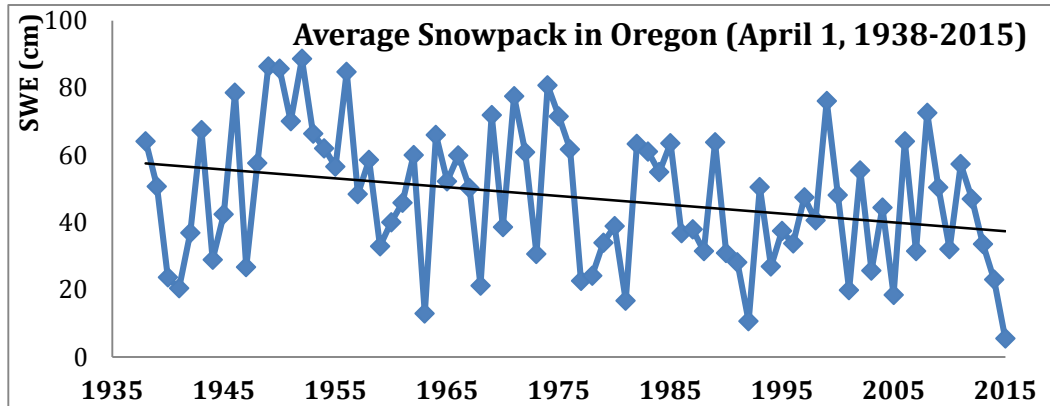


## **Introduction:**

Historical snowpack measurements have been recorded since the 1930's; over time this data has presented a negative trend, as illustrated in the graph below. Climate patterns will cycle through natural fluctuations, however SNOTEL snowpack recordings reveal a decrease in snowpack during peak years as well as historical lows.<sup>1</sup>



Data reflect the average SWE measurements taken from Natural Resources Conservation Service SNOTEL sites (33-59 total sites for each year). This data was compiled and provided by Phil Mote (Oregon Climate Change Research Institute).

Decreased snowpack has been accompanied by earlier timing of peak snowmelt, both correlated to warmer temperatures that prevent precipitation from falling or remaining as snow. (Mote, 2003) This changing climate results in significant modifications to flow regimes; early snowmelt can increase winter flows and decrease water availability later in the summer. Amplified winter runoff can lead to flooding, and limited runoff in summer months can contribute to drought conditions. (Mote, 2015) These changes influence an array of stakeholders, all unified through water. Food production, wildlife, hydropower, tribes, and water rights allocation are all impacted within watersheds dictated by Cascade snow hydrology are all impacted by decreased snowpack and early mountain runoff. As scientists, conservationists, and humanists, it is our responsibility to work together, not only to address potential impacts, but also to encourage risk analysis and adaptation to prepare for future conditions using the best available information.

## **Prompt:**

You are on a stakeholder committee to develop a plan of action that addresses potential consequences of decreasing snowpack and early snowmelt. This will begin with a discussion among your committee about the values of your constituents and what a thriving basin would need 20 years from now. In a plenary session, each committee will briefly share their values and their vision for the basin. Your committee will then have 20 minutes to determine a plan of action for achieving this vision as it relates to water management. Consider that the state of Oregon has received a federal grant to address water management solutions that enable flexibility for historically discrepant flow regimes. Your task within your committee is to agree upon how to partition funding into three fund pools: education & outreach, research, and infrastructure. You are not required to fund all three. Specify what percentage of the federal grant will be allocated to each fund pool. Itemize individual actions/steps supported within each fund pool to treat stakeholder concerns that help promote the vision for the basin. Provide

details on implementation such as who is responsible for execution of your itemized agenda, as well as intended impacts and what concern is being treated with each item.

While strategizing within your stakeholder committee, you will have the opportunity to ask your featured expert questions related to their field. Once your committee has agreed upon a set course of action, the committee must select one member to act as a representative to participate in a fishbowl deliberation amongst an interdisciplinary panel. Each student representative will come to the table with their action plan and itemized agenda. The panel will have 25 minutes to come to an agreement on how funding should be partitioned as well as a comprehensive agenda which considers the concerns of every stakeholder.

**Workshop Agenda:**

- 1:00-1:05: Welcome & Review Agenda
- 1:05-1:20: Introduction of Featured Field Experts
- 1:20-1:30: Committees Discuss Vision for Basin
- 1:30-1:40: Committees Share Visions
- 1:40-2:00: Committees Develop a Plan of Action
- 2:00-2:25: Fish Bowl Deliberation
- 2:25-2:30: Wrap-up

**Oregon 2015 Peak Snowpack**



"Oregon Basin Outlook Report: May 1, 2015" (USDA, NRCS, 2015),

*"The story of 2015 was really the exceptional warmth... Historically, droughts in the West have mostly been associated with dry winters, and only secondarily with warmth. But 2015 was different. The primary driver of the record low snowpacks was the warm winter, especially in California, but in Oregon and Washington as well."*

– Dennis Lettenmaier (OSU News, 10/31/2016, Mote & Lettenmaier)

**Further Reading on Climate Patterns**

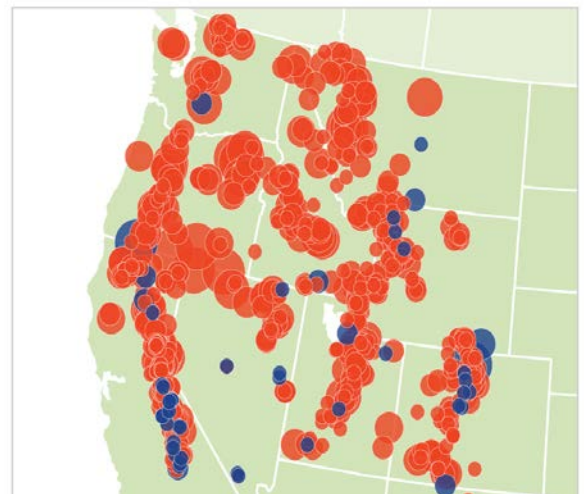
Mote, P.W., and D. Sharp. 2016 update to data originally published in: Mote, P.W., A.F. Hamlet, M.P. Clark, and D.P. Lettenmaier. 2005. Declining mountain snowpack in Western North America. *B. Am. Meteorol. Soc.* 86(1):39–49.

Mote, Philip W. "Trends in Snow Water Equivalent in the Pacific Northwest and Their Climatic Causes: TRENDS IN SNOW WATER EQUIVALENT." *Geophysical Research Letters* 30, no. 12 (June 2003). doi:10.1029/2003GL017258.

OSU News and Research Communications. "West Coast record low snowpack in 2015 influenced by high temperatures." <http://oregonstate.edu/ua/ncs/archives/2016/oct/study-west-coast-record-low-snowpack-2015-influenced-high-temperatures>

Mote, Philip W., David E. Rupp, Sihan Li, Darrin J. Sharp, Friederike Otto, Peter F. Uhe, Mu Xiao, Dennis P. Lettenmaier, Heidi Cullen, and Myles R. Allen. "Perspectives on the causes of exceptionally low 2015 snowpack in the western United States." *Geophysical Research Letters* 43, no. 20 (2016). doi:10.1002/2016gl069965.

Trends in April Snowpack in the Western United States, 1955–2016

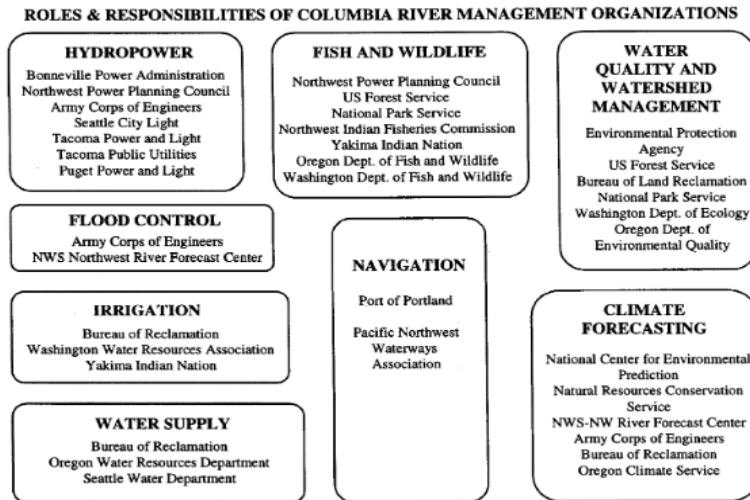


Mote, Sharp; 2016



## Further Reading on Water Management

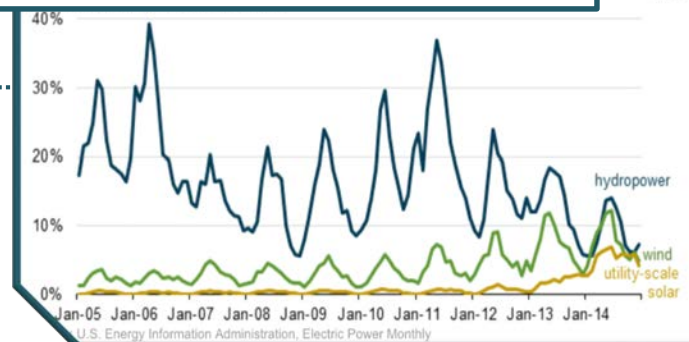
Oregon Water Resources Department. "Oregon's Integrated Water Resources Strategy." *Oregon.gov*, Aug 14, 2012 [https://www.oregon.gov/owrd/Pages/law/integrated\\_water\\_supply\\_strategy.aspx](https://www.oregon.gov/owrd/Pages/law/integrated_water_supply_strategy.aspx)  
Callahan, Bridget, Edward Miles, and David Fluharty. "Policy Implications of Climate Forecasts for Water Resources Management in the Pacific Northwest." *Policy Sciences* 32,no. 3(1999):269–93.  
Independent Scientific Advisory Board. *Climate Change Impacts on Columbia*. Portland, OR: ISAB Climate Change Report, 2007. [http://www.nwcouncil.org/media/31247/isab2007\\_2.pdf](http://www.nwcouncil.org/media/31247/isab2007_2.pdf)



Callahan, 1999

## Further Reading for Stakeholders

January Electricity Generation in California (2005-2014);  
Hydropower, Wind, & Solar by % of Total Energy Generated



eia

### Hydropower

#### Potential for Impact:

- ❖ Flood mitigation
- ❖ Harnessing power from high flow events beyond threshold capacity
- ❖ Effects on timing of release from reservoirs

#### Further Reading:

EIA. "California's continued drought, reduced snowpack mean lower hydropower output". April 9, 2015. <https://www.eia.gov/todayinenergy/detail.cfm?id=20732>  
EIA. "The Columbia River Basin provides more than 40% of total U.S. hydroelectric generation." June 27, 2014. <http://www.eia.gov/todayinenergy/detail.php?id=16891>

EIA, 2015

## Water Law

### Potential for Impact:

- ❖ Adaptation to water allocation and rights (surface water and groundwater)
- ❖ Changes to regulatory statutes and practices
- ❖ Drought assistance programs

### Further Reading:

Bateman, Brenda. "The Future of Water Law: What Happens When Climate Changes The Rules?".  
Water Resources Impact 16, no. 1 (January 2014).

Oregon Water Resources Department, "Water Management Workshop". 2016. Presentation.

[http://smallfarms.oregonstate.edu/sites/default/files/water\\_mgmt\\_workshop\\_mccord\\_plahn.pdf](http://smallfarms.oregonstate.edu/sites/default/files/water_mgmt_workshop_mccord_plahn.pdf)

## Ecology

### Potential for Impact:

- ❖ Decreasing stream temperature
- ❖ Changing flow regimes
- ❖ Seasonal depth at hatching grounds
- ❖ Fish disease and die-offs

### Further Reading:

Beechie, Timothy, Eric Buhle, Mary Ruckelshaus, Aimee Fullerton, and Lisa Holsinger. "Hydrologic regime and the conservation of salmon life history diversity." *Biological Conservation* 130, no. 4 (2006): 560-72. doi:10.1016/j.biocon.2006.01.019.

Independent Scientific Advisory Board. *Climate Change Impacts on Columbia*. Portland, OR: ISAB Climate Change Report, 2007. [http://www.nwcouncil.org/media/31247/isab2007\\_2.pdf](http://www.nwcouncil.org/media/31247/isab2007_2.pdf)

Crozier, Lisa G., and Richard W. Zabel. "Climate impacts at multiple scales: evidence for differential population responses in juvenile Chinook salmon." *Journal of Animal Ecology* 75, no. 5 (2006): 1100-109. doi:10.1111/j.1365-2656.2006.01130.x.

## Tribal Resources

### Potential for Impact:

- ❖ Effect on fish & wildlife
- ❖ Effect on food subsistence, culture, and traditions
- ❖ Hatchery environment during spawn season
- ❖ Health of native oyster estuary

### Further Reading:

"Natural Resources Department." Siletz Indians Tribal Services, Cape Lookout, Chinook Indians, Clackamas County Oregon - Education Natural Resources. <http://www.ctsi.nsn.us/Siletz-Tribal-Services-Umpqua-Clackamas-County-Tillamook/other-departments/natural-resources-2#co>

Shannon Hurn to Governor Kate Brown, September 22, 2015. 2015 Drought Briefing from ODFW.

For a copy, visit:

[http://hydrophilesresearchsymposium.org/sites/hydrophilesresearchsymposium.org/files/odfw\\_drought\\_briefing.pdf](http://hydrophilesresearchsymposium.org/sites/hydrophilesresearchsymposium.org/files/odfw_drought_briefing.pdf)

## **Farmers & Ranchers**

### Potential for Impact:

- ❖ Increased uncertainty in crop management (e.g., regulatory drought)
- ❖ Water scarcity during growing season
- ❖ Early season flooding
- ❖ Impacts on pasture and livestock conception and weaning rates
- ❖ Impacts on commodity pricing and marketplace competition

### Further Reading:

Miller, Michelle, Molly Anderson, Charles Francis, Chad Kruger, Carol Barford, Jacob Park, and Brent Mccown. "Critical Research Needs for Successful Food Systems Adaptation to Climate Change." *Journal of Agriculture, Food Systems, and Community Development*, 2013, 1-15. doi:10.5304/jafscd.2013.034.016

Bernton, Hal. "The Northwest's snowpack drought: With water cutbacks, farmers risk crop losses." *Seattle Times*, June 6, 2015. <http://www.seattletimes.com/seattle-news/the-northwests-snowpack-drought-even-with-cutbacks-farmers-risk-going-dry/>.

"Natural Resources Conservation Service." Drought Assistance | NRCS Oregon. Accessed Feb 2017. <https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/or/home/?cid=nrcseprd334210>

Please visit [http://hydrophilesresearchsymposium.org/2017\\_Blue\\_Ribbon](http://hydrophilesresearchsymposium.org/2017_Blue_Ribbon) for more information and links