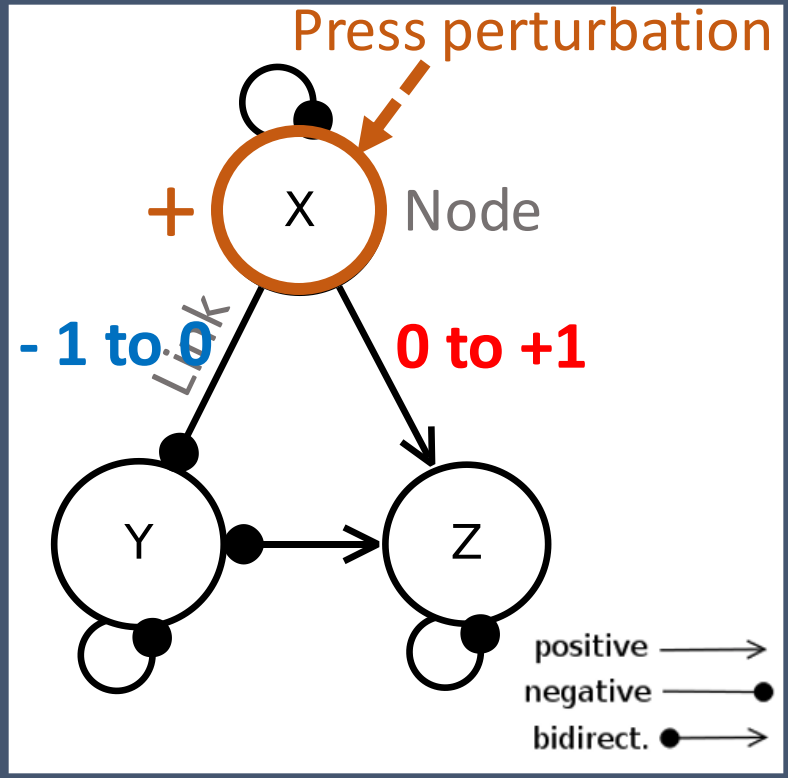
Integrated model suite

pugetsoundinstitute.org/psimf

Qualitative Network Models (QNM)

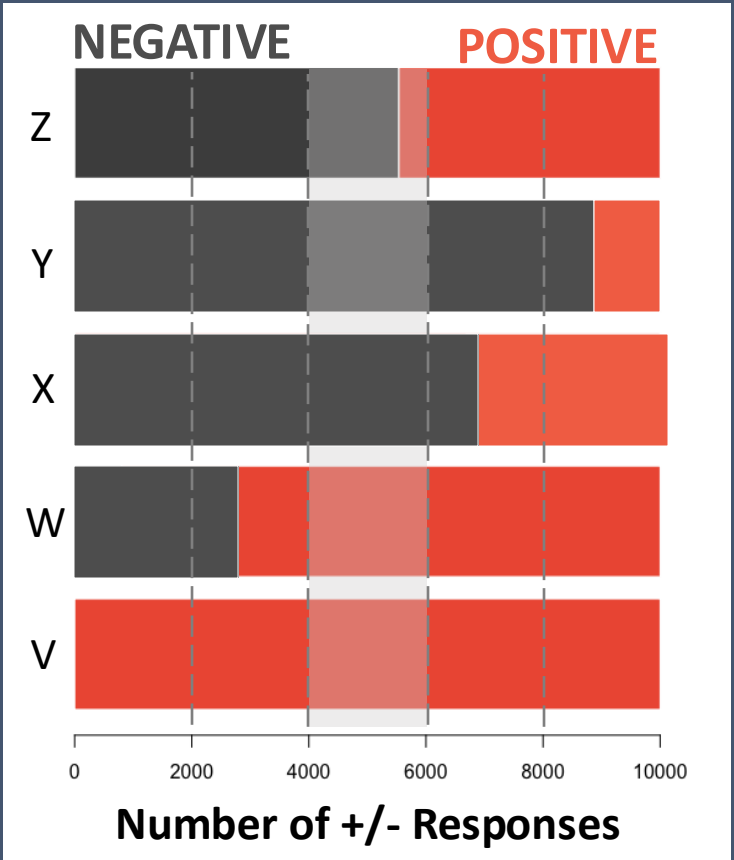
‘QPress’

10,000 simulations



Melbourne-Thomas et al. 2012 *Ecol. Monogr.*

Qualitative Network Models (QNM)



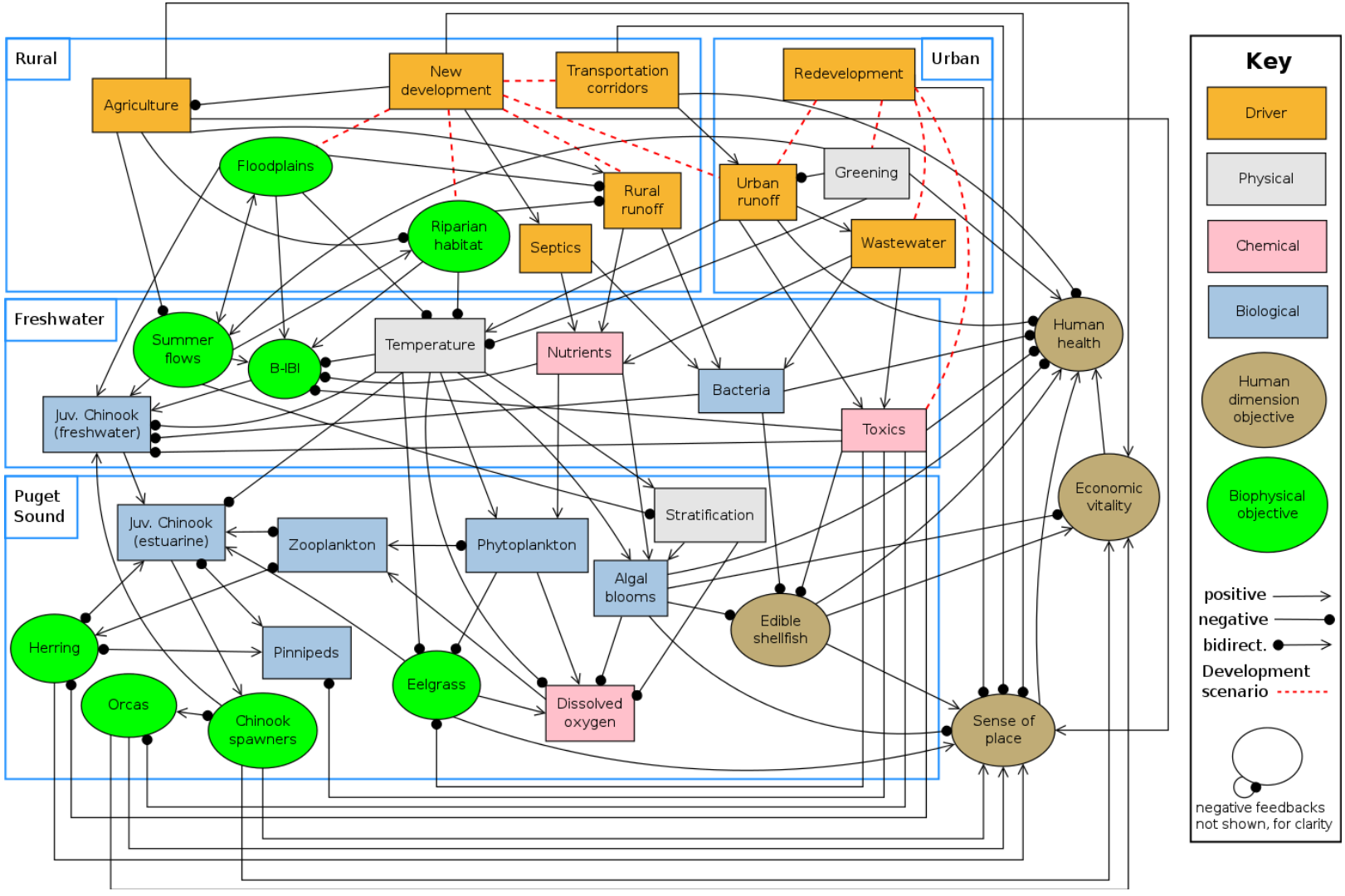
Equivocal (40-60%)

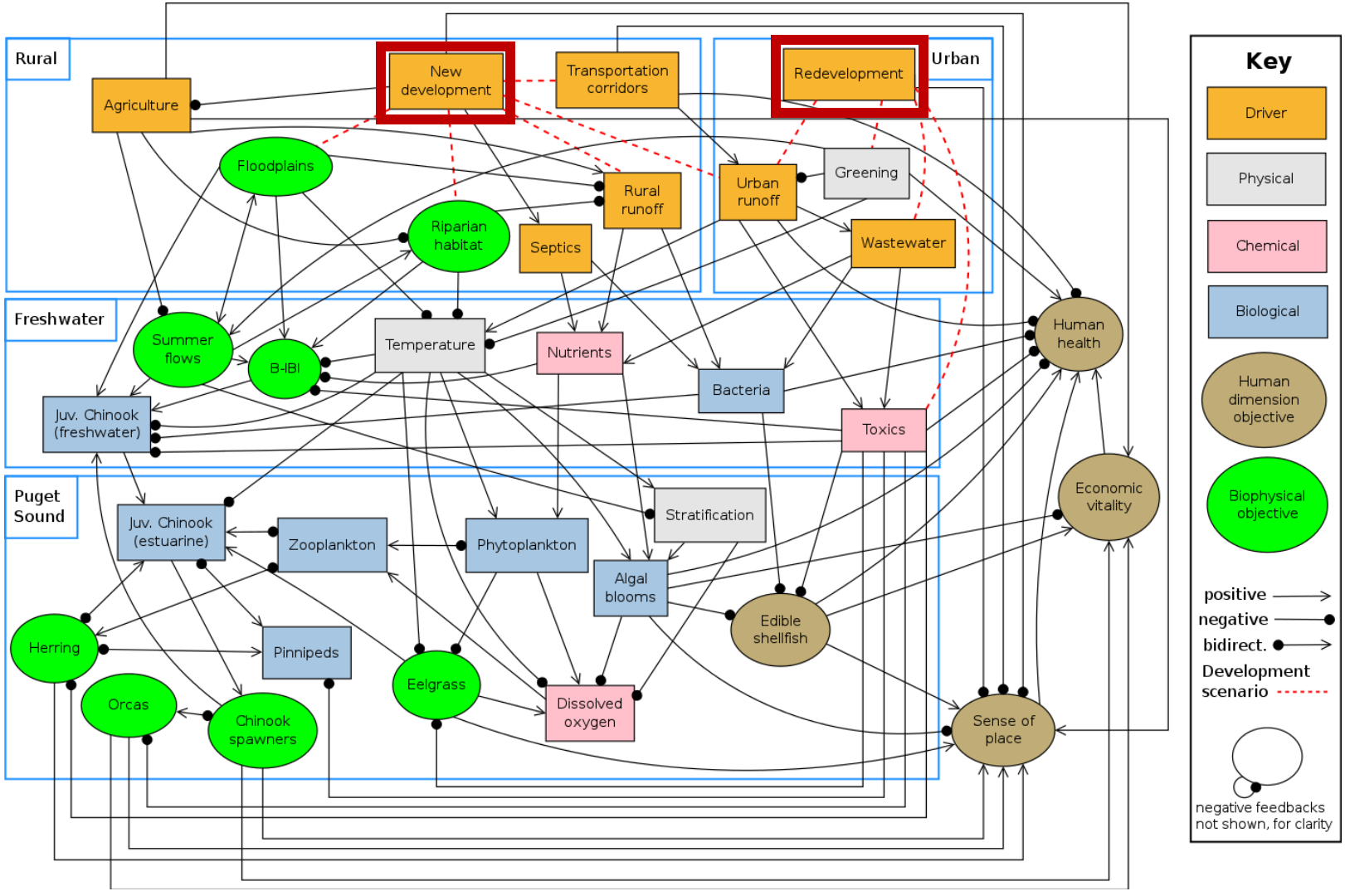
Strong negative (>80%)

Weak negative (60-80%)

Weak positive (60-80%)

Strong positive (>80%)


Rural
Urban
Freshwater
Puget Sound
Agriculture
New development
Transportation corridors
Redevelopment
Floodplains
Rural runoff
Urban runoff
Greening
Riparian habitat
Septics
Wastewater
Summer flows
B-IBI
Temperature
Nutrients
Bacteria
Human health
Juv. Chinook (freshwater)
Toxics
Juv. Chinook (estuarine)
Zooplankton
Phytoplankton
Stratification
Economic vitality
Algal blooms
Herring
Pinnipeds
Eelgrass
Edible shellfish
Orcas
Chinook spawners
Dissolved oxygen
Sense of place
Key
Driver
Physical
Chemical
Biological
Human dimension objective
Biophysical objective
positive
negative
bidirect.
Development scenario
negative feedbacks not shown, for clarity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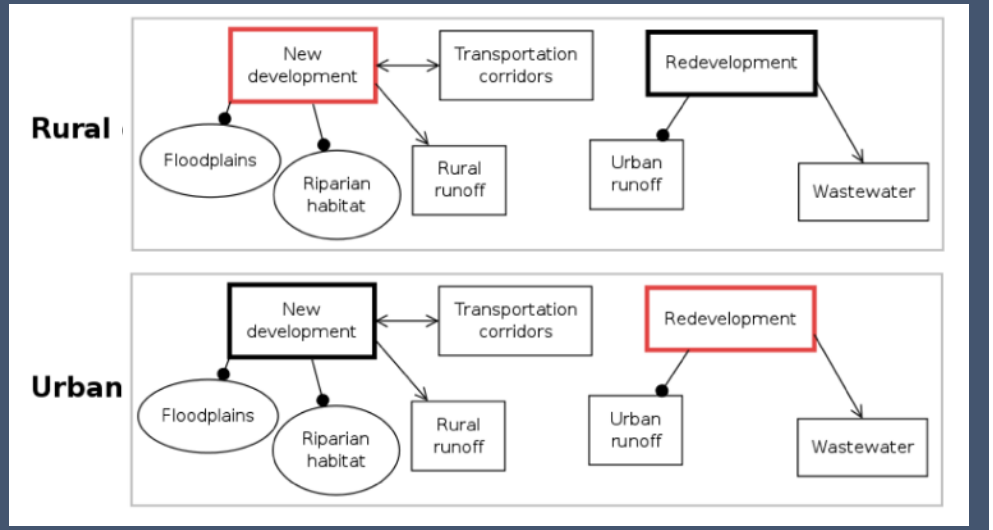
Rural vs. Urban Development



Recovery Objectives		Rural only	Urban only
Orcas	Species		
Chinook spawners			
Herring			
Eelgrass	Habitats		
Floodplains			
Riparian habitat			
Summer flows	Water		
B-IBI			
Dissolved oxygen			
Edible shellfish	Humans		
Human health			
Sense of place			
Economic vitality			
Ecosystem Stressors			
Temperature			
Nutrients			
Bacteria			
Toxics			
Algal blooms			

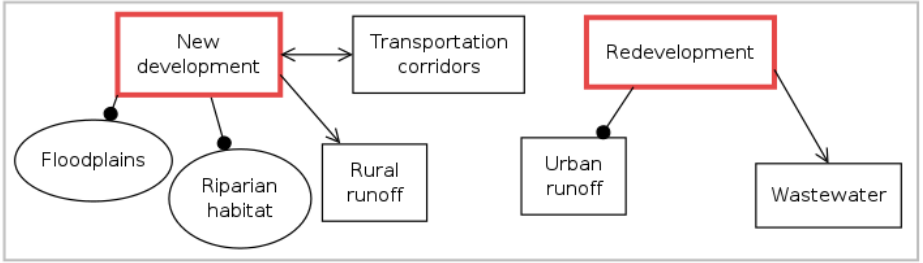
Positive

Negative

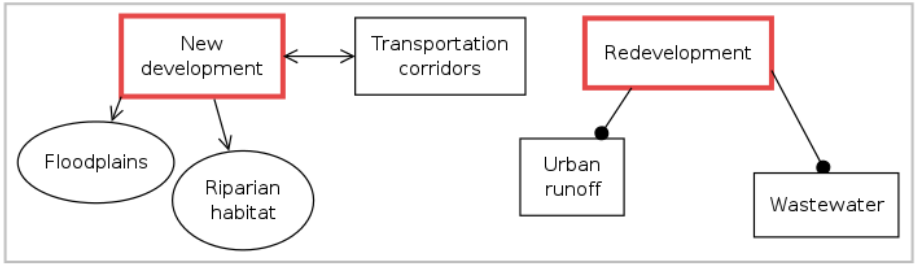
Positive			Negative	
Strong	Weak	Equivocal	Weak	Strong
> 80%	60-80%	40-60%	60-80%	> 80%

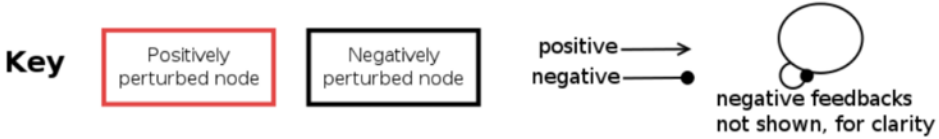
Rural-Urban Coordination

Status Quo



Moderate





Recovery Objectives		Status Quo	Moderate
Orcas	Species		
Chinook spawners			
Herring			
Eelgrass	Habitats		
Floodplains			
Riparian habitat			
Summer flows	Water		
B-IBI			
Dissolved oxygen			
Edible shellfish	Humans		
Human health			
Sense of place			
Economic vitality			

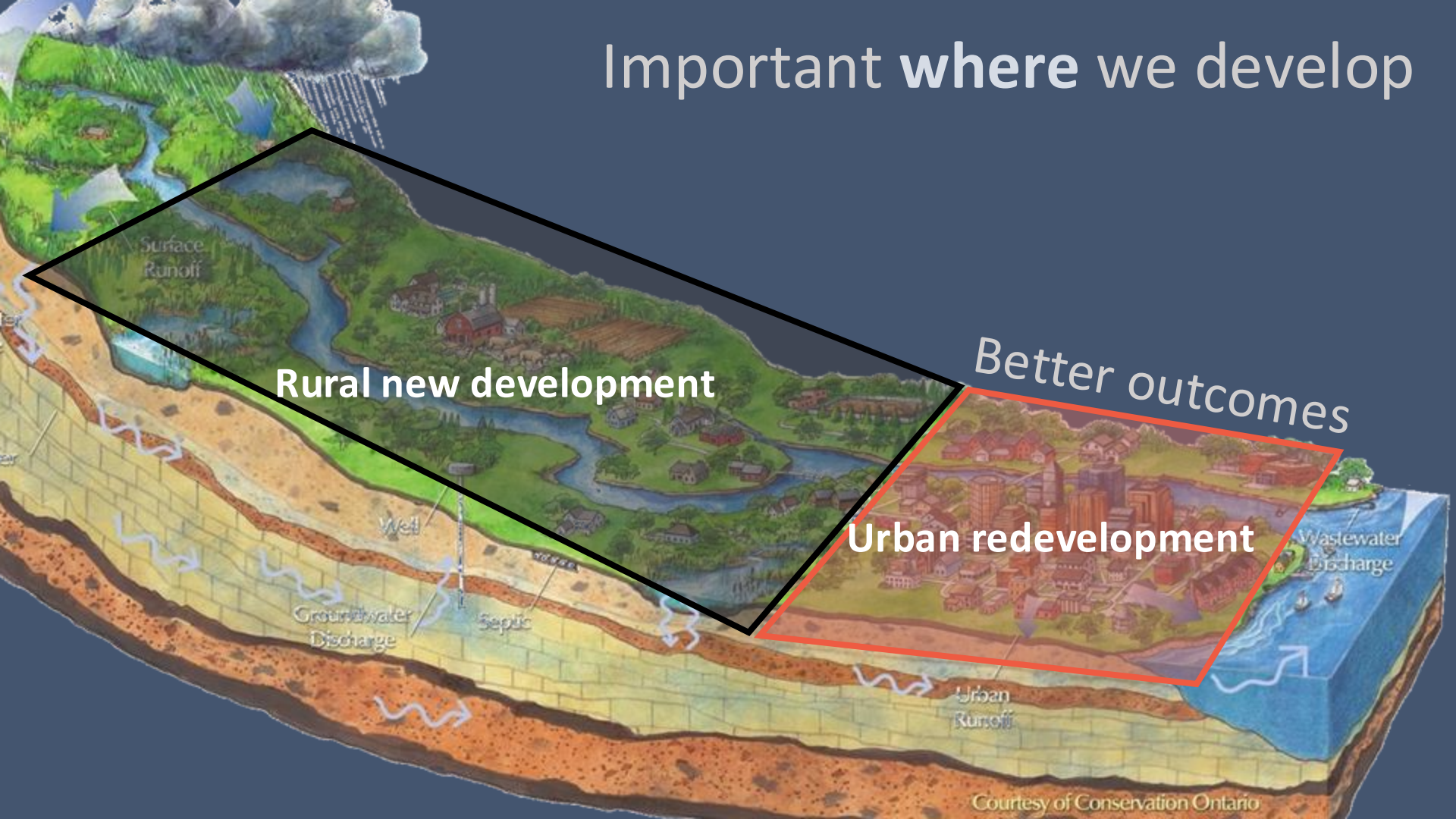
Ecosystem Stressors
Temperature
Nutrients
Bacteria
Toxics
Algal blooms

Positive

Negative

Positive			Negative	
Strong	Weak	Equivocal	Weak	Strong
> 80%	60-80%	40-60%	60-80%	> 80%

Important **where** we develop



Important **how** we develop

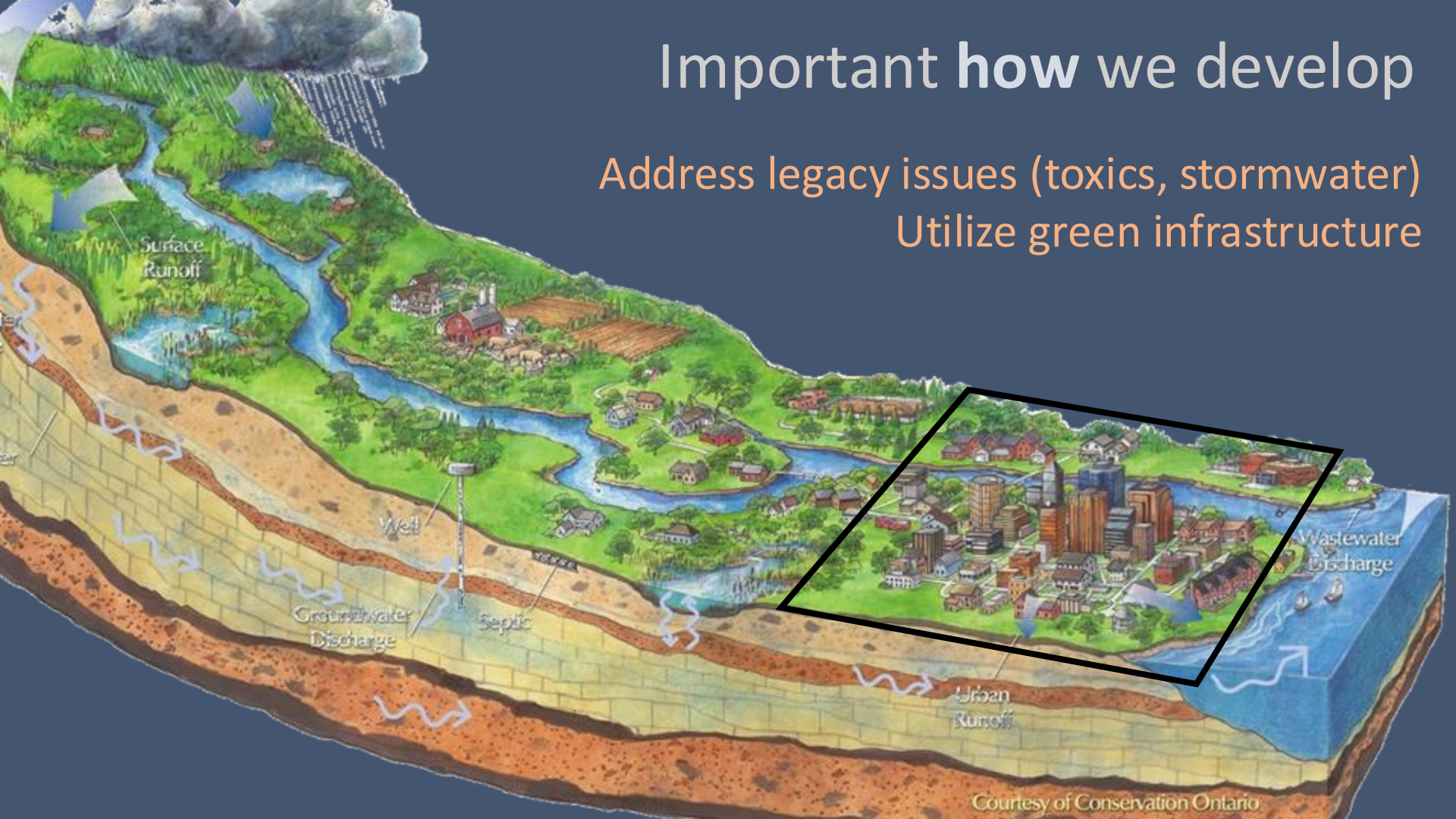
Important **how** we develop

Protect/restore critical habitats

Limit expansion of transportation corridors

Important **how** we develop

Address legacy issues (toxics, stormwater)
Utilize green infrastructure



Coordination = better outcomes

Work across recovery groups

Bridge the needs of rural and urban

Where? How much?

Protect/restore critical habitats

Limit expansion of transportation corridors

Address legacy issues

Utilize green infrastructure

Food Web

Marine food web, toxics in fish, fishery harvest

Terrestrial

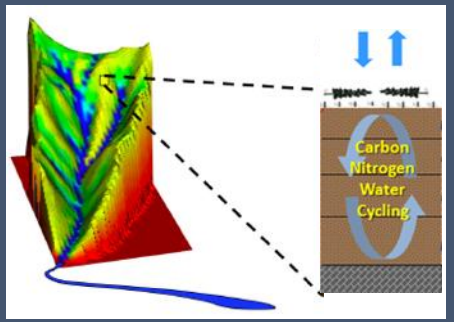
Population & development

Land cover

Nutrients
Toxics
Temperature

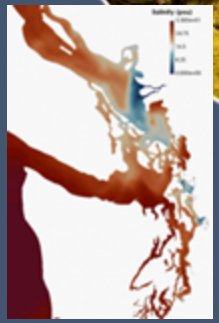
Terrestrial

Hydrology, land use, BMPs, green infrastructure



Estuarine & Marine

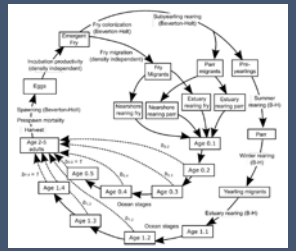
Circulation, biogeochemistry, primary production



Toxics
Nutrients
Freshwater

Salmon productivity & capacity

Salmon life cycle model (HARP)



FOOD WEB
Atlantis

GROWTH & DEVELOPMENT
Land Cover Change Model

HUMANS
WELLBEING
ECONOMIC VITALITY
EQUITY

ESTUARY
Salish Sea Model

WATERSHED
VELMA

Land cover

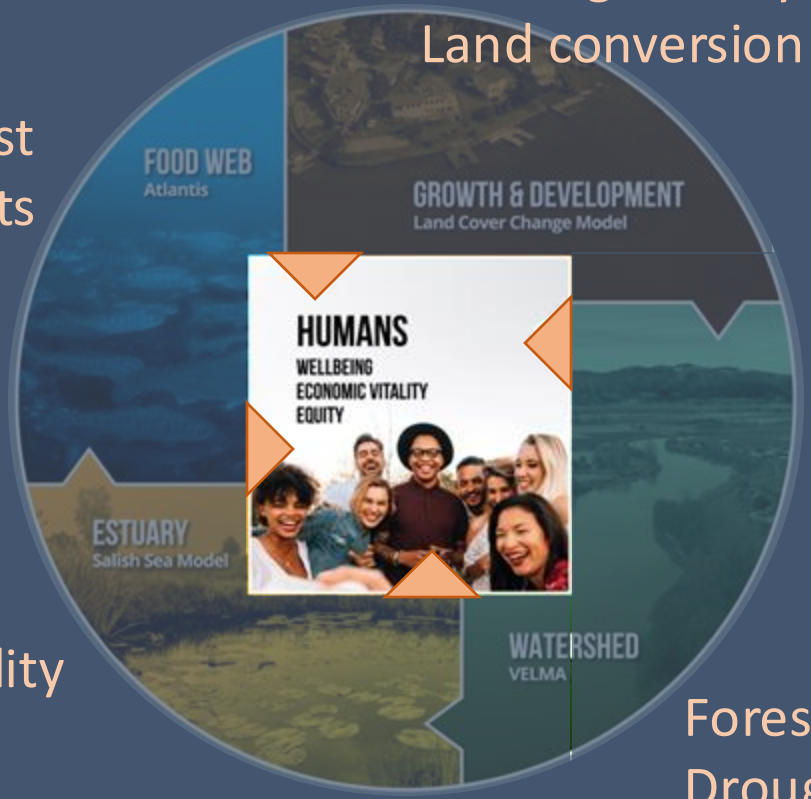
Nutrients
Toxics
Temperature

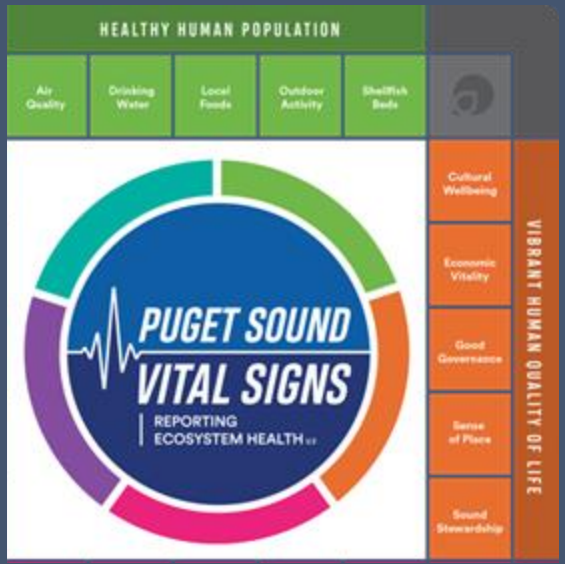
Freshwater habitat

Toxics
Nutrients
Freshwater

Housing density
Land conversion

Fishery harvest
Tribal treaty rights





Water quality

Forestry
Drought
Local Foods

Possible Management Runs

With population growth & climate change:

1. Growth management & development patterns
2. Forest and riparian management
3. Agriculture BMPs
4. Stormwater infrastructure
5. Fishery management

Possible Management Runs

With population growth & climate change:

1. Growth management & development patterns
2. **Forest and riparian management**
3. Agriculture BMPs
4. **Stormwater infrastructure**
5. Fishery management

- Buffer width/length
- Buffer placement
- Floodplain connectivity

- Improve existing infrastructure
- Green infrastructure / low impact design

Decision Support Modeling

QNM

- Compare relative outcomes
- Provide strategic advice
- Integrate non-quantifiable elements (human dim.)
- Rapid, iterative process

Both

- Test assumptions
- Identify uncertainties
- Evaluate tradeoffs

Integrated suite

- Evaluate response magnitude
- Provide tactical advice
- Computational/time intensive

Combining qualitative and quantitative models allow us to…

- synthesize decades of terrestrial, freshwater and marine information
- understand the cumulative, interactive effects of multiple threats
- identify comprehensive solutions across social-ecological objectives

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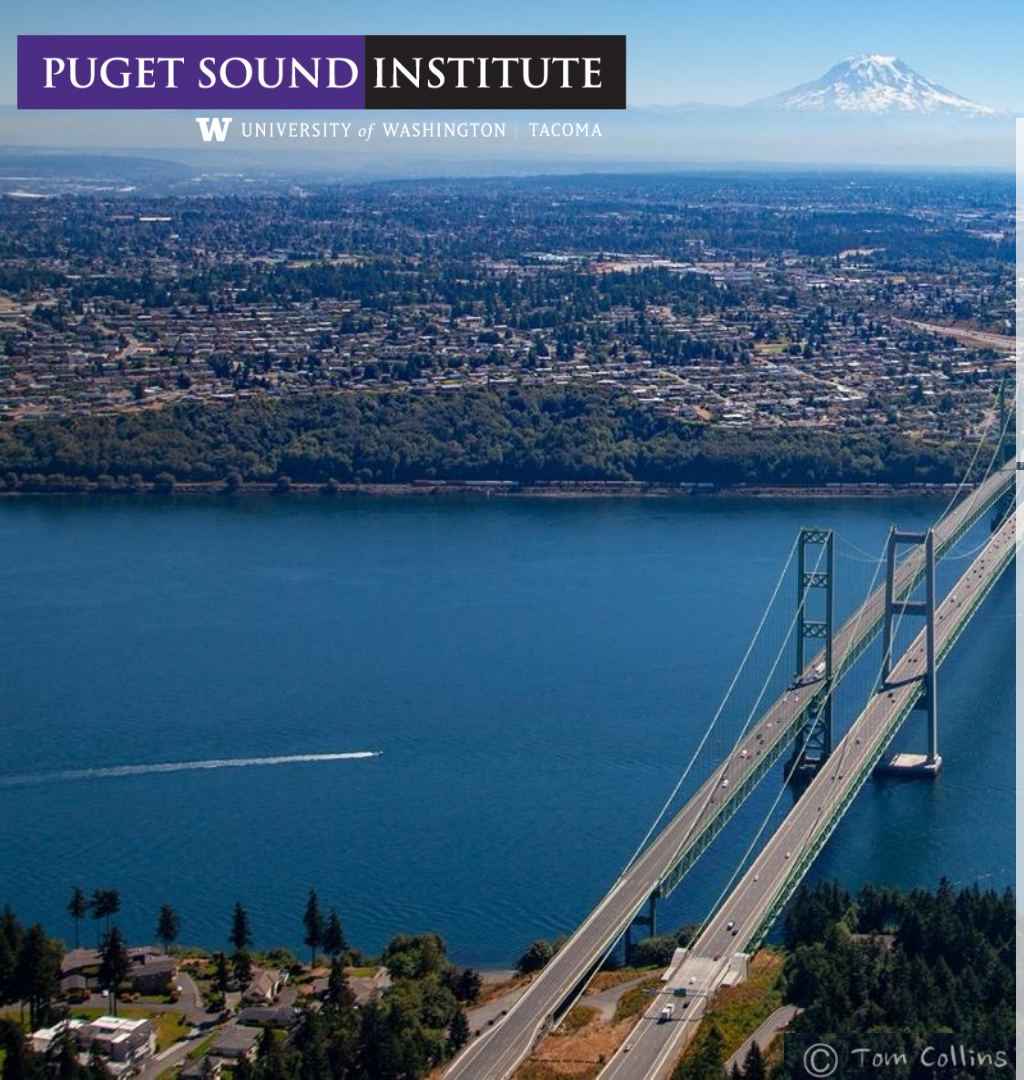

Partners & Funders

Qualitative Network Model

Magel & Francis 2022 *FMARS*

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PUGET SOUND National Estuary Program

Integrated Model Suite

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PAUL G. ALLEN FAMILY FOUNDATION

LONG LIVE THE KINGS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NOAA FISHERIES

SALISH SEA MODELING CENTER UNIVERSITY of WASHINGTON

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