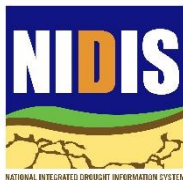


INTERMOUNTAIN WEST DROUGHT EARLY WARNING SYSTEM STRATEGIC PLAN

6/19/2017

2017 – 2018 Strategic Plan



Document prepared by the National Integrated Drought Information System (NIDIS) in partnership with key stakeholders including the Climate Assessment for the Southwest (CLIMAS) and Western Water Assessment (WWA).

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INTERMOUNTAIN WEST DROUGHT EARLY WARNING SYSTEM

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.

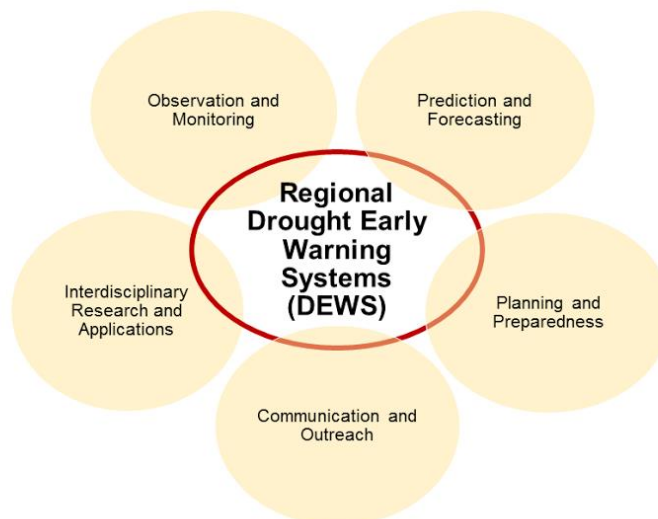
WHAT IS NIDIS?

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.

Key components of NIDIS Regional Drought Early Warning Systems



Intermountain West DEWS

Over the course of NIDIS's first 10 years, several regional DEWS were formed to pilot innovations, resources, and lessons to be transferred to a national DEWS.

In 2009, NIDIS launched the **Upper Colorado River Basin (UCRB) DEWS**, its first pilot DEWS in the nation, incorporating the states of Colorado, Utah, and Wyoming. Through a series of workshops, stakeholders identified several priorities, including the need to: 1) assess gaps in existing monitoring and forecasting systems; 2) assimilate existing drought-related indicators, triggers and trends into one accessible location; and 3) create a Colorado Basin drought portal and information clearinghouse through the U.S. Drought Portal (drought.gov).

Following a series of stakeholder engagement meetings, interviews, and an in-depth gaps assessment in 2009-2010, the [Colorado Climate Center \(CCC\)](#) at Colorado State University became a key partner in implementing the UCRB DEWS. In response to the feedback during this scoping process, and in an effort to avoid, or at least mitigate the impacts associated with the drought of 2002, the CCC, NIDIS, and other state and local partners began a proactive monitoring process which evolved into the UCRB weekly drought assessments. These assessments, now posted weekly on the CCC website and delivered regularly via webinar, not only provide Upper Basin stakeholders with timely information on drought and climate information and forecasts, but also foster a dialogue that helps shape the region's weekly recommendations to the U.S. Drought Monitor (USDM).



Network of NIDIS Drought Early Warning Systems (DEWS)

Note: While the colored shading denotes the DEWS regions, where the majority of DEWS actions focus, activities may extend beyond the shaded area when needed. The “fuzzy” edges reflect the permeability of the DEWS boundaries.

The importance and popularity of these regular monitoring and forecasting activities was further magnified during the 2012 drought. Since that time, the UCRB weekly drought assessments have become a model for consistent and easily digestible dissemination of drought and climate information and a primary activity for the IMW DEWS.

In April 2010, NIDIS and its partners initiated the **Four Corners – Tribal Lands DEWS** with the goals of integrating tribal observations and data into national and state monitoring efforts, ensuring maintenance and sustainability of existing observation networks, facilitating data sharing and access, and exploring ways to use existing data and provide technical training for tribal staff.

NIDIS, the U.S. Geological Survey (USGS), the National Drought Mitigation Center (NDMC) and [the Climate Assessment for the Southwest \(CLIMAS\)](#), a NOAA Regional Integrated Sciences and Assessments (RISA) team, hosted a 2010 workshop with tribal members, land and water management agencies, and

climate services providers to begin developing the Four Corners – Tribal Lands DEWS. The workshop had two overarching objectives: (1) identify critical information and data needs; and (2) develop a knowledge network. Since that workshop, CLIMAS and other partners have implemented several projects to help lay the foundation for a regional tribal DEWS. Activities have been replicated and lessons learned have been incorporated into drought early warning initiatives executed with tribal partners in other DEWS across the West.

In 2016, the Upper Colorado River Basin (UCRB) DEWS and the Four Corners Tribal Lands DEWS were combined to form the **Intermountain West (IMW) DEWS**. The IMW DEWS boundary expanded to include Arizona, Colorado, Utah, Wyoming, and western New Mexico. This expansion recognizes the work already underway throughout the IMW region to provide drought early warning information, and it expands upon those initiatives to meet the diverse needs of stakeholders from a variety of economic sectors who rely on drought and climate information, but often at very different spatial and temporal scales.



Intermountain West Drought
Early Warning System

While all five states in the IMW DEWS depend on the over-allocated Colorado River, climatic, geographic, economic, and social conditions vary significantly across the region. The Federal government manages vast stretches of land, rural communities dominate the landscape, and several major, growing metropolitan areas present unique opportunities and water demands through the region. Agriculture, ranching, mining, and tourism drive the region's economies.

Climate varies as well, from deserts and riparian woodlands to high valleys and alpine and systems. The Southwestern Monsoon is a dominant driver of weather in the southern states, while continental weather systems have greater impact on the northern states. Drought is a common feature in the IMW DEWS. Droughts may onset quickly as a flash drought in portions of Colorado and Wyoming, and may last decades, as with current conditions in parts of Arizona.

The IMW DEWS helps foster interstate coordination to cope with current and future droughts and growing water demands, and supports increased communication and collaboration between scientific, water, and land management communities.

Purpose of the Intermountain West DEWS

The IMW DEWS is a collaborative federal, tribal, state, and local interagency effort to improve drought early warning capacity and resilience throughout the region, and to better understand the relationship between drought and future climate scenarios in the region. Local stakeholder needs around data collection and monitoring; research and applications; planning for extreme climate events; and communication, education, and outreach present opportunities for delivering and providing early warning activities.

Specific goals of the IMW DEWS include:

- Provide a forum for federal, tribal, state, and local stakeholders across economic sectors, including water and land resource management, to develop and disseminate appropriate, relevant, useful and readily available drought, climate, weather, and water-related information to improve drought early warning capacity and drought resilience.
- Understand 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 INTERMOUNTAIN WEST DEWS STRATEGIC PLAN

Plan Purpose and Development

This IMW DEWS Strategic Plan (Plan) outlines priority tasks and activities across the region to build drought early warning capacity and resilience. It includes a list of current partners, outcomes, and key milestones. This Plan is a “living document” to which additional actions and partners may be added as needed.

The development of the IMW DEWS Strategic Plan relied upon the knowledge, experience, and contributions of many dedicated individuals, organizations and partnerships. Stakeholders from across the region, including federal, tribal, state, local, academic, and non-profit organizations and entities, assisted NIDIS, CLIMAS and the Western Water Assessment (WWA) (both NOAA RISA teams), and others in developing the IMW DEWS Strategic Plan (Appendix A).

Building upon the goals and objectives of the original UCRB and Four Corners – Tribal Lands DEWS, NIDIS and its partners held two regionally focused Drought and Climate Outlooks in the fall of 2016 to obtain input on priority needs and actions for the purposes of informing this Plan. Participants represented federal, tribal, state, local, academic and non-profit organizations representing interests including drought monitoring and management, water supply and conservation, agriculture, land management, forest health and wildfire, and emergency management. Feedback from these Outlooks was joined with information gathered from earlier workshops, meetings, and discussions within the original UCRB and Four Corners Tribal Lands DEWS, and is reflected in the priorities and activities identified in this Plan.

Intermountain West DEWS Priorities and Activities

The IMW DEWS prioritizes the following aims necessary to building drought early warning capacity and long-term drought resilience throughout America’s Intermountain West:

- **Priority 1 – Improve Decision Making to Enhance Drought Planning and Preparedness** – The IMW DEWS will investigate decision-making processes and tools needed to plan and prepare for drought across various sectors, user groups, and geographic areas in the IMW region. Specific activities will help examine the needs of the water supply, agricultural and hazard mitigation sectors, tribal communities and targeted regional assessments in sub-regions throughout Arizona and New Mexico.

- **Priority 2 – Improve Understanding and Utilization of Drought and Climate Science** – The IMW DEWS will work to coordinate communication, outreach, and training across the region to strengthen the understanding and utilization of drought and climate science. Related activities will build upon existing communication and outreach tools in the region, and will leverage new resources to support the use of specific tools and information. Examples of activities include: regular drought, climate, and water-year 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 targeted training for media on drought and climate information.
- **Priority 3 – Enhance Drought Monitoring & Research** – The IMW DEWS will improve access to data and information for drought risk management at the regional, tribal, state, and local levels through enhanced monitoring and improved usability of tools and indices. Examples of activities include: increased coverage and use of Community Collaborative Rain, Hail and Snow (CoCoRaHS) networks; improving the use of state-run agrometeorological monitoring networks; developing new regional drought outlook tools utilizing seasonal forecasting products; and refining emerging tools like the Evaporative Demand Drought Index (EDDI) and the Water Resources Monitor and Outlook (WRMO) to better meet user needs.
- **Priority 4 – Integrate and Develop Collaborative Information Networks** – The IMW DEWS will coordinate across networks to get drought information disseminated to the widest audience. Coordination will center on leveraging existing networks as well as identifying new information resources and networks in the region. Examples of activities include: widening existing networks to include Arizona and New Mexico; enhancing engagement with stakeholders in Utah and Wyoming; and supporting coordination of drought-related activities across Federal agencies.

For each priority, some of the associated activities outlined in this Plan have been started, while other activities will be initiated over the next two years (January 2017 – December 2018). The corresponding schedule (Appendix C) 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 other DEWS partners. As the IMW DEWS develops, 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 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 to 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 Decision Making to Enhance Drought Planning and Preparedness

A regional drought early warning system must understand how and when users of drought and climate information make decisions to prepare and plan for drought. In the IMW DEWS, regional stakeholders have worked to understand the usefulness of existing drought tools in the decision-making process. The IMW DEWS will investigate decision-making processes and appropriate tools needed across sectors, user groups, and geographic regions. Specific DEWS activities will examine the information needs of the water supply, agricultural, and hazard mitigation sectors, tribal communities, as well as targeted regional drought assessments in sub-regions throughout Arizona and New Mexico.

Activity 1.1 Enhance Decision Making in the Water Supply Sector

Activity 1.1a Advance Drought Risk Management among Western Slope Water Providers

Researchers from WWA and CCC will work with six water agencies in 2017 and 2018 to characterize the drought decision processes of water providers in Colorado’s Western Slope and their current use of drought information. They will conduct document analysis, in-depth interviews, and focus groups with the water agencies, and the resulting assessment will shape information delivery throughout the IMW DEWS. The research team will also conduct physical hydrology modeling to simulate the performance of widely-used snow-based drought indicators under future climate change scenarios. During the focus groups, researchers will explore whether water managers could use additional drought indicators (including EDDI, Activity 3.3) to compensate for the expected loss of robustness of snow-based indicators in a warming climate. This work is funded by a NOAA SARP (Sectoral Applications Research Project) grant entitled “*Advancing the use of drought early warning systems in the Upper Colorado River Basin.*”

Activity 1.1a Outcomes

- Mid-project workshop to present initial findings about drought decision processes and use of drought information; interim report to NIDIS. [Summer 2017]
- Focus groups with water agencies to explore results of simulations. [Winter 2017-2018]
- Final project workshop to present all findings. [Summer 2018]
- Final project report to NOAA (shared with NIDIS). [Fall 2018]

Activity 1.1b Improve Drought Resiliency Along the Wasatch Front

To build drought resiliency and improve drought risk management in Utah’s Wasatch Front region, WWA is working with water utilities and other related stakeholders along the

Wasatch Front (i.e. Jordan Valley Water Conservancy District (JVWCD), Weber Basin Water Conservancy District (WBWCD) and Salt Lake City Public Utilities (SLCPU)), on a variety of research and outreach activities. Specific focus areas include:

1. WWA will continue work with JVWCD to develop projections of future potential evapotranspiration, length of outdoor water season, and associated impacts on water demand.
2. Work with WBWCD will build on recent research conducted by the Wasatch Area Dendroclimatology Research Group, an interdisciplinary research team comprised of Utah State University, the U.S. Forest Service (USFS), Brigham Young University, Columbia University, and WWA. This research used tree-ring-based techniques to reconstruct natural streamflows for the Bear, Logan, and Weber Rivers and Great Salt Lake elevation. The primary goal of this research was to extend the record of streamflow and drought back 500-1,000 years to provide Wasatch Front water managers better information about regional climate variability and help them identify the best strategies for applying streamflow reconstructions to water resource management and planning.

WBWCD recently received a grant from the U.S. Bureau of Reclamation (BOR) to develop a drought contingency plan in collaboration with WWA, USU, the Utah Division of Water Resources, and an independent consultant. The impact of drought on Weber Basin water supply will be quantitatively assessed using paleo-streamflow records as an input for a systems model of Weber Basin water supply. WWA will provide projections of future Weber River water supply under climate change scenarios through a temperature and precipitation sensitivity analysis of Weber River streamflows. WWA will also assist in engaging Weber Basin stakeholders in development of a drought contingency plan. Quantitative modeling of Weber Basin water supply under paleo-drought and future scenarios will be completed by fall 2017, and a final drought contingency plan is expected by summer 2018.

3. WWA will work with SLCPU to determine the best strategy to quantitatively model their water system to assess impacts of future drought and to assemble a collaborative research group to conduct the modeling.

To complement these projects, NIDIS, WWA, and other regional partners will host a workshop for Wasatch Front water providers and other regional stakeholders on drought and future climate risk. This workshop will be in coordination with the Wasatch Front Drought & Climate Outlook described in Activity 2.6, and it will introduce new stakeholders to the IMW DEWS and increase integration in the region.

Activity 1.1b Outcomes

- Drought & Climate Outlook workshop with Wasatch Front water providers and other regional stakeholders (see Task 2.6). [Summer 2018]
- Written report and presentation by WWA to JVWCD based on the outcomes of the workshop. [Spring 2017]

- WWA will provide data from a temperature and precipitation sensitivity analysis of the Weber River to WBWCD. [Winter 2017]
- WBWCD drought contingency plan completed. [Summer 2018]

Activity 1.1c Improve the Usability of Snowpack Data by Water Managers

Monitoring snowpack is crucial to understanding water conditions and planning for drought in the Mountain West. The IMW DEWS will enhance the usability of new remote sensing-based snow data by water managers in the upper basin states of the region. These new tools can add to the valuable information already collected by established in situ monitoring networks (e.g. Natural Resources Conservation Service (NRCS) snow telemetry (SNOTEL) and snow course data and products) that provide important baseline data to calibrate these new monitoring products.

In 2015, WWA organized and hosted three day-long workshops in partnership with NIDIS, CCC, NRCS, Colorado Basin River Forecast Center (CBRFC) and other state and local partners to improve the usability of snowpack monitoring information in Colorado, Utah, and Wyoming. The workshops brought together 180 participants from across the region representing local, state and federal water managers, researchers, operational information providers, and others. Stakeholders asked for additional support and guidance in interpreting snowpack-monitoring data to fit their particular decision-making needs.

In 2016, WWA researchers conducted interviews of over 20 water managers and other water stakeholders in the Rio Grande and Uncompahgre Basins in Colorado to capture their current use of snow and runoff information in decision making for drought.

WWA researchers have also been involved in developing two different data products for high-resolution, spatially explicit monitoring of snow-water equivalent (SWE) from remote sensing: a real-time MODIS-based SWE product, and National Aeronautics and Space Administration (NASA) JPL (Jet Propulsion Laboratory) Airborne Snow Observatory (ASO) data. In addition to developing a list of key concerns, extreme weather events, and near misses from water managers in each basin, and hydrologic model runs driven by the scenarios described, WWA will analyze whether these two types of snowpack data would have improved runoff forecasts.

Based on feedback collected through the workshops, interviews, and data analysis, WWA, in partnership with the NRCS Snow Survey staff in the region, will develop a user's guide to snowpack monitoring data and products. The guide will cover the basics of snowpack hydrology, how to access snowpack monitoring data currently available, emerging spatial snow products, and considerations in interpreting the data.

Activity 1.1c Outcomes

- Project report with recommendations to NIDIS, CBRFC, NRCS and water agencies outlining the usability of spatial snowpack data [Summer 2017]
- *User's Guide to Snowpack Monitoring* (PDF and web-based) [Summer 2017]

Activity 1.2 Analyze Decision Model for Climate Adaption on Ranches and Rangelands

WWA will expand a modeling effort to help ranchers make herd management decisions in extreme drought, given uncertainties about the market, feed prices, and next year's climate and drought conditions, which drive both range production and forage insurance payouts. The Drought, Ranching, and Insurance Response (DRIR) Model integrates drought impact calculators developed by the U.S. Department of Agriculture's (USDA) Agricultural Research Service (ARS), a ranching drought decision model developed by Colorado State University Cooperative Extension, and a new module with the University of Colorado's Earth Lab that calculates the likely payoff of the USDA Risk Management Agency (RMA) Pasture, Forage and Range drought insurance program. The model simulates annual profit and end-of-year net worth for a cow/calf ranch over a five-year period, drawing from a user-supplied precipitation record, NOAA gridded precipitation for selected sites, or different drought scenarios. The ranch parameters (e.g., herd size) can be set by the user. A version of the model, with more extensive simulation capabilities, that can be run by multiple users in a decision lab is under development. In partnership with the USDA's Northern Plains Climate Hub (NPCH), ranchers from eastern Colorado and Wyoming will test the model in 2017 in realistic simulations, providing insights into the decision process and use of drought information.

Activity 1.2 Outcomes

- WWA will analyze and test the model using various drought indices (i.e., gridded precipitation, EDDI, and USDM) to evaluate the effect of different drought triggers on the insurance instrument's efficacy in reducing drought risk for producers, in order to fully incorporate the RMA range insurance program into the decision model [Spring - Summer 2017]

Activity 1.3 Assess Colorado's Weather and Climate Monitoring Systems

The CCC is conducting an assessment to identify gaps and limitations in current drought monitoring systems, particularly as they might relate to the accuracy of weather forecasts and warnings, which may, in turn, limit public safety and emergency response capabilities. The natural hazards being investigated primarily include floods and severe storms (both winter and summer), but may include drought as a natural hazard as well. Gaps in information are typically associated with poorer forecasts and less precise warning of imminent weather threats. By identifying gaps, efforts to prioritize improvements in monitoring systems may be undertaken. Partner agencies include the National Weather Service (NWS), Federal Emergency Management Agency (FEMA), the Colorado Department of Public Safety, and the Colorado Department of Natural Resources.

Activity 1.3 Outcomes

- Report on findings submitted to partners [Summer 2017]
- Prioritized list of recommendations to help fill observation and monitoring gaps [Fall 2017]

Activity 1.4 Assess Climate, Drought, and Extreme Heat Resilience in Arizona and New Mexico

CLIMAS will expand its existing regional assessment activities to cover a diverse representation of communities in Arizona and New Mexico, with the goal of better understanding (1) current concerns and plans regarding climate and drought risk and resilience (with a specific focus on drought and heat); and (2) needs for additional information and services. This effort will also include the construction of a database of key contacts to manage relationships with stakeholder groups, individuals, or organizations.

These assessments will focus on three target communities: urban, rural (2017) and tribal (2018). The project will ultimately result in a series of small focus groups throughout these target areas aimed at identifying information needs and emergent research priorities, and developing new networks and collaborations within the IMW DEWS.

Activity 1.4 Outcomes

- Development of database for urban/rural DEWS contacts [Winter-Spring 2017]
- Delivery of DEWS contacts database to NIDIS Program Office [Ongoing]
- Regional urban and rural focus groups [Spring-Summer 2017]
- Final report compiling findings from regional urban and rural focus groups [Fall 2017]
- Development of database of tribal DEWS contacts, delivery to NIDIS [Winter-Spring 2018]
- Regional tribal focus groups [Spring-Summer 2018]
- Final report compiling findings from regional tribal focus groups [Fall 2018]

Activity 1.5 Assess Drought Vulnerability of Wind River Indian Reservation to Inform Tribal Planning

The Wind River Indian Reservation (WRIR) in west-central Wyoming is home to the Eastern Shoshone and Northern Arapaho tribes, who reside near and depend on water from the streams that feed into the Wind River. In recent years, the region has experienced frequent severe droughts, which have impacted tribal livelihoods and cultural activities. Scientists with the North Central Climate Science Center (NCCSC) at Colorado State University, NDMC, and several other university and agency partners in the region are working with tribal water managers to assess how drought affects the reservation. The assessment integrates social, ecological, and hydro-climatological sciences with local knowledge. The findings will help inform the creation of a climate monitoring system and drought management plan, which the High Plains Regional Climate Center (HPRCC) and NIDIS are supporting. The drought plan will integrate climate science with hydrologic, social, and ecological vulnerabilities and risks, and identify response capacities and strategies to support the Tribal Water Code and related resources management to help the tribes ensure that agricultural and other societal needs are met during times of drought.

As part of the project, tribal water managers and the public will also be engaged in educational activities related to water resources and drought preparedness through joint activities with Wyoming EPSCoR to build the tribes' ability to respond to future drought. Additionally, the WWA at the University of Colorado-Boulder and the project team are evaluating team processes and outputs to document "lessons learned" to support the transfer of knowledge to other tribes and non-tribal entities in the region.

Activity 1.5 Outcomes

- In partnership with the Office of the Tribal Water Engineer, the NDMC, NCCSC, and WWA, facilitate the development of a WRIR Drought Mitigation and Response Plan [December 2017]
- WWA Evaluation of Science for the WRIR Drought Plan Final Report [December 2017]

Activity 1.6 Determine the Socio-Economic Value of Improved Streamflow Forecasts

This activity is part of a larger project funded by a NASA Research Opportunities in Space and Earth Sciences (ROSES) grant that aims to improve stream-flow forecasts in the Upper Colorado River Basin

using NASA derived information. The sub-project consists of a ROSES sub-grant to WWA and Riverside Technology, Inc., who will then investigate the socio-economic value of the improved streamflow forecasts using a variety of economic tools and analyses. The results of this activity will be valuable for stakeholders seeking to understand the full value of improved forecasts, and for regional water managers who are making decisions based on streamflow forecasts. The sub-project consists of archival research, literature review, focus groups, and interviews with key personnel in the water management community.

Activity 1.6 Outcomes

- Literature review of socio-economic values of streamflow forecasts for sub-project completed [Spring 2018]
- Interviews and focus groups [Fall 2018 - Spring 2019]
- Final report and peer reviewed publications [Fall 2019]

Activity 1.7 Identify Opportunities and Barriers for Decision Makers Utilizing Drought Information Tools

Many of the drought tools and products developed as part of the original UCRB DEWS as well as some currently under development as part of the IMW DEWS (i.e. EDDI), are the focus of a USGS and NCCSC-funded project aimed at identifying reasons that potential users of drought information do or do not make use of available products. Through a series of individual interviews and supplemental document analysis (initiated spring 2016), the research aims to improve the understanding of:

- (1) the factors that influence decision makers' choices to use decision support tools or not, and how they chose between available tools;
- (2) how scientists creating decision support tools currently interface with decision makers and how their outreach efforts do or do not match information channels preferred by managers; and
- (3) how those managing for drought within land management agencies in particular use drought information.

The resulting report from this project will be shared with the CCC, NIDIS, and other producers of drought information in the IMW DEWS.

Activity 1.7 Outcomes

- Presentation on preliminary results at 2017 American Meteorological Society annual meeting [Winter 2017]
- Project report detailing user's perspectives completed and shared with NIDIS and CCC [Summer 2017]
- Results will be presented to information providers and tool developers upon request [Summer 2017]

Priority 2 – Improve Communication and Utilization of Drought and Climate Science

To warn a community about drought with enough notice to effectively plan and prepare, a DEWS must regularly disseminate drought and climate information and forecasts. The Upper Colorado River Basin Drought Assessments (Activity 2.1), hosted by the CCC, have served as a model of information

dissemination for other DEWS regions. Other popular and well established communication portals and products geared towards Arizona and New Mexico (i.e. CLIMAS's suite of drought and climate outlook tools, described in Activity 2.3) are now being integrated into the network of tools available as part of the IMW DEWS. Stakeholders that attended the Fall 2016 IMW DEWS Drought & Climate Outlooks regularly identified this kind of information as a high priority need and expressed interest in receiving information through a variety of communications vehicles (virtually and in-person) and information providers. The IMW DEWS will leverage existing communications vehicles and develop new ones that best support stakeholders in the region.

This priority will focus on coordinated communication, outreach, and training across various regions and sectors in the IMW DEWS to improve the understanding and utilization of drought and climate science. Examples of activities include: regular drought, climate and water-year outlooks held in-person and via webinar; outreach and training to improve the use of available drought and climate information and tools; and targeted training for media on drought and climate information.

Activity 2.1 Upper Colorado River Basin Weekly Drought Assessments

The CCC develops weekly drought assessments for the Upper Colorado River Basin states (CO, UT, and WY). This weekly assessment is closely coordinated with the USDM weekly schedule. Based on time of year and current conditions, the CCC holds periodic interactive webinars with information users and providers including NWS forecast offices, BOR, CBRFC, NRCS, USGS, state natural resource offices, state climate offices, agricultural and municipal water providers.

In addition to providing timely updates on regional drought and climate conditions (i.e. streamflow, snowpack, water supply, temperature, precipitation and other indices), these assessments have helped provide a testbed for new and emerging monitoring tools, products, and indices.

This activity will expand the current monitoring products to cover the entire IMW region. The weekly assessments currently cover the IMW region for temperature, soil moisture, and outlooks. CCC will complete work to expand coverage of the IMW region for precipitation, snow, streamflow, and reservoir products. Due to the historical success and popularity of these assessments (within the region and amongst the USDM authors) NIDIS, the CCC, and other partners will discuss options for replicating and/or expanding these assessments into other IMW DEWS states. This will be a focal discussion point at the IMW DEWS Information Provider Coordination Meeting (Activity 4.1) in Spring 2017.

Activity 2.1 Outcomes

- Weekly drought assessments available on CCC [webpage](#) and IMW DEWS pages on U.S. Drought Portal
- Periodic briefings held via webinar/conference call
- Expansion of precipitation products to cover the entire IMW DEWS region [Fall 2017]

Activity 2.2 Colorado Basin River Forecast Center Water Supply Forecast Monthly Briefings

Each year from December through June, the CBRFC holds monthly water supply forecast briefings for stakeholders throughout the region focused on the Colorado River Basin and the Great Basin, two of the most important river systems for water and resource managers in the IMW DEWS Regions. These briefings are held via webinar and are often available as recordings after each live broadcast. CBRFC

conducts monthly briefings for both the Colorado River Basin and Great Basin that explain the water supply forecasts and include a discussion of current conditions. Additional briefings (including a peak flow briefing, usually in mid-March) will be scheduled as needed, reflecting changing conditions or expressed interest.

Activity 2.2 Outcomes

- Monthly briefings for both the Colorado River and Great Basins held via webinar/conference call
- Archived briefings can be found on CBRFC's webpage and links to those resources will also be posted on the IMW DEWS pages on U.S. Drought Portal

Activity 2.3 Intermountain West Climate Dashboard

WWA produces the [Intermountain West Climate Dashboard](#), which consists of a series of graphics based on various drought and climate indices that provide an array of water and climate information for states in the Intermountain West (particularly CO, UT, and WY) that are automatically updated when each respective product posts new data or information. The Dashboard also includes detailed descriptions of each graphic. In consultation with partners in Arizona and New Mexico (including CLIMAS), WWA will expand the Dashboard to reflect the geographic boundaries of the newly expanded IMW DEWS.

Monthly briefings, based on the climate graphics and discussing observed conditions are also released around the 10th of each month.

Activity 2.3 Outcomes

- The [Intermountain West Climate Dashboard](#) is updated in real-time on the WWA web page when the original provider of each graphic updates their product
- Monthly Climate and conditions briefings
- Redesign of the Dashboard to create a cleaner interface and reflect the new geographic boundaries of the IMW DEWS [Spring 2017]

Activity 2.4 Southwest Drought & Climate Outreach

CLIMAS produces web-based communications tools that provide easily digestible climate and drought information geared towards stakeholders in Arizona and New Mexico. Due to the success and popularity of these tools, NIDIS, CLIMAS and other partners will replicate and/or expand these resources to cover other IMW DEWS states.

- [Southwest Climate Outlook](#) (SWCO): The monthly SWCO summarizes climate and weather information from disparate sources in non-scientific language, providing stakeholders with timely climate-related information. It is produced by CLIMAS in collaboration with University of Arizona Cooperative Extension, the Arizona State Climate Office, and the New Mexico State Climate Office. Since 2002, it has evolved into a tool for two-way communication with stakeholders and a platform for responding to needs throughout the region. Each outlook, distributed via email and posted to the CLIMAS website, includes a discussion of recent and current conditions (precipitation and temperature, snowpack and water supply, drought, and ENSO) and seasonal forecasts utilizing NOAA's Climate Prediction Center (CPC) seasonal outlooks (three months) for precipitation and temperature.

- [Southwest Climate Podcast](#): This monthly podcast synthesizes information from a variety of sources and translates national and global discussions of timely climate-related topics and their relationship to the Southwest, including: climatic events (El Niño and La Niña), the monsoon, increasing temperatures, water supply and reservoir storage. The Southwest Climate Podcasts currently focus primarily on the states of Arizona and New Mexico, but frequently address broader Colorado River Basin issues that impact all of the IMW DEWS states.
- [ENSO News and Information Hub](#): The ENSO News and Information Hub is used to connect climate information to potential and observed impacts associated with current and recent climatic events (El Niño and La Niña) for Arizona and New Mexico. First created in 2015 to respond to the 2015-2016 El Niño event, it will be expanded in 2017 to reflect the swing to La Niña conditions and provide a platform to integrate multimedia outreach (web, podcast, blog and print) with climate assessment and analysis to reflect emerging conditions.

Activity 2.4 Outcomes

- Monthly Southwest Climate Outlook distributed via email and posted to CLIMAS website
- Monthly Southwest Climate Podcast
- ENSO News and Information Hub updated to include La Niña [Winter 2017]

Activity 2.5 In-Person Drought and Climate Outlooks

In response to feedback from stakeholders as part of the IMW DEWS, NIDIS and its partners will host periodic drought and climate outlooks throughout the region to provide a recap of recent events, an update on current conditions and impacts, climate outlooks and forecasts, and highlight new and emerging research and tools. These half-day to full-day events will also bring partners and stakeholders together to continue to grow and maintain the IMW DEWS partner network.

NIDIS will coordinate with relevant partners to create a two-year calendar for Outlooks (and other workshops if needed) based on key climatic times of the year, sector-based decision-making timelines, and/or regionally specific needs (i.e. beginning/end of the water year, spring runoff) with the goal of streamlining meetings and leveraging time and travel resources. These events will leverage partner events where applicable. The calendar will be posted to the U.S. Drought Portal's IMW Pages.

To coincide with the goal of increased engagement in previously underrepresented and newly expanded regions of the IMW DEWS, Outlooks in year one (2017) will be located along the Wasatch Front (Spring 2017) and coupled with Activity 1.1a, Western New Mexico and Colorado's Western Slope/Eastern Utah (Summer 2017). Additional Outlooks and workshops in other regions may also occur in 2017 and 2018 and will be identified in the two-year IMW DEWS Outlook calendar.

Activity 2.5 Outcomes

- Two-year calendar of Outlooks and other potential workshops [Winter 2017]
- Wasatch Front Drought & Climate Outlook [Spring 2017]
- Western New Mexico Drought & Climate Outlook [Summer 2017]
- Western Slope/Eastern Utah Drought & Climate Outlook [Summer 2017]
- All presentations and associated materials for each event will be posted to drought.gov
- A two-page summary of each event will be developed and posted on drought.gov

Activity 2.6 Leverage IMW DEWS Activities with State-Specific Drought and Water Supply Outreach

At the state level across the Intermountain West, a variety of existing communications tools can increase access to and build capacity to better use drought and climate information. The IMW DEWS will promote and build upon information and resources produced by several state-based initiatives to enhance the ability of decision makers throughout the region. Examples include:

- **Arizona Drought Monitoring Technical Committee (MTC):** The Arizona MTC is comprised of climate and drought experts (Arizona State Climatologist, Arizona Department of Water Resources (ADWR), NWS, CBRFC, NRCS, Salt River Project (SRP), Arizona Department of Emergency Management, USGS, County Officials, Cooperative Extension, State Universities and others). The MTC gathers and evaluates drought, climate and weather data and distributes a monthly report to land managers, policy-makers and the public.
- **Colorado State University Extension Drought Team:** At times of widespread moderate to extreme drought, Colorado State University Extension has a team of county extension agents and topic specialists (crops, water resources, livestock, public health, communications, etc.) who meet periodically. The Drought Team disseminates information to stakeholders to help prepare for and navigate drought situation. The CCC helps the Drought Team target resources towards most drought-impacted areas.
- **Colorado Water Availability Task Force (WATF):** The Colorado WATF is chaired by the Colorado Water Conservation Board (CWCB) and holds regular meetings to monitor conditions that affect Colorado's water supply, including snowpack, precipitation, reservoir storage, streamflow, and long term weather forecasts from University of Colorado Boulder's Cooperative Institute for Research in Environmental Sciences (CIRES) and NOAA Physical Sciences Division (PSD). Meeting documents (including presentations and a monthly summary document) are available to the public on [CWCB's website](#).
- **New Mexico Drought Monitoring Workgroup:** The New Mexico Drought Monitoring Workgroup is hosted at the Albuquerque NWS weather forecast office and chaired by the New Mexico State Climatologist. The Drought Monitoring Workgroup provides a synthesis of climate, hydrology data, and drought impacts to the New Mexico Drought Task Force and recommendations to the USDM. Reports and meeting dates are posted to a website hosted by the New Mexico Office of the State Engineer, and presentations/webinars are archived on YouTube (youtube.com/nmclimate).
- **Wyoming Drought Impacts and Outlook:** The Wyoming State Climate Office produces a series of Drought Impacts and Outlook Summaries for Wyoming. Of the multiple climate and drought outlook documents NOAA helps produce, this is first outlook specifically focused on a state. The outlook is produced in partnership with NIDIS, NWS, NDMC, the HPRCC, the USDA Northern Plains Climate Hub (NPCH), University of Wyoming Extension, and WWA. The summaries are released approximately monthly or on an as-needed basis depending upon conditions.

- **Wyoming Water Forum:** The Wyoming State Engineer's Office hosts monthly meetings (September - May) to share information and insight on the latest water-related topics through the state. Special programs provide an in-depth review of a particular water-related issue or topic. The forum also provides updates on water-focused activities in an informal setting at the end of each presentation. Interested stakeholders can participate in-person or remotely via webinar/conference call.

Activity 2.6 Outcomes

- Arizona MTC weekly recommendations to the USDM, monthly web-based reports on short-term drought status, and quarterly long-term drought status map and summary reports
- Colorado WATF regular meetings and summary documents
- Colorado Extension Drought Team meeting minutes, fact sheets, webinars and other outreach materials
- Synthesis of the New Mexico Drought Monitoring Workgroup reports and YouTube videos posted to the Office of the State Engineer's website
- Wyoming Water Forum monthly meetings (annually, September through May)
- Produce monthly Wyoming Drought Impacts and Outlook summaries (or as-needed, depending on conditions)

Activity 2.7 Informational Drought & Climate Webinar for Media in Colorado

Drought and climate have become more mainstream topics for the media in recent years. To respond to the media industry's (radio, print, television etc.) increased interest but limited time and resources, the CCC will host an informational webinar to help build the media's capacity to convey the correct message and better understand the science and information sources. The webinar will be geared specifically to Colorado media professionals (and neighboring states/regions, if applicable) and focus on each area of analysis covered in CCC's regular drought assessments (referenced in Activity 2.1). The webinar will also include discussion of how each component (i.e. precipitation, snowpack, streamflow, surface water, evaporative demand) is evaluated and how subsequent recommendations are made to the USDM authors and what the respective drought categories (i.e. D0, D1, D2...) represent. Partners include Colorado State University Media Relations, NDMC, CWCB and WWA.

Activity 2.7 Outcomes

- One Media webinar, to be held in Spring/Summer 2017

Activity 2.8 Develop a Series of Web Videos/Digital Shorts

The CCC will develop a series of short explanatory web videos providing consumer friendly explanations of a variety of complex topics and drought indices and tools. These videos will give visitors (to the website and to the webinars) detailed explanations about the various products and indices displayed or discussed as part of the weekly drought assessments. After watching these digital shorts, viewers and listeners will have a better understanding of what standardized precipitation index is and why it is important for drought monitoring.

Activity 2.8 Outcomes

- Archived YouTube videos with links posted to drought.gov

Activity 2.8a Brief Video “News Flashes” of Current Drought Conditions

As a supplement to the weekly drought assessments (see activity 2.1) and to keep viewers informed on drought in the region, the CCC will produce brief (two to five minutes) video “News Flashes,” produced on an “opportunity and news worthiness” basis as drought conditions emerge and diminish. The first video’s production will begin in spring 2017 at the initiation of snowmelt. Production of subsequent videos will continue on an as-needed basis, as determined by the CCC staff.

Activity 2.8a Outcomes

- Archived YouTube videos promoted by social media developed when conditions warrant

Activity 2.9 Special Topic Webinars

NIDIS and its partners will periodically host timely special topic webinars to help educate stakeholders and users on various drought and climate topics and tools. NIDIS will coordinate with key partners to create a two-year calendar for these webinars which will respond to developing drought and climate events, emerging issues (i.e. the relationship between groundwater and surface water in drought-prone regions), and provide a forum for further explanation of new and developing tools and resources.

The webinars will cover topics like the CPC seasonal forecasts, CPC drought outlook, and a new regional drought outlook product being developed by the CCC (see Activity 3.5) and discuss how each relate specifically to the IMW DEWS region to give users the resources they need for better decision-making and planning.

Activity 2.9 Outcomes

- Special topic webinars two-year calendar by Spring 2017
- Webinars will be recorded and posted on drought.gov with associated presentations and resources as soon as possible

Activity 2.10 Update and Maintain the IMW DEWS Information on the U.S. Drought Portal

The IMW 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 IMW DEWS pages on drought.gov also serve as an information portal for an explanation of past, current, and upcoming IMW 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 IMW DEWS stakeholders to review and provide content for IMW DEWS specific pages.

Activity 2.10 Outcomes

- Stakeholder review of IMW DEWS pages on drought.gov [Summer 2017]
- Initial update to IMW DEWS pages on drought.gov completed [Summer 2017]

- Routine enhancements to the IMW DEWS webpage, to include timely updates, relevant content, and visual improvements in layout and formatting. [Winter 2017 – Fall 2018]

Priority 3 – Drought Monitoring and Research to Improve Drought Early Warning

The development and deployment of useful drought and climate-related tools is at the heart of IMW DEWS activities. The work under this priority will focus on improving access to data and information for drought risk management through enhanced monitoring and improving the usability of tools and indices. Examples of activities include: enhanced coverage and use of CoCoRaHS networks, improving the use of state-run agriculture/water weather monitoring networks, developing new regional drought outlook tools using seasonal forecasting products, and refining emerging tools like EDDI and the WRMO to better meet user needs.

Activity 3.1 Enhance Coverage and Use of Community Collaborative Rain, Hail and Snow (CoCoRaHS) Network

Engaging the public in drought monitoring and condition reporting is already taking place with 3,000 rain gauge volunteers in the 5-state area actively collecting and sharing daily precipitation data via CoCoRaHS (www.cocorahs.org). This is a large asset to the IMW DEWS, and CoCoRaHS will continue to support partnerships between local, regional, state and federal agencies and citizen scientists at the ground level.

Activity 3.1a Increase Number of CoCoRaHS Volunteers in IMW DEWS States

Through collaborations with each State Climate office and several of the NWS offices serving the IMW region, a two-year campaign (Spring 2017 through Spring 2019) will be initiated to increase the number of active volunteers by 25% in WY and UT and by 10% in AZ, CO, and NM. To increase the number of volunteers, NIDIS and partners will conduct outreach to conservation districts, State Engineer's offices, USDA's Climate Hubs, federal land managers, and other partners to promote CoCoRaHS volunteer opportunities.

Activity 3.1a Outcomes

- Measurable increase in active CoCoRaHS volunteers (25% in WY and UT, and 10% in AZ, CO, and NM) from Spring 2017 – Spring 2019

Activity 3.1b Increase Collection of Drought Impacts using new “Condition Monitoring Reports”

In addition to reporting precipitation amounts, CoCoRaHS volunteers nationwide have the ability to submit “Condition Monitoring Reports” to report general conditions of their local area on a scale of wet to dry, as well as sectors/categories that are being impacted such as agriculture, plants and wildlife, tourism etc. These reports help populate the NDMC's Drought Impact Reporter (DIR). Beginning in 2017, CoCoRaHS volunteers will be contacted by e-mail when USDM drought classification in their area deteriorates to D-2 or worse. They will then be encouraged to submit a Condition Monitoring Report each week while conditions are changing, and approximately once each month during more stable times of year. Colorado and New Mexico will pilot the collection of Condition Monitoring Reports along with precipitation data reporting.

CoCoRaHS staff at the CCC will coordinate with each IMW DEWS state CoCoRaHS coordinator to prepare message statements appropriate to each state. An informational and training animated video developed in coordination with the Carolinas Integrated Science Assessment (CISA) will be used to help train and engage volunteers. One or more instructional webinars will be held for interested participants across the IMW DEWS region.

Activity 3.1b Outcomes

- CoCoRaHS e-mail messaging system by state and county, to notify volunteer rain gauge readers when drought conditions have worsened initiated [Summer 2017]
- Training webinar for IMW DEWS CoCoRaHS volunteers on use of the Condition Monitoring Reporting system [Summer 2017]
- Animated training video developed [Spring 2018]
- Training tools (including the afore mentioned webinar) and animated video will be posted to the CoCoRaHS website and drought.gov
- Summary report developed for NIDIS, NDMC, and CoCoRaHS with metrics evaluating IMW DEWS CoCoRaHS participation rates, engagement [Spring 2019]

Activity 3.2 Enhance Existing Drought Monitoring Tools and Indices

Activity 3.2a Incorporate Soil Moisture Time Series Information in CCC Weekly Drought Assessments

Soil moisture time series plots for stations with adequate historical context can illustrate where soil moisture is improving or degrading, and can provide insight into how quickly drought conditions are changing. Soil moisture can also influence precipitation outlooks during the growing season. The CCC will develop soil moisture time series plots for NRCS Soil Climate Analysis Network (SCAN) and SNOTEL stations meeting the required criteria and begin to incorporate this information into the weekly drought assessments and webinars (see Activity 2.1) when appropriate.

Activity 3.2a Outcomes

- Soil moisture time series plots will be developed for relevant NRCS SCAN and SNOTEL sites [Winter 2017]
- CCC will conduct an evaluation of soil moisture time series plots for incorporation into weekly drought assessments and, if data collected is useful, incorporate into weekly drought assessments and periodic webinars [Winter - Spring 2017]

Activity 3.2b Enhance the Usability of CoAgMET and Other Mesonet Networks

[The Colorado Agricultural Meteorological Network \(CoAgMET\)](#) is Colorado's Mesonet, with weather stations across the state, primarily in irrigated agricultural areas, with data at some stations going back 25 years. Each station measures the weather conditions used to calculate reference evapotranspiration, including temperature, relative humidity, solar radiation, and wind speed and direction. The CCC maintains the CoAgMET network, with support from the CWCB. Funding for this monitoring is not permanently certain, but CWCB recognizes the importance of maintaining this type of on-the-ground agricultural and water resource focused

monitoring as it provides the basis on which many other drought and water resource monitoring tools are built and calibrated. CWCB funding is also supporting CCC to develop maps of daily ET by summer 2017.

There are similar networks in place or under development throughout the IMW DEWS states, some include the [Arizona Meteorological Network \(AgWxNet\)](#), the [New Mexico Climate Center Stations](#), and [Utah's AgWeather Network](#). These networks are well positioned to track the weather conditions that influence evaporation and water demand. In Colorado, at least 10 new stations (funded with support from BOR) will be added to CoAgMET in the Colorado River Basin by summer 2017, to improve monitoring of consumptive use of crops throughout western Colorado. These stations will enhance monitoring of ET through the computational interpretation of temperature, wind, humidity, and solar radiation data along with soil temperature and moisture measurements. These data sources can be integrated with existing drought monitoring products. This is a great opportunity to physically represent the often-overlooked environmental demand side of water resource management, which is key for tracking the regional water balance.

Activity 3.2b Outcomes

- Improved spatial coverage of ET stations due to the addition of 10 new CoAgMET stations in the Colorado River Basin [Summer 2017]
- CoAgMET maps of daily reference ET and the contributing variables (temperature, humidity, wind speed, solar radiation) [Summer 2017]
- Graphs of accumulated reference ET and departures from average at selected locations [Summer 2018]

Activity 3.3 Enhance the Usability of the Evaporative Drought Demand Index (EDDI)

EDDI was developed with strong fiscal and technical support from NIDIS by researchers with NOAA Earth Systems Research Laboratory (ESRL) Physical Science Division (PSD), and WRCC/Desert Research Institute (DRI). The index was promulgated and tested operationally in partnership with CCC, NCCSC, and WWA. EDDI is a new drought index that can serve as an indicator of both rapidly evolving “flash” droughts (developing over a few weeks) and sustained droughts (developing over months but potentially lasting years), both of which are common in the IMW DEWS region. EDDI has been shown to offer early warning of drought stress relative to current operational drought indicators, such as the USDM. EDDI’s ability to capture the precursor signals of water stress at weekly to monthly timescales also makes it a potent tool for drought preparedness at those timescales. Currently, maps of gridded EDDI over varying timescales are available for the entire IMW DEWS and are being incorporated into the CCC’s weekly drought assessments and the WWA Intermountain West Climate Dashboard. They are also being considered by many of the USDM authors in their weekly analyses.

There is little experience among current EDDI users regarding 1) how EDDI relates to other more common drought indicators, and 2) how EDDI reflects and anticipates on-the-ground drought impacts. WWA will develop an online EDDI User Guide to inform users in these areas, drawing from the expertise of the broader EDDI team at NOAA ESRL/PSD and DRI (EDDI is also being socialized as an activity in the California-Nevada DEWS, and information collected on user needs will be shared amongst researchers in both regions). In addition to the User Guide, WWA will hold at least one webinar training to

introduce the EDDI User Guide to stakeholders in the IMW DEWS. Additional outreach to users throughout the IMW DEWS and other regions of the country via presentations at a variety of outlooks and workshops will also continue.

Upon request from stakeholders (like CCC), attribution surfaces can be developed that accompany each EDDI map to illustrate how much each variable (air temperature, humidity, solar radiation, and wind speed) contribute to the anomaly in reference ET that each EDDI map represents. These products will be available starting in spring 2017.

CCC will evaluate differences in growing season reference ET levels measured by CoAgMET weather stations and EDDI across Colorado's Eastern Plains for the years of 1995-2015. Findings of interest will include: correlation between EDDI and CoAgMET growing season reference ET over the same geographic area, differences in the magnitude of EDDI and CoAgMET-measured reference ET, differences in the variability of EDDI and CoAgMET reference ET, and differences in year-to-year reference ET percentile rankings as reported by EDDI and CoAgMET. CCC will submit a scientific journal article based on the findings of this research.

Activity 3.3 Outcomes

- User's Guide to EDDI [Spring 2017]
- Webinar on EDDI and User's Guide [Spring 2017]
- Development of EDDI Homepage on drought.gov [Winter 2017]
- Customized maps displaying the relative effects of temperature, wind speed, solar radiation and humidity on changes in evaporative demand will be available upon request from stakeholders [Spring 2017]
- CoAgMET vs EDDI reference ET journal article published by CCC [Fall 2018]

Activity 3.4 Integrate Water Resource-Related Data and Predictive Information

WRMO is a new online tool being designed and developed by a team at NOAA, including NIDIS, the CBRFC, and NOAA's PSD. It will provide uniform access to 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 water resource information delivery to water management stakeholders. The WRMO was developed in response to requests from water managers for an integrated and synthesized tool for water resource-related data and predictive information. The WRMO will integrate hydrometeorologic monitoring, RFC water supply forecasts, and CPC 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) water resources outlooks that are an enhancement of the current product (both 1 and 2 updated daily) 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.

The current effort has two parts:

- 1) Develop an online tool that provides consistent products across the western RFCs. For decades, NOAA's River Forecast Centers (RFCs) have been providing forecasts of water supply (defined as the

April-July runoff) at lead times up to six months at hundreds of locations across the western United States. However, this product is issued in various formats in different RFC domains. This new interface will provide a consistent, regional overview, responding to the needs of water managers for improved visualization of the forecasts, and for forecast-related data including forecast verification.

2) 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 system. In FY17, CBRFC will determine how to effectively use the existing CPC products, and what other sub-seasonal to seasonal climate outlook information would be meaningful to water managers.

The WRMO is being introduced to potential users and stakeholders at IMW DEWS meetings and workshops (including the fall 2016 Drought & Climate Outlooks in Arizona and Colorado) and directly to existing RFC stakeholders (e.g. the CBRFC annual stakeholder meeting). An evaluation protocol is being implemented to help refine the WRMO in order to better meet user needs.

Activity 3.4 Outcomes

- Stakeholder engagement and socialization of the WRMO to IMW DEWS stakeholders [Summer 2017]
- Develop and design prototypes maps and graphics interpreting CPC's seasonal climate outlooks for water managers in partnership with NOAA CPC and PSD [Winter 2017]
- Document use of product suite and evaluate usability and effectiveness in decision constructs – [Summer 2017]
- Develop a report for NIDIS on findings and post to the U.S. Drought Portal [Summer 2017]
- Reengage with stakeholders to evaluate product refinements and new climate products [Fall 2017 - Winter 2018]

Activity 3.5 Develop a New Drought Outlook Product Tailored to the IMW DEWS

IMW DEWS stakeholders have called for improving the prediction component of tools used for drought early warning and monitoring in the region. The CCC has improved monitoring of drought and water to strengthen drought early warning in the region, with products primarily based on current, observed conditions. Prediction is occasionally addressed, through the assessment of national-level information products, but has not yet been adequately explored.

CCC will develop a new tool which will utilize existing seasonal products (e.g. CPC outlooks, North American Multi-Model Ensemble (NMME)) to provide probabilistic temperature and precipitation forecasts targeted over the entire IMW DEWS five state region. These seasonal forecasts will propagate into a new Regional Drought Outlook tool that will be tailored specifically for IMW users and providers. Incorporation of local expertise (e.g., knowledge of the region's hydrologic cycle, a thorough understanding of locally specific definitions of drought) from scientists at the local, state, and federal levels, can improve upon current outlooks provided at a national scale, in determining the likelihood of drought onset, persistence, or improvement in the IMW DEWS region.

Activity 3.5 Outcomes

- Presentation at the 2017 American Meteorological Society (AMS) Annual Meeting [January 2017]

- Experimental IMW Seasonal Forecast Tool produced and available on CCC website and U.S. Drought Portal [Spring 2017]
- Experimental IMW Regional Drought Outlook Tool to be produced and available on the CCC website and U.S. Drought Portal [Fall 2017]
- Research to Operations (R2O) specific manuscript to be submitted to BAMS and NIDIS detailing the production of a regional drought outlook product for the IMW [Spring 2018]
- Research manuscript submitted to peer-reviewed journal detailing a skill assessment of the CPC outlooks and NMME forecasts over the IMW [Summer/Fall 2018]

Priority 4 – Integrate and Develop Collaborative Information Networks

The purpose of this priority is to improve coordination among climate and drought information providers in the IMW DEWS region without handicapping efforts to get information disseminated to the widest audience. Examples of activities include: widening existing networks to include Arizona and New Mexico, enhancing IMW DEWS engagement in Utah and Wyoming, supporting coordination of drought-related activities amongst federal climate initiatives (North Central and Southwest Climate Science Centers, Northern Plains and Southwest Climate Hubs, WWA and CLIMAS, etc.), and identifying and leveraging partner resources to enhance drought monitoring, planning, and preparedness.

Activity 4.1 Improve Coordination of Drought and Climate-Related Information

In June 2017, NIDIS brought together the state climatologists, state drought coordinators (or the equivalent of) from each IMW state in addition to other key partners (i.e. NDMC, RISAs, RCCs, RFCs, USDA Climate Hubs, DOI Climate Science Centers, and others) to discuss ways to coordinate and disseminate information between and among climate information providers. This meeting discussed coordinated messaging and branding, and identified opportunities for leveraging expertise, time, funding, and other resources. Participants will develop an IMW DEWS Drought & Climate Information Dissemination Outreach Plan clarifying goals, roles, and responsibilities resulting from the meeting, and the plan will be reevaluated annually.

Activity 4.1 Outcomes

- IMW DEWS Information Provider Coordination Meeting [Summer 2017]
- Coordinated IMW DEWS Drought & Climate Information Dissemination Outreach Plan – [Summer 2017]
- Reevaluate the Coordinated IMW DEWS Drought & Climate Information Dissemination Outreach Plan [Summer 2018]

Activity 4.2 Integrate Drought and Climate Science into Wildfire Management Planning and Policy

The relationship between drought and wildfire can seem simple. However, the drought and wildfire nexus encompasses many human and environmental interconnections. There are regional variations in fire regimes and fuel characteristics, and there are also several cross-sector, local, state, tribal and federal agencies involved in wildfire planning, response, and management in the Western United States. Understanding the impacts of drought at state and regional levels, as well as coordinating at this scale, will be vital to developing a successful, integrated network of drought information to be used in natural resource, fire and air quality agencies.

In October 2015, NIDIS, DRI/WRCC, NDMC, and other partners hosted the [Integrating Drought Science and Information into Wildfire Management Workshop](#) in Boise, Idaho. Seventeen federal, state, NGO and academic organizations from across the West, including representatives from the National Interagency Fire Center (NIFC), attended to discuss 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 current use of drought information in wildfire management, participants called for additional, regionally focused workshops to further collect information on the use of drought indicators and impact information by the wildfire management community. These regionally focused workshops will provide an opportunity to connect the drought and wildfire management communities at the regional level. DRI/WRCC and NIDIS plan to hold at least two workshops in the IMW DEWS region over the next two years.

Activity 4.2 Outcomes

- Workshop in Southwest Geographic Area Coordination Center (GACC) Region [Spring 2017]
- Workshop in Rocky Mountain GACC Region [Winter 2018]
- Workshop in Great Basin GACC Region in Spring 2018 * (in coordination with the CA-NV DEWS)
- Post-workshop reports consisting of outcomes, findings, and recommendations posted to the U.S. Drought Portal

Activity 4.3 Coordinate Drought-Related Activities Among Federal Climate Initiatives

The IMW DEWS region contains two USDA Climate Hubs (the Northern Plains Climate Hub (NPCH) and the Southwest Climate Hub (SWCH)), two DOI Climate Science Centers (North Central Climate Science Center (NCCSC) and the Southwest Climate Science Center (SWCSC)) and two DOI Landscape Conservation Cooperatives (LCCs) (the Desert and Southern Rockies LCCs). These providers are important partners, participating in DEWS stakeholder group activities such as conference calls, webinars, and/or in-person meetings. NIDIS, NDMC, CLIMAS, WWA and other IMW DEWS partners and land management agencies (i.e. BLM, Extension, USFS) will continue coordinating with these Federal Climate Initiatives to leverage resources to best meet the needs of stakeholders in the region.

Activity 4.3 Outcomes

Examples of potential and planned activities include:

- Northern Plains Climate Hub:
 - Collaborate with NDMC to produce an operational forage tool for ranchers [Fall 2017]
 - Conduct trainings in partnership with NDMC, NIDIS, and other federal and state partners for agricultural producers on NDMC's suite of decision-making tools (i.e. the use and development of the USDM, and the DIR) [Fall 2017]
 - Collaboration with USDA's Farm Services Agency (FSA) to enroll agricultural producers and land management agencies as CoCoRaHS volunteers
- Southwest Climate Hub:
 - La Niña Outlook and Impacts Forum in partnership with NDMC, CLIMAS, NIDIS and others [Winter 2017]
 - Collaboration with USDA FSA to enroll ranchers and farmers as CoCoRaHS volunteers

- NDMC will partner with the SWCH to produce a Spanish language version of the USDM map and associated narrative for the SWCH stakeholders. [Fall 2017]
- North Central Climate Science Center:
 - Vulnerability assessment to support the development of the Wind River Indian Reservation drought and mitigation plan (Activity 1.5) [Fall 2017]
- Southwest Climate Science Center:
 - Southwest Ecological Drought Workshop [Spring 2017]

Activity 4.4 Develop a Matrix of Federal, Tribal, State, and Local Drought Related Activities and Resources

To improve awareness, collaboration, and avoid duplicating efforts among government agencies, NIDIS will lead an effort to document drought-related activities and resources in the IMW DEWS. This activity will also help identify sectors and communities lacking resources and highlight potential opportunities to leverage resources to enhance their benefit.

NIDIS and partners will develop a matrix and circulate to stakeholders to collect information on existing and planned activities in the region. The completed matrix will be made publicly available and be used by NIDIS and IMW DEWS stakeholders as a reference tool. The matrix will be updated on a quarterly basis (to coincide with IMW DEWS stakeholder group calls). Key partners include BOR, NDMC, CCC, WWA, and CLIMAS.

Activity 4.4 Outcomes

- First matrix of drought related projects and activities in IMW DEWS region posted on drought.gov, updated on a quarterly basis [Summer 2017]

Activity 4.5 Develop a Database of Stakeholders and Partners across the IMW DEWS Region

NIDIS, in collaboration with CCC, WWA, CLIMAS and other partners will create a comprehensive database of partners and stakeholders in the IMW DEWS region. This reference database will be hosted by NIDIS and accessible by key partners as needed to aid in streamlined communication across IMW DEWS partner networks.

Activity 4.5 Outcomes

- Consolidation of existing contact lists [Summer 2017]
- Updated on a quarterly basis [Ongoing]

Activity 4.6 Create a GIS-based Interactive Stakeholder Contact Map

Building off of the database in activity 4.5, the CCC will develop a GIS-based database with a mapping interface of stakeholders, enabling users to find contacts by location, jurisdiction, and organization. Improving access to this information will enhance information providers' ability to collect and verify drought impacts and conditions, which is valuable information during the weekly USDM drought monitoring process. In 2017, the first version of this mapping tool will focus on Colorado and the counties that fall within the Upper Colorado River Basin in Utah and Wyoming, and ultimately expand to include the rest of those two states.

Activity 4.6 Outcomes

- Original UCRB DEWS contact lists integrated into the interactive map format [Spring 2017]
- Further expansion into other IMW DEWS states (Arizona, New Mexico) [Summer 2018]

Activity 4.7 Leverage IMW DEWS Network to Support Drought Planning

NIDIS and its partners will support ongoing and emerging tribal, state, and local drought planning initiatives. Several programs, such as FEMA's Pre-Disaster Mitigation Program and BOR's Drought Response Program can support drought planning and preparedness across the IMW DEWS. NIDIS and key regional stakeholders can often provide technical expertise, support, and other planning resources. NIDIS will work with partners including BOR, FEMA, USGS, NRCS, NDMC, and others to identify ways to coordinate and leverage partner programs and technical expertise with federal, regional, tribal, state and local efforts in order to support more comprehensive and effective drought planning.

Examples of drought planning efforts utilizing some of these resources that are already underway or being planned can be found in Appendix D.

Activity 4.7 Outcomes

- NIDIS will utilize the IMW DEWS partner network to promote funding announcements and other resources through the U.S. Drought Portal, IMW DEWS webinars, and other communications vehicles.

APPENDIX A: INTERMOUNTAIN WEST DEWS PARTNERS

The development of this IMW West DEWS Strategic 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 IMW DEWS. This list of partners is not exhaustive and will evolve as new regional partnerships form.

Table A – IMW DEWS Partnerships

Partner Agencies and Organizations
Arizona Department of Water Resources
Arizona State Climate Office
Central Arizona Project
Climate Assessment for the Southwest (CLIMAS)
Colorado Climate Center at Colorado State University
Colorado Department of Water Resources
Colorado River Water Conservation District
Colorado Water Conservation Board
Denver Water
Desert Research Institute
Federal Emergency Management Agency
Jordan Valley Water Conservancy District
National Aeronautics and Space Administration
National Drought Mitigation Center
National Oceanic and Atmospheric Administration <ul style="list-style-type: none"> ▪ Climate Prediction Center ▪ Colorado Basin River Forecast Center ▪ High Plains Regional Climate Center ▪ National Center for Environmental Information ▪ National Weather Service ▪ Western Regional Climate Center
New Mexico Cooperative Extension
New Mexico Office of the State Engineer
New Mexico State Climate Office
Salt Lake City Public Utilities
U.S. Army Corps of Engineers
U.S. Department of Agriculture <ul style="list-style-type: none"> ▪ Agricultural Research Service ▪ Forest Service ▪ Natural Resources Conservation Service ▪ Northern Plains Climate Hub ▪ Risk Management Agency ▪ Southwest Climate Hub
U.S. Department of the Interior

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- Bureau of Land Management
- Bureau of Reclamation
- Geological Survey
- North Central Climate Science Center
- Southwest Climate Science Center

U.S. Environmental Protection Agency

University of Arizona Cooperative Extension

University of Wyoming Extension

Utah Division of Water Resources

Weber Basin Water Conservancy District

Western Governors Association

Western States Water Council

Western Water Assessment

Wyoming State Climate Office

Wyoming State Engineer's Office

APPENDIX B: NIDIS WORKING GROUPS

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

Table B - Intermountain West 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 Decision Making to Enhance Drought Planning and Preparedness						
Activity 1.1 Enhance decision making in the water supply sector					X	
Activity 1.1a Advance drought risk management among water providers in Colorado’s Western Slope		X	X	x	X	
Activity 1.1b Improve drought resiliency along the Wasatch Front		X	X	X	X	
Activity 1.1c Improve the usability of snowpack data by water managers	X	X			X	
Activity 1.2 Analyze decision model for climate adaption on ranches and rangelands	X			X	X	
Activity 1.3 Assess Colorado’s weather and climate monitoring systems		X		X	X	
Activity 1.4 Assess climate, drought and extreme heat resilience in Arizona and New Mexico				X	X	X
Activity 1.5 Assess Drought Vulnerability of Wind River Indian Reservation to inform tribal planning	X	X		X	X	

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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
Activity 1.6 Determine the socio-economic value of improved streamflow forecasts		X	X	X	X	
Activity 1.7 Identify Opportunities and Barriers for Decision Makers Utilizing Drought Information Tools					X	
Priority 2 – Improve Understanding and Utilization of Drought and Climate Science						
Activity 2.1 Upper Colorado River Basin weekly drought assessments	X	X	X		X	X
Activity 2.2 Colorado Basin River Forecast Center Water Supply Forecast Monthly Briefings	X	X	X		X	X
Activity 2.3 Intermountain West Climate Dashboard	X	X	X	X	X	X
Activity 2.4 Southwest Drought & Climate Outreach	X	X	X	X	X	X
Activity 2.5 In-person Drought and Climate Outlooks	X				X	X
Activity 2.6 Leverage IMW DEWS activities with state specific drought and water supply outreach	X	X			X	
Activity 2.7 Informational drought & climate webinar for media in Colorado	X					X
Activity 2.8 Develop a Series of Web Videos/Digital Shorts	X					X

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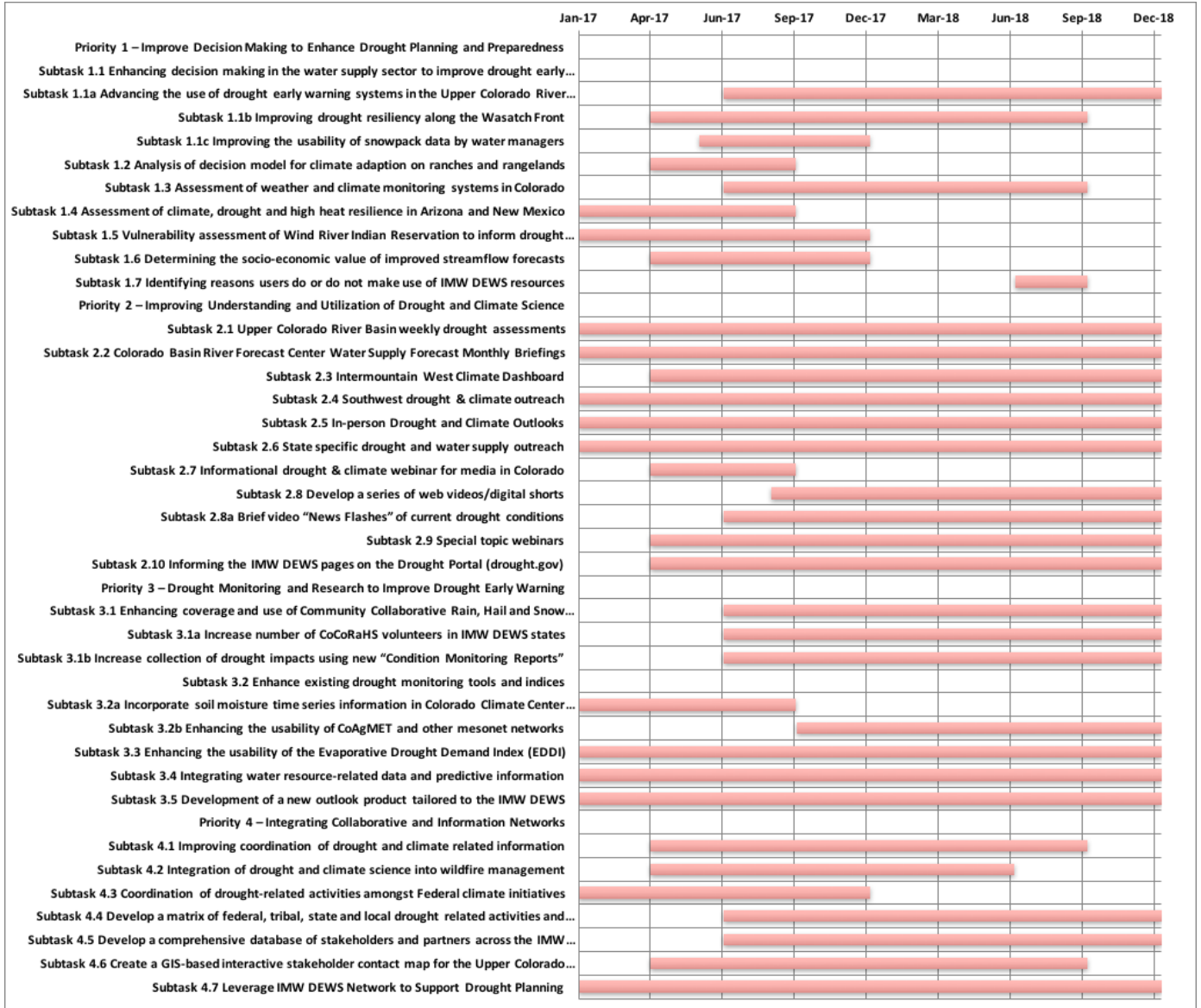
Activity	NIDIS Working Groups					
	Education and Public Awareness	Monitoring and Observations	Predictions and Forecasting	Interdisciplinary Research & Applications for Risk Assessment	Planning and Preparedness	U.S. Drought Portal
Activity 2.8a Brief Video “News Flashes” of Current Drought Conditions	X					X
Activity 2.9 Special Topic Webinars	X	X	X		X	X
Activity 2.10 Inform the IMW DEWS pages on the Drought Portal (drought.gov)	X					X
Priority 3 – Enhance Drought Monitoring and Research						
Activity 3.1 Enhance Coverage and Use of Community Collaborative Rain, Hail and Snow (CoCoRaHS) Network						
Activity 3.1a Increase Number of CoCoRaHS Volunteers in IMW DEWS States	X	X				
Activity 3.1b Increase Collection of Drought Impacts Using New “Condition Monitoring Reports”	X	X				
Activity 3.2 Enhance Existing Drought Monitoring Tools and Indices		X			X	
Activity 3.2a Incorporate Soil Moisture Time Series Information in CCC Weekly Drought Assessments	X	X			X	
Activity 3.2b Enhance the usability of CoAgMET and other mesonet networks		X			X	
Activity 3.3 Enhance the usability of the Evaporative Drought Demand Index (EDDI)	X	X	X	X	X	X

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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
Activity 3.4 Integrate water resource-related data and predictive information		X	X	X	X	
Activity 3.5 Develop a new outlook product tailored to the IMW DEWS			X	X	X	X
Priority 4 – Integrate and Develop Collaborative Information Networks						
Activity 4.1 Improve coordination of drought and climate related information	X	X	X	X	X	X
Activity 4.2 Integrate drought and climate science into wildfire management	X	X	X	X	X	
Activity 4.3 Coordinate drought-related activities amongst Federal climate initiatives	X			X	X	X
Activity 4.4 Develop a matrix of federal, tribal, state and local drought related activities and resources	X				X	X
Activity 4.5 Develop a database of stakeholders and partners across the IMW DEWS region	X					
Activity 4.6 Create a GIS-based interactive stakeholder contact map for the Upper Colorado River Basin	X					
Activity 4.7 Leverage IMW DEWS Network to Support Drought Planning					X	

APPENDIX C: PROJECT LIST

Table C – Intermountain West DEWS Projects and Timelines



APPENDIX D: ACRONYMS

ADWR	Arizona Department of Water Resources
ARS	Agricultural Research Service
ASCE	American Society of Civil Engineers
ASO	Airborne Snow Observatory
ASCO	Arizona State Climate Office
BLM	U.S. Bureau of Land Management
BOR	U.S. Bureau of Reclamation
CAP	Central Arizona Project
CLIMAS	Climate Assessment for the Southwest
CBRFC	Colorado Basin River Forecast Center
CCC	Colorado Climate Center
CDWR	Colorado Department of Water Resources
CIRES	Cooperative Institute for Research in Environmental Sciences
CoAgMET	Colorado Agricultural Meteorological Network
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
CPC	Climate Prediction Center
CWCB	Colorado Water Conservation Board
DEWS	Drought Early Warning System
DIR	Drought Impact Reporter
DOI	Department of the Interior
DRI	Desert Research Institute
DRIR	Drought Ranching and Insurance Response Model
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
FSA	Farm Service Agency
HPRCC	High Plains Regional Climate Center
IMW	Intermountain West
JPL	Jet Propulsion Laboratory
JVWCD	Jordan Valley Water Conservancy District
LCC	Landscape Conservation Cooperative
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NCCSC	North Central Climate Science Center
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
NPCH	Northern Plains Climate Hub
NRCS	National Resources Conservation Service
NWS	National Weather Service
PSD	Physical Sciences Division

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RCC	Regional Climate Centers
RFC	River Forecast Center
RMA	Risk Management Agency
R2O	Research to Operations
RISA	Regional Integrated Sciences & Assessments
RMA	Risk Management Agency
ROSES	Research Opportunities in Space and Earth Sciences
SARP	Sectoral Applications Research Project
SCAN	Soil Climate Analysis Network
SLPCU	Salt Lake City Public Utilities
SNOTEL	Snow Telemetry
SWCH	Southwest Climate Hub
SWCSC	Southwest Climate Science Center
SWCO	Southwest Climate Outlook
SWE	Snow-water equivalent
TWC	Tribal Water Code
UCRB	Upper Colorado River Basin
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
WADR	Wasatch Area Dendroclimatology Research Group
WATF	Water Availability Task Force (Colorado)
WBWCD	Weber Basin Water Conservancy District
WGA	Western Governors Association
WRCC	Western Regional Climate Center
WRIR	Wind River Indian Reservation
WRMO	Water Resources Monitor and Outlook
WSWC	Western States Water Council
WWA	Western Water Assessment

APPENDIX E: EXAMPLES OF STATE AND LOCAL DROUGHT PLANNING ACTIVITIES

The following section describes some of the state and local drought planning activities currently underway in the Intermountain West DEWS region that either have the potential, or are already leveraging resources from a variety of IMW DEWS partners.

Colorado: The Dolores Water Conservancy District will develop a drought contingency plan in partnership with the Ute Mountain Ute Tribe Farm and Ranch Enterprise, and the Montezuma Valley Irrigation Company. The plan will include the areas served by the Bureau of Reclamation's (BOR) Dolores Project, located in southwest Colorado, which provides irrigation water for approximately 36,600 acres of irrigated land, provides municipal and industrial water to the Ute Mountain Ute Tribe, the tribal community of Towaoc, several other towns and cities, and serves downstream fish and wildlife purposes. This planning effort is supported in part by BOR's Drought Response Program.

New Mexico: The Middle Rio Grande Conservancy District, located in central New Mexico, will develop a drought contingency plan to identify and prioritize actions to ensure a dependable water supply to its customers while reducing exposure and vulnerability to prolonged water shortages. The District provides irrigation water to farmland, four counties and six Pueblos within the middle Rio Grande Valley. Water shortages from long term and persistent drought, lasting over a decade, have created intense challenges for the District to balance responsibilities. In addition to serving irrigators, the District's system of ditches and drains support a number of environmental services including 30,000 acres of a unique and contiguous riparian forest known as the Rio Grande Bosque, and providing critical habitat for several endangered species, such as the silvery minnow, the southwestern willow flycatcher, the New Mexico meadow jumping mouse and the western yellow-billed cuckoo. The plan will support the requirements of the new 2016 Biological Opinion, and assist the state in carrying out its Rio Grande Compact delivery obligations. The District will collaborate with a diverse group of municipal, county, state, tribal and non-profit organizations to conduct the planning efforts.

The City of Gallup, New Mexico will partner with local and state governmental agencies to create a regional drought contingency plan for a community of about 20,000 people including numerous disadvantaged communities throughout McKinley County, and the Zuni and Navajo Reservations. The area that Gallup serves has a history of chronic poverty and more than 40 percent of Navajo households rely on water hauling to meet daily water needs. BOR's Navajo-Gallup Water Supply Project (NGWSP) is currently in the planning and design-build stages to bring a dependable potable water supply source to the Navajo Nation and the City of Gallup. The drought contingency plan will help the City manage the future system and regional NGWSP water supplies. The Plan is critical to the protection and management of the existing and future water supplies from drought conditions.

Both planning efforts mentioned in New Mexico received drought contingency planning grants in 2016 through BOR's Drought Response Program.

Utah: Weber Basin Water Conservancy District, located in northern Utah, will prepare a Drought Contingency Plan for all the facilities and water users within its service area. This effort will build off an existing plan that does

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not provide insight into the severity of potential future drought, or address the long-term impacts of drought. This is critical for the area as the basin has been in a drought for six of the last ten years and the District has junior water rights which are vulnerable during droughts. Currently, the district serves over 50 customer agencies and provides water for nearly 600,000 people whose health and economic livelihood are increasingly at risk from drought and the accompanying degradation of water quality. Due to its favorable climate, the area anticipates growth of 1 million people by 2060. This new plan, with collaboration from city, county, state, commercial, and environmental stakeholders, will engage the public in the decision-making process while being more responsive to their needs.

The Salt Lake City Department of Public Utilities (SLPCU) will partner with a variety of local stakeholders to update their 2003 Drought Contingency Plan to improve the drought monitoring process, refine the actions taken in response to drought, and develop an improved administrative framework. SLPCU, located in Salt Lake County, Utah, serves 340,000 residential and 1,200 industrial customers in its 135-square-mile service area and its water supplies are increasingly at risk from both drought and population growth. This project will update the 2003 plan to guide the City in securing resilience in their water supply in anticipation of more frequent, prolonged, and severe drought; impacts from climate change; and increases in residential and industrial demands. Specific update items include a formal process for stakeholder involvement, long-term mitigation actions, and identifying potential drought indicators and triggers.

Both planning efforts mentioned in Utah received drought contingency planning grants in 2016 through BOR's Drought Response Program.

The Utah Division of Emergency Management will be revising its State Mitigation Plan in 2017. One component of this plan is identifying drought and emergency management responses to drought. As part of the Utah Hazard Mitigation Team, WWA will assist in development of the drought component of the "Utah Mitigation Plan." WWA will coordinate with the agriculture extension program at Utah State University to better connect with agricultural stakeholders in Utah.

APPENDIX F: DROUGHT MONITORING RESOURCES FOR THE INTERMOUNTAIN WEST DEWS

Nationwide coverage

NIDIS - Drought.gov

Main Portal - <https://www.drought.gov/>

Data, Maps & Tools - <https://www.drought.gov/drought/data-maps-tools>

National Drought Mitigation Center

US Drought Monitor- <http://droughtmonitor.unl.edu>

Drought Monitoring Tools - <http://drought.unl.edu/MonitoringTools.aspx>

NRCS National Water and Climate Center

Interactive Map 3.0 Beta - https://www.wcc.nrcs.usda.gov/webmap_beta

Multi-state/basin-wide coverage

NIDIS – Drought.gov

Intermountain West DEWS portal - <https://www.drought.gov/drought/dews/intermountain-west/>

Colorado Climate Center

NIDIS – IMW DEWS Current Conditions - <http://climate.colostate.edu/~drought/>

NIDIS - IMW DEWS Webinars - http://climate.colostate.edu/webinar_registration.html

Western Water Assessment (WWA)

Intermountain West Climate Dashboard- <http://wwa.colorado.edu/climate/dashboard.html>

Climate Assessment for the Southwest (CLIMAS)

Southwest Climate Outlook - <http://www.climas.arizona.edu/swco>

Rio Grande-Bravo Climate Outlook - <http://www.climas.arizona.edu/rgbo>

NOAA NWS Colorado Basin River Forecast Center (CBRFC)

CBRFC Conditions Map - <https://www.cbrfc.noaa.gov/>

Water Supply Webinars - <http://cbrfc.noaa.gov/present/present.php>

Upper Colorado Situational Awareness page - <https://www.cbrfc.noaa.gov/dash/lp.php>

High Plains Regional Climate Center

(HPRCC) HPRCC Monthly Climate Summary - <https://hprcc.unl.edu/climatesummaries.php>

Maps and Graphs Portal - <https://hprcc.unl.edu/onlinedataservices.php#mapsGraphs>

Midwest-Great Plains Climate-Drought Outlook Webinar - <https://hprcc.unl.edu/webinars.php>

Western Regional Climate Center (WRCC)

WestWide DroughtTracker - <http://www.wrcc.dri.edu/wwdt/>

Great Basin Weather and Climate Dashboard - <http://www.gbdash.dri.edu/>

State-wide or within-state coverage

Wyoming State Climate Office

Wyoming Drought Briefings - <http://www.wrds.uwyo.edu/drought/reports/outlook.html>

Wyoming Snow Pages (w/ NRCS Wyoming Snow Survey) - <http://www.wrds.uwyo.edu/wrds/nrcs/nrcs.html>

NRCS Wyoming Basin Outlook Reports - <http://www.wrds.uwyo.edu/wrds/nrcs/snowpack/snowmap.html>

Colorado Water Conservation Board

CO Drought Update & Water Availability Task Force Meetings <http://cwcb.state.co.us/public-information/flood-water-availability-task-forces/Pages/main.aspx>

Arizona Department of Water Resources

AZ Drought Status Report -

<http://www.azwater.gov/azdwr/StatewidePlanning/Drought/DroughtStatus2.htm>

New Mexico Drought Monitoring Workgroup

NM Drought Status Reports - http://www.nmdrought.state.nm.us/dtf_workgroup.html

HPRCC, Office of Tribal Water Engineer (Wind River IR), NIDIS, NDMC, NCCSC

Wind River Climate and Drought Summary - <https://hprcc.unl.edu/publications.php> (“Reports”)

NRCS Arizona Snow Survey

Main page and portal - <https://www.nrcs.usda.gov/wps/portal/nrcs/main/az/snow/>

NRCS Colorado Snow Survey

Main page and portal - <https://www.nrcs.usda.gov/wps/portal/nrcs/main/co/snow/>

NRCS New Mexico Snow Survey

Main page and portal - <https://www.nrcs.usda.gov/wps/portal/nrcs/main/nm/snow/>

NRCS Utah Snow Survey

Main page and portal - <https://www.nrcs.usda.gov/wps/portal/nrcs/main/ut/snow/>

Products and data (w/ new interactive charts)

Site: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ut/snow/products/?cid=nrcseprd1329940>

Basin: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ut/snow/products/?cid=nrcseprd1330021>

Under development

Evaporative Demand Drought Index (EDDI) – NOAA ESRL PSD, Desert Research Institute, WWA, NIDIS

<https://www.esrl.noaa.gov/psd/eddi/>

Water Resources Monitor and Outlook (WRMO) – CBRFC, NOAA ESRL PSD, NIDIS

<https://cbrfc.noaa.gov/WRMO>

Tools for finding resources

NOAA Western Region Climate Service Providers Database –WRCC, WWA, CLIMAS

<http://www.wrcc.dri.edu/ClimSvcProviders/>

Appendix G: Disclaimer

The Intermountain West (IMW) Drought Early Warning System (DEWS) Strategic Plan is a collaborative Federal, state, tribal and local interagency effort to improve early warning capacity and resilience to drought in the Intermountain West. The contents of this plan should not be used as evidence against any IMW 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 Colorado River Basin. Nothing in the Plan is intended to, nor shall the Plan be construed so as to, interpret, diminish, or modify the rights of any Intermountain West 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 stakeholders 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 stakeholder in this process. Nor shall any party be deemed to accept or agree with any particular assumption, conclusion, and other information contained in the Plan or its resulting studies, unless explicitly stated by those parties.