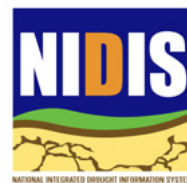


**2021–2023**

# Missouri River Basin

## Drought Early Warning System (DEWS) Strategic Action Plan



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



# Executive Summary

## DROUGHT IN THE MISSOURI RIVER BASIN

The Missouri River Basin (MRB) is no stranger to drought. Prolonged droughts in the 1930s and 1950s substantially affected water supplies, agriculture, energy, transportation of goods, and ecosystems. More recently, short duration droughts wreaked havoc on the MRB. The intense 2012 summertime drought surprised the region, as flooding was expected to continue into a second year following the devastating floods of 2011. In 2017, record low May–July precipitation, warm temperatures, and windy conditions led to rapid soil moisture declines in the Upper MRB. Agricultural losses alone totaled in excess of \$2.6 billion dollars. It was particularly the floods of 2011 and then the extreme and rapidly evolving drought in 2012 that emphasized the need for an early warning system that not only could improve how we anticipate drought events but could also improve collaboration and coordination of data and monitoring networks for floods in the Missouri Basin.

**WHAT IS NIDIS?** In 2006 (Public Law 109-430), Congress authorized the National Integrated Drought Information System (NIDIS) with a mandate for interagency coordination and integrated drought research that builds upon existing federal, tribal, state, and local partnerships to create a national drought early warning system (DEWS). The program was reauthorized in 2014 (Public Law 113-86) and again in 2019 (Public Law 115-423).

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

## THE MISSOURI RIVER BASIN DEWS

It was in this context that the National Integrated Drought Information System (NIDIS) began developing a Drought Early Warning System (DEWS) in 2014 specifically focused on the MRB. A DEWS improves the regional capacity to respond to, and cope with drought by utilizing existing networks to make climate and drought science readily available, easily understandable, and usable.

## BUILDING A MRB DEWS STRATEGIC PLAN

The first MRB DEWS Strategic Plan from 2015–2016 focused on three priorities: (1) to improve data and information for drought risk management at the state level and (2) for tribal nations in the basin; and (3) to make improvements in drought monitoring and forecasts for the region. In early 2017, meetings were held to update the plan, including a new focus on enhancing tribal capacity to use drought information and the use of new tools and drought indicators across the region. Before that plan could be finalized, drought quickly engulfed the Northern Plains region. The effects of the 2017 Northern Plains flash drought motivated NIDIS to coordinate multi-agency assessments of its impacts, causes, and predictability; the U.S. Army Corps of Engineers to renew their efforts to strengthen soil moisture monitoring in the region; and impacted states to examine their response plans. Additionally, NIDIS launched a partnership in 2019 with the University of Colorado-Boulder’s Masters of the Environment Program to engage the tribal nations of the Missouri River. In this context, partners from across the MRB met in Billings, MT, in August 2019 to discuss next steps. Four priorities and a series of outcomes and actions organized by the five components of a DEWS were identified to be part of the next iteration of a MRB Strategic Action Plan (SAP).

## FOUR KEY PRIORITIES FOR 2021–2023

1. Build a comprehensive understanding of the many drought indicators used in the MRB DEWS to better demonstrate their value, limitations, and sector-specific, seasonal, and geographical applications. This will help users focus on information that is important to the region to better inform drought early warning and preparedness.
2. Build a comprehensive understanding on how drought impacts relate to drought indicators to better quantify drought impacts across sectors and communities, and tie impacts to drought conditions and outlooks in a manner that resonates with target audiences.
3. Identify and communicate proactive measures that can be taken prior to or during the development of drought to build drought resilience and strengthen drought response by empowering those coping with drought impacts to act.
4. Enhance collaboration, coordination, and two-way communication among national, tribal, state, and local partners and between DEWS regions to strengthen drought early warning, preparedness, and resilience across the MRB.

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

Initial Activities to be Undertaken by the MRB DEWS	
<b>NETWORK COORDINATION AND INTEGRATION</b>	
Hold annual meetings of the network, with a focus on better engagement with the tribal nations in the MRB, strengthening mechanisms of communication and coordination amongst partners and engaging new partners.	
Establish the foundation of a drought learning network to encourage the exchange of best practices, lessons learned, and peer-to-peer exchanges to foster preparedness and resilience to drought.	
Evaluate the effectiveness of the MRB DEWS network and engagement strategies in building collaborations, increasing partners' ability to find and use information in decision-making, and expanding participation in drought planning and preparedness activities.	
<b>DROUGHT PREDICTIONS AND FORECASTING</b>	
Develop simple, effective communication materials to increase user understanding of forecasts and outlooks to include information on uncertainties inherent in the products.	
<b>DROUGHT OBSERVATIONS AND MONITORING</b>	
Ensure that new and existing monitoring networks are interoperable and that partners know what data is available throughout the basin by leveraging existing and new initiatives to increase monitoring in the region.	
Engage with tribal and federal partners to address weather and in situ station gaps on tribal lands.	
<b>DROUGHT PLANNING AND PREPAREDNESS</b>	
Provide resources to educate and encourage practices that build ecosystem health to build resilience to drought and other natural hazards such as flooding.	
Develop guidance on what it means to proactively plan for and prepare for drought at the local and state levels to achieve early warning and preparedness through case studies and peer-to-peer learning opportunities.	
Support states and tribes who are updating drought and related plans to move to more proactive plans with technical information and lessons learned from other states and tribes.	
<b>DROUGHT COMMUNICATION AND OUTREACH</b>	
Provide opportunities for capacity building for key products and tools that can be applied in the MRB to include feedback to continually improve tools and information.	
Bolster drought impact reporting through available mechanisms and work to analyze this information in a way that can inform decision-making.	
<b>INTERDISCIPLINARY RESEARCH AND APPLICATIONS</b>	
Determine the appropriate drought indicators for different types of drought in the MRB to address seasonal and geographical differences and use that to amplify communication when conditions are setting up for a potential drought.	

# The National Integrated Drought Information System and the Missouri River Basin Drought Early Warning System

## NATIONAL INTEGRATED DROUGHT EARLY WARNING SYSTEM

Congress created the National Integrated Drought Information System in 2006 (Public Law 109-430) with a mandate for interagency coordination and integrated drought research that builds upon existing federal, tribal, state, and local partnerships to create a national drought early warning system (DEWS). The program has been reauthorized in 2014 (Public Law 113-86) and again in 2019 (Public Law 115-423). NIDIS is working toward this goal by developing a network of regional DEWS across the nation. 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.

## COMPONENTS OF A DROUGHT EARLY WARNING SYSTEM

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

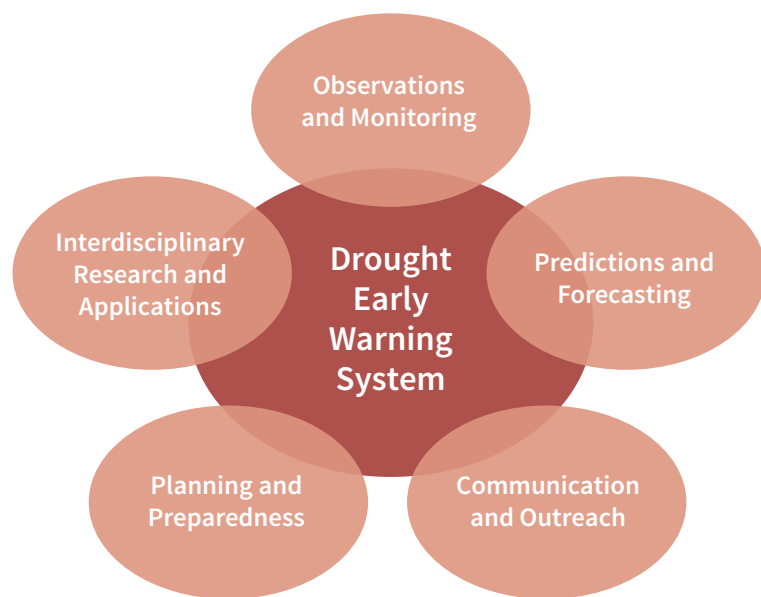
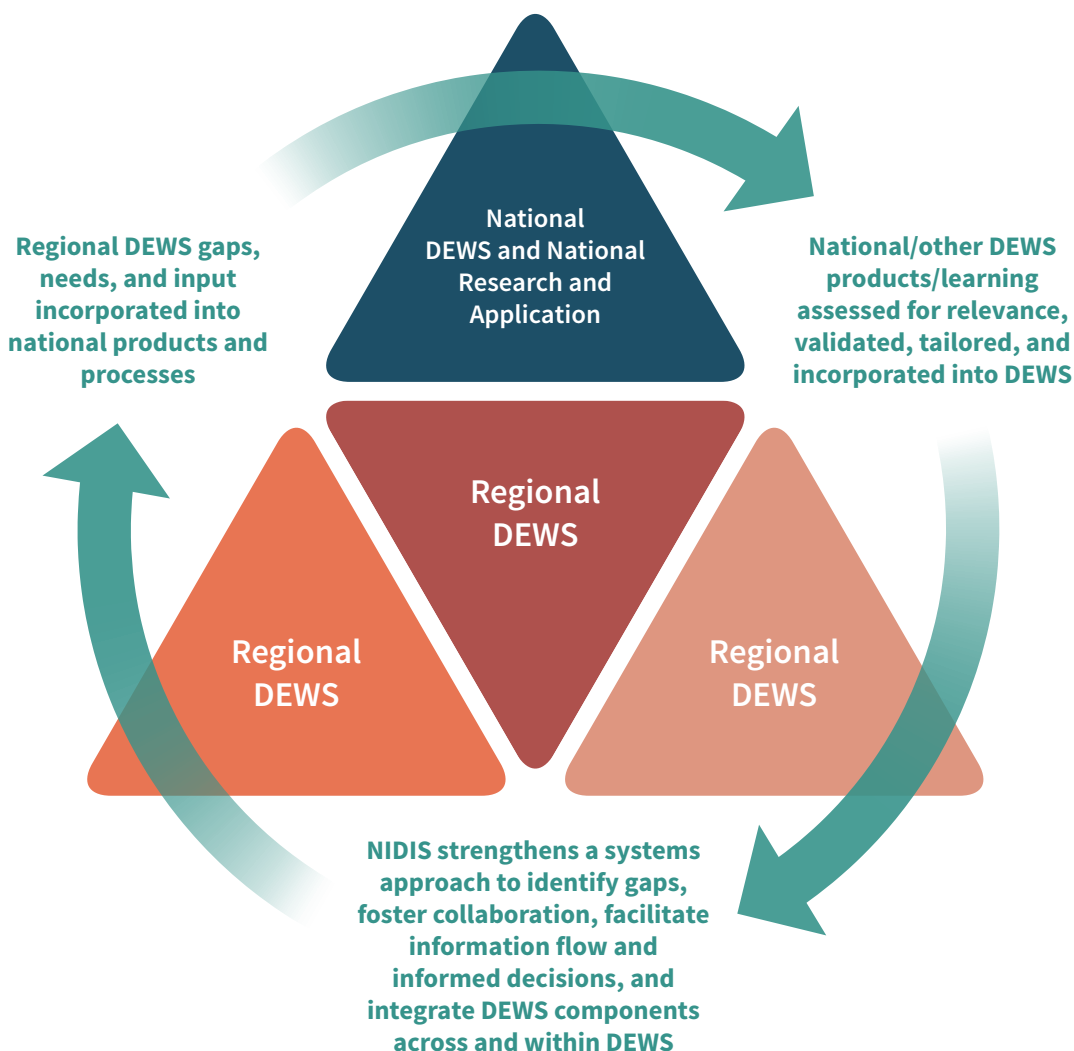


Figure 1: A Drought Early Warning System is made up of five components including Predictions and Forecasting, Observations and Monitoring, Planning and Preparedness, Communications and Outreach, and Interdisciplinary Research and Applications. Credit: NOAA NIDIS, Fiona Martin

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

## BRINGING IT TOGETHER ACROSS SCALES

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



relevance, validated, tailored, and then incorporated into the regional DEWS. It is this cross-scale exchange of information and learning that helps to improve our capacity for national early warning across diverse sectors of the economy.

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

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



Figure 3: Location and spatial extent of the Missouri River Basin (MRB) Drought Early Warning System (DEWS). Credit: NOAA NIDIS, Fiona Martin

ensure drought resilience and preparedness are prioritized in times of drought as well as when drought is not present. Convening and fostering dialogue on drought related priorities is one of NIDIS's primary roles in each regional DEWS.

## LAUNCHING THE MISSOURI RIVER BASIN DROUGHT EARLY WARNING SYSTEM

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

The MRB is no stranger to drought. Prolonged droughts in the 1930s and 1950s substantially affected water supplies, agriculture, energy, transportation of goods, and ecosystems. More recently, short duration droughts wreaked havoc on the MRB. The intense 2012 summertime drought surprised the region, as flooding was expected to continue into a second year following the devastating floods of 2011. In 2017, record low May–July precipitation, warm temperatures, and windy conditions led to rapid soil moisture declines in the Upper MRB. Agricultural losses alone totaled in excess of \$2.6 billion dollars. It was particularly the floods of 2011 and then the extreme and rapidly evolving drought in 2012 that emphasized the need for an early warning system that not only could improve how we anticipate drought events but could also improve collaboration and coordination of data and monitoring networks for floods in the Missouri Basin. It is in this context that NIDIS began developing a DEWS in 2014 specifically focused on the MRB (*Figure 3*).



## MISSOURI RIVER BASIN DROUGHT EARLY WARNING SYSTEM PROGRESS TO DATE

The first MRB DEWS Strategic Plan from 2015–2016 focused on three priorities: (1) to improve data and information for drought risk management at the state level; (2) to do the same for tribal nations in the basin; and (3) to make improvements in drought monitoring and forecasts for the region. In early 2017, two meetings were held in Nebraska City, NE, and Rapid City, SD, to begin to draft a plan for 2017–2018. Updates included a new focus on enhancing tribal capacity to access and communicate drought information, and to

improve the use of new tools and drought indicators across the region. Before that plan could be finalized, the Northern Plains region was plunged into drought. The effects of the 2017 Northern Plains flash drought motivated NIDIS to coordinate multi-agency assessments of its impacts, causes, and predictability; the U.S. Army Corps of Engineers to renew their efforts to strengthen soil moisture monitoring in the region; and impacted states to examine their response plans. Additionally, NIDIS launched a partnership in 2019 with the University of Colorado-Boulder’s Masters of the Environment Program to engage the tribal nations of the Missouri River. These activities have all informed the development of this Regional Implementation Plan for 2020–2022.

The following table summarizes some of the key outcomes and progress that has been made by partners in the MRB DEWS since its inception in 2014. This is not meant to be an exhaustive list, but to provide a sense of how drought early warning capacity was enhanced in the MRB through the network in this region.

Key Outcomes and Progress
<b>DROUGHT PREDICTIONS AND FORECASTING</b>
The Second NASA-DEVELOP project in the upper MRB was completed to improve the Fire Risk Estimation tool that incorporates drought indicators into a daily wildfire risk map for the Great Plains.
<b>DROUGHT OBSERVATIONS AND MONITORING</b>
USACE worked with Upper MRB states to develop a plan to strengthen Plains snowpack and soil moisture monitoring and is working with states to fund new stations based on the plan to enhance both short and long term prediction.
NDMC and NIDIS collaborated with MRB states to make improvements to the National Drought Impact Reporter.
NIDIS supported the State of Montana to assess strengths and weaknesses of drought metrics and improve selection of relevant indices for MT and the region.
Monthly water supply and climate summaries for the Wind River Indian Reservation were developed and serve as models for other tribal nations across the United States (HPRCC, NC CASC, NDMC, NIDIS).

Key Outcomes and Progress
<b>DROUGHT PLANNING AND PREPAREDNESS</b>
NIDIS Tribal Engagement Strategy for the Missouri River Basin and Midwest DEWS was developed.
Kansas and Nebraska Tribes received a BIA grant for drought adaptation planning.
In collaboration with the Great Plains Tribal Water Alliance, a series of proposals were developed for drought vulnerability assessments and drought planning with the Rosebud, Oglala, Standing Rock, and Flandreau Sioux Tribes.
NDMC worked with Nebraska Emergency Management Agency to implement a more robust drought mitigation and response plan for NE as part of their multi-hazard planning effort, expanding the plan to focus on sectors beyond agriculture.
NIDIS supported the NDMC to survey and map the status of drought and drought related plans for the MRB.
MRB DEWS members served on the SD Drought Mitigation Plan (completed November 2015).
Montana DNRC and EPA held a Drought Ready Communities Course for drought planners in the Upper Missouri River Headwaters, in anticipation of producing sub-basin drought plans.
<b>DROUGHT COMMUNICATION AND OUTREACH</b>
A monthly climate summary and outlook webinar series for the North Central U.S. has been delivered since 2012 and is a key mechanism for providing stakeholders with the latest climate and drought conditions. Webinar frequency increased during the 2017 drought with additional webinars to cover different topics, communities, and sectors.
Quarterly drought and climate two-page summary focused on the Missouri Basin states have been produced by the High Plains Regional Climate Center since 2011.
Drought Impact Briefs were issued for the lower MRB during 2018 drought conditions.
A Kansas Drought Tournament (December 2016) was held as part of the implementation of the state's water supply plan, which included the use of drought simulation exercises to educate the public and identify gaps in water conservation efforts.
<b>DROUGHT INTERDISCIPLINARY RESEARCH AND APPLICATIONS</b>
<p>2017 Northern Plains Drought</p> <ul style="list-style-type: none"> <li>• <i>Flash Drought: Lessons learned from the 2017 Drought Across the U.S. Northern Plains and Canadian Prairies</i> report released</li> <li>• <i>The Causes, Predictability, and Historical Context of the 2017 U.S. Northern Great Plains Drought</i> report released</li> <li>• Hoell et al. 2020. <i>Lessons Learned from the 2017 Flash Drought Across the U.S. Northern Great Plains and Canadian Prairies</i>. <i>Bull. Amer. Meteor. Soc.</i> 1–46.</li> </ul>

# The Missouri River Basin Strategic Action Plan

## PURPOSE AND EMERGING ISSUES

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

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

## UPDATE CYCLE AND PROCESS

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





## FOUR KEY PRIORITIES FOR 2021–2023

1

Build a comprehensive understanding of the many drought indicators used in the MRB DEWS to better demonstrate their value, limitations, and sector-specific, seasonal, and geographical applications. This will help users focus on information that is important to the region to better inform drought early warning and preparedness.

2

Build a comprehensive understanding on how drought impacts relate to drought indicators to better quantify drought impacts across sectors and communities, and tie impacts to drought conditions and outlooks in a manner that resonates with target audiences.

3

Identify and communicate proactive measures that can be taken prior to or during the development of drought to build drought resilience and strengthen drought response by empowering those coping with drought impacts to act.

4

Enhance collaboration, coordination, and two-way communication among national, tribal, state, and local partners and between DEWS regions to strengthen drought early warning, preparedness, and resilience across the MRB.



# Activities for 2021–2023

## 1.0 MRB DEWS NETWORK COORDINATION AND INTEGRATION

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

### **Outcome 1.1: The MRB DEWS network is strengthened by improving drought communication and coordination.**

Activity 1.1a Hold annual DEWS partner meetings, alternating between the upper and lower MRB annually. Consider partnering with tribal nations to periodically hold meetings on reservations.

Activity 1.1b Identify options for targeted, engaging communication with and among the MRB DEWS network members. One-way communications through newsletters and email blasts are limiting.

Activity 1.1c Use other federal, tribal, and state meetings as an opportunity to engage new partners in the DEWS and encourage collaboration, coordination, and regular two-way communication.

Activity 1.1d Examine if there are mechanisms that would make it feasible for regional partners to come together to align priorities, coordinate activities, and pool resources (e.g., joint tribal fund) in a regional center concept.

Activity 1.1e Share information through the U.S. Drought Portal about funding opportunities related to drought. Specifically highlight opportunities for funding to implement drought related projects from drought and climate change adaptation plans and assist the tribal nations and other communities in securing funds for these types of projects.

Activity 1.1f Work with NDMC to evaluate the effectiveness of the MRB DEWS network and engagement strategies in building collaborations, increasing partners' ability to find and use information in decision-making, and expanding participation in drought planning and preparedness activities.

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

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

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

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

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

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

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

Activity 1.2f Identify DEWS facilitators or champions who can share drought adaptation actions within stakeholder communities (e.g., change in crop choice, water infrastructure, cover crops, etc.).

Activity 1.2g Develop a multi-state virtual collection of drought agriculture (and other) extension bulletins, materials, and other resources that contain information on preparing for and responding to drought through the learning network. Consider establishing a formal or informal group to help with the vetting process/input of drought-related materials produced in the region.

Activity 1.2h Develop a list of regular professional/association meetings of the water utility, energy, agriculture, natural resource management, tourism and recreation, etc. sectors and attend and present relevant drought early warning and preparedness information.

## **Outcome 1.3: New partnerships are built within the MRB Region.**

Activity 1.3a Engage Tribal Colleges and Universities and begin a dialogue to improve engagement and partnerships with the tribal nations in the region.

Activity 1.3b Improve consultation with tribal nations and bring additional federal partners to the table including EPA, Indian Health Services, etc.

Activity 1.3c Build and maintain on-the-ground networks to facilitate two-way communication between

the core DEWS group and the public to optimize the dissemination of information (e.g., early warning information, response options, preparedness activities).

Activity 1.3d Strengthen the partnership between NIDIS and the NWS to deliver timely information concerning drought through Weather Forecast Offices and River Forecast Centers in the region; develop more specific methods for this to happen in a coordinated way.

Activity 1.3e Coordinate and communicate regularly with Canadian partners to link them more strongly to the MRB DEWS network.

Activity 1.3f In partnership with NDMC, determine what engagement strategies lead to more effective communication, coordination, and networking across sectors and jurisdictions within the MRB DEWS and implement those strategies.

## 2.0 PREDICTIONS AND FORECASTING

There are many challenges to improved drought predictions and forecasting. Drought characteristics and physics must be understood in space and time for droughts to be predicted with skill. While larger efforts are aimed at improvements in areas such as subseasonal-to-seasonal (S2S) forecasting, there are things that can be done with partners to better communicate the uncertainties of predictions and forecasting and make this information more accessible and useful in this region.

### **Outcome 2.1: User understanding of forecasts and outlooks is improved by providing information on uncertainty in a meaningful form.**

Activity 2.1a Develop, by state or climate region, summaries (two-pagers) of CPC outlook skill/verification dot maps for different seasons and time frames (8–14 days, 30 days, 3 months).

Activity 2.1b Work with USGS to further communicate and contextualize projections of future stream flow with paleohydrologic records, building on their work with local watershed groups and exploring tailoring the information for other end-users.

Activity 2.1c Understanding that downscaling information to the farm/ranch/habitat scale is not possible, support state and federal agencies to better incorporate locally relevant information in the context of larger scale (e.g., county, watershed, state) information and products so that it is trusted and informs on-the-ground decisions. Build on the work of key partners such as the HPRCC and states that have been working to deliver climate projections in relevant ways.

Activity 2.1d Develop effective and simple communication materials (e.g., explain indices and forecasts in plain language so that the public can quickly locate data and information relevant to them).

Activity 2.1e Engage with social scientists to translate probabilities of future events into an online resource such as a flow diagram/decision tree that could then be populated with scenarios to drive actions.

### **Outcome 2.2: Current forecasts are improved by incorporating new information as it becomes available into existing products and services.**

Activity 2.2a Support research to determine if incorporating the 1–14-day precipitation outlooks into Grass-Cast would be appropriate and explore applications beyond rangelands to other ecosystems and



applications (e.g., wildland fire management, wildlife habitat).

Activity 2.2b Support research that advances the integration of soil moisture data into river forecasting, and link to similar efforts with initiatives such as the National Water Model.

Activity 2.2c Support research that uncovers a more holistic understanding of the physics of drought in the region to be able to interpret forecasts and give value-added to model output, building off studies completed on the predictability of the 2017 Northern Plains drought.

Activity 2.2d Support research that leads to the incorporation of drought forecasts and indicators into wildland fire products where appropriate to support public and wildland firefighter safety and decisions pre-ignition, during fires and post-fire to support recovery.

### 3.0 OBSERVATIONS AND MONITORING

There is a general consensus that more in situ measurements, especially of soil moisture, are needed across the MRB, and that this should be accomplished through the continued support of existing stations and networks in addition to new stations being deployed in areas lacking coverage. Programs like the USACE Upper Missouri River Plains Snow and National Coordinated Network are working to strengthen mesonet networks are addressing some of these gaps.

#### **Outcome 3.1: New and existing monitoring networks across the MRB are interoperable.**

Activity 3.1a Ensure that DEWS partners are aware of standards and protocols for sensors and point data collection for new stations and networks (e.g., AASC Recommendations and Best Practices for Mesonets, USACE Upper Missouri River Plains Snow and Soil Moisture Monitoring Network, National Coordinated Soil Moisture Monitoring Network Strategy). Explore other resources for those installing soil moisture monitoring equipment such as videos of the installation process.

Activity 3.1b Develop a catalog relevant to drought monitoring data and make it available for the

MRB DEWS through the U.S. Drought Portal so that partners know where and what monitoring data is available across the region, why it is important, and who is using the data.

Activity 3.1c Ensure coordination and collaboration with the USACE Upper Missouri River Plains Snow and Soil Moisture Monitoring Network and consider this region as a pilot for enhancement of soil moisture monitoring through the Network and state efforts to add to their networks.

### **Outcome 3.2: Monitoring stations locations are known and gaps in coverage are addressed.**

Activity 3.2a Understand key gaps in stations, with analysis including remote sensing data, to determine where additional stations are needed. Determine how ongoing programs and initiatives might be leveraged to meet these needs holistically.

Activity 3.2b Engage with tribal nations to install weather/mesonet stations on tribal lands to increase drought monitoring for the tribes in this region. This includes identifying funding sources that could be used (e.g., USBR Water Smart Program, NRCS programs, Conservation District Programs) and/or programs with which to coordinate and partner (e.g., Tribal Soil Climate Analysis Network [NRCS]).

Activity 3.2c Develop partnerships and/or agreements with the Tribal Colleges and Universities to deploy and maintain stations on tribal lands as well as explore how traditional ecological knowledge can be incorporated along with western science to better understand drought on the landscape.

Activity 3.2d Examine what other metrics that might be monitored (e.g., stock ponds), including the complexities that might affect the data and meaning (outtake and input levels in stock ponds, associated soil types, and seepage) to better understand local conditions.

## **4.0 PLANNING AND PREPAREDNESS**

Across the MRB, partners have made great improvements in communicating and responding to drought. However, there is a desire to take explicit preparedness actions on the ground that build resilience and to effectively communicate what needs to be done, based on the tools and knowledge available.

### **Outcome 4.1: Ecosystem health in the MRB is improved through restoration efforts.**

Activity 4.1a Provide information, education, and incentives to restore the water cycle and storage within the basin through the restoration of beavers, beaver dam analogs, wetlands, soil health, and natural stream morphology in the system where appropriate. Coordinate with BLM and NRCS to build on existing technical and financial assistance. Provide information on the FEMA Building Resilient Infrastructure and Communities (BRIC) program as a funding source for these restoration efforts.

Activity 4.1b Build on and communicate options for restoring soil health based on the work of NRCS and others and share success stories (e.g., joint workshops, U.S. Drought Portal, learning networks, peer-to-peer exchanges).

Activity 4.1c Partner with USGS on delivering drought information and predictions related to ecological systems along with accompanying resources describing how to apply this information in the region.

Activity 4.1d Secure and share information learned from the Montana Pilot Drought Project, including the multiple resource benefits of holistic restoration of ecosystem, water cycle, stream, floodplain, grazing, etc.

Activity 4.1e Work with tribal nations, states and watershed districts to share information, provide mentorships, build resilience, and communicate successes and lessons learned specific to drought and ecosystem health.

## **Outcome 4.2: Drought adaptation actions and approaches are understood and implemented.**

Activity 4.2a Develop guidance on what it means to proactively plan for and prepare for drought at the local and state levels to achieve early warning and preparedness.

Activity 4.2b Develop list of programs, practices, and assistance used to build resiliency (NRCS, BLM, States, Conservation Districts and others), highlighting key practices for various land uses.

Activity 4.2c Develop case studies that highlight successful examples of resilient farms, businesses, municipalities/cities, and communities.

Activity 4.2d Provide opportunities for peer-to-peer learning (tribes, states, cities, etc.), especially post-drought, to include states that were not impacted so they stay current on preparedness activities.

Activity 4.2e Support states and tribal nations who are updating drought and related plans to move to more proactive plans with technical information and lessons learned from other states and tribal nations.

## **Outcome 4.3: Drought vulnerability across the region is well understood, with a focus on climate variability as one of the biggest challenges and how that can inform and streamline multiple planning processes.**

Activity 4.3a Map and characterize where variability is high and low and how this aligns with community resilience (e.g., water access, water infrastructure). This should include areas that are in drought frequently and/or where drought can develop quickly.

Activity 4.3b Assess areas and sectors with high and/or chronic drought vulnerability and work with partners to find ways to build resilience in these systems.

Activity 4.3c Share learning, especially amongst the tribal nations, on drought vulnerability assessment methods and how this can inform multiple planning activities (e.g., Agricultural Resource Management Plans, Integrated Resource Management Plans, All Hazard Mitigation Plans)

Activity 4.3d Identify and communicate actions that realize co-benefits and avoid maladaptation to a suite of extremes. Nest drought in the context of other extremes so that it is not just drought alone but extreme drought, followed by extreme flood that challenges the resilience of farmers, ranchers, businesses, etc.





## 5.0 COMMUNICATION AND OUTREACH

The MRB DEWS network has grown since the inception of the DEWS and functioned well during the most recent drought in the upper basin, but there are many ways to improve communication and outreach. There is a desire to use the network to provide training on various products and tools and improve communication with the public and impact reporting.

### **Outcome 5.1: Innovative techniques to communicate with and engage the public are developed and implemented.**

Activity 5.1a Identify key audiences and understand which communication channels are most effective for each target group. Apply this knowledge to improve drought communication and messaging at appropriate scales (e.g., basin, county, state).

Activity 5.1b Support the use of tabletop exercises with various target audiences, including interested public, during non-drought times to explore communication pathways and actions to prepare for the next drought.

Activity 5.1c Integrate drought early warning information into existing early warning communication pathways (e.g., FEMA, BIA, Red Cross, NWS) with recommended actions where appropriate.

### **Outcome 5.2: Provide training and learning opportunities for key tools and products to the MRB Region.**

Activity 5.2a Work with BIA to hold a Tribal Conference in the Upper MRB to include a day on drought tools and information with appropriate partners in 2020 or 2021.

Activity 5.2b Hold a Human Health and Drought workshop that includes consideration of mental health, animal health, and ecosystem health to inform the NIDIS Human Health and Drought Strategy. Coordinate with other health related initiatives where appropriate (e.g., DOI One Health).

Activity 5.2c Hold rotating meetings with each state (and the state, federal, local, and tribal nation

partners therein) to foster a better understanding of local progress and needs, as well as the capabilities of regional partners (e.g., NIDIS, NDMC, HPRCC, Northern Plains Climate Hub) who may be able to assist. This is also an opportunity to collect successes and lessons learned to inform the drought learning network.

Activity 5.2d Provide continued training opportunities for university extension, tribal, state, and federal staff on the U.S. Drought Monitor and other key tools.

Activity 5.2e Support the use of drought scenario exercises to inform drought early warning and preparedness in the region, and carry out such exercises where it is appropriate. This could inform drought response activities such as when and how coordinated federal partner support ramps up as drought progresses in intensity, exploring future drought risk to inform planning, etc.

**Outcome 5.3: Drought impact reporting is bolstered through available mechanisms (e.g., CoCoRaHS and Condition Reporting, National Drought Impact Reporter, state-based impact reporting).**

Activity 5.3a Identify new networks of citizen and expert observers to recruit, recognizing this may vary by state (e.g., agriculture extension, forestry extension, tribal natural resource managers, wildland fire community).

Activity 5.3b Work to include new types of impacts that might not be currently collected (e.g., human health [vector borne diseases, mental health], ecological [invasive species], long-term [take months/years to manifest]).

Activity 5.3c Support research to understand how to collect more quantitative impact information and then how that can be used to inform the U.S. Drought Monitor.

## 6.0 INTERDISCIPLINARY RESEARCH AND APPLICATIONS

There are still many questions to answer in the region concerning drought evolution and impacts to inform early warning products and services. There is a need to better understand currently available indicators and indices, and to determine which are most appropriate for the region based on season, geography, type of drought, and impacted sector. Additionally, ranchers and producers often recognize that drought is evolving before it is reflected in the data and products currently used. Research is needed to better understand the observations they are basing their early decisions on, and the implications for applying them to improve early warning.

**Outcome 6.1: Our understanding of the best application of drought indicators temporally and spatially across the MRB is improved and drought early warning is strengthened.**



Activity 6.1a Determine what indicators, indices, and conditions those in the region are looking at and when (e.g., how much snow in Feb–March plus temperature anomalies, rain in May–June) and use that to amplify communication when conditions are setting up for potential drought.

Activity 6.1b Scale the work that Montana is doing on indicator selection for season, geography, and sector. Consider both the best indicators for going into and coming out of drought.

Activity 6.1c Determine if the ability of drought indicators to show drought has changed over time and whether there are indicators that have worked in that past that are less reliable now due to climate change, shifting baselines, and use changes.

Activity 6.1d Determine the appropriate drought indicators for different types of drought in the region.

**Outcome 6.2: An understanding of what formal/informal indicators are informing on-the-ground decisions (e.g., on farms and rangelands) is gained through research and used to strengthen drought early warning and response.**

Activity 6.2a Work with farmers and ranchers to understand what indicators they are monitoring on their farm/ranch/operation level. Support research to understand if these observations can be aggregated with that of other producers, scientific data, and indicators to develop a broader regional picture of the evolution of drought to improve early warning.

Activity 6.2b Apply University of Nebraska-Lincoln research on “Which climate thresholds are important to you?” to explore if there is a way to determine key climatic thresholds for various sectors and understand if these can be blended with current indicators to improve decisions.

Activity 6.2c Apply this research to ecosystems or sectors that are impacted by drought (e.g., ecological drought, tourism and recreation, human health). Build an understanding of what tribal members, tourism operators, health professionals, and wildland fire managers are observing and determine if it can be combined with drought indicators to improve early warning.

**Outcome 6.3: The decision points of various sectors (e.g., farmers/ranchers, wildfire management, reservoir operations, water management, natural resource management, tourism and recreation, human health) are better understood, and information providers are aligning information products, formats, and timing.**

Activity 6.3a Catalog what drought decision calendars are currently available and applicable to the MRB and make them available via the U.S. Drought Portal and information providers.

Activity 6.3b Develop decision calendars/trees/cycles for additional sectors to inform product and information development and delivery to better target information.

**Outcome 6.4: The suite of actions to prepare for and respond to drought that increase resilience over the long-term are understood and shared.**

Activity 6.4a Support research to explore the root causes/solutions that are common to multiple complex problems (e.g., drought, flooding, wildfires, reductions in soil quality) to provide better guidance on which adaptation actions have the potential to result in co-benefits and avoid maladaptation.

Activity 6.4b Support research to prioritize adaptation actions. Determine what actions are more



impactful that can be implemented now (e.g., forecasting, long-term analytics, state and local plans, water storage, ecosystem restoration).

**Outcome 6.5: Data, products, and services are improved and/or expanded to better serve the region.**

Activity 6.5a Expand the Upper MRB FIRE Risk Matrix to the entire MRB (through NASA DEVELOP or other mechanisms).

Activity 6.5b Examine the technical viability of developing StockpondCAST and StreamCAST—the equivalent of Grass-CAST for stock ponds and streams.

Activity 6.5c Expand the University of Nebraska-Lincoln’s AgriTools app to other states beyond Nebraska.

Activity 6.5d Examine the feasibility of the expansion of the Useful to Usable (U2U) approach to the MRB and Northern Plains to agriculture but also to ecosystems. The U2U approach was a large initiative, but are there lessons learned that can be applied to make products that are more usable.

Activity 6.5e Develop a simple water index for the MRB for the public and media (e.g., 0 to 10 with 0 being extremely dry and 10 being extremely wet).

Activity 6.5f Support the initial research and thinking on the development of a U.S. Water Monitor.

# Linking Outcomes to Priorities

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

**Priority 1:** Build a comprehensive understanding of drought indicators.

**Priority 2:** Improve understanding of how drought impacts relate to indicators.

**Priority 3:** Identify and communicate proactive measures to build resilience.

**Priority 4:** Enhance collaboration, coordination, and two-way communication among partners.

Mapping Outcomes to Priorities in the MRB DEWS Strategic Action Plan

	PRIORITY 1	PRIORITY 2	PRIORITY 3	PRIORITY 4
Outcome 1.1				X
Outcome 1.2			X	X
Outcome 1.3				X
Outcome 2.1	X			
Outcome 2.2	X			
Outcome 3.1	X	X		
Outcome 3.2	X	X		
Outcome 4.1			X	
Outcome 4.2			X	
Outcome 4.3			X	
Outcome 5.1			X	
Outcome 5.2	X			X
Outcome 5.3		X		
Outcome 6.1	X	X		
Outcome 6.2	X	X	X	
Outcome 6.3			X	
Outcome 6.4			X	
Outcome 6.5	X		X	

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# Linkages to National and Cross-DEWS Initiatives

## PURPOSE AND EMERGING ISSUES

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



National/Cross-DEWS Initiatives	MRB DEWS Activities
<b>Weather Research and Forecasting Innovation Act of 2017 (Weather Act)</b>	The Weather Act calls for NOAA to prioritize weather research in part to improve forecasts and warnings for protection of life and economy, to improve understanding of forecast capabilities for atmospheric events and their impacts, and to make reliable and timely foundational forecasts of subseasonal (2 weeks to 3 months) to seasonal (3 months to 2 years) forecasts of temperature and precipitation. While there are many other initiatives included in the Weather Act, these are the areas in which NIDIS also has a strong interest—in terms of drought early warning. NIDIS is making and leveraging investments in regards to the same temporal scale as they apply to drought in partnership with the NWS regional and local forecast offices, the Climate Prediction Center, and the Office for Oceanic and Atmospheric Research. The MRB, especially the upper basin, is a location where predictability is challenging. Hopefully efforts such as the <i>The Causes, Predictability, and Historical Context of the 2017 U.S. Northern Great Plains Drought</i> report will help inform these efforts.
<b>Water Prediction Center/ NOAA Water Initiative</b>	NOAA has multiple efforts aimed at water security that NIDIS plays a role in. The Water Initiative aims to improve the Nation's water security by providing science-based information and services that address vulnerability to water risks and enabling greater efficiency and effectiveness in the management of water resources. NOAA will advance this mission primarily through transforming integrated water prediction services in collaboration with decision makers, partners, and users. In addition the Water Prediction Center focuses on collaborative research to inform essential emergency management and water resources decisions across all time scales. NIDIS is involved in efforts to enhance drought prediction and monitoring, looking at applications of the National Water Model to drought early warning and serving as part of these initiatives where they intersect with drought.
<b>Tribal Engagement Strategy</b>	There are many similarities in the gaps and needs in the MRB, whether the recipient of the information and services be a tribal nation or a state or community. By considering the principals of engagement that are enumerated in the <i>Tribal Engagement Strategy</i> and engaging the tribal nations of the MRB in a meaningful way, we will achieve many of the outcomes in both documents.
<b>National Coordinated Soil Moisture Monitoring Network</b>	There is a clear need in the MRB to fill gaps in spatial coverage of soil moisture sensors. The work of the USACE to strengthen snowpack and soil moisture monitoring in the upper Missouri is linked to the National Coordinated Soil Moisture Monitoring Network Strategy and will serve as a pilot for how to build out the network. The gaps analysis will inform efforts in the Basin and work within the Basin will contribute to this national effort.
<b>NIDIS Drought and Wildland Fire Nexus Strategy (NDAWN)</b>	A recently completed NASA DEVELOP project improved a tool for the Great Plains to incorporate drought information into daily fire risk maps. There is a desire to expand the geographic coverage of this tool.
<b>NIDIS Coping with Drought</b>	NIDIS uses the Coping with Drought federal funding opportunity to address research needs gathered through the consultative process within the DEWS. The outcomes of applied research funded through the CWD program will be transferred to the DEWS. For example, the FY20 competition is focused on indicators, impacts, and triggers which aligns with priorities 1 and 2 for this region.

National/Cross-DEWS Initiatives	MRB DEWS Activities
<b>Drought and Human Health</b>	NIDIS is engaged in developing a Drought and Human Health Strategy. There are opportunities to hold regional workshops on the topic. Feedback from the MRB has already resulted in better connections to the DOI One Health Initiative. There is a desire to hold a regional workshop with the partners of the MRB to focus on tribal nations and inform the national strategy.
<b>Drought Impact Reporting and Analysis</b>	There are many efforts in the MRB around impact reporting and analysis that will transfer to other states as well as to our national efforts and vice versa. Missouri has been working with the NDMC and the National Drought Impact Reporter to improve reporting and use that information in decisions. Montana has been working independently to do the same and feed this information to the national archive. Both of these approaches can be transferred to other states. NIDIS is also involved in efforts nationally to improve reporting and analysis that can inform what is happening at the state and region. This two-way learning is optimal on these complex issues.
<b>Improving Indicator Use and Linking to Triggers</b>	A common refrain from partners across the DEWS is the desire to better understand which indicators and indices should be used for a region/state both spatially and temporally as well as for different sectors. There are efforts within the MRB DEWS as well as nationally with NDMC and internationally with the Commission on Environmental Cooperation (CEC) to contribute answers to these questions. Deliberate efforts to share learning across these initiatives will hopefully accelerate this work.
<b>National Drought Forum</b>	The National Drought Forum held in 2019 resulted in ten priority actions, many of which are reflected in the <i>MRB Strategic Action Plan</i> . These include, but are not limited to, improvement of flash drought forecasts, enhancements to observations, monitoring, and decision support tools, better quantification of drought impacts, and ecosystem restoration to mitigate drought impacts. The synergies between priorities at the regional and national effort should amplify our progress in addressing these complex challenges.

## LINKAGES TO REGIONAL PARTNERS AND INITIATIVES

NIDIS has a mandate to work across the federal government, coordinating drought related activities with other federal agencies, and to build upon and leverage existing partnerships, networks, and initiatives. This is especially important in the regional DEWS where these partners and regional organizations are key to realizing success in the region. In the MRB, key regional partners include the USDA Northern Plains Climate Hub, the National Drought Mitigation Center, the Department of the Interior North Central Climate Adaptation Science Center, and the NOAA High Plains Regional Climate Center, NCEI Regional Climate Services and National Weather Service Central Region Headquarters. Regional initiatives include the U.S. Army Corps of Engineers Upper Missouri River Basin Plains Snow and Soil Moisture Monitoring Network. The activities above call out many places where linkages are being made with these regional partners and programs. These linkages have been key in much of the past progress and will continue to be key moving forward. Additional partners, programs, assistance, and activities offer additional beneficial linkages that can be developed and built upon to identify more resources, to work across more agencies, to leverage more partnerships, and to utilize more assistance that will result in more efficiency and effectiveness of everyone's contributions and increase co-benefits.



## Appendix 1: Partners

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

Partner Agencies and Organizations
Colorado Climate Center
Desert Research Institute (DRI)
Federal Emergency Management Agency (FEMA)
Fort Belknap Indian Community
Great Plains Tribal Water Alliance (GPTWA)
Iowa Department of Natural Resources
Idaho Department of Water Resources
Kansas Climate Office
Kansas Water Office
Missouri Climate Office

Partner Agencies and Organizations	
<b>Missouri Department of Natural Resources</b>	
<b>Montana Climate Office</b>	
<b>Montana Department of Natural Resources and Conservation</b>	
<b>National Aeronautics and Space Administration (NASA)</b>	
<b>National Drought Mitigation Center (NDMC)</b>	
<b>Nebraska Climate Office</b>	
<b>National Oceanic and Atmospheric Administration (NOAA)</b> <ul style="list-style-type: none"> <li>• Central Region Collaboration Team</li> <li>• Climate Prediction Center (CPC)</li> <li>• Earth Systems Research Laboratory (ERSL)</li> <li>• High Plains Regional Climate Center (HPRCC)</li> <li>• National Center for Environmental Information (NCEI) Regional Climate Services</li> <li>• National Weather Service (NWS) Weather Forecast Offices (WFO)</li> <li>• NWS Missouri River Forecast Center (RFC)</li> </ul>	
<b>North Dakota Climate Office</b>	
<b>North Dakota State Water Commission</b>	
<b>South Dakota Department of Environment and Natural Resources</b>	
<b>South Dakota State University Extension</b>	
<b>University of Nebraska-Lincoln</b>	
<b>U.S. Army Corps of Engineers (USACE)</b>	
<b>U.S. Department of the Interior (DOI)</b> <ul style="list-style-type: none"> <li>• Bureau of Indian Affairs (BIA)</li> <li>• Bureau of Land Management (BLM)</li> <li>• U.S. Bureau of Reclamation (USBR)</li> <li>• U.S. Geological Survey (USGS)</li> <li>• North Central Climate Adaptation Science Center (NC CASC)</li> </ul>	
<b>U.S. Environmental Protection Agency (USEPA)</b>	

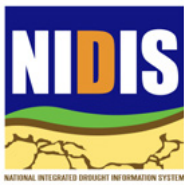
Partner Agencies and Organizations	
<b>U.S. Department of Agriculture (USDA)</b>	<ul style="list-style-type: none"> <li>• Agricultural Research Service (ARS)</li> <li>• Farm Service Agency (FSA)</li> <li>• U.S. Forest Service (USFS)</li> <li>• Midwest Climate Hub</li> <li>• Natural Resources Conservation Service (NRCS)</li> <li>• Northern Plains Climate Hub</li> <li>• Risk Management Agency (RMA)</li> </ul>
<b>Western Governors Association (WGA)</b>	
<b>Western States Water Council</b>	
<b>Western Water Assessment (WWA)</b>	
<b>Wyoming State Climate Office</b>	
<b>Wyoming State Engineers Office</b>	
<b>University of Wyoming Extension</b>	

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## Appendix 2: Disclaimer

The *MRB DEWS Strategic Action Plan 2021–2023* is a collaborative federal, state, tribal, and local interagency effort to improve early warning capacity and resilience to drought in the MRB. The contents of this plan should not be used as evidence against any MRB 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 MRB. Nothing in the Plan is intended to, nor shall the Plan be construed so as to, interpret, diminish, or modify the rights of any MRB state, any federally recognized tribe, or the federal government under federal or state law or administrative rule, regulation, or guideline.

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



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

