# Pacific Northwest Hydrologic Observatory

*Deepening our knowledge of water to sustain life and livelihoods in the Pacific Northwest*

## What Do Fish Really Want?

Northwest streams and fish have evolved together for millennia. Improving our understanding of the hydrology of Pacific Northwest ecosystems is critical for managing aquatic species. Many--such as salmon, steelhead, and bull trout--are already threatened.

Taking the pulse of river systems by measuring nutrient flux, channel form, temperature, flow patterns, and source-type will clarify impacts of climate and land use change.

The Observatory will help determine whether fish favor stream regimes with particular water temperature, water chemistry, stream configuration or other hydrologic characteristics.

According to Roy Haggerty of OSU's Geosciences Department, being able to forecast changes in low flows and peak flows, as well as changes in the total extent of the stream network will be invaluable for Northwest fisheries managers.

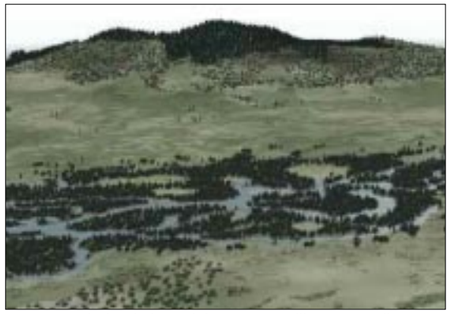
In addition to siting more stream gages, using nutrient tracers, and increasing aquatic species population monitoring, fish will be equipped with radiotelemetry units and miniature data loggers. "In the Observatory, fish actually become part of the instrument network," says Stan Gregory of OSU's Fisheries and Wildlife Department.

## A New Angle on the Northwest?

The Observatory won't just store information in separate drawers of some virtual filing cabinet . It will lead in the application of new technologies to share its information with a broad audience, from scientists to school kids.

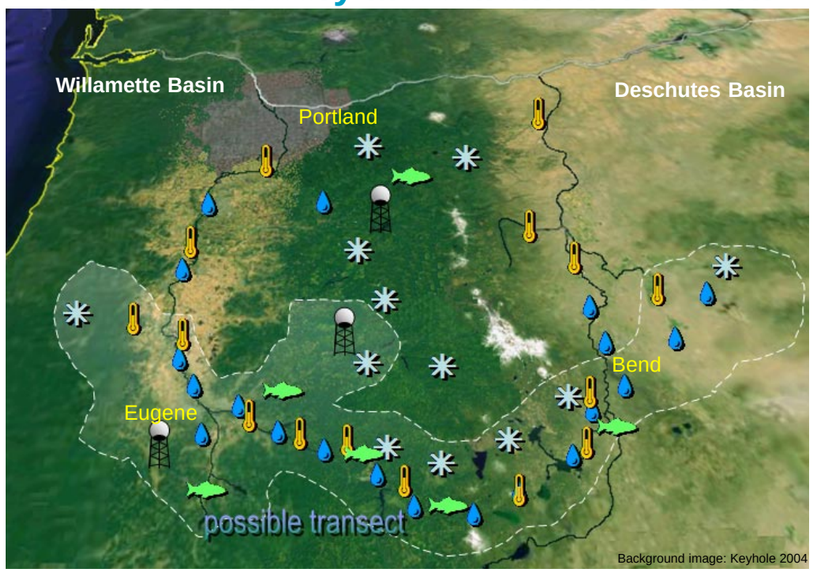
One of the most striking items in the technology toolbox is visualization.

Whether we're talking about rotatable 3-D images of hydrologic processes on computer screens, or physical models of watersheds draped with digital land use or geologic data, we have an unparalleled opportunity to showcase exciting information in new ways," says Mike Bailey, professor of computer science at OSU.



A computer-derived view of the Upper Willamette Valley's pre-settlement landscape circa 1850, based on historical sources. (Willamette River Basin Planning Atlas, 2002).

## The Observatory Measurement Network




This figure illustrates one possible configuration of Observatory measurement sites.

The Observatory will measure and link a wide range of physcial phenomena. This information will be processed and made available to the science community worldwide and to citizens of the nation and the Northwest.

**Potential Observatory Measurement Sites**
(in addition to existing networks)

- Multi-variable water station
- Streamflow gage
- Fish telemetry
- Snow telemetry
- Weather radar

***For more information on the Pacific Northwest Hydrologic Observatory, visit http://forestry.pnwho.oregonstate.edu, or phone Jeff McDonnell, Richardson Chair in Watershed Hydrology, Oregon State University, 541.737.8720.***

## Water in the Pacific Northwest: Running Out?

Being short of water in the Pacific Northwest isn't some future condition dreamt up by gloomy planners. It's today's reality.

Even right now, there's not enough water to satisfy all the needs of farmers, cities, industries, and fish.

And with a population that will at least double in 50 years; with potentially big swings in climate; and with accumulating environmental stresses--one of the most important questions facing the Northwest is: how can we manage water to support the quality of life that's so much a part of who we are?

Water isn't just an issue in the Northwest. The General Accounting Office recently found that even under normal water conditions, water managers in 36 states anticipate water shortage in the next 10 years.[1]

And the National Research Council says that the U.S. needs to make a new commitment to research on water resources in order to confront increasingly severe water problems faced by all parts of the country.[2]

With its astounding physical diversity, its history of environmental innovation, its nationally-recognized network of science centers, and a population committed to stewardship, the Pacific Northwest is the perfect home for a new Hydrologic Observatory.

[1] GAO, 2003; States' Views of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages.
[2] National Research Council, 2001; Envisioning the Agenda for Water Resources Research in the 21st Century

## The Pacific Northwest Observatory: Finding Out

The National Science Foundation is establishing a series of new Hydrologic Observatories. Their purpose is to establish innovative ways of gaging the sustainability of the nation's water supplies and to better link our understanding of water to climate, ecology, and society.

A consortium of interests is partnering to establish the Pacific Northwest Hydrologic Observatory--a new window on how water "works" in the Pacific Northwest. Oregon State University and its Institute for Water and Watersheds is supporting the development effort

A hydrologic observatory is like a space station, where scientists train lots of instruments on earth's land and waters. The resulting data are streamed back to researchers world-wide to help improve our every-day lives, such as through improved weather forecasting.

Similarly, the Observatory will be "in orbit" over the Pacific Norhwest and provide a place where visiting scientists can conduct nationally important research to achieve an in-depth understanding of how climate, landscape, and human activity shape our water supply.

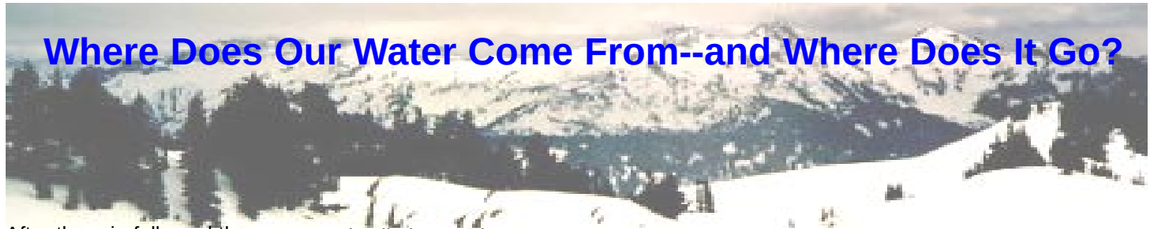
The Observatory will monitor snow and precipitation, climate change, streamflows, water quality, groundwater, and ecological change--and then broadcast that information widely.

"We aren't yet able to provide good answers to emerging questions about how water will be impacted by climate variation, population growth, or land use change," says lead investigator Jeff McDonnell of Oregon State University. "We need to find out more about the details of snowmelt, how geology and precipitation zones interact, how our big rivers work, and how our water demand intersects with future supplies."

The Observatory will initiate its exploration in Oregon's Willamette and Deschutes River Basins to identify how water works in a wet and a dry area, each with rapidly growing populations.

The Observatory will provide vital information to Northwest citizens as they grapple with increasingly difficult water resource challenges.

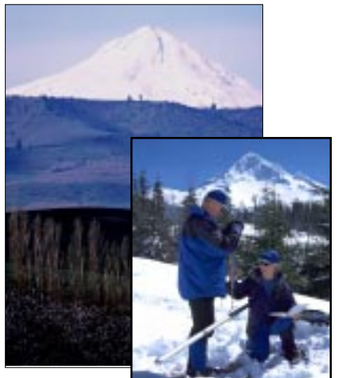
# Where Does Our Water Come From--and Where Does It Go?



After the rain falls and the snow melts, for the most part we lose track of water. We can measure it roughly in water table levels, or take snapshots of it as it goes by stream gages--but over 100 years after we first started measuring, we still don't have a good understanding of how water moves through our landscape.

Getting that understanding is what the Pacific Northwest Hydrologic Observatory is all about. The Northwest provides an unrivaled physical laboratory. The Observatory will measure and compare our big rivers in new ways (and we have some of the biggest rivers in the U.S.); contrast water behaviors in side-by-side humid and arid landscapes; develop and test new landscape-based hydrologic classifications--all to improve our ability to forecast not only how our water world may change--but also the consequences of that change, especially by identifying emerging water scarcities.

"This is a chance for us to put it all together--to solve the equation where water is the sum of climate, geology, ecology, and human activity. We're designing the Observatory to take those measurements that are most critical for advancing hydrologic science," says Jeff McDonnell, Richardson Chair of Hydrology with Oregon State University's College of Forestry. "By moving from a simplistic 'black box' approach, toward one based on an organized and systemic explanation of process, we'll reduce uncertainty and improve our ability to predict water quantity, quality and scarcity at the basin scale."





## Are Snow Packs at Risk?

2005 has one of the lowest snow packs on record in the Northwest. Mountain snowpacks act as a key reserve for precipitation because they store water during the winter and release it during spring and early summer when conditions are warmer and drier. The water sector report for the U.S. National Assessment of Climate Change states that the potential response of snowmelt-dominated watersheds to climate warming is among the most profound impacts of climate change in terms of ecological health and water supply. According to Anne Nolin, snow climatologist with Oregon State University's Geosciences Department, recent studies show that snowpacks are declining across the western US but most dramatically (-29%) in the Pacific Northwest .

"Our snow measurements are mostly from the highest, coldest places," said Nolin. "We have little information on the much larger , lower elevation snow zone most affected by climatic variation. By getting that information, the Observatory will boost our understanding of snow hydrology."

## Water: Is Geology Destiny?

"Many people would be surprised that most summer flow out of the high Cascades is not due to snowmelt. Rather, the high Cascades act as a huge hydrologic sponge that stores decades of water deep underground," says Gordon Grant, research hydrologist with the U.S. Forest Service PNW Research Station.

"Recent analysis of Cascade streams large and small has revealed that geology plays a critical role in determining streamflows."

By relating streamflow to local geology--especially the age of rock age and drainage density--the degree of geologic influence can be evaluated. Geology can be used to predict streamflow behavior under current and future climate and land use change scenarios.

"The Observatory will allow us to deepen our understanding of how our diverse and distinctive geology influences our water production and supply," according to Grant.

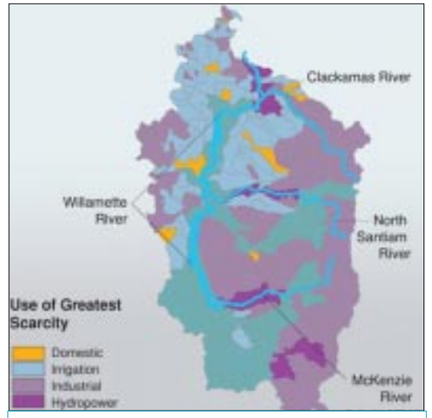


## Water Scarcities: Who's First--and When?

Because water in the Northwest is already in short-supply, it's not hard to believe that a varying climate, a doubling of our population, and increasing stresses on the environment will add up to marked water scarcities.

The challenge is turning that conventional wisdom into meaningful information that can be acted on by Northwest citizens to assure sustainable water supplies. And that means "running the numbers" from climate and precipitation trends, groundwater levels, demographics--and Oregon's water right system--to identify where and when water scarcities emerge, and which water users will be most affected.

The recent Willamette Alternative Futures Project was a first run at doing just this, says David Hulse of the University of Oregon's Landscape Architecture Department. "We were able to show substantial water scarcities emerging by 2050 in the northern Willamette basin. But our work did not consider climate change or groundwater availability, and used static representations of stream flow at a coarse spatial reporting unit. The Observatory will allow us to refine our approach and include those additional parameters, as well as cover new ground in the arid Deschutes basin."




Areas of water scarcity from Willamette River Basin Planning Atlas, OSU Press, 2002

## Hydro Regions: A New Window on Understanding?

How do you figure out how water works in a region where it takes so many forms? The Pacific Northwest has big, booming, mountain streams, pokey and meandering valley streams, and desert rivulets, to name a few--all with different sources. Some water dashes out of soaked mountain gravels almost immediately; some water can take decades to well out of the vast volcanic sponge underlying the Cascades.

The Observatory will help get a handle on this region's hydrology by literally going to the source. Cross-referencing geologic formations with precipitation zones creates a new source map--one made of distinct hydro regions,

"We're interested in looking at hydrology through a framework of rocks, rain, and snow," said John Selker of OSU's Bioengineering Department. "We believe we can come to a new understanding of the behavior of rivers by capturing the interactions between climate and geology at a fairly local scale."

Development of this new type of hydrologic classification would be at the heart of the Observatory's mission. The measurement strategy would be guided by the classification--and the value of the classification would be tested for national utility by Observatory researchers.