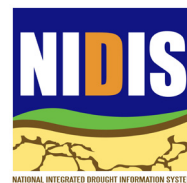
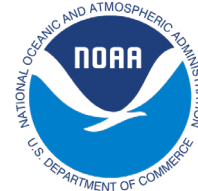


2021–2023

Pacific Northwest

Drought Early Warning System (DEWS) Strategic Action Plan



Document prepared by the National Integrated Drought Information System (NIDIS)
in partnership with key stakeholders in the region (Appendix C).



Executive Summary

DROUGHT IN THE PACIFIC NORTHWEST

The Pacific Northwest (PNW) is often associated with rainy winters, foggy coastlines, and large-scale irrigated agricultural projects in the semi-arid/arid interior. It is an ecologically diverse region where water supplies are heavily reliant on snowpack, rain, and groundwater, as well as on highly managed rivers, like the internationally regulated Columbia River. Despite its soggy reputation, the region is primarily wet in the winter but dry in the summer, and has experienced multiple droughts in the early 21st century. Agriculture, water supply, hydropower, tourism and recreation, fisheries, and wildland fire regimes have all been affected. Recently, in 2001 and 2015, virtually the entire region experienced significant drought. In 2015 historic levels of drought were experienced across western Washington and Oregon. While the coastal regions experienced an unprecedented single-year drought, the eastern portions of Oregon and Idaho had been suffering a fourth year under prolonged drought. While precipitation rates were only moderately below

WHAT IS NIDIS? In 2006 (Public Law 109-430), 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). The program was reauthorized in 2014 (Public Law 113-86) and again in 2019 (Public Law 115-423).

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.

normal, much higher than average temperatures, record low levels of snowpack, and record early runoff led to severe and extreme levels of drought. A much warmer climate is anticipated to become the normal 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 wake-up call to enhance monitoring and early warning, and to reevaluate how water is managed for the future.

THE PACIFIC NORTHWEST DEWS

In response to drought in the PNW, and following a series of stakeholder engagement activities in 2015, the National Integrated Drought Information System (NIDIS) and its partners formally launched the PNW Drought Early Warning System (PNW DEWS) in February 2016. A DEWS improves the regional capacity to prepare for, respond to, and cope with drought by utilizing existing networks to make climate and drought science readily available, easily understandable, and usable.

BUILDING A PNW DEWS STRATEGIC PLAN

The first PNW DEWS Strategic Plan from 2017–2018 focused on three priorities: (1) to provide a forum for a diverse group of partners across sectors to share appropriate, relevant, useful, and readily available drought, climate, weather, and water information at local and regional scales; (2) to develop an understanding of existing observations and monitoring networks, data, tools, research, and other planning and mitigation resources available for the DEWS; and (3) to identify the economic sector-specific and geographic needs for future drought monitoring, prediction, planning, and information sources. Partners from across the PNW met in Portland, OR in October 2019 to discuss next steps. Discussions acknowledged the progress made to better communicate and collaborate in preparing for and responding to drought, and led participants to ask how the DEWS might further facilitate not only information delivery but also action to reduce the impacts of drought. Four priorities and a series of outcomes and actions organized by the five components of a drought early warning system were identified. The 2020 drought in the region resulted in greater coordination and collaboration between the states and exposed some additional needs, which were added to the plan.

FOUR KEY PRIORITIES FOR 2021–2023

1. Improve early warning by building an understanding of the drought indicators/indices used in the PNW to better demonstrate their value, limitations, and sector-specific, seasonal, and geographical applications.
2. Increase understanding of drought impacts across sectors by building a robust drought impact reporting and analysis system to include citizen science monitoring programs.
3. Improve communication across the partners in the PNW DEWS network as a key channel for disseminating drought information to the public and other regional DEWS.
4. Increase the ability to share drought-related lessons learned both within and across DEWS, sectors, and tribal, state, and local agencies pertaining to drought preparedness and response.

The following table contains activities that the PNW DEWS network will initially focus on, organized by components of a drought early warning system. It is not inclusive of everything in the plan and emerging issues could shift priorities. More detailed information on the larger suite of activities in the plan can be found in the body of this document. Annual meetings will be used to reassess priorities and direct action within the DEWS during the life of the plan.

Initial Activities to be Undertaken by the PNW DEWS
NETWORK COORDINATION AND INTEGRATION
<p>Plan in-person meetings with opportunities for exchange, and include experts (e.g., CPC, latest advances, products that are soon to be available) and perspectives from other DEWS. Target key audiences for a portion of the meeting, with field trips and other shared learning opportunities made available with an aim to strengthen mechanisms of communication and coordination amongst partners and to engage new partners.</p>
<p>Establish the foundation of a drought learning network to encourage the exchange of best practices, lessons learned, and peer-to-peer exchanges to foster preparedness and resilience to drought.</p>
<p>Evaluate the effectiveness of the PNW DEWS network and engagement strategies in building collaborations, increasing partners' abilities to find and use information in decision-making, and expanding participation in drought planning and preparedness activities.</p>
DROUGHT PREDICTIONS AND FORECASTING
<p>Support work to better understand the timing of decisions for various sectors and what drought information is needed when, to better tailor information delivery and improvements to forecasting products.</p>
<p>Review the products and tools available that convey the probability of drought expanding or recovering, and determine if we need to develop a new tool, improve on existing tools, and/or provide training and raise awareness of tool(s).</p>
DROUGHT PLANNING AND PREPAREDNESS
<p>Collate and share drought related adaptation strategies through the drought learning network when it is established to encourage communities and sectors to move to a more proactive planning approach that considers multiple sectors.</p>
<p>Identify planned or regular gatherings of the tribal nations and tribal representatives to provide drought information where it is appropriate.</p>
DROUGHT COMMUNICATION AND OUTREACH
<p>Hold a communication workshop to support coordination between states toward a more regionally coordinated response to drought.</p>
<p>Hold a workshop with key state drought task force members and USDM authors to better understand the USDM process and drought in the west with a goal of improving PNW input to the USDM through a more coordinated regional process.</p>
INTERDISCIPLINARY RESEARCH AND APPLICATIONS
<p>Identify and support research to study the evolution and attribution of drought in the region, to better plan for future drought in the region, and to determine if acidification is a concern in the PNW.</p>
<p>Identify and support research to understand the actions that can be taken to reduce the impacts of drought and identify the barriers to implementation.</p>

The National Integrated Drought Information System and the Pacific Northwest Drought Early Warning System

NATIONAL INTEGRATED DROUGHT EARLY WARNING SYSTEM

Congress created the National Integrated Drought Information System in 2006 (Public Law 109-430) 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). The program has been reauthorized in 2014 (Public Law 113-86) and again in 2019 (Public Law 115-423). 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 regional DEWS that is well-networked and responsive to the specific needs of each region driven from the bottom-up.

COMPONENTS OF A DROUGHT EARLY WARNING SYSTEM

Early warning is the provision of timely and effective information—through identified institutions—that allows individuals exposed to a hazard to act to avoid or reduce their risk and prepare for effective response. In the case of drought, five components (*Figure 1*) have been identified as necessary for drought early

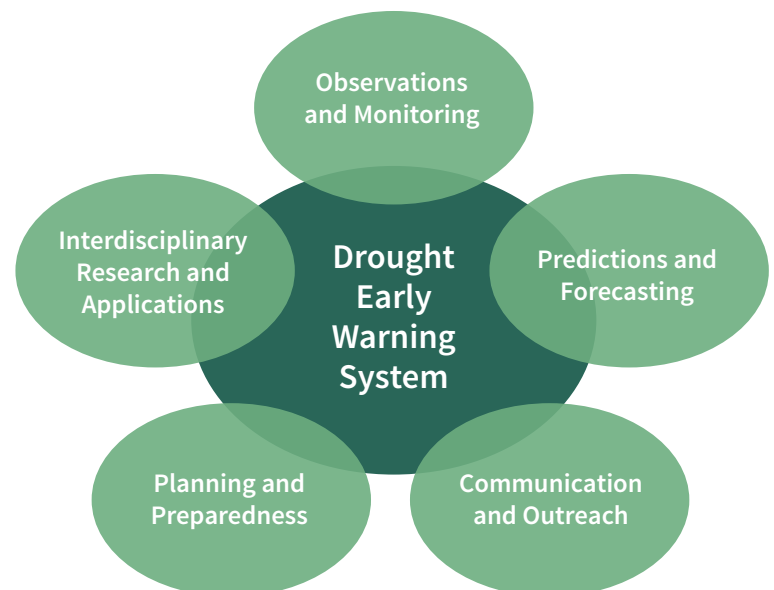
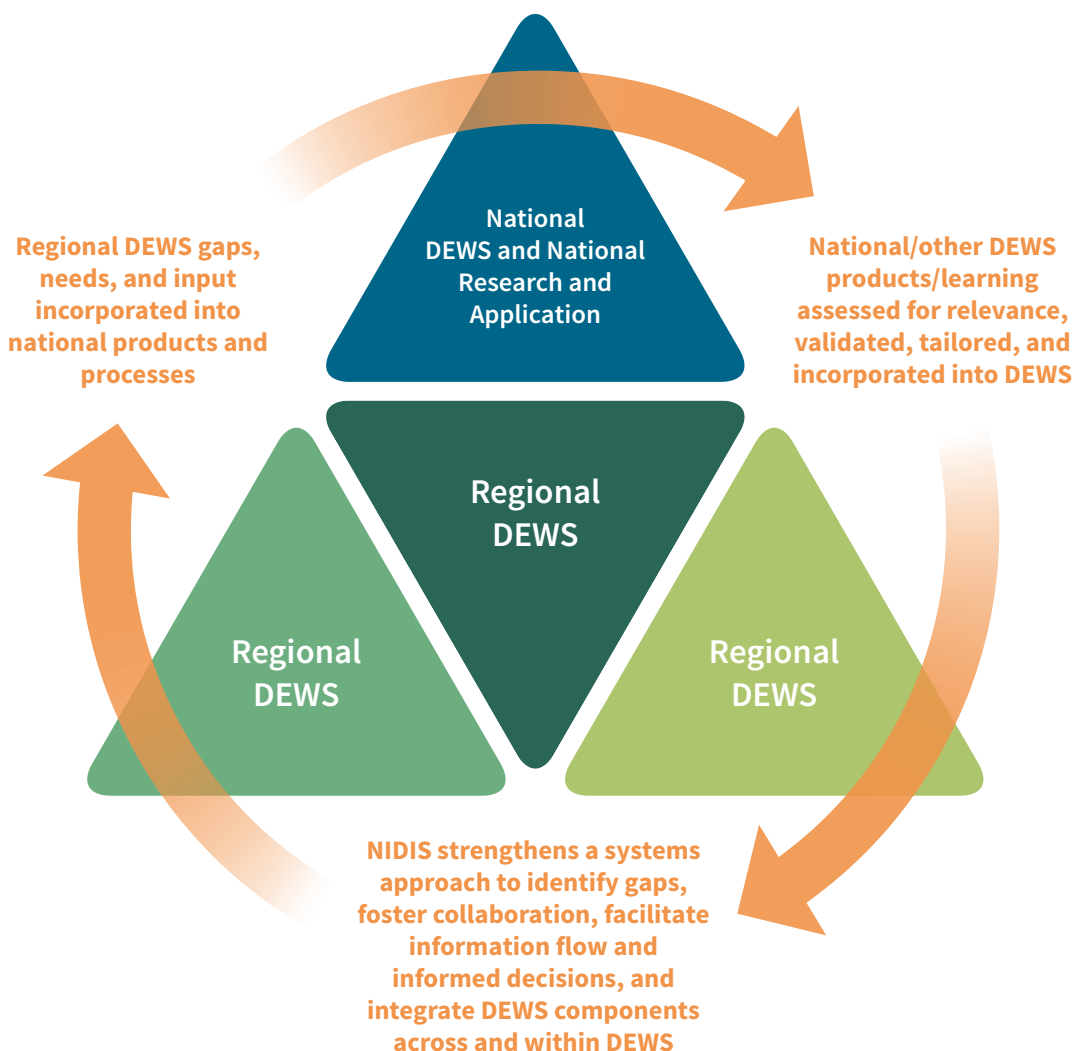


Figure 1: A Drought Early Warning System is made up of five components including Predictions and Forecasting, Observations and Monitoring, Planning and Preparedness, Communications and Outreach, and Interdisciplinary Research and Applications. Credit: NOAA NIDIS, Fiona Martin

warning. In order for these systems to be successful, they must support efforts to understand past, present, and future conditions and to plan proactively and respond using an adaptive management process that applies learning to improve future outcomes. Activities and actions in one component inform those in other components, and in the early warning system itself there is feedback and learning that informs and improves the system over time.

BRINGING IT TOGETHER ACROSS SCALES

NIDIS employs a systems—or holistic approach—to identify gaps, foster collaboration, facilitate information flow and informed decisions, and integrate the five components of early warning both across and within regional DEWS. This capitalizes on the strengths in part of the system to address needs in another. The regional DEWS provide a foundation on which a national early warning system rests (*Figure 2*). Regional gaps, needs, and input are incorporated into national products and processes. Initiatives that cross DEWS boundaries, or that are larger than any one regional DEWS, are elevated to be addressed holistically by NIDIS and partners at a national scale. This includes complex issues such as the relationship between drought and wildland fire, or drought and public health, which require larger investments in research and targeted decision support tools. In the same way, these national efforts, products, and learning can be



assessed for relevance, validated, tailored, and then incorporated into the regional DEWS. The components of a drought early warning system are necessary and important, but it is this cross-scale exchange of information and learning that has the potential to improve our capacity for national early warning.

A key ingredient to a successful early warning system is the people and partners who are dedicated to making the network function. This aspect of a DEWS network requires

Figure 2: This diagram illustrates the regional DEWS as the foundation of a national DEWS and how the needs of the regions inform activities at the national level and how learning is shared across the components of the system. Credit: NOAA NIDIS, Fiona Martin



Figure 3: Location and spatial extent of the Pacific Northwest (PNW) Drought Early Warning System (DEWS). Credit: NOAA NIDIS, Fiona Martin

sustained commitment and attention in order to ensure drought preparedness and resilience are prioritized in times of drought as well as when drought is not present. Convening and fostering dialogue on drought-related priorities is one of NIDIS’s primary roles in each regional DEWS.

LAUNCHING THE PACIFIC NORTHWEST BASIN DROUGHT EARLY WARNING SYSTEM

Over the course of NIDIS’s first 10 years, several regional DEWS were formed to test new approaches for drought early warning and to transfer lessons learned to other regions, over time building a distributed national DEWS.

In 2001 and 2015, virtually the entire PNW region experienced significant drought. In 2015 historic levels of drought were experienced across western Washington and Oregon. While the coastal regions experienced an unprecedented single year drought, the eastern portions of Oregon and Idaho had been suffering a fourth year under prolonged drought. The drought of 2015 was not only the new drought of record for the region, but also a wake-up call to improve monitoring and early warning of drought, and to reevaluate how water is managed for the future.

In response to the intensity of drought in the PNW in 2015, and following a series of stakeholder engagement activities, NIDIS and its partners formally launched the PNW DEWS (*Figure 3*) in February 2016 in Portland, Oregon.



PACIFIC NORTHWEST DROUGHT EARLY WARNING SYSTEM PROGRESS TO-DATE

The first *PNW DEWS Strategic Plan* from 2017–2018 focused on three Priorities: (1) to provide a forum for a diverse group of partners across sectors to share appropriate, relevant, useful, and readily available drought, climate, weather, and water information at local and regional scales; (2) to develop an understanding of existing observations and monitoring networks, data, tools, research, and other planning and mitigation resources available for the DEWS; and (3) to identify the economic sector-specific and geographic needs for future drought monitoring, prediction, planning, and information sources. In late 2018, the DEWS partners met in Boise, ID and decided to proceed for one more year under the original strategic plan, given that progress was being made and there was still relevant work to be done.

The following table (*next page*) summarizes some of the key outcomes and progress that has been made by NIDIS and partners in the PNW DEWS. This is not meant to be an exhaustive list but provides a sense of how drought early warning capacity was enhanced in the PNW through the network in this region.



Key Outcomes and Progress
DROUGHT PREDICTIONS AND FORECASTING
Investment from NOAA RISA/CIRC, NIDIS, and USDA NW Climate Hub has been used to continue to build out tools in the Climate Toolbox to provide climate, drought, and water decision support products for the region.
DROUGHT OBSERVATIONS AND MONITORING
Washington Department of Agriculture partnered with NASA to expand a Fallowed Agriculture Field Tracking (FAFT) system using the Google Earth Engine platform. The FAFT system was supported by NIDIS and developed by NASA and partners in the California DEWS.
NDMC and NIDIS partnered with the states to make improvements to the National Drought Impact Reporter. Specifically, work was undertaken with Washington state in 2019 to update the drought condition monitoring system to fill PNW needs and with the Oregon Forestry Department on a forest-focused survey.
DROUGHT PLANNING AND PREPAREDNESS
The Northwest CASC held two ecological drought workshops that generated drought impact and management fact sheets for the US Forest Service and supported the USFS in dialogues around drought resilience.
A partnership between NIDIS and the Northwest CASC was put in place to continue the OR-WA Water Year meetings and to increase engagement with coastal and small water suppliers in planning and preparedness activities.
A series of ecological drought and soil health workshops have been held in the region to help stakeholders understand management actions to mitigate drought impacts.
DROUGHT COMMUNICATION AND OUTREACH
Bi-monthly Pacific Northwest Drought and Climate Outlook webinars have highlighted current and future conditions as well as work being done by researchers and practitioners in the region.
Annual Water Year Recap and Outlook Meetings have been held for Idaho and Washington/Oregon.
Drought Impact Statements were issued for the PNW region in 2018 during drought conditions.
The Northwest River Forecast Center held Water Supply Forecast Monthly Briefings each year, from January to late Spring.
DROUGHT INTERDISCIPLINARY RESEARCH AND APPLICATIONS
USGS performed an analysis of daily streamflow records to include basin and location for stations, derived streamflow statistics, and basin characteristics. Subsequent publications describe drought impacts at sites with relatively unaltered flows and the significance of snowpack on low flows, with a second publication documenting a method for low-flow estimation from a single flow measurement.
A CIRC project explored agricultural insurance loss due to drought across the inland PNW and spatiotemporal relationships to climate. A series of dashboards have been designed for farmers and researchers to examine the relationships between commodity losses at the state and county level to climate-related hazards including drought, heat, frost, and freeze conditions.
NIDIS, in partnership with the USDA Northwest Climate Hub, is funding a research project with Oregon State University on techniques dryland farmers can use to build soil resilience to drought and climate change.

The Pacific Northwest Strategic Action Plan

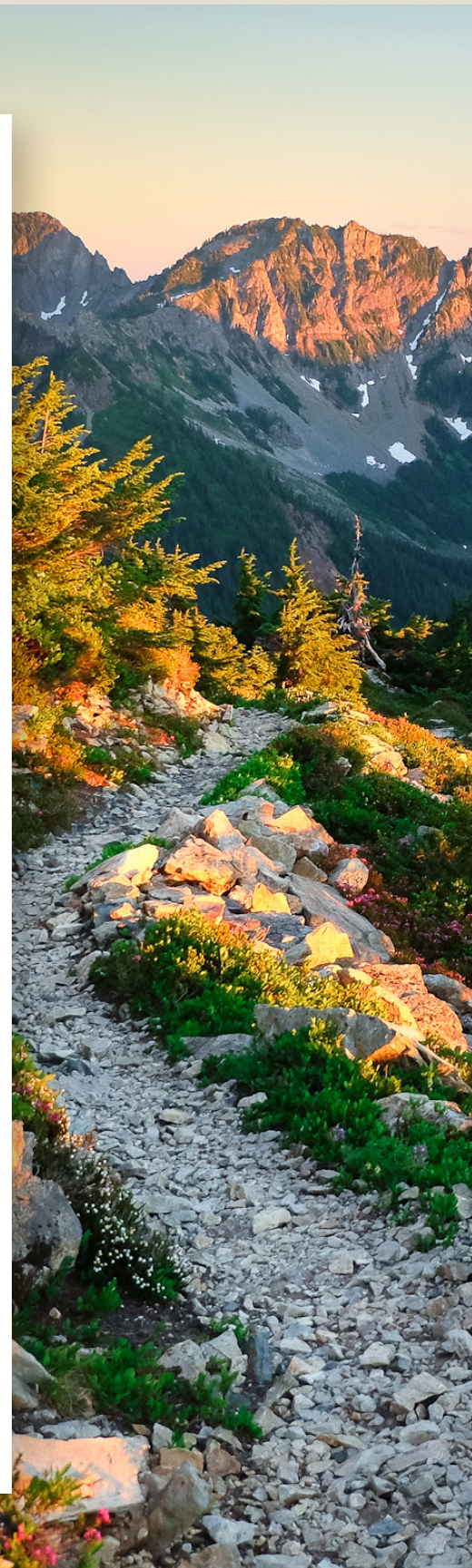
PURPOSE AND EMERGING ISSUES

Partners from across the PNW met in Portland, OR in October 2019 to discuss strategic next steps for the DEWS. Significant progress has been made to better communicate and collaborate in preparing for and responding to drought, and led participants to ask how the DEWS might further facilitate not only information delivery but also action. Four priorities and a series of desired outcomes and actions, organized by the five components of a drought early warning system, were identified. These were vetted through a virtual input session in late November 2019, one-on-one discussions, and a plan review opportunity for partners of the PNW DEWS.

The Strategic Action Plan (SAP) is organized around the five components of a drought early warning system. This approach helps to make valuable linkages to the NIDIS Working Groups more explicit, as they are also organized around the components of drought early warning. The Working Groups exist to provide technical and subject matter expertise, and to identify core competencies, gaps, and paths of action on intergovernmental activities as part of the NIDIS consultation process. The NIDIS Program Office supports a network of regular communication and information sharing between these Working Groups to ensure meaningful engagement and effective collaboration on priorities and activities.

UPDATE CYCLE AND PROCESS

This SAP covers three years, with the option of extending to a fourth year if the partners agree that the priorities and activities are still relevant, and serve the PNW DEWS. The SAP is considered a living document. Through annual PNW DEWS meetings, priority activities will be selected, actions can be added, and the Plan may be adapted to address emerging issues as needed.





FOUR KEY PRIORITIES FOR 2021–2023

1

Improve early warning by building an understanding of the drought indicators/indices used in the PNW to better demonstrate their value, limitations, and sector-specific, seasonal, and geographical applications.

2

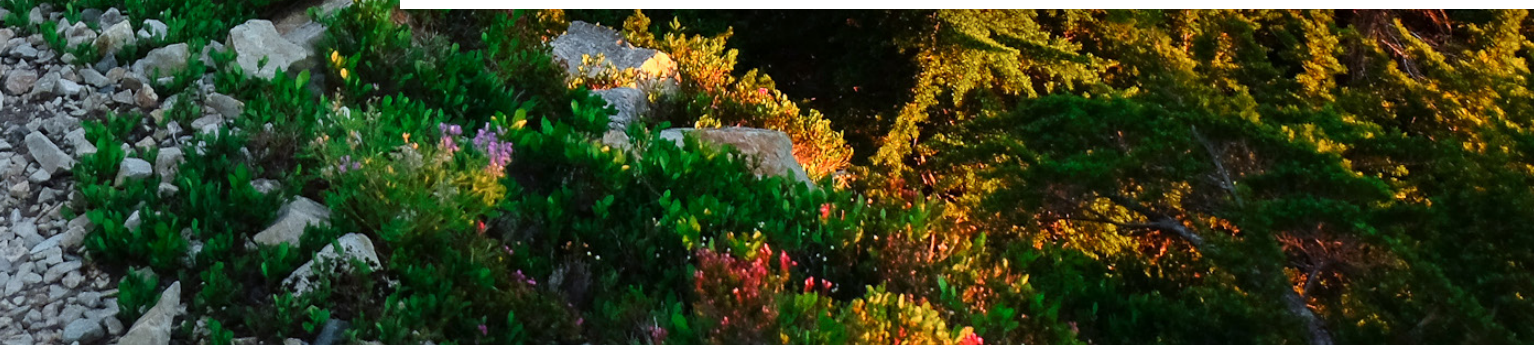
Increase understanding of drought impacts across sectors by building a robust drought impact reporting and analysis system to include citizen science monitoring programs.

3

Improve communication across the partners in the PNW DEWS network as a key channel for disseminating drought information to the public and other regional DEWS.

4

Increase the ability to share drought-related lessons learned both within and across DEWS, sectors, and tribal, state, and local agencies pertaining to drought preparedness and response.





Activities for 2021–2023

1.0 PNW DEWS NETWORK COORDINATION AND INTEGRATION

Networks and partnerships require time and attention to be maintained and to grow. The need exists to support partners, convene the network around various topics, and identify key lessons to share within and across the DEWS. This convening role is a key aspect of what NIDIS provides to the PNW DEWS. For example, establishing a drought learning network was identified as a key way to strengthen the PNW DEWS (see *Outcome 1.2*). The need for a learning network has been identified in multiple regional DEWS, and some initial work has begun in the Intermountain West (IMW) DEWS. For a learning network to be successful, partners must stay engaged. It must function at various scales to ensure buy-in from policy and decision-makers to implement actions on the ground and pathways must be created for information to flow in multiple directions.

Outcome 1.1: The PNW DEWS network is strengthened by improving drought communication and coordination.

Activity 1.1a Plan in-person meetings with opportunities for exchange, and include experts (e.g., CPC, latest advances, products that are soon to be available) and perspectives from other DEWS. Target key audiences for a portion of the meeting, with field trips and other shared learning opportunities made available.

Activity 1.1b Establish mechanisms to encourage co-funding opportunities for projects, meetings, and research with other network partners.

Activity 1.1c Use the new drought.gov site capabilities to better connect and communicate with the network.

Activity 1.1d Engage additional partners to include federal, state, tribal, and economic sector representatives that are not currently part of the DEWS network. The flow of information works best

with broad representation (e.g., state water resources departments, watermasters, fisheries, NRCS, nonprofits, Columbia River, Trout Unlimited, Google, watershed councils, soil and water conservation districts, agriculture, land managers).

Activity 1.1e Develop an understanding of what information products and decision support tools exist across agencies to avoid duplication and increase collaboration.

Activity 1.1f Evaluate the effectiveness of the PNW DEWS network and engagement strategies in building collaborations, increasing partners' abilities to find and use information in decision-making, and expanding participation in drought planning and preparedness activities.

Activity 1.1g NIDIS will coordinate and support post-drought assessments in the PNW in partnership with the DEWS network when deemed necessary by the character, duration, or impact of drought.

Outcome 1.2: Establish a drought learning network to encourage the exchange of best practices, lessons learned, etc. both within and across regions.

Activity 1.2a Examine other learning networks for successes and failures in order to design a drought learning network.

Activity 1.2b Establish a drought learning network to increase communication and collaboration across the PNW and with other DEWS.

Activity 1.2c Explore ways to appropriately represent resources and best practices from the tribal nations through the learning network.

Activity 1.2d Link the learning network to the U.S. Drought Portal's DEWS, state, and sector pages to share success stories, innovations, lessons learned, best practices, case studies, guidance, videos, etc.

Activity 1.2e Implement peer-to-peer learning exchanges (e.g., state-to-state, for practitioners, sectors, specific communities) in the region and between regions.

2.0 PREDICTIONS AND FORECASTING

There are many challenges to improved drought predictions and forecasting. Drought characteristics and physics must be understood in space and time for droughts to be predicted with skill. While larger efforts are aimed at the national level through initiatives like the NOAA Earth Prediction Innovation Center (EPIC) and large investments in subseasonal-to-seasonal (S2S) forecasting, there are measures that can be taken with partners to better communicate the uncertainties of predictions and forecasting and make this information more accessible and useful in this region.



Outcome 2.1: Products and tools are available that convey the probability of drought expanding or recovering, looking at both drought onset and drought termination.

Activity 2.1a Review the products and tools available that convey the probability of drought expanding or recovering, and determine if we need to develop a new tool, improve on existing tools, and/or provide training and raise awareness of tool(s).

Activity 2.1b Finish and make available a Total Moisture Probability of Drought Recovery Tool funded through NIDIS/CIRC.

Activity 2.1c Investigate if ensemble forecasts can be used to look at indices (e.g., SPEI, SWSI) to contribute to a probabilistic tool for drought onset/recovery.



Outcome 2.2: Improved communication is delivered about available drought prediction and forecast tools.

Activity 2.2a Create a water supply forecast (NWRFC, NRCS, USBR, USACE) multitool by integrating these products in one location (website).

Activity 2.2b Support work to better understand the timing of decisions for various sectors and what drought information is needed when, to better tailor information delivery and improvements to forecasting products.

Activity 2.2c Assess the utility and merits of drought predictions and indicators in relation to their importance to the region and to uncertainties (either in the data or forecasts) associated with their use. Provide this information to users when these products are applied.

Outcome 2.3: Regional input is provided to improve predictions and forecasting (e.g., EPIC, S2S) at the national level, focusing on improving their application regionally.

Activity 2.3a Coordinate with NWS RFCs and other forecasting entities in the region (e.g., USGS, NRCS) to understand regional channels that inform national efforts to improve forecasting. Consider whether forecasting low water events based on thresholds would be helpful with a standardized regional approach.

Activity 2.3b Tailor drought forecasting to local and watershed levels.

Activity 2.3c Provide input to research seeking to improve forecasting models that relate to stream flow and snow; these are the models that are needed to improve early warning in the PNW (e.g., seasonal progression models).

3.0 OBSERVATIONS AND MONITORING

In order to improve drought early warning and our knowledge of current conditions, we need better observations and monitoring going into, during, and coming out of drought. This includes a better understanding of the most relevant metrics temporally, spatially, and by sector for the region, as well as improving drought impact reporting and analysis.

Outcome 3.1: Improved understanding and use of drought indices and indicators across the region.

Activity 3.1a Compile information on what drought indicators and indices currently exist for the region, building on work that the National Drought Mitigation Center, regional universities, and partners in other regions have done.

Activity 3.1b Determine what metrics work best temporally, spatially, and by sector. Determine answers to questions like, “On April 1st what information do you need to know in order to make informed decisions for the spring and early summer months?” or “What mix of metrics give the most complete picture of current conditions?”

Activity 3.1c Examine sectors and determine what drought indicators are best for monitoring drought and drought impacts for forestry, fire, recreation, health, water supply, agriculture, tourism, economic, etc.

Activity 3.1d Validate indices based upon historical impacts to better understand what impacts may be felt at different drought severities and to inform thresholds in drought planning efforts.

Activity 3.1e Develop resources to standardize use of different indices and indicators for sectors and applications (e.g., for different stream gauges across the region pertaining to natural runoff, what are the period of record and what does that mean when interpreting the data for various uses?).

Activity 3.1f Develop talking points to communicate confidence and uncertainty in products as appropriate when working with the public and decision-makers.

Outcome 3.2: Drought indicators and/or indices are sufficient to capture emerging drought-related impacts in the region

Activity 3.2a Correlate drought indicators and/or indices to emerging drought-related impacts in the region to determine if they are adequate or if additional indicators are needed.

Activity 3.2b Support work to understand how well existing indicators and indices relate to changes in trees and forests due to drought.

Activity 3.2c Link drought indicators to impacts to refine definitions of when drought causes hardship, for use by the state governments to improve communications and decisions.

Activity 3.2d Identify gaps and look at the need to create new indices or indexes for the region.

Outcome 3.3: The collection and use of citizen science monitoring is improved.

Activity 3.3a Learn from innovative programs and apps to gather citizen science observations and look at the feasibility of applying this to drought monitoring.

Activity 3.3b Develop an app or a strong mobile website experience to support citizen science, building on what has worked in other arenas for impact collection (e.g., upload pictures of flow and stream conditions, snow melt lines, enter river stage on hiking routes.)

Activity 3.3c Research what kind of incentives result in effective citizen science of the type needed for drought monitoring. Learn from efforts such as the Local Environmental Observer (LEO) network that communicates back to observers with some regularity.

Activity 3.3d Develop programs to include schools/kids in collection data across the region (e.g., “drought badge” for scouts). Then, use data to both refine messaging and bolster fine-scale data and information as part of citizen monitoring.

Outcome 3.4: Local monitoring and observational data are incorporated into products and decisions both locally and nationally.

Activity 3.4a Use a systematic impacts reporting tool that scientists can then use to develop improved indicators/metrics.

Activity 3.4b Work to more effectively and systematically improve impact reporting from the individual to community, state, and U.S. Drought Monitor author level.

Activity 3.4c Hold a workshop devoted to best practices for impacts collection, and learn from other states or efforts that have worked well over time.

Activity 3.4d Provide DEWS partners with standards and protocols for sensors and point data collection for new stations and networks (e.g., soil moisture monitoring).

Outcome 3.5: Professional/technical expert data is located and incorporated into impact reporting efforts.

Activity 3.5a Determine if there is data being collected for various sectors (e.g., water utilities, tourism, and recreation) that might be helpful to develop a holistic picture of drought impacts and economic losses associated with drought.

Activity 3.5b Determine if an annual survey of water managers to track water supply challenges is appropriate. This could be similar to the USDA National Agricultural Statistics Service (NASS) reporting program but for sectors beyond agriculture.

Activity 3.5c Catalogue publicly available information sources (e.g., streamflow gauges) and consider how they might be incorporated into drought monitoring.

4.0 PLANNING AND PREPAREDNESS

Success for the PNW DEWS would be having the tools and information that give those on the ground sufficient time to plan for and minimize economic damage in drought. This includes products and services geared towards many communities and sectors (e.g., municipalities, farmers, ranchers, tribes).

Outcome 4.1: The tribal nations and communities of the PNW have the drought information products and resources they need to adequately plan for and respond to drought.

Activity 4.1a Engage in the existing, robust regional tribal organizations and networks to evaluate what drought information is needed and how to fill those gaps.

Activity 4.1b Identify planned or regular gatherings of the tribal nations and tribal representatives to provide drought information where it is appropriate (e.g., Tribal Climate Camps).

Activity 4.1c Integrate drought information and considerations into climate change tools that already exist that were developed specifically for tribes where appropriate.

Outcome 4.2: Sectors and communities are supported in planning for drought.

Activity 4.2a Collate and share drought-related adaptation strategies through the drought learning network when it is established.

Activity 4.2b Share information through the U.S. Drought Portal about funding opportunities related to drought. Specifically highlight opportunities for funding to develop drought plans, implement drought related projects from drought and climate change adaptation plans, and assist the tribal nations and other communities in securing funds for these types of projects.

Activity 4.2c Provide mechanisms for communities and tribal nations to share their experiences with various grant options (e.g., BIA Resilience grants, USBR grants).

Activity 4.2d Support communities in planning for drought and its impacts by advancing the use of a multisector approach and providing information on how to use this approach. One way to accomplish this is by integrating outreach into existing state programs that work with communities (e.g., Oregon Water Resources Place-Based Planning project).

Activity 4.2e Provide water utility managers with drought planning workshops and webinars.

5.0 COMMUNICATION AND OUTREACH

While the existing PNW DEWS network has strengthened communication, there is still a need for improved engagement within the network, with the public, and with partners outside the region.

Outcome 5.1: Communication across the states and region is improved with a focus on key partners within the DEWS.

Activity 5.1a Hold a communication workshop to support coordination between states toward a more regionally coordinated response to drought.



Activity 5.1b Examine communication coordination efforts from other regions (e.g., Midwest DEWS) to determine what is working and if it can be applied to the PNW.

Activity 5.1c Hold a workshop with key state drought task force members and USDM authors to better understand USDM process as well as drought in the west with a goal of improving PNW input to the USDM.

Activity 5.1d Implement regular, scheduled coordination amongst PNW states on U.S. Drought Monitor recommendations, sharing methods for soliciting and summarizing input (e.g., monthly coordination calls), and coordinating on drought communication across the region.

Activity 5.1e Use the annual Water Year Recap and Outlook meeting as the basis to develop an annual “water assessment” for the region to communicate events, impacts, and adaptations in the region.

Outcome 5.2: Outreach and communication with the public pertaining to drought is improved.

Activity 5.2a Continue to provide and improve upon regular communications to the public about current conditions and outlooks through webinars, the U.S. Drought Portal, and other mechanisms as appropriate.

Activity 5.2b Enlist social/behavioral science experts in determining how to organize communication methods and protocols.

Activity 5.2c Develop fact sheets that tell various constituents about what actions they can take to reduce the impacts of drought, building on the work of the Southern Climate Impacts Planning Program (a NOAA RISA program). These should be general or easily adjusted to allow targeting to specific audiences (e.g., municipalities, rangeland, agriculture)

Activity 5.2d Determine if there is a need for states to work with federal agencies and universities to develop and maintain drought page(s) that could represent drought at local scales and by sector, perhaps including impacts using or building on existing resources (e.g., U.S. Drought Portal, NW Climate Toolbox).

Activity 5.2e Capitalize on sense of place by communicating how drought impacts specific areas (downscaling regional impacts) to draw in stakeholders to see benefits of the DEWS and better utilize indicators that bring big data to individuals. This includes understanding what programs the states and other partners have in place that could be used as pathways to communicate with interested stakeholders.



6.0 INTERDISCIPLINARY RESEARCH AND APPLICATIONS

While our understanding of drought forecasting, monitoring, evolution, and impacts continues to be refined—there is more research that needs to

be completed to improve drought early warning, planning, and response. In the process, there should be a focus to improve the connection between the research community and end users to ensure research results can be applied.

Outcome 6.1: Actions that can be taken to reduce the impact of drought to various sectors are understood and shared and barriers to implementing those actions have been lessened or removed.

Activity 6.1a Study drought relevance to water rights and regulatory compliance and explore if existing regulatory platforms can be informed by drought information (e.g., Natural Resource Damages Act (NRDA), Clean Water Act (CWA), Endangered Species Act (ESA), Safe Drinking Water Act (SDWA)).

Activity 6.1b Research watershed recharging or storage approaches for the PNW—especially since more precipitation is expected to fall as rain versus snow in the future—to understand how to capture water for use throughout the water year.

Activity 6.1c Study water reuse and efficiency during drought to determine what works and share it across the region.

Outcome 6.2: Our understanding of how changes in the environment and society will affect drought risk to communities is increased.

Activity 6.2a Support research on the effects of climate change (e.g., temperature increase, shift in the jet stream, drying, decrease in snow water equivalent) on the environment and how this changes drought.

Activity 6.2b Identify and support research to study the evolution and attribution of drought in the region, to better plan for future drought in the region, and to determine if acidification is a concern in the PNW.

Activity 6.2c Support research to understand how population growth, water use, and land use will change resilience to drought and when an area might feel the impacts of drought (at what level, for how long). Create opportunity for cities and communities using this type of information to plan for climate change and drought to share with those who would like to incorporate it into planning efforts.

Activity 6.2d Support research to identify the tipping points associated with complex drought impacts (e.g., forests die off from drought, insects, etc.) and use these to create messaging to drive action.

Outcome 6.3: Secondary and tertiary impacts or effects of drought that should be included in drought planning and preparedness are identified and better understood.

Activity 6.3a Identify and support research on key emerging questions for this region. One example is looking at drought effects on soil–vegetation dynamics—do changes in soils and vegetation post-drought lead to increased tree windfall, changes in water flow after rain events, and changes in recharge to groundwater?

Linking Outcomes to Priorities

Given that the outcomes and activities in the Plan are organized by DEWS components, it might be difficult to discern at first glance how they contribute to the priorities. The table below indicates how the outcomes mentioned above are associated with the four priorities:

Priority 1: Develop a better understanding of how drought indices correspond to sectors.

Priority 2: Improve drought reporting and citizen scientist participation in monitoring.

Priority 3: Improve communication across regions and among partners.

Priority 4: Share lessons learned from drought management, monitoring, and response actions after drought.

Mapping Outcomes to Priorities in the PNW DEWS Strategic Action Plan

	PRIORITY 1	PRIORITY 2	PRIORITY 3	PRIORITY 4
Outcome 1.1			X	X
Outcome 1.2				X
Outcome 2.1	X			
Outcome 2.2	X		X	
Outcome 2.3	X			
Outcome 3.1	X			
Outcome 3.2	X	X		
Outcome 3.3		X		
Outcome 3.4		X		
Outcome 3.5		X		
Outcome 4.1	X			X
Outcome 4.2				X
Outcome 5.1			X	
Outcome 5.2			X	
Outcome 6.1			X	X
Outcome 6.2		X		X
Outcome 6.3		X		X

Linkages to National and Cross-DEWS Initiatives

PURPOSE AND EMERGING ISSUES

NIDIS has implemented regional DEWS as the foundation on which to provide national drought early warning in recognition that impacts and early warning information differ across the regions. While each DEWS has the same base ingredients, they ultimately have their own flavor to reflect the needs of the regions. That said, there are challenges that cross multiple regions or require a coordinated effort at the national level. These include issues like the complex interactions of drought and wildland fire, drought and human health, tribal engagement, drought impact reporting and analysis, linking drought triggers and indicators, the NIDIS Coping with Drought grant program, and soil moisture monitoring. The regional DEWS have the ability to tap into these larger initiatives where there is interest and need, again providing an opportunity for cross-regional and scalable (regional-to-national) learning and progress. The table on the next page illustrates some of these linkages as they apply in the PNW.



National/Cross-DEWS Initiatives	PNW DEWS Activities
Weather Research and Forecasting Innovation Act of 2017 (Weather Act)	The Weather Act calls for NOAA to prioritize weather research in part to improve forecasts and warnings for protection of life and economy, to improve understanding of forecast capabilities for atmospheric events and their impacts, and to make reliable and timely foundational forecasts of subseasonal (2 weeks to 3 months) to seasonal (3 months to 2 years) forecasts of temperature and precipitation. While there are many other initiatives included in the Weather Act, these are the areas that NIDIS also has a strong interest in, in terms of drought early warning. NIDIS is making and leveraging investments in regards to the same temporal scale as they apply to drought in partnership with the NWS regional and local forecast offices, the Climate Prediction Center, and the Office for Oceanic and Atmospheric Research.
Water Prediction Center/ NOAA Water Initiative	NOAA has multiple efforts aimed at water security that NIDIS plays a role in. The Water Initiative aims to improve the Nation's water security by providing science-based information and services that address vulnerability to water risks and enabling greater efficiency and effectiveness in the management of water resources. NOAA will advance this mission primarily through transforming integrated water prediction services in collaboration with decision makers, partners, and users. In addition, the Water Prediction Center focuses on collaborative research to inform essential emergency management and water resources decisions across all time scales. NIDIS is involved in efforts to enhance drought prediction and monitoring, looking at applications of the National Water Model to drought early warning and serving as part of these initiatives where they intersect with drought.
Tribal Engagement Strategy	NIDIS will release a Tribal Engagement Strategy for the Missouri River Basin (MRB) and Midwest (MW) DEWS in late 2020. While the plan is specific to the MRB and MW DEWS, many of the principles of engagement and needs are similar to those in the PNW, which should help address the needs of this region as well.
National Coordinated Soil Moisture Monitoring Network	The National Coordinated Soil Moisture Monitoring Network Strategy will include best practices, etc. that will be useful to partners in the PNW who are interested in installing additional sensors. Given the level of effort in places like the upper Missouri River and Montana, which is a member of both the Missouri River Basin and PNW DEWS, there will be opportunities for sharing lessons learned.
NIDIS Drought and Wildland Fire Nexus Strategy (NDAWN)	There have been past efforts to better coordinate with the National Interagency Fire Center and the regional Geographic Area Coordination Centers in this region on drought and wildland fire information in the development of the NDAWN strategy and we will continue to work with these partners in the implementation of the strategy.
NIDIS Coping with Drought	NIDIS uses the Coping with Drought federal funding opportunity to address research needs gathered through the consultative process within the DEWS. The outcomes of applied research funded through the CWD program will be transferred to the DEWS. For example, the FY20 competition is focused on indicators, impacts, and triggers, which aligns with Priorities 1 and 2 for this region.
Drought and Human Health	NIDIS is currently engaged in developing a Drought and Human Health Strategy and there are opportunities to hold regional workshops on the topic.

National/Cross-DEWS Initiatives	PNW DEWS Activities
Drought Impact Reporting and Analysis	There are many efforts in the PNW around impact reporting and analysis that will transfer to other states as well as to our national efforts and vice versa. Washington has been working with the NDMC and the National Drought Impact Reporter to improve reporting and use that information in decisions. NIDIS is also involved in efforts nationally to improve reporting and analysis that can inform what is happening at the state and region. This two-way learning is optimal for these complex issues.
Improving Indicator Use and Linking to Triggers	A common request from partners across the DEWS is the desire to better understand which indicators and indices should be used for a region/state both spatially and temporally as well as for different sectors. There are efforts within the PNW DEWS as well as nationally with NDMC and internationally with the Commission on Environmental Cooperation (CEC) to contribute answers to these questions. Deliberate efforts to share learning across these initiatives will hopefully accelerate this work.
National Drought Forum	The National Drought Forum held in 2019 resulted in ten priority actions, many of which are reflected in the PNW strategic action plan. These include, but are not limited to, enhancements to observations and monitoring and decision support tools; better quantification of drought impacts; and tailored drought communications for sectors, populations, and watersheds. The synergies between priorities at the regional and national effort should amplify our progress in addressing these complex challenges.

LINKAGES TO REGIONAL PARTNERS AND INITIATIVES

NIDIS has a mandate to work across the federal government, coordinating drought related activities with other federal agencies, and to build upon and leverage existing partnerships, networks, and initiatives. This is especially important in the regional DEWS where these partners and regional organizations are key to realizing success in the region. In the PNW, key regional partners include the Pacific Northwest Climate Impacts Research Consortium (a NOAA RISA), the USDA Northwest Climate Hub, the National Drought Mitigation Center, the NOAA Western Regional Climate Center, and the Department of the Interior Northwest Climate Adaptation Science Center.





Appendix 1: Partners

The development of this PNW DEWS Strategic Action Plan and its associated 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 PNW DEWS. This list of partners is not exhaustive and will evolve as new regional partnerships form.

Partner Agencies and Organizations
Climate Impacts Group (University of Washington) (CIG)
Pacific Northwest Climate Impacts Research Consortium (CIRC)
City of Hillsboro (OR)
Clackamas County (OR)
Desert Research Institute (DIR)
Idaho State Climate Office
Idaho Department of Water Resources
Montana Climate Office
Montana Department of Natural Resources and Conservation
Mt. Hood Meadows
National Aeronautics and Space Administration (NASA)

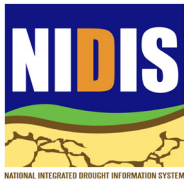
Partner Agencies and Organizations	
National Drought Mitigation Center, University of Nebraska Lincoln (NDMC)	
National Oceanic and Atmospheric Administration (NOAA) <ul style="list-style-type: none"> • Climate Prediction Center (CPC) • Western Regional Climate Center (WRCC) • Western Region Collaboration Team • National Weather Service River Forecast Centers (NWS RFCs) • National Weather Service Weather Forecast Offices (NWS WFOs) • National Weather Service Western Regional Office 	
Oregon Climate Office	
Oregon Water Resources Department	
Oregon Department of Agriculture	
Pacific Northwest Tribal Climate Change Network	
Skokomish Indian Tribe Department of Natural Resources	
University of Idaho	
U.S. Army Corps of Engineers (USACE)	
U.S. Department of Agriculture (USDA) <ul style="list-style-type: none"> • Agricultural Research Service (ARS) • Farm Service Agency (FSA) • Forest Service (USFS) • Natural Resources Conservation Service (NRCS) • Northwest Climate Hub • Risk Management Agency (RMA) 	
U.S. Department of the Interior (DOI) <ul style="list-style-type: none"> • Bureau of Land Management (BLM) • Bureau of Reclamation (USBR) • Geological Survey (USGS) • Northwest Climate Adaptation Science Center (NWCASC) 	
U.S. Environmental Protection Agency (EPA)	
Washington Department of Ecology	
Western Governors Association (WGA)	
Western States Water Council (WSWC)	



Appendix 2: Disclaimer

The *PNW DEWS Strategic Action Plan 2021–2023* is a collaborative federal, state, tribal, and local interagency effort to improve early warning capacity and resilience to drought in the PNW. The contents of this plan should not be used as evidence against any PNW DEWS state; any federally recognized tribe; or the federal government in any administrative, judicial, or other proceeding. The assumptions, conclusions, and other information contained in the Plan do not represent a legal interpretation or legal position related to any issue raised in, or otherwise relevant to, litigation, nor do they represent a consensus view of federal agencies or other stakeholders involved in the Plan’s development. The Plan is not intended as an attempt to resolve any particular dispute within the PNW. Nothing in the Plan is intended to, nor shall the Plan be construed so as to, interpret, diminish, or modify the rights of any PNW state, any federally recognized tribe, or the federal government under federal or state law or administrative rule, regulation, or guideline.

Finally, all parties recognize that partners participating in this process may disagree over the appropriate scope, methods, results, or interpretation of technical analyses performed in developing or implementing this DEWS. As such, neither the Plan, nor any work performed pursuant to it, shall be attributed to any organizations or individuals by virtue of their participation as a partner in this process. Nor shall any party be deemed to accept or agree with any assumption, conclusion, and other information contained in the Plan or its resulting studies, unless explicitly stated by those parties.



Document prepared by NIDIS
in partnership with key stake-
holders in the region.

