

PACIFIC NORTHWEST DROUGHT EARLY WARNING SYSTEM STRATEGIC PLAN

8/14/2017

2017-2018 Strategic Plan

Developed by the National Integrated Drought Information System (NIDIS) in partnership with key stakeholders including the Pacific Northwest Climate Impacts Research Consortium (CIRC).

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THE PACIFIC NORTHWEST DROUGHT EARLY WARNING SYSTEM

The National Integrated Drought Information System and Drought Early Warning Systems

In 2006, Congress authorized the National Integrated Drought Information System (NIDIS) with a mandate for interagency coordination and integrated drought research that builds upon existing federal, tribal, state, and local partnerships to create a national drought early warning system (DEWS). NIDIS is working toward this goal by developing a network of regional DEWS (see map, below). These regional DEWS utilize existing networks to make climate and drought science readily available, easily understandable, and usable; and to improve regional capacity to respond to and cope with drought.

A regional DEWS is supported by stakeholders, comprised of relevant partners and community members across the region, including universities, the private sector, and federal, tribal, state and local entities. Stakeholders participate in the NIDIS consultation process, and they support NIDIS priorities by leveraging existing resources, programs, and partnerships. This relationship ensures a robust, “ground-up” regional DEWS that is well-networked and responsive to the specific needs of each region. NOAA and the NIDIS program did not establish the DEWS and do not control or manage the DEWS functions or operations; rather, the DEWS constitute the continuation, and leveraging, of existing partnership networks.

WHAT IS NIDIS?

The National Oceanic and Atmospheric Administration’s (NOAA) National Integrated Drought Information System (NIDIS) was authorized by Congress in 2006 (Public Law 109-430) with an interagency mandate to develop and provide a national drought early warning information system, by coordinating and integrating drought research, and building upon existing federal, tribal, state, and local partnerships.

WHAT IS A DEWS?

A Drought Early Warning System (DEWS) utilizes new and existing networks of federal, tribal, state, local and academic partners to make climate and drought science accessible and useful for decision makers; and to improve the capacity of stakeholders to monitor, forecast, plan for, and cope with the impacts of drought.



The Pacific Northwest DEWS

In response to frequency of drought in the Pacific Northwest, and following a series of stakeholder engagement activities in 2015, NIDIS and its partners formally launched the Pacific Northwest DEWS (PNW DEWS) in February 2016 at the [Pacific Northwest DEWS Kickoff Meeting](#) in Portland, OR. 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 drought early warning information needs of decision makers in the region.

The Pacific Northwest is often associated with rainy forecasts, foggy days on the coast, and large scale irrigated agricultural projects in the arid interior. It 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, even the coastal regions of the Pacific Northwest are no strangers to drought. The region experienced multiple droughts in the early 21st century. In 2015, virtually the entire region reached historic drought conditions. While the coastal regions experienced an unprecedented single year drought, the eastern portions of Oregon and Idaho had been suffering under prolonged drought for four years.



Higher than average temperatures, low levels of snowpack, and record early runoff, defined the Pacific Northwest drought of 2015. These conditions are in-line with what experts anticipate to be normal conditions for the region by mid to late century under most climate projections. As such, the drought of 2015 was not only the new drought of record for the region, but also a wakeup call to reevaluate how water is managed for the future.

Pacific Northwest water supply is largely contingent on snowpack, often referred to as a “natural reservoir.” As temperatures warm in the spring, the snowpack melts, feeding streams, rivers, lakes, reservoirs, and groundwater sources. This water is used for agricultural lands, supports land-based and aquatic ecosystems (often relied upon by federally listed endangered species), supplies hydropower, sustains drinking water supplies to cities, and supplements groundwater aquifers often relied upon by a variety of communities ranging from some of Idaho’s largest cities (i.e. Boise) to small systems and vulnerable communities. How and when that snowpack develops and eventually melts and contributes to land-based water supplies largely dictates how and if drought may develop throughout the year.

Climatologically, Pacific Northwest precipitation frequency tapers off in late spring and summer months, when snowmelt supplements water supply. The snow drought of 2014-2015, coupled with hotter and drier spring and summer conditions, led to record low levels in the region’s rivers and streams, and reservoirs. These record low flows severely impacted coastal watershed basins. Temperature continues to play a key role in stressing water supply conditions in the region. Mountain

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snowpack was ample across much of the region in early 2016, but abnormally warm spring temperatures led to earlier than normal snowmelt. The winter of 2016-17 had abundant snowpack, but a wet and cool spring led into a hot, dry summer in 2017. Climate change projections for the region show projections of warmer temperatures in all seasons, particularly winter and summer.

Key components of NIDIS Regional Drought Early Warning Systems



Purpose of the Pacific Northwest DEWS

The PNW DEWS is a collaborative federal, tribal, state, and local interagency effort to improve early warning capacity and resilience to drought in the region. This is accomplished through local stakeholder-driven activities encompassing data collection and monitoring; research; planning for climate extremes; and communication, education, and outreach. Activities will focus on areas throughout the states and provinces encompassing the Columbia River Basin (British Columbia, Idaho, western Montana, Oregon and Washington).

Specific goals of the PNW DEWS include:

- 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 develop appropriate, relevant, useful, and readily available drought, climate, weather, and water-related information at regional and local scales.
- 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 information system.

- Identify the economic sector-specific and geographic needs for future drought monitoring, prediction, planning, and information resources.

THE PACIFIC NORTHWEST DEWS STRATEGIC PLAN

Plan Purpose and Development

The PNW DEWS Strategic Plan (Plan) outlines priority tasks and activities across the region to build drought early warning capacity and resilience. Partners across the region assisted NIDIS, the Pacific Northwest Climate Impacts Research Consortium (CIRC, a NOAA RISA team), and the National Drought Mitigation Center (NDMC) with the development of this Plan. The Plan includes a list of current partners (listed in Appendix A), outcomes, and key milestones. It is a “living document” to which additional actions and partners may be added.

In 2015, planning meetings were held in Boise, ID, and Vancouver, WA, as well as a listening-session at the 6th annual Northwest Climate Conference in Coeur D'Alene, Idaho, to obtain input on priority needs and actions necessary to improve drought early warning and resiliency in the inland and coastal Pacific Northwest region. Participants included more than 90 federal, tribal, state, local, non-profit, and academic partners with a diverse a range of interests and expertise. Information obtained from these workshops in addition to the PNW DEWS Kickoff Meeting held in in February 2016 in Portland, Oregon informed this Plan.

Pacific Northwest DEWS Priorities and Activities

The PNW DEWS prioritizes the following aims necessary to building drought early warning capacity and long-term drought resilience throughout the Pacific Northwest:

- **Priority 1 – Improve Drought Monitoring and Research for Drought Risk Management** - This priority focuses on improving data and information for drought risk management at the regional, tribal, state, and local levels. Activities include enhanced monitoring for stream-system resiliency, expanding satellite-based crop data for fallowed lands monitoring, development of a suite of climate visualization tools to include near real-time surface water monitoring, exploration of datasets identifying areas of water scarcity, and integrating water resource-related data and predictive information to enhance decision-making.
- **Priority 2 – Expand Drought Early Warning Communication and Outreach** – This priority focuses on improved and coordinated communication, outreach, and training across regions and sectors in the PNW DEWS to support the dissemination of drought and climate information and forecasts. Activities include regular drought and climate outlooks held in-person and via webinar, outreach and training to improve the use of available drought and climate information and tools, and the development of strategies to improve coordination of drought communication and messaging.

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- **Priority 3 – Optimize Information and Collaborative Networks** - The PNW DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local, and academic partners to reach its goals. This priority focuses on developing new, and expanding upon some of the existing information and collaborative networks in the PNW DEWS. The PNW DEWS will also increase collaboration with Canadian partner agencies and organizations to identify opportunities for regional and transboundary coordination and information sharing.
- **Priority 4 – Enhance Drought Planning and Mitigation** - This priority focuses on improving drought planning, preparedness, and mitigation in the region, including leveraging federal resources to support state, local and tribal drought planning; tribal drought planning workshops and trainings; improving drought impact collection and reporting; and the expansion of citizen science monitoring networks.

For each priority, some of the associated activities outlined in this Plan have been started, while others will be initiated over the next two years. The corresponding schedule summarizes the expected timeframe for each activity's implementation. Milestone dates are based on the following quarters, designated by seasons: Winter (Jan, Feb, Mar); Spring (Apr, May, Jun); Summer (Jul, Aug, Sep); and Fall (Oct, Nov, Dec).

Additionally, some of the activities are funded while other activities will require efforts to acquire funding. Funding sources may include NIDIS and DEWS partners. As the PNW DEWS continues to develop, it will be important to identify and leverage resources and available funding among DEWS partners.

Coordination with NIDIS Working Groups

Vital to the mission of NIDIS are its six interagency Working Groups, each focused on a different component of NIDIS activities within and across government agencies and throughout the country. These six areas of focus are: (i) education and public awareness, (ii) monitoring and observations, (iii) predictions and forecasting, (iv) interdisciplinary research and applications for risk assessment, (v) planning and preparedness, and (vi) the U.S. Drought Portal for improving accessibility to usable drought risk information. The [NIDIS Implementation Plan December 2016 Update](#) provides additional information on the NIDIS Working Groups.

Coordination, communication, and transferability of information and actions between the NIDIS Working Groups and the DEWS is essential the overall process of building an integrated drought information system. The NIDIS Program Office supports a network of regular communication and exchange of information between these entities to ensure meaningful engagement and effective collaboration on priorities and activities. Appendix B illustrates how each of the activities in this Plan correlates with the Working Group(s).

Priority 1 – Improve Drought Monitoring and Research for Drought Risk Management

Effective drought risk management depends on the development and deployment of drought and climate-related monitoring systems, data collection, research, and decision support tools. Under this priority, the PNW DEWS will undertake activities to improve the collection and dissemination of data needed to support decision-making and develop and refine drought and climate indices. Related actions include enhanced monitoring for stream-system resiliency, expanding satellite-based crop data for fallowed lands monitoring, development of climate visualization tools to include near real-time surface water monitoring, the exploration of datasets to identify areas of water scarcity, and integrating water resource-related data and predictive information to enhance decision-making.

Activity 1.1 Expand the Stream Gage Network in the Pacific Northwest

To better understand the drought vulnerability and resilience of streams across the western U.S., the U.S. Geological Survey (USGS) conducted a multi-region investigation of streamflow in 2015. Summer low flows were unprecedented in recent history, even in areas where precipitation was close to normal. The project measured streamflow at 536 ungaged sites across six western states (including Idaho, Oregon, and Washington) facing drought conditions in the spring of 2015. USGS also analyzed streamflow data from 480 daily streamflow sites on rivers without large dams, reservoirs, or major withdrawals that have at least 10 years of record. The analysis of the daily stream flows includes a description of streamflow responses over the summer, a temporal comparison of 2015 to other years, and a spatial assessment of factors (i.e. precipitation, snowpack, and surface geology) contributing to the vulnerability or resilience of streams during drought events. This information is key to assessing the reliability of water supplies and to protecting aquatic life.

This study is also working to develop a method for estimating low flows at ungaged sites, including quantifying the uncertainty of these estimates from a single measurement. Utilizing stream flow observations from sites that are not normally gaged continuously will provide more spatial resolution for the assessment of the vulnerability/resilience of streams under drought conditions. In turn, this added resolution will help managers predict and address the economic and ecosystem impacts of drought.

USGS provided final results of the analysis of daily streamflow records in January 2017, a [web site](#) with maps displaying results, a library of basin boundaries for the 480 streamflow gauging stations, and tabular data with derived streamflow statistics and basin characteristics (for the ungauged sites) that will be available through [ScienceBase](#) by Spring 2017.

Depending on available future funding, USGS will complete an analysis of factors influencing low flows, including conclusions about the role of precipitation and surficial geology that could be used to infer the vulnerability of streams in different settings and a range of hydrologic conditions (year types). The results of this analysis will be used to develop and inform a regional tool for assessing stream vulnerability to drought through the PNW DEWS. This additional work would be shared in a second report/journal article documenting a method for low flow estimation, with confidence intervals, at

ungauged sites from a single flow measurement that can be used to fill spatial gaps in low flow statistics across the western U.S.

Activity 1.1 Outcomes

- USGS provides final results of the analysis of daily streamflow records [Winter 2017]
- Maps displaying results posted on USGS [website](#) and drought.gov [Spring 2017]
- Library of basin boundaries for streamflow gauging stations and tabular data with derived streamflow statistics and basin characteristics available through ScienceBase [Spring 2017]
- Journal article describing the investigation of drought impacts at sites with relatively unaltered flows, and significance of snowpack on low flows [Spring 2017].
- *Development of a regional tool to address PNW stream vulnerability to drought [Fall 2018 - pending available funding]*
- *Report/journal article documenting a method for low flow estimation from single flow measurements across the western U.S. [Fall 2018 - pending available funding]*

Activity 1.2 Provide Fallowed Agricultural Field Tracking

During the recent drought across California, the California Department of Water Resources (CA DWR) requested support from NIDIS and its partners in monitoring increases in land fallowing during drought events. In response, NIDIS worked with scientists at NASA, California State University Monterey Bay (CSUMB), USGS, and the U.S. Department of Agriculture (USDA) to develop a successful application of satellite imagery to track changes in the extent of fallowed agricultural land in California's Central Valley on a monthly basis during both the winter and summer growing seasons. The project team developed a capability to use satellite data to support near real-time mapping of drought impacts on agricultural production and land fallowing, and accelerated the availability of this type of information by more than 10 months.

The approach uses time series of data from Landsat, Terra, and Aqua satellites to track changes in crop canopy conditions for each individual field, and applies decision tree algorithms to separate cultivated fields from fallowed fields. The team conducted monthly field surveys along nine transects and 670 field sites across the Central Valley in 2014 and 2015. This data was used to quantify the accuracy of the algorithms, with overall classification accuracy greater than 90% in all months and both producer's and user's accuracies exceeding 88% for the winter and summer seasons. This capability allowed California state agencies to monitor changes in fallowed agricultural acreage across the state as the drought continued to develop, and to identify agricultural regions where impacts were most severe.

The project team applied this capability in 2014, 2015, and 2016 to provide monthly maps and reports on land fallowing in the California Central Valley to CA DWR and other California agencies. The information was used by state agencies to support planning for drought response and mitigation, and to inform the distribution of drought emergency relief funds to support programs to aid farm worker households whose livelihoods were disrupted.

As part of the Pacific Northwest DEWS, the NASA/CSUMB team will implement the algorithms developed for California on Google's Earth Engine platform and adapt the capabilities to provide fallowed land data for Washington. Implementing the satellite data processing workflows on Earth Engine will also make it easier to scale the system to other states served by the Pacific Northwest DEWS in the future. The team will use data collected by the Washington State Department of Agriculture (WSDA) on field boundaries, crop type, and field conditions over the past three years to train and validate the modified algorithms for Washington. In 2017, the project team will work with the Washington State Department of Ecology (ECY) and WSDA to define requirements for implementation. The project team will also develop a Google App Engine interface to the fallowed area maps to allow users in state agencies to view and query maps, and quickly calculate summary charts and graphs from the fusion tables to summarize changes in land fallowing by county, zip code, irrigation district, crop type, field size and other variables. The project team will also prepare a training manual, short training videos, and conduct a training workshop to facilitate transition of the capability to sustained operational use by partner agencies. The project team plans to have an operational system in place for Washington State in early 2018 and will consider future expansion to other Pacific Northwest states.

This project will enhance the capacity for water resource managers and agricultural agencies to monitor changes in land fallowing in near real-time, empowering them with the ability to identify regions with large increases in land fallowing in time to take mitigation actions.

Activity 1.2 Outcomes

- NASA/CSUMB will identify field boundaries, conditions, and crop types [Winter/Spring 2017]
- Report summarizing stakeholder requirements and specifications for the system [Summer 2017]
- Google Earth Engine based on implementation of system for monthly and annual monitoring of land fallowing
- Web-based data query and access system to facilitate creation of summary reports and maps using the Google Earth Engine implementation (linked to the PNW DEWS pages on drought.gov)
- Training manual, short videos for use in training workshops developed [Winter 2018]
- Training workshop for partner agencies [Winter 2018]

Activity 1.3 Support the Northwest Climate Toolbox

The PNW DEWS region depends on water for energy generation, agriculture, shipping, and ecosystem services. Floods and droughts can have severe impacts on the regional economy. Recognizing that water managers are often tasked with making decisions in the face of extreme climate events, researchers at the University of Idaho (UI), University of Washington (UW) and Oregon State University (OSU) (all affiliated with CIRC) developed the Northwest Climate Toolbox (NW Climate Toolbox).

The Toolbox is a web-based platform that allows users to interact with climate and hydrologic data through an interface that displays maps, time series, and decision support tools with an emphasis on climate, agriculture, hydrology and water applications. The Toolbox includes a set of historical observations, seasonal climate forecasts, climate models and hydrological models. CIRC researchers at

the University of Washington have developed a near real-time monitor of surface hydrologic conditions in the Pacific Northwest (including the Klamath River Basin). This monitor combines recent observations with model results to provide an overview of current and historical moisture conditions at a high spatial resolution.

This system will be integrated with similar climate visualization tools that are under development at the University of Idaho, to result in a single Northwest Climate Toolbox, available at <https://climatetoolbox.org/>. NIDIS and USDA's Northwest Climate Hub (NWCH) are providing funding support of this CIRC-led project.

Activity 1.3 Outcomes

- NW Climate Toolbox updates during PNW DEWS bi-monthly (see Activity 2.1a) Drought & Climate Outlook webinars [Winter 2017]
- Integrate other drought, climate, and water products into the toolbox and refine outputs following stakeholder events through 2018

Activity 1.4 Identify Areas of Water Scarcity in the Pacific Northwest

To reveal areas that are more prone to drought-stress and water scarcity, CIRC will identify hotspots of water scarcity in the Pacific Northwest through several national and regional climate and drought datasets (e.g. the Palmer Drought Severity Index (PDSI) and the U.S. Drought Monitor (USDM)). CIRC is working in consultation with a stakeholder panel, whose members have expertise in climate, water, and drought in the Pacific Northwest. The findings from this project can help inform and direct future DEWS activities in the region to identify the most vulnerable areas.

Activity 1.4 Outcomes

- Project update for key PNW DEWS stakeholders via webinar [Spring 2017]
- Develop user-friendly program interface to be incorporated into the NW Climate Toolbox and drought.gov [Fall 2018]

Activity 1.5 Integrate Water Resource-Related Data and Predictive Information

A new online tool, the Water Resources Monitor and Outlook (WRMO), is being designed and developed by a team at NOAA, including NIDIS, the Western River Forecast Centers (RFCs), the Physical Sciences Division (PSD), and the CPC. The WRMO will provide uniform access to RFC Ensemble Streamflow Prediction (ESP) water supply forecasts along with a suite of climate and hydrological information; visualization and analysis of observed and seasonal forecast data forecast evolution; and verification tools to improve information delivery to water management stakeholders. Water managers in the region have requested an integrated and synthesized tool for water resource-related data and predictive information. The WRMO will integrate hydrometeorologic monitoring, forecasts, and outlooks, and recent scientific advances in weather and climate prediction into the product suite. Ultimately, the product suite will contain three web-based elements: 1) water resources monitoring information; 2) an enhanced water resources outlook; and 3) sub-seasonal to seasonal climate

outlooks for water resources. The seasonal water outlooks will leverage the existing operational forecasts at CPC together with some forecast verification tools.

For decades, NOAA's RFCs have been providing forecasts of water supply (defined as the April to July runoff) at lead times up to six months at locations across the western United States. However, this product is issued in various formats in different RFC domains, which limits its utility. This interface will provide consistency and allow a regional overview of water supply. It will also respond to the needs of water managers for improved visualization of the forecasts, and for the forecast-related data including forecast verification.

Water managers have also requested water supply outlooks that are more skillful and at longer lead times. The CPC seasonal outlooks may provide the input to the current ESP models, but may also provide other sub-seasonal to seasonal climate outlook information that would be relevant for anticipating water supply for the upcoming year. In FY17, NOAA PSD and CPC will partner to scope out what work would need to be done to effectively use the existing CPC products, and identify other information that might be relevant. This will be the basis of a prototype Climate Outlook for water managers (Element 3), to complement the current RFC operational water supply forecasts.

The WRMO will be introduced to potential users and stakeholders at PNW DEWS meetings and workshops, directly to existing RFC users, and during other opportunities such as professional society meetings. An evaluation is also being conducted in conjunction with this outreach to help refine the WRMO to better meet user needs.

Activity 1.5 Outcomes

- Beta version of Elements 1 and 2 available [Spring 2017]
- Stakeholder engagement and introduction of the WRMO to PNW DEWS stakeholders [Summer 2017]
- Develop scoping document for a Climate Outlook for water managers, including prototypes of maps and graphics [Winter 2017]
- Document use of product suite and evaluate usability and effectiveness in decision constructs, report to NIDIS on findings [Fall 2017]
- Evaluate product refinements and new climate products [Fall 2017/Winter 2018 - *pending available funding*]

Priority 2 – Expand Drought Early Warning Communication and Outreach

PNW DEWS stakeholders have highlighted the need for improved and coordinated drought communication and outreach across the region and between sub-regions within the PNW. This priority outlines distinct activities that will provide drought and climate information as part of the PNW DEWS and help build the capacity of partners in the region to better understand and utilize available tools and information. PNW DEWS stakeholders want to receive this information consistently through a variety of delivery mechanisms and from a mix of information providers. Examples of activities include regular drought and climate outlooks held in-person and via webinar, outreach and training to increase

and improve the use of available drought and climate information and tools, and the development of strategies to improve coordination of drought communication and messaging.

Activity 2.1 Drought, Climate, and Water Year Outlooks

Activity 2.1a PNW DEWS Drought and Climate Outlook Webinars

NIDIS, CIRC, NWS Western Region, the NWCH, and other partners will hold joint, bi-monthly webinars designed to provide stakeholders timely drought and climate information. Each webinar will feature recent, current, and forecasted drought conditions and anomalous climatic events. It will include discussions of observed impacts and other relevant updates from across the region. Webinars will periodically feature other NOAA initiatives (i.e. NCEI state of the climate, CPC forecast, WRCC Quarterly Climate Impacts and Report). Webinar materials and recordings will be posted on drought.gov in a timely fashion to maintain relevance for drought decision-making.

Activity 2.1a Outcomes

- PNW DEWS Drought & Climate Outlook Bi-Monthly Webinars (*Scheduled for the 4th Monday of the month starting February 27, 2017*)
- Webinars will be recorded and posted to drought.gov along with any other supporting materials. [Ongoing]

Activity 2.1b In-Person Water Year Outlooks

NIDIS and its partners (including CIRC, NWS, NDMC, and the University of Washington's Climate Impacts Group (CIG)) will hold at least two in-person Water Year Outlooks each year to provide an update on current drought conditions as well as climate and drought outlooks, highlight drought research and decision support tools, and provide a forum for stakeholders to discuss observed and anticipated drought impacts.

A Fall Inland PNW Water Year Outlook will be held in Boise, ID, building off the NRCS Idaho Snow Survey's annual Water Year Outlook in partnership with Idaho Department of Water Resources (IDWR), Bureau of Reclamation (BOR), Idaho Power, CIRC, the NWCH, and others.

Fall PNW Water Year Outlooks will be hosted by NIDIS and its partners (including CIRC, CIG, NWRFC, USDA National Water and Climate Center) and will be located on the east (Boise, ID) and west (tied to the 8th Northwest Climate Conference in Tacoma) sides of the Cascade Mountains.

Additional Outlook agenda topics may include: ENSO forecasts and anticipated and resulting impacts to the region, snowpack, spring runoff forecasts, wildfire season outlook/recap, reservoir status, groundwater/aquifer monitoring etc. Additional Outlooks may be scheduled if deemed necessary at the onset, during, or after drought or other climate extreme events.

Activity 2.1b Outcomes

- Pacific Northwest Drought, Climate & Water Year Outlooks [Fall 2017 and 2018]
- All presentations and associated materials (agendas etc.) will be posted on drought.gov in a timely manner
- A two-page summary of each outlook will be developed and posted on drought.gov in a timely manner

Activity 2.2 Northwest River Forecast Center Water Supply Forecast Monthly Briefings

The Northwest River Forecast Center (NWRFC) produces volumetric water supply forecasts for rivers throughout the Pacific Northwest. Each year from January through late spring, the NWRFC offers monthly water supply forecast briefings for stakeholders throughout the region. The briefings focus on current hydrologic conditions (precipitation, snow, and runoff) and include the latest climate outlooks and water supply forecasts. These briefings generally occur on the first Thursday of each month and are held via webinar. Briefing presentations are posted to the [NWRFC website](#) after each live broadcast and will be linked to from drought.gov as well.

Activity 2.2 Outcomes

- Monthly briefings held via webinar/conference call between January and late spring, annually
- Presentations will be posted on the NWRFC's [webpage](#) and linked to from drought.gov

Activity 2.3 Host Drought Messaging and Communication Workshop

To improve regional drought communication and messaging, NIDIS, in collaboration with NDMC, will organize a regional workshop focused on drought messaging and coordination for stakeholders in the Pacific Northwest. This workshop will host drought and climate communications experts from the public and private sector to address the following thematic areas: (1) drought messages that can be used across sectors and jurisdictions; (2) communication strategies for state and local drought plans; and (3) identifying the most effective “messengers” to deliver drought information and response strategies in a timely fashion. The target audience is county and state emergency managers and drought coordinators.

Following the workshop, NIDIS, NDMC, CIRC, and other partners will develop a strategy for creating a suite of drought communication tools to be considered for use by partners in the region.

Activity 2.3 Outcomes

- PNW Coordinated Drought Messaging and Communication Workshop [Fall 2018]
- Develop regional drought communications tools strategy and best practices [Winter 2018]
- Develop suite of regional drought communication tools [Spring/Summer 2018]

Activity 2.4 Update and Maintain the PNW DEWS Information on the U.S. Drought Portal

The PNW DEWS pages on the U.S. Drought Portal (drought.gov) provide the public with background information on the DEWS and its development, as well as reports on recent and current drought conditions, discussions of climate forecasts, and other information resources. The PNW DEWS pages on drought.gov also serve as an information portal for an explanation of past, current, and upcoming PNW DEWS activities, including upcoming workshops and webinars, research, and other tools and resources. The Portal can also serve as a platform to socialize new monitoring tools and drought indices and facilitate impact collection.

NIDIS will work with its partners to update and maintain this web portal with current content to meet the needs of this DEWS. NIDIS will solicit regular feedback from PNW DEWS stakeholders to review and provide content for PNW DEWS specific pages.

Activity 2.4 Outcomes

- Stakeholder review of PNW DEWS pages on drought.gov [Fall 2017]
- Initial update to PNW DEWS pages on drought.gov completed [Fall 2017]
- Routine enhancements to the PNW DEWS webpage, to include timely updates, relevant content, and visual improvements in layout and formatting [Winter 2017 – Fall 2018]

Priority 3 – Optimize Information and Collaborative Networks

The Pacific Northwest region has a wealth of collaborative and information networks due to the regional (and international) dependence on shared water resources like the Columbia River and Cascade snowpack. Despite these robust resources, these networks don't always include or reach small and vulnerable communities and do not always extend to coastal and rural portions of the region that were some of the hardest hit in the recent drought. The PNW DEWS will expand existing networks to include coastal and vulnerable communities, improve the integration of drought information and plans into wildfire management, and coordinate drought-related activities among federal climate initiatives.

Activity 3.1 Improve Drought Coordination among Federal, Tribal, State, and Local Agencies

Activity 3.1a Quarterly Stakeholder Calls

The PNW DEWS consists of a diverse group of federal, tribal, state, local, academic and international partners. On a quarterly basis, a conference call will be held bringing together key stakeholders in the region to discuss progress and updates to the Strategic Plan, agency and partner activities, and opportunities to leverage resources.

Efforts will be made on these calls and in other stakeholder coordination efforts to integrate lessons learned and related activities from other DEWS regions, including the Missouri River Basin DEWS where the State of Montana is also a key stakeholder.

Activity 3.1a Outcomes

- Quarterly calls with key stakeholders.
- Call notes distributed within one week of call.

Activity 3.1b Develop a Matrix of Federal, Tribal, State, and Local Drought Related Activities and Resources

Drought is increasingly common in the PNW DEWS region, and thus, partner agencies at all levels of government are actively engaged in drought-related activities. To improve awareness, collaboration, and avoid duplication, NIDIS will document these activities and resources in the PNW DEWS. This activity will also help identify sectors and communities lacking resources and highlight potential opportunities to leverage resources to enhance their benefit.

A template matrix will be developed by the NIDIS program office and circulated among PNW DEWS partners and stakeholders to collect information on existing and planned activities in the region. Information collected will include but is not limited to the following: lead agency/organization, funding, associated timelines and primary contact(s). The completed matrix will be made publically available and be used by the NIDIS program office and PNW key stakeholders as a reference tool. The matrix will be updated on a quarterly basis (to coincide with PNW DEWS quarterly stakeholder calls). Key partners include NIDIS, CIRC, NDMC, NWS, CIG, USGS, BOR, and the Columbia River Inter-Tribal Fisheries Commission (CRITFC).

Activity 3.1b Outcomes

- First version of matrix completed [Summer 2017]
- Updated on a quarterly basis
- A public facing version of this document will be posted on drought.gov

Activity 3.1c Increase Outreach to Tribal Communities through Collaboration with the Pacific Northwest Tribal Climate Change Network

NIDIS, the University of Oregon, and CIRC will provide PNW DEWS updates and drought and climate outlooks on at least four PNW Tribal Climate Change Network monthly calls, annually. These short presentations by regional experts (i.e. state/tribal/local drought coordinators, state climatologists, NOAA/NWS climatologists) will provide information on current and regional drought conditions and drought outlooks, and a discussion on forecasted anomalous climatic events. These presentations will also provide participants with an update on PNW DEWS activities (including new forecasting and monitoring tools and resources, upcoming trainings/workshops, and other partner initiatives) and provide room for participants to report out on their observed drought impacts and experiences.

Activity 3.1c Outcomes

- Develop outreach/coordination strategy and calendar [Winter 2017]
- Facilitate at least four drought update climate outlook presentations. Webinars will be recorded and any supporting materials (presentations etc.) will be posted to the PNW DEWS pages on drought.gov in a timely fashion [Spring 2017]
- Present on other drought decision support tools, and research and planning initiatives, as needed

Activity 3.1d Coordinate Drought-Related Activities amongst Federal Climate Initiatives

The PNW DEWS region contains a robust network of regional federal climate initiatives (CIRC, NWCH, Northwest Climate Science Center (NWCSC), North Pacific Landscape Conservation Cooperative, etc). Each of these entities has interconnected priorities and activities related to drought, and are key partners in the PNW DEWS as they provide specific sectoral expertise and stakeholder networks especially for agricultural, ecological, and land management communities.

Representatives from each of these organizations will continue to hold quarterly conference calls (initiated in Fall 2016) to identify opportunities for joint projects or forums to integrate drought planning into these interlinked challenges for a more solid decision making process among local to federal partners. Upcoming example activities include:

- **Northwest Ecological Drought Workshops:** The NWCSC hosted two [Ecological Drought Workshops](#) (Portland, OR and Boise, ID) in the Spring of 2017 to better understand the environmental impacts of drought. PNW DEWS stakeholders partnered with the NWCSC to support these workshops through the identification of participants, speakers, and other cross-promotional activities.
- **U.S. Forest Service Stakeholder Drought Workshops:** The NWCH is working with the National Climate Hub and the U.S. Forest Service (USFS) to administer regionally relevant drought workshops with forest service stakeholders and agency professionals to incorporate drought resilience into programming and management activities within USFS. Additionally, the NWCH is working to address concerns about drought impacts across managed landscapes in agriculture, forestry, and rangeland management.

Activity 3.1d Outcomes

- Quarterly conference calls with regional federal partners engaged in agency climate initiatives [Ongoing]
- Two NWCSC Ecological Drought Workshops [Spring 2017]
- USFS Stakeholder Drought Workshops [Fall 2017]

Activity 3.2 Develop Networks of Coastal Water Suppliers for Drought Response and Planning

Drought is a considerable risk to communities along the Pacific Northwest coast, despite the high volumes of annual precipitation they receive. The factors underlying these risks include high seasonal

variability in precipitation from fall through spring with very little precipitation during summer months when demand is highest. Streamflows on the coast are not augmented by snowmelt in other Pacific Northwest watersheds because of the low elevation of the coastal watersheds. These water systems also tend to be small with limited groundwater resources and reliable infrastructure for surface water storage during natural surface flow shortages. This vulnerability was exemplified in 2015 when coastal communities in Oregon and Washington experienced Extreme Drought (D3) and were among the most severely impacted areas in the region.

Beyond these physical challenges, drinking water is often supplied by small utilities with limited resources. After the 2015 drought, the City of Newport and the Oregon Water Resources Department (OWRD) developed a collaborative network of water interests known as the Mid-Coast Water Planning Partnership that includes industrial water users (e.g. paper production, fish processing), conservation interests, fishery managers, and municipal water suppliers from the central Oregon coast. The goal of this collaborative is to develop short-term drought contingency planning and identify long term goals to support water resilience in anticipation of changing demand and supplies.

NIDIS will partner with CIRC and Oregon Sea Grant to support the Mid-Coast Partnership by participating in its coordinating committee and offering technical support to help participants anticipate and respond to seasonal conditions. This activity will be led by CIRC. This collaborative will engage a coast-wide network of water managers through seasonal water outlook webinars and in-person events such as *2018 State of the Coast*, hosted annually by Oregon Sea Grant.

Activity 3.2 Outcomes

- Develop inventory of coastal water providers in Oregon and Washington [Spring 2018]

Activity 3.3 Integrate Drought and Climate Science into Wildfire Management Planning and Policy

The relationship between drought and wildfire can seem simple, but the drought and wildfire nexus encompasses many human and environmental interconnections. Because of regional variations in fire regimes and fuel characteristics, as well as the number of agencies involved in wildfire management, natural resource, fire, and air quality agencies must coordinate and understand the impacts of drought at state and regional levels when responding to wildfire and integrate drought information into their planning.

In October 2015, NIDIS, DRI/WRCC, NDMC and others hosted the [*Integrating Drought Science and Information into Wildfire Management Workshop*](#) in Boise, ID. Seventeen federal, state, NGO, and academic organizations from across the West, including representatives from the National Interagency Fire Center (NIFC), discussed the role that drought plays in fire behavior regimes and its impacts on wildfire management, planning, prepositioning of fire response resources, and post-fire restoration opportunities.

To improve the use of drought information in wildfire management, participants called for additional, regionally focused workshops to identify how the wildfire management community is currently using

impact information and drought indicators. DRI/WRCC and NIDIS plan to hold at least two workshops in the PNW DEWS region over the next two years.

Activity 3.3 Outcomes

- Workshop in PNW Geographic Area Coordination Center (GACC) Region [Spring 2017]
- Workshop in Northern Rockies Mountain GACC Region [Fall 2017] **(in collaboration with the Missouri River Basin DEWS)*
- Post-workshop reports consisting of outcomes, findings and recommendations to NIDIS

Activity 3.4 Improve Drought Resiliency in the Agricultural Sector and Other Land Management Communities

In collaboration with Oregon State Extension, the NWCH, NRCS, NIDIS, and CIRC will hold a series of workshops on the soil health, drought, and climate nexus with land managers. Healthy and productive soils and erosion prevention measures are effective drought mitigation strategies that benefit farmers and ranchers. Enhancing soil health is often a win-win conversation with producers, providing actionable practices that reduce drought impacts while also building productivity and resilience on farms/ranches. The PNW DEWS will conduct workshops that bring in a diverse group of stakeholders who manage land to discuss management strategies that are focused on making linkages between drought mitigation and soil health improvement.

Activity 3.4 Outcomes

- Host a series of workshops in the Pacific Northwest on soil health and drought mitigation strategies [Winter 2018]

Activity 3.5 Increase Transboundary Coordination with Canadian Partners

In June of 2016, NOAA's North American Climate Services Partnership (NACSP) joined with the biennial North American Drought Monitor Forum to convene a joint workshop on drought, wildfire, and climate services in North America. The North American Drought, Wildfire, and Climate Services Forum brought together nearly 50 participants from the U.S., Canada, Mexico, and the Caribbean to discuss existing drought monitoring, drought assessment, and outlook tools and products, and to explore opportunities for enhanced collaboration and partnerships across sectoral and jurisdictional boundaries.

Forum participants recommended the establishment of demonstration projects to coincide with forecasted climactic events (i.e. La Niña) to determine the effectiveness of climate services provided in the region and advance drought research. The Pacific Northwest region (include states and provinces in the U.S and Canada) was identified as a potential demonstration project region due to the opportunity to capitalize on lessons learned during the drought of 2015. NIDIS will convene a conference call with Agriculture and Agri-Food (AAFC) (the lead on drought in Canada for the NACSP) to discuss this recommended demonstration project and future opportunities for collaboration.

Activity 3.5 Outcomes

- Coordination call between NIDIS and AAFC to identify potential areas of collaboration within the PNW DEWS [Winter 2017]

Priority 4 – Enhance Drought Planning and Mitigation in the Pacific Northwest

Each state in the Pacific Northwest has an existing state drought plan. Some have not been updated in several years, and some are in the process of being updated. Drought plans have a strong emphasis on drought indicators, but may lack triggers for initiating response actions and drought impact information to inform those decisions. To help Pacific Northwest states reduce the impacts of drought events, the PNW DEWS will focus on improving drought mitigation planning in the region.

NIDIS and other PNW DEWS partners can help inform the development of drought mitigation and response plans by leveraging resources to support state, local and tribal drought planning; providing tribal drought planning workshops and trainings; improving drought impact collection and reporting; and expanding citizen science monitoring networks.

Activity 4.1 Leverage the PNW DEWS Network to Support Drought Planning

The PNW DEWS will support ongoing and emerging tribal, state, and local drought planning initiatives. Several federal programs, such as the Federal Emergency Management Agency's (FEMA) Pre-Disaster Mitigation Program and BOR's Drought Response Program support drought response and mitigation planning across the PNW DEWS. NIDIS will work with partners including BOR, FEMA, USGS, NRCS, NDMC to identify ways these and other programs can be leveraged with federal, regional, tribal, state, and local efforts to support more comprehensive and effective drought planning. NIDIS can also provide technical support for plan development and other decision support tools and resources.

Examples of drought planning efforts utilizing some of these resources that are already underway can be found in Appendix E.

Activity 4.1 Outcomes

- NIDIS will utilize the PNW DEWS partner network to identify and promote funding opportunities and announcements through the PNW DEWS pages on drought.gov, PNW DEWS webinars, and other communications mediums [Ongoing].

Activity 4.2 Host Tribal Drought Planning Workshops

Throughout the PNW DEWS scoping process, tribal stakeholders asked for more information about the drought planning process, from collecting adequate impact information to understanding government assistance funding proposal processes. NIDIS, CIRC, and the University of Oregon (UO) will work with regional tribal organizations (i.e. Columbia River Inter-Tribal Fish Commission (CRITFC), Affiliated Tribes of Northwest Indians (ATNI), Northwest Indian Fisheries Commission, Upper Columbia United Tribes, Upper Snake United Tribes, Northwest Indian College) and the NIDIS Planning and Preparedness Working Group to support tribes in drought planning, building off of the 2016 CSC Tribal Climate Boot

Camp. Support could include trainings/workshops/webinars on the collection and dissemination of drought impact data, drought and climate indices for decision-making, and funding opportunities and proposal writing strategies. Efforts will be take to leverage similar efforts in the Intermountain West and Missouri River Basin DEWS to support tribal stakeholders.

Activity 4.2 Outcomes

- NIDIS will work with the aforementioned organizations to develop a workshop/training strategy and corresponding timeline [Fall 2017]
- Tribal Drought Planning Workshop hosted [Fall 2018]
- All related training materials, manuals, presentations, agendas and workshop reports generated will be made available on drought.gov

Activity 4.3 Enhance Drought Planning Through Coordinated Drought Impact Collection and Post-Drought Assessments

At the 2016 PNW DEWS Kickoff Meeting, DEWS stakeholders responsible for state, tribal, or local drought planning activities expressed the need for more robust and coordinated drought impact collection to support drought planning and to identify critical areas prone to the impacts of drought.

In September 2016, NIDIS and NDMC hosted a workshop for PNW DEWS state drought coordinators and climatologists to explore the selection and use of drought indicators and triggers. The workshop featured drought planning experts from the NDMC, colleagues from the State of Colorado who developed one of the most robust state drought response and mitigation plans and drought vulnerability assessments, experts from BOR's Drought Response Program, the NWS, and the USDA NRCS's National Water and Climate Center. Meeting participants called for further drought impact collection region-wide. The following activities reflect recommendations from the 2016 workshop.

Activity 4.3a Develop a Regional Strategy and Tools to Improve Drought Impact Reporting in the Pacific Northwest

At NIDIS's September 2016 PNW Drought Indicators and Triggers Workshop in Boise, ID, representatives from each of the PNW states agreed to coordinate with NDMC and NIDIS to improve drought impact collection by developing a regionalized impact reporting form for the region. NDMC is currently updating the Drought Impact Reporter (DIR) to make it more useful for decision makers and practitioners nationwide. After the PNW Drought Impact Reporting Form is developed, the PNW DEWS will identify key user groups (i.e. Extension, NWS, USDA Agricultural Research Service (ARS), state level parks and fish and wildlife agencies, water masters, irrigation districts) to train on this form and the DIR. Trainings will be held via webinar and incorporated into other in-person PNW DEWS and partner workshops and meetings.

NIDIS and NDMC will also consult with AAFC, the Canadian agency responsible for the [Agroclimate Impact Reporter](#), to explore how it can be included in this effort.

Activity 4.3a Outcomes

- Regionalized reporting form will be developed by NDMC to update the DIR in consultation with PNW DEWS stakeholders [Winter 2017]
- NIDIS will convene a conference call between NDMC and PNW DEWS state drought coordinators and climatologists to target the initial user groups to receive training [Spring 2017]
- Begin training webinars in Spring 2017 and continue as needed.

Activity 4.3b Develop Post-Drought Assessment Templates

PNW DEWS stakeholders identified post-drought assessments as vital exercises for a community, to not only revisit and collect lessons learned during a drought event, but also identify indicators (and associated drought indices) that may help states better define the beginning and end of droughts. To provide regional consistency to post-drought assessment exercises so information may be analyzed across state-lines, NDMC and NIDIS will develop a “Post-Drought Assessment Template” for use in the PNW DEWS.

Activity 4.3b Outcomes

- Draft post-drought assessment template developed by NDMC [Spring 2017]
- PNW DEWS stakeholders will review draft template and provide comments to NDMC [Winter 2018]
- Final post-drought assessment template completed and posted to drought.gov as a downloadable planning resource [Winter 2018]

Activity 4.4 Strengthen Existing Citizen Science Networks

Citizen scientists help collect drought and climate impact information while simultaneously increasing awareness of community-level drought impacts that are foundational to any drought early warning system. The following activities will leverage and expand upon existing citizen science networks.

Activity 4.4a Improve the Network of CoCoRaHS Observers in the Pacific Northwest

In coordination with the NWS Weather Forecast Offices (WFOs) in the Pacific Northwest, NIDIS, CIRC and other DEWS partners will support the CoCoRaHS coordinators in the four Pacific Northwest states by co-producing informational handouts or presentation material that illustrate the value of CoCoRaHS data, especially in sparsely-populated areas. PNW state coordinators and the NWS WFOs have requested assistance in promoting the value of the network, especially during the summer when reporting and monitoring decreases. This activity will also include identifying further areas of collaboration and leveraging opportunities with the Local Environmental Observation Network (LEO) referenced in Activity 4.4b.

Activity 4.4a Outcomes

- Develop CoCoRaHS slide to use in DEWS presentations and webinars [Winter 2017]
- CIRC will work with state CoCoRaHS coordinators, state climatologists, and state drought coordinators to develop a 1-page outreach handout to communicate the value of CoCoRaHS for drought monitoring [Summer 2017]

Activity 4.4b Support the Expansion of the Local Environmental Observation (LEO) Network in the Pacific Northwest

In 2016, the U.S. Environmental Protection Agency (EPA) announced the expansion of the [Local Environmental Observers \(LEO\) Network](#), a program initiated and championed by the Alaska Native Tribal Health Consortium (ANTHC). This expansion includes developing a lower-48 LEO network hub at Northwest Indian College in Bellingham WA and creates a model for the other 35 tribal colleges and universities in the lower 48 to replicate across the U.S.

The LEO Network is comprised of local observers and experts who share on-the-ground knowledge about unusual animal, environmental, and weather events. LEO connects observers within their respective community, provides an opportunity to share valuable observations, and raises awareness about significant environmental events.

NIDIS and the University of Oregon will partner with the ANTHC to expand the LEO Network in the Pacific Northwest and find ways for these observations to inform other regional citizen science networks (ie. CoCoRaHS) and drought impact collection efforts. Planned activities include promoting LEO in presentations on webinars and at NIDIS workshops and meetings. NIDIS will also help connect LEO with PNW CoCoRaHS network of observers, NWS WFOs, CIRC, CIG, and other state and local partners. NIDIS will work with NDMC and AAFC to integrate LEO Network observations into their respective drought impact reporting tools, such as the DIR.

Activity 4.4b Outcomes

- NIDIS, CIRC, and the University of Oregon will include LEO Network Observers on PNW DEWS webinars, PNW Tribal Climate Change Network calls, and integrate information about their work into other PNW DEWS outreach mediums [Winter 2017]
- The University of Oregon will work with LEO Network organizers to create a LEO Network observer slide/template presentation to use in DEWS presentations and webinars, which will be posted to drought.gov [Summer 2017]

APPENDIX A: PACIFIC NORTHWEST DEWS PARTNERS

The development of this Plan and its implementation reflects the knowledge and experience of dedicated individuals, organizations, and partners. Collaboration is the key to improving drought early warning capacity and long-term resilience through implementation of the Pacific Northwest DEWS. This list of partners is not exhaustive and will evolve as new regional partnerships are formed.

Table A – Partnerships

Partner Agencies and Organizations
Affiliated Tribes of Northwest Indians
Agriculture and Agri-Food Canada
British Columbia Ministry of Forests, Lands and Natural Resource Operations
California Department of Water Resources
California State University at Monterey Bay
Climate Impacts Group
Columbia River Inter-Tribal Fish Commission
Desert Research Institute
Environment Canada
Federal Emergency Management Agency
Idaho Department of Water Resources
Idaho Power
Montana Department of Natural Resource Conservation
Montana Climate Office
National Aeronautics and Space Administration
National Drought Mitigation Center
National Interagency Fire Center
National Oceanic and Atmospheric Administration <ul style="list-style-type: none"> ▪ Climate Prediction Center ▪ National Center for Environmental Information ▪ National Marine Fisheries Service ▪ National Weather Service ▪ Northwest River Forecast Center ▪ Western Regional Climate Center
North American Climate Services Partnership
Northwest Power and Conservation Council
Pacific Northwest Climate Impacts Research Consortium
Office of the Washington State Climatologist
Oregon Climate Change Research Institute
Oregon Climate Service
Oregon Sea Grant

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Oregon State University
Oregon Water Resources Department
U.S. Army Corps of Engineers
U.S. Department of Agriculture <ul style="list-style-type: none">▪ Agricultural Research Service▪ California Climate Hub▪ Forest Service▪ Natural Resources Conservation Service▪ Northwest Climate Hub
U.S. Department of the Interior <ul style="list-style-type: none">▪ Bureau of Land Management▪ Bureau of Reclamation▪ Geological Survey▪ Northwest Central Climate Science Center
U.S. Environmental Protection Agency
University of Idaho
University of Oregon
University of Washington
Washington State Department of Agriculture
Washington State Department of Ecology
Washington State University
Western Governors Association
Western States Water Council

APPENDIX B: NIDIS WORKING GROUPS

Coordination, communication, and transferability of information and actions between the NIDIS Working Groups and the Pacific Northwest DEWS is essential the overall process of building a collaborative information system. The table below highlights how each of the activities in the Plan corresponds with the individual Working Groups. As the Pacific Northwest DEWS and the NIDIS Working Groups continue to develop, activities among these groups will be leveraged and coordinated.

Table B – Pacific Northwest DEWS and NIDIS Working Groups

Activity	NIDIS Working Groups					
	Education and Public Awareness	Monitoring and Observations	Predictions and Forecasting	Interdisciplinary Research Applications for Risk Assessment	Planning and Preparedness	U.S. Drought Portal
Priority 1 – Improve Drought Monitoring and Research for Drought Risk Management						
Activity 1.1 Expanding the stream gauge network in the Pacific Northwest		X	X		X	
Activity 1.2 Followed agricultural field tracking		X		X	X	
Activity 1.3 Northwest Climate Toolbox			X		X	X
Activity 1.4 Exploring datasets to identify areas of water scarcity in the Pacific Northwest				X	X	
Activity 1.5 Integrating water resource-related data and predictive information		X	X		X	
Priority 2 – Expand Drought Early Warning Communication and Outreach						
Activity 2.1 Drought, Climate and Water Year Outlooks						
Activity 2.1a PNW DEWS Drought and Climate Outlook Webinars	X	X	X		X	X

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Activity 2.1b In-person Water Year Outlooks	X	X	X		X	X
Activity 2.2 Northwest River Forecast Center Water Supply Forecast Monthly Briefings	X	X	X		X	X
Activity 2.3 Explore opportunities for regionally coordinated drought messaging and communication	X				X	X
Activity 2.4 Inform the PNW DEWS pages on the Drought Portal (drought.gov)						X
Priority 3 – Optimize Information and Collaborative Networks						
Activity 3.1 Improve drought coordination among federal, state, tribal, and local agencies						
Activity 3.1a Quarterly stakeholder calls	X				X	
Activity 3.1b Develop a matrix of federal, tribal, state and local drought related activities and resources	X				X	
Activity 3.1c Increase outreach to tribal communities through collaboration with the Pacific Northwest Tribal Climate Change Network	X	X			X	X
Activity 3.1d Coordination of drought-related activities amongst Federal climate initiatives	X				X	X
Activity 3.2 Support efforts to develop networks of coastal water suppliers for drought response and planning	X	X		X	X	

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Activity 3.3 Integration of drought and climate science into wildfire management	X	X	X	x	X	x
Activity 3.4 Improving drought resiliency in the land management community	X	X		X	X	
Activity 3.5 Transboundary coordination with Canadian partners	X				X	
Priority 4 – Enhance Drought Planning and Mitigation in the Pacific Northwest						
Activity 4.1 Leverage the PNW DEWS network to support drought planning	X				X	
Activity 4.2 Tribal drought planning workshops	X	X	X	X	X	X
Activity 4.3 Enhancing drought planning through coordinated drought impact collection and post-drought assessments						
Activity 4.3a Develop a regional strategy and tools to improve drought impact reporting in the Pacific Northwest	X	X			X	X
Activity 4.3b Develop post-drought assessment templates		X		X	X	
Activity 4.4 Leverage and expand upon existing citizen science networks						
Activity 4.4a Improve the network of CoCoRaHS observers in the Pacific Northwest	X	X			X	X
Activity 4.4b Support the expansion of the Local Environmental Observation (LEO) Network in the Pacific Northwest	X	X		x	X	X

APPENDIX C: PROJECT LIST

Table C - PNW DEWS Projects and Timelines



APPENDIX D: ACRONYMS

AAFC	Agriculture and Agri-Food Canada
ANTHC	Alaska Native Tribal Health Consortium
ARS	Agricultural Resource Service
ASCE	American Society of Civil Engineers
ASO	Airborne Snow Observatory
ATNI	Affiliated Tribes of Northwest Indians
AWN	Agriculture Weather Network (Washington State Univeristy)
BLM	U.S. Bureau of Land Management
BOR	U.S. Bureau of Reclamation
CA DWR	California Department of Water Resources
CIG	Climate Impacts Group
CIRC	Pacific Northwest Climate Impact Research Consortium
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
CPC	Climate Prediction Center
CRITFC	Columbia River Inter-Tribal Fisher Commission
CSC	Climate Science Center
CSUMB	California State University at Monterey Bay
DEWS	Drought Early Warning System
DIR	Drought Impact Reporter
DOI	Department of the Interior
DRC	Drought Readiness Council
DRI	Desert Research Institute
ECY	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EDDI	Evaporative Demand Drought Index
ESP	Ensemble Streamflow Prediction
ESRL	Earth Systems Research Laboratory
FEMA	Federal Emergency Management Agency
LCC	Landscape Conservation Cooperative
LEO	Local Environmental Observers Network
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NCEI	National Center for Environmental Information
NDMC	National Drought Mitigation Center
NIDIS	National Integrated Drought Information System
NMME	North American Multi-Model Ensemble
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
NACSP	North American Climate Services Partnership
NWCH	Northwest Climate Hub
NWCSC	Northwest Climate Science Center
NWRFC	Northwest River Forecast Center
NWS	National Weather Service

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OSC	Oregon State Climatologist
OSU	Oregon State University
OWSC	Office of the Washington State Climatologist
PNW	Pacific Northwest
PSD	Physical Sciences Division
RCC	Regional Climate Centers
RFC	River Forecast Center
RISA	Regional Integrated Sciences & Assessments
SARP	Sectoral Applications Research Project
SCAN	Soil Climate Analysis Network
SNOTEL	Snow Telemetry
SWE	Snow-water equivalent
SWSI	Surface Water Supply Index
UI	University of Idaho
UO	University of Oregon
UW	University of Washington
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDM	U.S. Drought Monitor
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WGA	Western Governors Association
WRCC	Western Regional Climate Center
WRMO	Water Resources Monitor and Outlook
WSAC	Water Supply Availability Committee
WSDA	Washington State Department of Agriculture
WSWC	Western States Water Council

APPENDIX E: STATE AND LOCAL DROUGHT PLANNING ACTIVITIES

The following section describes several state and local drought planning activities currently underway and/or in development in the Pacific Northwest.

- **Idaho:** Following NIDIS's 2016 PNW DEWS Drought Impacts and Triggers Workshop, stakeholders in Idaho identified the Henry's Fork Watershed as a potential pilot drought planning project. Through the Henry's Fork Watershed Council (HFWC), this basin has made significant headway in developing an integrated water management/drought plan that gives a diverse set of stakeholders a voice in the management of the watershed. The current plan lacks triggers to initiate specific drought mitigation actions. Rather, they rely on a series of meetings to address water shortages. A pilot project to develop triggers to initiate agricultural and ecosystem drought mitigation efforts might be helpful for this group. The project may include an update to the existing Henry's Fork Drought Management Plan with a emphasis on increasing drought impact collection and documentation in the watershed and identifying ways to use them to trigger specific response actions in the drought plan. Idaho stakeholders have prioritized improving the collection of ecological drought impacts, and this pilot could help replicate similar efforts in the state with the ultimate goal of contributing to an update of the state plan. NIDIS and NDMC will help IDWR and the Henry's Fork Foundation to identify potential partner agencies to leverage funding and technical expertise. Potential partners include: Idaho Department of Water Resources (IDWR), Henry's Fork Foundation, Henry's Fork Watershed Council, BOR, NIDIS, NDMC, USGS and CIRC. NIDIS and NDMC will work with Henry's Fork Watershed Council to enhance their drought and water management plans for the basin.
- **Montana:** In 2014, the National Drought Resilience Partnership began a [demonstration project in Montana](#) in the Missouri River Basin Headwaters as a model for successfully leveraging federal resources to improve drought planning and monitoring at the state and local (watershed) levels. MT DNRC is building off these projects and relationships to not only improve watershed-level drought planning but also inform the update to the Montana State Drought Management Plan (led by Montana Department of Natural Resources Conservation (MT DNRC)). Activities include MT DNRC receiving funding from BOR to support local communities with drought planning, and Montana Department of Emergency Services (MT DES) working with FEMA to identify ways to incorporate drought planning into local hazard mitigation plans. NIDIS continues to work with partners in MT to identify lessons learned that can be transferred to other PNW DEWS partners to support drought planning efforts. Several interested parties, including conservation districts, land use planners, public water supply systems, watershed groups, land owners, and non-profits in the Upper Clark Fork are pursuing additional federal support to build on the lessons learned from the NDRP's work in the Missouri River Basin Headwaters.

In addition, NIDIS remains involved as Montana updates its state-wide Drought Management Plan, and as the state and the Northern Plains region grapples with extreme drought conditions in 2017. In October 2016, staff for the Governor's Drought and Water Supply Advisory Committee attended a training on Indicators and Triggers for Drought in Boise, ID hosted by PNW DEWS. The training and additional feedback from NIDIS and the NDMC led to the state to hold a public comment period on a DRAFT Outline and helped set the stage for a review of how Montana defines drought. This effort is ongoing and is building upon lessons learned to forge a better partnership with the state's Department

of Emergency Services as well as looking at long-term mitigation strategies. The plan update will take two years to complete.

- **Oregon:** Responsibility for Oregon's drought monitoring and response process within two state committees: the Water Supply Availability Committee (WSAC), and the Drought Readiness Council (DRC). The WSAC evaluates current conditions and the DRC makes a determination whether to pass county-level drought requests on to the Governor's office. The Oregon State Climatologist (OSC) sits on both committees. The WSAC is currently evaluating drought metrics and products to use in Oregon's drought monitoring process including the Evaporative Demand Drought Index (EDDI), Surface Water Supply Index (SWSI), and the USDM. The OSC, in partnership with local NWS weather forecasting offices, leads the state's weekly call to discuss and provide recommendations to the USDM. Many of the members of the WASC also participate in these calls. The OSC is working with partners to leverage and streamline these efforts to eliminate duplication and increase efficiency in drought monitoring and reporting.

Santiam Water Control District received a drought contingency planning grant from BOR in 2015 to develop and implement a drought contingency plan covering approximately 766 square miles from the western slope of the Cascade Mountains to the Willamette Valley in Oregon.

- **Washington:** The State of Washington issued its first statewide drought declaration in 10 years during the 2015 drought. Although there had been attempts to edit the current plan on record (written in 1992), Washington Department of Ecology (ECY) (the state agency tasked with leading drought coordination and response) recognized an updated plan would have been much more useful in responding to this and future droughts. ECY applied for and received a drought contingency planning grant from the Bureau of Reclamation to assist them in updating the state's plan. Each of the state agencies and the Office of the Washington State Climatologist (OWSC at the University of Washington) that have representatives on the Drought Contingency Task Force have a specific roles and expertise to contribute to the process. For example, OWSC is assisting in the technical aspects of the plan and has been reviewing different drought indicators that may be useful for predicting and monitoring drought in WA. Since WA's definition of drought is based on forecasted conditions, OWSC is also looking into past verification of historical seasonal climate forecasts for the state and identifying advancements in seasonal streamflow forecasting. Furthermore, ECY is considering how future climate projections may impact the drought plan, and OWSC is working on a literature review on this topic. A technical advisory panel consisting of experts in drought, seasonal climate forecasts, and regional climate change projections (including NDMC, NWRFC, NIDIS, USACE, CIRC and others) has been assembled to review OWSC's piece of the work. The work was completed in July 2017.

In 2016, Whatcom County (located on the U.S.-Canada border) received a Bureau of Reclamation drought contingency planning grant to evaluate development of a water market, and to assist irrigators and other water users in securing a reliable supply of water during future droughts.