Water in the West
– it’s all about supply and demand

This problem will be intensified by climate change
Willamette River Basin, Oregon

**At-Risk Snow:**
- For a 2°C temperature increase we project a 25% decrease in snow covered area
- Low elevation snowfall converts to rainfall
- ~4 km³ of water volume per year

**Willamette River Basin:**
- 29,000 km²
- 70% of Oregon’s population
- Water use: hydropower, fish, irrigation, municipal

(Nolin and Daly, 2006; Nolin et al., in press)
Water sustainability and climate

Anticipating water scarcity and informing integrative water system response in the Pacific Northwest
Our Key Questions:

• Where are climate change and human activity most likely to create conditions of water scarcity?

• Where is water scarcity most likely to exert the greatest impact on ecosystems and communities?

• What strategies would allow communities to prevent, mitigate, or adapt to scarcity most successfully?
ENVISION

Climate Trajectories
- Precipitation
- Temperature

Human Trajectories
- Population
- Income

Multi-Agent Decision Modeling

Hydrologic System
- Snowpack Modeling
- Upper Basin Hydrology
- Dams and Reservoirs
- Mainstem Water Quantity/Quality
- Aquifer Storage/Recharge

Ecosystem
- Vegetative Succession
- Land Cover Change
- Aquatic Habitat Provisioning
- T&E Aquatic Species

Landscape Change
- Human Landscape
- Biophysical Landscape
- Hydrologic Landscape

Analysis and Evaluation of Adaptation and Mitigation Responses: Policy, Management and Other Interventions

Human System
- Land use regulations, policies
- Property rights and other institutions
- External economy influences
- Markets and prices

Public Water Mgmt.

Water Use

Land Use
Envision Willamette 2100 v2 (Summer 2012)

Landscape Data
- Land Use/Land Cover
- Streams, DEMs, Roads
- Soils
- Population Density Pattern
- Population Growth
- Stand density/age
- Zoning
- Climate, Water Rights, ...

Policies and Scenarios

Socioeconomic Models
- Population Growth
- Land Use/Land Cover Change
- Agriculture and Forest Management
- Urban and Rural Development

Water System Models
- Upper Basin Hydrology
- Mainstem Hydrology/Temperature
- Dam Operations
- Demand/Water Rights/Withdrawals
- Snow
- Groundwater

FLOW Framework

Ecosystem Models
- Forest Carbon Dynamics
- Fish Community Dynamics and Biodiversity
- Vegetation Dynamics

Willamette Water 2100 Project
Each IDU described in GIS by a set of attributes used to model climate effects, vegetation dynamics, hydrology, decisions…
Spatial Scale of IDUs for WW2100
Stream Network Representation – Based on National Hydrology Dataset (NHD)

Groundwater is modeled

Dam operations are incorporated explicitly
Tradeoff Analysis - Willamette

Percent Change 2010-2060

<table>
<thead>
<tr>
<th></th>
<th>Extracted Forest Products</th>
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<th>Total Carbon</th>
<th>Habitat</th>
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<td>Unmanaged Growth</td>
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