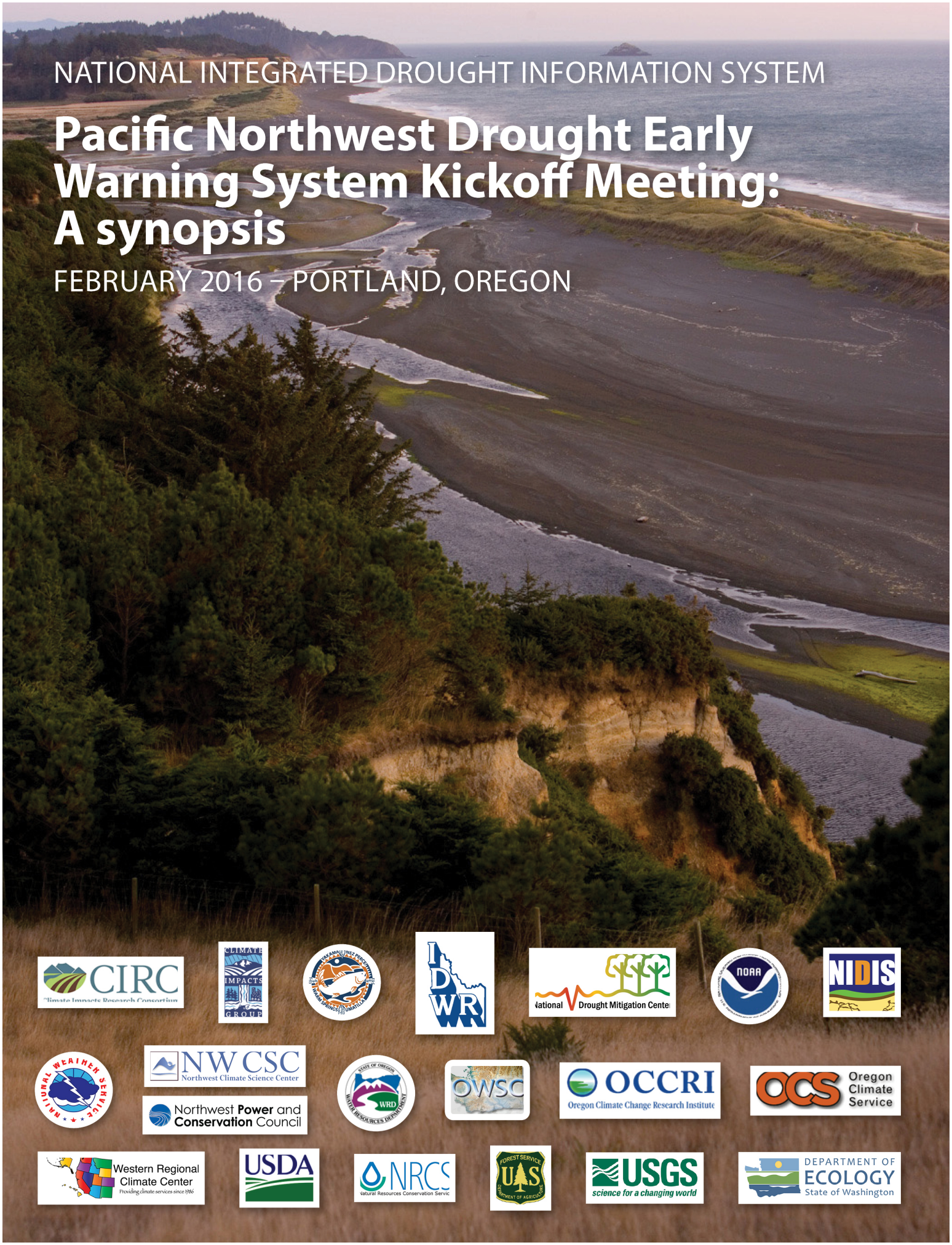
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Pacific Northwest Drought Early Warning System Kickoff Meeting: A synopsis

FEBRUARY 2016 – PORTLAND, OREGON



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Introduction to the Pacific Northwest DEWS

NOAA's National Integrated Drought Information System (NIDIS) is initiating the development and implementation of a **Drought Early Warning System (DEWS)** in the Pacific Northwest. NIDIS DEWS comprise a network of regional drought early warning systems throughout the United States, where, in accordance with Congressional mandate (P.L. 109-430 and P.L. 113-86), NIDIS is working closely with federal, state and local interagency partners to improve early warning capacity and resilience to drought.

Background

The Pacific Northwest, often associated with rainy forecasts and endlessly foggy days, is an ecologically diverse region heavily reliant on snowpack, precipitation, groundwater and highly managed rivers like the internationally regulated flow of the Columbia River for its water supply. Despite its soggy reputation, the Pacific Northwest is not a stranger to drought. The region experienced multiple droughts in the early 21st century. By 2015, when virtually the entire region reached historic drought conditions, the eastern portions of Oregon and Idaho had been suffering under prolonged drought for four years. While these areas east of the Cascade Mountains had been experiencing drought for many years, in many ways the coastal regions of Oregon and Washington were hit hardest by the drought of 2015.

WHAT IS NIDIS?

The National Oceanic and Atmospheric Administration's (NOAA) National Integrated Drought Information System (NIDIS) program was authorized by Congress in 2006 (Public Law 109-430) with an interagency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local partnerships in support of creating a national drought early warning system.

WHAT IS A DEWS?

A DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local and academic partners in order to make climate and drought science readily available, easily understandable and usable for decision makers; and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.

Higher than average temperatures, which defined the drought of 2015 in the Pacific Northwest, were in line with what experts expect for the region by mid to late century under most climate scenarios. The drought of 2015 was not only the new drought of record for the region, but led many to consider it a preview of the future and for them to reevaluate how water is managed in the region.

Pacific Northwest water supply is largely contingent on snowpack, which is often referred to as a natural reservoir. As temperatures warm throughout the spring, the snowpack melts, feeding streams, rivers, lakes and reservoirs that are used to irrigate agricultural lands, support ecosystems (often relied upon by federally listed endangered species), supply hydropower and sustain drinking water supplies to cities, and supplementing ground water aquifers often relied upon by small systems and vulnerable communities. How and when that snowpack develops and eventually melts largely dictates how and if drought may develop throughout the year.

Over the historical record, Pacific Northwest precipitation frequency tapers off in late spring and summer months, when water supply is supplemented by snowmelt. Consistent with recent climate change projections for the future, the snow drought of 2014-15, coupled with a hotter and drier spring and summer conditions, led to record low levels in the region's rivers and streams and severely impacted coastal watershed basins.

Pacific Northwest Drought Early Warning System (PNW DEWS) consists of the states that encompass the Columbia River Basin.

In response to the potential for drought in the Pacific Northwest, NIDIS and its partners launched the Pacific Northwest DEWS in February 2016. The Pacific Northwest DEWS is a collaborative federal, tribal, state, and local interagency effort to improve early warning capacity and resilience to both drought and understand the relationship between drought and future climate change scenarios in the region. This is accomplished through local stakeholder-driven activities encompassing data collection and monitoring; research; planning for climate extreme events; and communication, education, and outreach. Activities will focus on the states encompassing the Columbia River Basin (Idaho, western Montana, Oregon and Washington.)

Specific objectives of the Pacific Northwest DEWS are to:

- Provide a forum for a diverse group of federal, tribal, state, and local stakeholders that represent all economic sectors, including water and land resource management, to strategize and develop appropriate, relevant, useful and readily available drought, climate, weather and water-related information.
- Develop an understanding of the existing observation and monitoring networks, data, tools, research and other planning and mitigation resources available for a drought early warning system.
- Identify the economic sector-specific and geographic needs for future monitoring, prediction, planning and information resources.

Mission of the Pacific Northwest DEWS
Enhance drought resilience in the Pacific Northwest region by improving the ability for communities to collaborate, plan and be prepared for drought, understand the relationship between drought and potential future climate change scenarios, better utilize available tools and climate forecasts and to proactively identify, mitigate and respond to drought impacts.

Pacific Northwest DEWS Kickoff Meeting and Planning Process

The Pacific Northwest DEWS Kickoff Meeting was held February 2-3, 2016 in Portland, OR to formally launch the DEWS. The two-day event brought together federal, tribal, state, local, and academic partners and other stakeholders for an in-depth discussion on drought events in the Pacific Northwest, with attention to water, climate, land resources, and emergency management. Discussions centered on improving the capacity to meet the early warning information needs of decision makers in the region.

The desired outcomes of the Pacific Northwest DEWS Kickoff Meeting included:

- Increased knowledge and awareness of present decision-support tools and processes, including the National Integrated Drought Information System (NIDIS) and its partners.
- Identification of current knowledge and information gaps.
- Development of recommendations for improved early warning, which would include better coordination of integrating, displaying, and disseminating climate, weather, and water data and information.
- Development of recommendations for future actions, collaborative research, and decision support tools.
- Identification of baseline evaluation metrics for drought and its associated impacts.

Information gathered during two regional drought outlooks and one listening session in 2015 helped to inform the planning for the Pacific Northwest Kickoff Meeting in February 2016.

Partners from across the region involved in the launch and development of the PNW DEWS included:

Climate Impacts Research Consortium (CIRC)
Climate Impacts Group (CIG)
Columbia River Inter-Tribal Fish Commission (CRITFC)
Desert Research Institute (DRI)
Idaho Department of Water Resources (IDWR)
National Drought Mitigation Center (NDMC)
National Oceanic & Atmospheric Administration (NOAA)
- National Integrated Drought Information System (NIDIS)
- National Weather Service (NWS)
- Northwest River Forecast Center (NWRFC)

Northwest Power & Conservation Council
Office of Washington State Climatologist (OWSC)
Oregon Climate Change Research Institute (OCCRI)
Oregon Climate Service (OCS)
Oregon Water Resources Department (OWRD)
U.S. Department of Agriculture (USDA)
- Natural Resource Conservation Service (NRCS)
- Northwest Climate Hub
- U.S. Forest Service (USFS)

U.S. Department of Interior (DOI)
- Northwest Climate Science Center (NWCSC)
- U.S. Geological Survey (USGS)

Western Regional Climate Center (WRCC)
Washington State Department of Ecology (WADOE)

Inland Pacific Northwest Drought Outlook on May 4, 2015 in Boise, ID

On May 4, 2015, more than 45 water managers representing the agriculture, energy, recreation, forestry and fish and wildlife sectors from across the Pacific Northwest gathered at the National Interagency Fire Center (NIFC) campus in Boise, Idaho for an Inland Pacific Northwest Drought Outlook to discuss how to shape a potential DEWS for the Pacific Northwest. The Inland Pacific Northwest, made up of the Columbia River drainage and regions east of the Cascade Mountains tends to be drier than coastal portions of the region and experiences drought more frequently. Participants expressed interest in exploring better communication avenues between the scientific community and resource managers, access to improved shoulder season forecasts, and opportunities to enhance long-term drought planning and mitigation.

Coastal Pacific Northwest Drought Outlook on September 22, 2015 in Vancouver, WA

As the drought of 2015 crept into the coastal regions of the Pacific Northwest, it provided an opportunity to explore how resource managers were dealing with an extreme drought in real time. On September 22, 2015 the University of Washington Climate Impacts Group (CIG), the Office of the Washington State Climatologist (OWSC), the Climate Impacts Research Consortium (CIRC) a NOAA Regional Integrated Science and Assessment (RISA) team, and NOAA's National Integrated Drought Information System (NIDIS), Regional Climate Service, and National Weather Service hosted a

Coastal Pacific Northwest Drought Outlook in Vancouver, Washington. More than 60 stakeholders attended the Outlook to discuss drought impacts and forecasting and monitoring needs for western Oregon and Washington. Participants echoed the suggestions from the Inland Outlook for better coordinated drought communication and outreach across sectors, a centralized location for information on drought impacts, and more on-the-ground instrumentation (i.e. more SNOTEL, streamflow monitoring that includes water temperature, soil moisture and groundwater).

Listening Session at the 2015 Northwest Climate Conference

The sixth annual Northwest Climate Conference (NWCC) in Coeur d'Alene, ID on Nov. 5, 2015, brought together researchers, resource managers, and policy makers from academia, public agencies, tribal nations, non-governmental organizations, and the private sector to discuss the latest climate science and adaption solutions, as well as challenges to infrastructure, industry, environment and communities in the Pacific Northwest. While the drought of 2015 could not be attributed directly to climate change it did cause impacts associated with climate change scenarios. During a listening session on November 5, 2015, approximately 100 participants discussed ways lessons learned during the drought could be used to build the components of a Pacific Northwest DEWS, and to prepare for future events with similar impacts. Needs voiced included enhanced and coordinated public communication on drought impacts and mitigation methods; increased streamflow monitoring; and more research on the relationship between drought and wildfire fuels management.

Summary of the Pacific Northwest DEWS Kickoff Meeting

The Kickoff Meeting included presentations from keynote speakers and content experts, panel discussions, small discussion groups, and participant surveys that dove deeper into priority needs and proposed actions that had been identified by stakeholders during the 2015 meetings.

Nearly 100 participants from across the Pacific Northwest (Idaho, Montana, Oregon & Washington) as well as California, Colorado, Nebraska, Nevada and Washington, DC attended the Pacific Northwest DEWS Kickoff Meeting in Portland, OR February 2-3, 2016.

Keynote Speaker Highlights

Keynote speakers included Robin Webb, Director of NOAA's Physical Sciences Division (PSD); Lauri Aunan, Natural Resources Policy Advisor to Governor Kate Brown (Oregon); and Mark Svoboda, Climatologist, US Drought Monitor Author and Monitoring Program Area Leader at the National Drought Mitigation Center in the School of Natural Resources, University of Nebraska.

Robin Webb, Director of NOAA Physical Sciences Division (PSD)

Dr. Webb, director of NOAA's Physical Sciences Division (PSD) which is part of the Earth System Research Laboratory located in Boulder, CO, opened the meeting with a brief overview of NOAA's role as an "Environmental Intelligence Agency" that provides leadership in observation, monitoring, assessment, modeling, and forecasts and products which are critical to the success of a Pacific Northwest Drought Early Warning System. He said NOAA is not only a leader in developing and providing climate and weather forecasts and outlooks, but also pioneers innovative research projects like the recent 2016 NOAA El Niño Rapid Response Field Campaign, and the Forecast-Informed Reservoir Operations (FIRO) proposed management strategy that uses data from watershed monitoring and modern weather and water forecasting to help water managers operate reservoirs in response to current and forecasted conditions.

Lauri Aunan, Natural Resources Advisor to Governor Brown (Oregon)

Ms. Aunan, one of four natural resource policy advisors for Oregon Governor Kate Brown, focuses on policies to enhance Oregon's resiliency to drought and other water supply issues. Drought emerged as a priority area for Gov. Brown, who saw 2015 as a "warning shot" for the future. Eastern Oregon in particular had been experiencing a multi-year drought, but western Oregon was hit harder by drought in 2015 than most could remember. In addition to signing an Executive Order requiring all state agencies to reduce water consumption 15% by 2020, the governor and legislature were able to work together to establish grant and loan programs for drought monitoring and emergency assistance.

Information resources like the U.S. Drought Monitor and other federal data were useful in helping the governor and her staff demonstrate the need for a swift response to current conditions. They used this information to bolster support to evaluate whether the state had the necessary tools to mitigate the effects of future droughts and water shortages. The governor guided a "drought package" through the legislature, and credited the availability of federal data as a key to the success of the effort. Looking to the future, Ms. Aunan said in order for Oregon to adapt to future droughts and possible new climatic realities, the state will need to ramp up programs to upgrade infrastructure, educate the public and change the common perception that there is an abundance of water, all the while recognizing that water scarcity will test Oregon's longstanding history of collaboration.

Mark Svoboda, Climatologist & US Drought Monitor Author at NDMC

Mr. Svoboda, one of the original and current authors of the U.S. Drought Monitor (USDM), said that while the USDM is one of the most effective drought communication and awareness tools, it is an assessment of current conditions, not a forecast. One of the strengths of the USDM is that it

combines an objective percentile approach to assessing drought with local expert input from state climatologists, drought coordinators, water and resource managers to build ownership and validation into the process. The USDM is used by various federal agencies to advise and support decision making. Examples include the USDA "fast tracking" of drought designations and the Internal Revenue Service's (IRS) livestock tax deferral program. Mr. Svoboda said that he hopes the establishment of the Pacific Northwest DEWS will help to strengthen the linkages between USDM authors and local drought task forces, State Climate Offices, NWS Weather Forecast Offices (WFOs) and River Forecast Centers (RFCs), and Regional Climate Centers to further refine the usefulness of the USDM for the region.

Highlights of the Presentations and Panel Discussions

Theme 1: Setting the Stage for the Pacific Northwest DEWS

The first day of the meeting provided presentations on the current climate and drought outlooks; an overview of history of drought in the region; and ocean conditions.

- Above average temperatures for the region throughout 2015 resulted in a diminished snowpack despite near average winter precipitation, but below average for spring and summer.
- The drought of 2015 is being considered by many as the new drought of record for the region, especially for western Oregon and Washington. Experts expect to see more of this type of drought in the future based on climate predictions.
- Impacts of little to no snowpack were further exacerbated by higher than average temperatures and below average precipitation during the spring and summer of 2015, leading to extremely low streamflows throughout the region.
- Recent droughts in the region tend to come in three different "flavors": dry winter, dry summer or warm winter. Identifying impacts, triggers and thresholds for each will be key to developing a nimble and effective drought early warning system for the Pacific Northwest[1].

Theme 2: How is Drought and Water Managed in the Pacific Northwest

This series of panel discussions explored federal perspectives on managing water in the region; state approaches to drought policy and planning; as well as available federal drought-related resources and initiatives. The highlights were grouped into the following subthemes:

Impacts

- **Managing demands on the Columbia River during multi-year droughts is especially difficult.**
  - Not all reservoirs have the same storage capacity, which means planning for drought year conservation storage can be difficult when managing a large system.
  - Consistent and efficient energy generation is the primary goal of the Bonneville Power Authority (BPA). Heaviest load demands tend to occur in winter and late summer and meeting these demands can be difficult during multi-year droughts.

[1] K.A. Bumbaco, P.W. Mote "Three recent flavors of drought in the Pacific Northwest." Journal of Applied Meteorology and Climatology, 49 (2010), pp. 2058-2068 http://dx.doi.org/10.1175/2010JAMC2423.1

- **The Washington State Department of Agriculture (WSDA) made preliminary estimates that the state's agricultural industry lost $335 million as a result of the 2015 drought.** Washington produces 60% of the nation's apples and WSDA estimates that the 2015 losses to Washington's apple crop due to drought to be approximately $86.52 million. Not only was the total yield smaller, but the size and quality of individual apples were negatively impacted by low water availability and unusually high temperatures.
- **Wildfire managers faced fewer numbers of fires but those that did ignite were larger and hotter than normal, making them more difficult to control.** In large part due to a combination of the "snow drought" and hot and dry summer, wildfires burned in areas typically not prone to fire (temperate rainforests of the Olympic Peninsula and high alpine ecosystems that in a typical year would have been covered in snow). Federal fire managers use existing drought and climate science and tools to help assess fire season severity, and the need to increase and direct staffing throughout the season. Short term forecasts are helpful but managers need more skill in monthly and seasonal outlooks. Managers also requested better data pertaining to snowpack and how precipitation conditions impact fuels and fire behavior.
- **Better tools are needed to help non-irrigated agricultural crops mitigate drought impacts.**
- **Pacific Northwest fisheries were severely impacted by the drought of 2015. Historic low flows and higher than normal water temperatures led to unprecedented die offs and hindered the ability of adult salmon to reach their spawning grounds.** In the summer of 2015 tens of thousands of Columbia River Basin adult sockeye salmon perished before they reached natal spawning grounds.

Jeff Marti, Washington State drought coordinator holds up a smaller than average Gala apple from Washington.

Use of Forecasts & Monitoring

- **Lack of skill in short-term forecasting during the shoulder season** (fall, but especially during spring months) can make spring reservoir refill activities during dry years especially difficult.
- **Timing of spring runoff is paramount for water managers in the Pacific Northwest. Decision making calendars need to be analyzed**. The shifting dates of streamflows has an important impact on date of use for water rights. The timing of runoff may change year to year but the dates associated with water rights availability are set in stone. This further emphasizes the importance of shoulder season forecasts to help decision makers identify the triggers associated with going into *and* out of drought.
- **Better understanding and monitoring of groundwater resources is needed.** States in the region (especially Oregon and Washington) are heavily reliant on surface water and look to groundwater as an emergency response resource for drought. Groundwater monitoring needs to be improved if states are going to use this resource as a safety net. Oregon used the 2015 drought to convince lawmakers to provide funding to improve groundwater supply monitoring capability.

State of Planning for Drought

- **Many state drought plans have a strong emphasis on drought indicators (utilizing data from USGS, NRCS, RFC and NWS) but lack triggers for initiating action.**
  - Washington does have drought triggers for declaring drought (demonstration of less than 75% of water supply that will result in a "hardship") but the definition of a "hardship" can be somewhat subjective.
  - Oregon is exploring ways to develop a quantitative drought indicator to trigger drought declarations and response.
- **Each state in the region has a drought plan but many are out of date or in the process of being updated.** Washington received a grant from the U.S. Bureau of Reclamation to update their drought contingency plan, which is currently from 1992. Oregon updated its Drought Annex in December 2015 in response to a July 2015 executive order from Governor Kate Brown.
- **States want to avoid emergency water transfers or actions.** Short-term mitigation actions (like tapping groundwater supplies) can be detrimental in the long term, especially if a short-term drought turns into a multi-year event.
- **Drought can be overshadowed in hazard mitigation and emergency response plans.** Plans tend to be revisited and updated after a drought year, which is currently the case. Other extreme events and hazards can take precedence when drought hasn't been a recent factor. Due to drought's relatively slow onset it can be difficult for agencies focused on emergency response to know how to take action.

Opportunities to Build Upon

- **The 2015 drought helped focus drought-related federal activities and funds.** For example, the Northwest River Forecast Center (NWRFC) provides daily river forecasts as well as monthly water supply briefings January through June and responded to the needs of stakeholders (other federal, tribal, state, and local agencies) by providing data comparing historical runoff in relation to El Niño Southern Oscillation (ENSO) climate signals.
- **New federal funding opportunities are becoming available in response to recent droughts**. In September 2015 FEMA announced three new Climate Resilient Mitigation Activities eligible to receive funding through the Hazard Mitigation Activities grants related to drought mitigation as well as sustainably mitigating other risks (i.e. flooding and erosion).
- **There are at least 28 federal agency programs that receive funding to do climate-related work or research, creating a robust network of federal climate initiatives/programs in the PNW.** Some agencies have robust but industry-specific stakeholder networks (i.e. The Climate Impacts Research Consortium (CIRC) a NOAA Regional Integrated Science and Assessments (RISA) team has been charged with working with coasts and communities; the Northwest Climate Hub (USDA) works with agricultural sector including forestry and tribal interests across agriculture; and the NW Climate Science Center (NW CSC) has solicited proposals on the ecological response to drought). How can the PNW DEWS leverage these networks to increase transferability of information and resources across sectors?

Theme 3: Drought Early Warning and Preparedness Priorities and Actions

The second day of the meeting included an overview of presentations on new and innovative tools and research to monitor drought and its impacts. Highlights include:

- **Advances in remote sensing technologies increase capabilities to collect data in remote areas**. NASA's OLYMPEX field campaign (in partnership with the University of Washington) is measuring precipitation (including snow depth and snow water equivalent) in remote areas of the Olympic Peninsula. NASA, NOAA, USGS, USDA and California Department of Water Resources (CADWR) have demonstrated the feasibility of using satellite imagery to track the extent of fallowed land for drought impact reporting in California's Central Valley on a monthly basis. CADWR plans to operationalize the fallowed lands monitoring service for future use in drought impact reporting. Stakeholders in the Pacific Northwest have expressed interest in expanding the use of fallowed lands monitoring there.
- **Researchers at the Climate Impacts Research Consortium (CIRC) are creating the NW Climate Toolbox to help translate climate data into useable information that is available on a range of timescales.** In addition to tools like the Climate Engine, UW Hydro Monitor and the WestWide Drought Tracker, the NW Climate Toolbox will also include new maps, particularly for growers interested in seasonal forecasts, climate projections, growing degree days, irrigation demand, and climate suitability.
- **Streamflow monitoring**. Hydrologic technicians with the U.S. Geological Survey (USGS) recently conducted a low flow study of hundreds of rivers and streams in six western states (including Idaho, Oregon and Washington) to provide information to resource managers to better understand how streams respond to drought and plan for future drought impacts. Data is currently being compiled and analyzed. Results will be available in a summary report is expected in late 2016.
- **Need for better documentation of impacts to assist in incorporating triggers into planning and subsequent actions**. Tools like the National Drought Mitigation Center's (NDMC) Drought Impact Reporter can help users collect observed impacts and access historic data by station.

Theme 4: Preparing for New Realities in Drought and Water Management

The meeting culminated with a discussion of potential actions to enhance long term drought resilience, with a specific focus on integrating climate change into long term water planning. Highlights include:

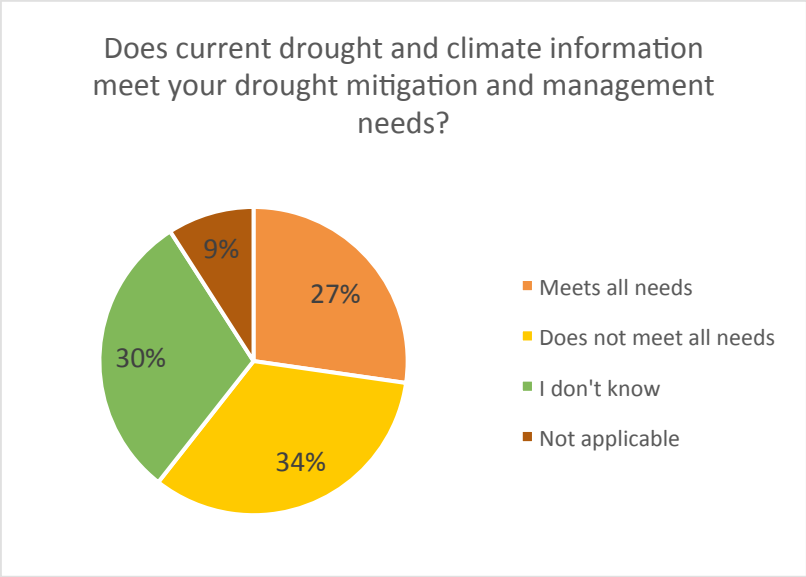
- **Climate scenarios project reduced snowpack for the region, and climate models project warmer winters in the 21st century.** Even if precipitation levels remain the same, or increase, whether precipitation falls as rain or snow is the most dominant impact and largely temperature-driven. Diminished snowpack can influence, streamflow, water temperatures, wildfire potential, soil moisture, landslide and flooding risk. Snow and rain/snow mixed dominant watersheds will be the most impacted in these scenarios.
- **Drought does not necessarily equate to a water supply shortage for large water utilities in the region**. Utilities like Portland Water Bureau that were dependent on rain rather than snow for water supply were somewhat buffered from the snow drought of 2015 and did not reach the point that they needed to declare a shortage despite the depiction of their region on the USDM. This situation illustrated a need to better educate the public and decision makers as to what drought means for various sectors.
- **Even though many rain-dependent utilities in the region did not need to declare a shortage during the 2015 drought, they still see the need to explore potential future risks to their water supply associated with climate change**. These could include turbidity, aquifer drawdown, wildfire, and water temperature.

Priority Needs and Proposed Actions

The second day of the meeting included a series of breakout discussions to identify data and information needs, gaps and vulnerabilities in a Pacific Northwest Drought Early Warning System. Based on feedback received during the 2015 Pacific Northwest DEWS development process, three priority areas were targeted for discussion:

- Research & Monitoring
- Communication & Outreach
- Information Networks

Research & Monitoring



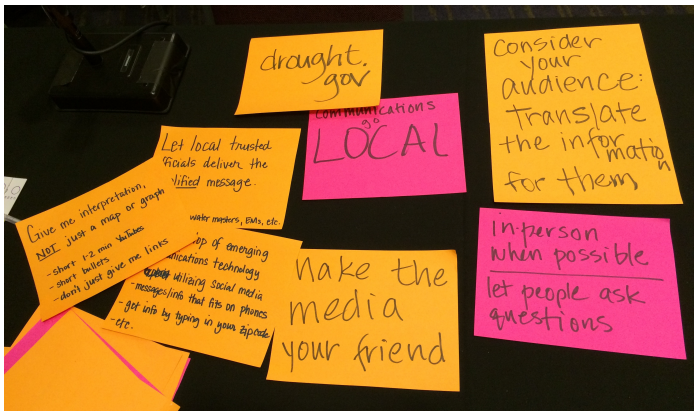
As the new drought of record, the 2015 drought should be used as a roadmap of where better monitoring is needed to plan and prepare for future droughts and climate scenarios. There was broad consensus at the Kickoff Meeting that additional research and monitoring of soil moisture, snow, groundwater and streamflow would help resource managers prepare for and mitigate drought in the Pacific Northwest. Only about one-quarter of survey respondents (n=33) said that they had all of the information they needed for making decisions related to drought mitigation or management.

- **Enhanced groundwater and aquifer monitoring and forecasting are needed to improve the understanding of draw-down and recharge on short and long time scales.** Most small water systems (which often support vulnerable communities) are reliant on groundwater sources which lack robust information, modeling and understanding of the relationship between snow drought on aquifer recharge. Priority aquifers in the region should be identified and monitored for draw-down and recharge rates.
- **Expand satellite-based crop data.** Consider expanding fallowed lands monitoring system currently underway in California.
- **Increase soil moisture monitoring network**.
- **Increase snowpack monitoring**. Certain areas, such as the western side of the Olympic Peninsula, are under-monitored and particularly susceptible to impacts associated with snow drought. As freezing levels rise more SNOTEL sites will also be needed at higher elevations.
- **Monitor for stream-system resiliency.** Increased low flow, water temperature and water quality monitoring stations needed and data should be incorporated into long-term drought planning.

- Over half of survey respondents (n=32) found it **difficult to use drought-related information to identify specific triggers** to inform operational decisions.

Communication & Outreach

Throughout the Pacific Northwest DEWS development process, the need for better communication and outreach was repeatedly highlighted by stakeholders across sectors and jurisdictions. In fact, 60% of those responding to the evaluation survey said that improving communication among agencies or sectors was a critically important role of the DEWS, and over 40% said that improving communication among sub-regions within the PNW was critically important. Needs and potential actions are as follows:



- **Incorporate communication strategies into state and local drought plans.**
- **Improve access to information**. Stakeholders agree there is not a lack of information available, but that the challenge is finding effective ways to access, present and communicate it.
    - Create "multi-stop shop" utilizing multiple information sources and platforms
    - Educate information users on how to use data appropriately.
- **Local trusted officials are often the best "messengers" for drought information but need to be educated**. Foster and maintain relationships between the scientific and water management communities and these information providers.
- **Providing information at multiple scales is critical.** Broad spatial scale products are effective at helping set the context, but more localized information is often needed (and may illuminate conflicting information.)

Information Networks

The weather, climate and water management community in the Pacific Northwest is especially robust, but the challenge will be connecting all of the individuals and agencies in an effective manner. Additionally, there are strong information and collaborative networks in the Columbia River Basin, but these networks don't always include or reach small and vulnerable communities and do not always extend to coastal regions that were some of the hardest hit in the most recent drought. Opportunities for expanding and improving upon some of these networks include:

- Widen existing information networks to include coastal and vulnerable communities.
- Improve integration of drought information and plans into emergency management networks.
- Maintain and extend the collaborative network developed among federal water agencies in the Pacific Northwest during the 2015 drought.

- Coordinate the already strong network of federal climate initiatives (i.e. NW Climate Science Center (DOI), NW Climate Hub (USDA), CIRC (NOAA RISA)) to leverage resources, information and stakeholders.
- Utilize, improve upon and expand citizen science networks (i.e. CoCoRAHS) to collect impacts information in remote areas and engage vulnerable communities.

Emergent Priorities

- **Need to define, identify and assist "vulnerable communities".** There was consensus amongst participants at the meeting that "vulnerable communities" were often hit the hardest during the drought of 2015 and past droughts. Vulnerable communities could be defined by income, rural vs. urban, language, social vulnerability index, access to resources and technology, reliance on small water systems, and other factors.

- Need to provide assistance at multiple levels of jurisdiction on how to best address the needs of multiple sectors in mitigation and management plans.

Next Steps – Pacific Northwest DEWS Strategic Plan

The PNW DEWS Strategic Plan will provide the framework for future actions and activities to foster the development of the PNW DEWS. The two-year plan will include partner agencies and organizations involved in implementing the DEWS as well as key activities and milestones. The PNW DEWS and its Strategic Plan are fluid processes and will continue to evolve to be reflective of current needs and resources.

Appendix A – Pacific Northwest DEWS Kickoff Meeting Agenda

Pacific Northwest Drought Early Warning System
Kickoff Meeting

February 2-3, 2016

Courtyard by Marriott Portland City Center

Portland, OR

The Pacific Northwest DEWS Kickoff Meeting will be held February 2-3, 2016 in Portland, OR to formally launch the Drought Early Warning System. This two-day event will bring together federal, tribal, state, academic, and local partners and stakeholders for an in-depth discussion on drought in the Pacific Northwest, with attention to water, climate, land and emergency management. Specifically, the discussions will center on improving the capacity to meet the information needs of decision makers in the region.

Desired outcomes of the Pacific Northwest DEWS Kickoff Meeting include:

1. Increasing the knowledge and awareness of present decision-support tools and processes, including the National Integrated Drought Information System and its partners
2. Identifying knowledge and information gaps.
3. Developing recommendations for improved early warning, which would include better coordination of integrating, displaying, and distributing climate, weather and water data and information.
4. Developing recommendations for future actions, collaborative research, and decision support tools.
5. Identifying baseline evaluation metrics for drought and its associated impacts.

Day 1: Tuesday, Feb. 2, 2016

8:30-9:00am	**Registration**	
9:00-9:35	**Welcome**	Robin Webb (NOAA/PSD) Lauri Aunan (Advisor to Oregon Gov. Brown)
9:35-10:05	**Drought & Climate Outlook**	David Simeral & Kelly Redmond (WRRC/DRI)
10:05-10:20	**Goals & Objectives**	Veva Deheza (NOAA/NIDIS)
10:20-10:35	***BREAK***	
10:35-11:05	**Bridging Drought Impacts & Resilience (Ice Breaker)**	John Stevenson (CIRC)
11:05 -11:45	**History of Drought in the Region** • State/Regional • Ocean conditions	Kathie Dello (CIRC) & Karin Bumbaco (OWSC) Nick Bond (OWSC)
11:45 – 12:45 pm	***WORKING LUNCH***	
12:45 - 1:35 pm	**How is Drought & Water Managed in the PNW?** Federal, Regional & International Perspectives Moderator: Jim Ruff, Northwest Power and Conservation Council	Eve James (Bonneville Power Authority) Mary Mellema (Bureau of Reclamation) Tina Teed (US Army Corps of Engineers)
1:35 – 2:55 pm	**State & Tribal Drought Plans & Policies** Moderator: Mark Svoboda (NDMC)	David Hoekema (IDWR) Ann Schwend (MT DNRC) Alyssa Mucken (OR WRD) Jeff Marti (WA DOE) Rhonda Dasher (Confederated Tribes of the Colville Reservation)
2:55 – 3:10	***BREAK***	
3:10 - 4:10 pm	**Federally Sponsored Drought-Related Resources** Snapshot of agency resources to help build information networks Moderator: Timi Vann, NOAA ▪ National Weather Service ▪ NOAA Northwest River Forecast Center ▪ NOAA National Marine Fisheries Service ▪ NOAA Office of Oceanic & Atmospheric Research ▪ Natural Resource Conservation Service ▪ U.S. Geological Survey ▪ U.S. Bureau of Indian Affairs ▪ U.S. Bureau of Land Management ▪ National Interagency Fire Center ▪ Environmental Protection Agency ▪ Federal Emergency Management Agency ▪ Northwest Climate Science Center ▪ USDA Climate Hub ▪ Climate Impacts Research Consortium	Katherine Rowden (NWS) Steve King (NWRFC) Ritchie Graves (NMFS) Claudia Nierenberg (NOAA/OAR) Deb Harms (NRCS) Greg Furher (USGS) Keith Hatch (BIA) Louisa Evers (BLM) John Saltenberger (NIFC) Yvonne Vallette (EPA) Kristen Meyers (FEMA) Gustavo Bisbal (NWCSC) Beatrice Van Horne (USDA Climate Hub) Phil Mote (CIRC)

4:10– 4:40	**Exploring the benefits of having a regional drought early warning system** • What has been learned to date in the PNW DEWS development process • Preview of Day 2	Kathie Dello (CIRC) Karin Bumbaco (OWSC) Alicia Marrs (NOAA/NIDIS) John Stevenson (CIRC)
4:40 pm	**Day 1 Adjourn**	Alicia Marrs (NOAA/NIDIS)
Evening	***Networking Event (no-host)***	

Day 2: Wednesday, Feb. 3, 2016

8:30 – 9:00 am	**Registration**	
9:00 – 9:10	**Welcome and Recap of Day 1**	Alicia Marrs (NOAA/NIDIS)
9:10 -9:40	**Opening Keynote: The U.S. Drought Monitor:** How is it developed? How is it used?	Mark Svoboda (NDMC)
9:40 – 10:40 pm	**Monitoring and Impacts:** Local/Regional/National Tools & Initiatives Moderator: Mike Strobel (NRCS) • NW Climate Toolbox: Phil Mote (CIRC) • USGS Low-flow Study: Chris Konrad (USGS) • OLYMPEX field campaign: Lynn McMurdie (NASA/UW) Fallowed Lands Monitoring: Forrest Melton (NASA/CSUMB) • NDMC Decision Support Tools: Mark Svoboda (NDMC)	
10:40-10:55	***BREAK***	
10:55 – 12:00	**Diving Deeper into the Needs and Gaps in PNW Drought Early Warning** *(small group break out session)* • Overview of the initial strategy for enhancing drought early warning capacity in the PNW • Identification of data and information needs, gaps and vulnerabilities in a PNW DEWS	Facilitators: Karin Bumbaco (OWSC) Kathie Dello (CIRC) Alicia Marrs (NOAA/NIDIS) John Stevenson (CIRC)
12-1:00 pm	***WORKING LUNCH***	
1:00 – 2:30 pm	**Prioritizing Actions to Enhance Drought Early Warning** *(facilitated small group breakout sessions)* • Develop metrics to measure the success of a PNW DEWS • Prioritize actions to enhance long term drought resilience	Facilitators: Karin Bumbaco (OWSC) Kathie Dello (CIRC) Alicia Marrs (NOAA/NIDIS) John Stevenson (CIRC)
2:30 – 2:45	***BREAK***	

2:45 – 3:30 pm	**Incorporating Climate Change into Water Planning** Moderator: Nick Bond, OWSC • Piloting Utility Management Applications (PUMA) • Big Wood River Basin Alternative Futures Project • Puget Sound State of Knowledge Report	Kavita Heyn (PWB) John Stevenson (CIRC) Joe Casola (UW/CIG)
3:30– 4:00	**Next Steps & Wrap Up** • Review findings from breakout sessions • Discuss next steps and roadmap for the PNW DEWS	Facilitators: Karin Bumbaco (OWSC) Kathie Dello (CIRC) Alicia Marrs (NOAA/NIDIS) John Stevenson (CIRC)
4:00 pm	**Adjourn**	

Appendix B – Pacific Northwest DEWS Kickoff Meeting Attendees

Bonneville Power Administration (BPA)
California State University at Monterey Bay (CSUMB)
City of Gresham (Oregon)
City of Hillsboro Water Department (Oregon)
Clackamas River Water Providers
Climate Impacts Group, University of Washington (CIG)
Climate Impacts Research Consortium (CIRC), a NOAA RISA Team
Columbia River Inter-Tribal Fish Commission (CRITFC)
Confederated Tribes of the Colville Reservation
Cow Creak Umpqua Tribe
Desert Research Institute (DRI)
Federal Emergency Management Administration (FEMA)
Idaho Department of Water Resources (IDWR)
Idaho Power
Montana Climate Office
Montana Department of Natural Resources and Conservation (MT DNRC)
National Aeronautics and Space Administration (NASA)
National Drought Mitigation Center (NDMC)
National Interagency Fire Center (NIFC)
National Oceanic & Atmospheric Administration (NOAA)

- Earth System Research Laboratory (ESRL)/Physical Sciences Division (PSD)
- National Integrated Drought Information System (NIDIS)
- National Marine Fisheries Service (NMFS)
- National Weather Service (NWS)
- Office of Oceanic & Atmospheric Research (OAR)
- Northwest River Forecast Center (NWRFC)
- Western Regional Climate Center (WRCC)

Northwest Power and Conservation Council (NWPCC)
Office of Washington State Climatologist (OWSC)
Oregon Climate Change Research Institute (OCCRI)
Oregon Climate Service (OCS)
Oregon Department of Environmental Quality (OR DEQ)
Oregon Water Resources Department (OWRD)
Portland State University (PSU)
Portland Water Bureau (PWB)
Quinault Nation
Tuckness Farms Inc.
University of Washington (UW)
Upper Snake River Tribes Foundation
U.S. Army Corps of Engineers (USACE)
U.S. Department of Agriculture (USDA)

- Natural Resource Conservation Service (NRCS)
    - National Water and Climate Center
    - Oregon Snow Survey

- U.S. Forest Service (USFS)
- USDA Northwest Climate Hub (USDA NW HUB)

U.S. Department of Interior (DOI)

- Bureau of Indian Affairs (BIA)
- Bureau of Land Management (BLM)
- Bureau of Reclamation (BOR)
- U.S. Fish & Wildlife Service (FWS)
- U.S. Geological Service (USGS)
    - Oregon Water Science Center
- Northwest Climate Science Center (NWCSC)

U.S. Environmental Protection Agency (EPA)
Washington State Department of Agriculture (WSDA)
Washington State Department of Ecology (ECY WA DOE)
Washington Department of Fish and Wildlife
Washington Department of Health
Washington State Emergency Management Division
Washington State University (WSU)
Washington State University, Center for Sustaining Agriculture and Natural Resources
West Slope Water District (Oregon)