Interview Data Report: Connecting Ecological Drought Monitoring Tools with Natural Resource Stakeholders in Montana

NOAA NIDIS Coping with Ecological Drought Grants
NA22OAR4310225, NA22OAR4310224, and NA22OAR4310223

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Contents

1. Acronyms

BLM	Bureau of Land Management
BoR	Bureau of Reclamation
DNRC	Department of Natural Resources and Conservation (Montana)
FWP	Fish Wildlife and Parks (Montana)
LWG	Local Watershed Group
MTCO	Montana Conservation Office (?)
NIDIS	National Integrated Drought Information System
NOAA	National Oceanic and Atmospheric Association
NPS	National Parks Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service (Montana)
Univ.	University
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

2. Introduction

This report summarizes results from interviews conducted as part of NOAA NIDIS Coping with Ecological Drought grant titled "Connecting Ecological Drought Monitoring Tools with Natural Resource Stakeholders in Montana". The research team conduced 25 semi-structured interviews with participants who work for government agencies and non-governmental organizations (NGOs) at the local, state, and federal levels and play a role in managing and/or conducting research on forest, grassland, and/or riparian ecosystems in Montana. Qualitative coding, analysis of interview transcripts, and intercoder reliability tests were done using Nvivo software. The results outlined in this report provide qualitative and contextual insights on ecological drought indicators and impacts from science, research, and management stakeholders in Montana and should not be generalized.

3. Demographics, Impacts, and Indicators

Interviewees include researchers, scientists, and managers working on ecological concerns within and beyond Montana. The interviewees represent 14 local, state, and federal government agencies and NGOs operating at local, statewide, regional, and national scales (Table 1). The primary ecological drought management concerns of interviewees are categorized into six areas (Table 1). The ecological drought impacts and indicators reported by each interviewee are included in Table 1 below to demonstrate the frequency of the most common impacts and indicators. These data provide an analysis of which indicators are used to monitor particular ecological drought impacts and management concerns. The data also highlight how ecological drought concerns differ among interviewees and may be approached differently across agencies and scales.

Table 1 shows demographic information of interviewees including agency and management area (color-coded for scale), along with their primary ecological drought management concern (color-coded for type of concern). Reported ecological drought impacts and indicators are listed to demonstrate trends in commonality and divergence across all interviews. Bolded terms indicate the most commonly reported impacts and indicators as an analysis of how these relate to each other and to the demographic data presented in this table.

Key to color-coding for management area:

National or Large Area	Area Surrounding and including MT	Statewide in MT	Specific site(s) in MT

Agency	Area	Management Concern	Impacts	Indicators
BLM	Montana, North Dakota, South Dakota	**Freshwater ecosystems and species**	Aquatic Ecosystems, Groundwater, **Surface Water**	Animal Behavior, Dry Conditions, Fire Risk, Precipitation, Riparian, Soil Moisture, Vegetation
BOR	Missouri basin region (international), MT focus	**State drought planning**	Fire, **Surface Water**, **Wildlife**	Dry Conditions, Evapotranspiration, Fires Risk, Other, Snowpack, Soil Moisture
DNRC	Statewide MT	**Science communication**	Vegetation, **Wildlife**	Dry Conditions, Evapotranspiration, Precipitation, Snowpack, Soil Moisture, **Surface Water**, Temperature, Vegetation
DNRC	Clark and Kootenai River Basins	**Science communication**	Aquatic Ecosystems, Riparian Ecosystems, Fire, **Surface Water**	Fire Risk, Forest Health, Precipitation, Snowpack, Soil Moisture, **Surface Water**, Temperature
DNRC	Yellowstone River Basin (Wyoming, Montana, South Dakota)	**State drought planning**	Grassland, Riparian, Fire, Pests, **Surface Water**, Other, **Wildlife**	Agriculture, Animal Behavior, Dry Conditions, Groundwater, Precipitation, Riparian, Snowpack, Soil Moisture, **Surface Water**, Vegetation
DNRC	MT Forests	**Fire and forestry management**	Aquatic Ecosystems, Forests, Fire, Pests	Fire Risk, Forest Health, Precipitation, Temperature
FWP	Statewide MT	**State drought planning**	Aquatic Ecosystems, **Surface Water**, **Wildlife**	Animal Behavior, Aquatic Species, Dry Conditions, Precipitation, Snowpack, **Surface Water**, Temperature
FWP	Statewide MT	**Wildlife conservation**	Aquatic Ecosystems, Forests, Grassland, **Surface Water**, **Wildlife**	Animal Behavior, Other, Riparian, **Surface Water**, Vegetation
LWG	MT Watershed	**Science communication**	Aquatic Ecosystems, Forests, Fire, **Surface Water**	Agriculture, Forest Health, Groundwater, Precipitation, **Surface Water**
LWG	Blackfoot Valley, MT	**Freshwater ecosystems and species**	Aquatic Ecosystems, Riparian, **Surface Water**, **Wildlife**	Animal Behavior, Dry Conditions, Riparian, Soil Moisture, **Surface Water**, Temperature
MTCO	National	**State drought planning**	Aquatic Ecosystems, Forests, Grasslands, **Wildlife**	Agriculture, Animal Behavior, Evapotranspiration, Fire Risk, Precipitation, Snowpack, Soil Moisture, **Surface Water**, Temperature, Vegetation

Agency	Area	Management Concern	Impacts	Indicators
NPS	Montana and Colorado parks	**Climate adaptation**	Alpine, Forests, Riparian, **Surface Water**, Vegetation, **Wildlife**	Animal Behavior, Aquatic Species, Dry Conditions, Fire Risk, Forest Health, Precipitation, **Surface Water**, Temperature, Vegetation
NPS	Greater Yellowstone Ecosystem	**Fire and forestry management**	Forests, Pests, Vegetation, **Wildlife**	Dry Conditions, Fire Risk, Forest Health, Other, Precipitation, Soil Moisture, **Surface Water**, Temperature, Vegetation
NRCS	Yellowstone River Basin (Wyoming, Montana, South Dakota)	**Science communication**	**Surface Water**, **Wildlife**	Evapotranspiration, Precipitation, Snowpack, **Surface Water**, Temperature, Vegetation
NWS	Eastern MT	**State drought planning**	Other	Dry Conditions, Evapotranspiration, Precipitation, Snowpack, Soil Moisture, **Surface Water**, Vegetation
Univ.	National	**Science communication**	Forests, Pests, **Wildlife**, Other	Agriculture, Evapotranspiration, Forest Health, Precipitation, Snowpack, Soil Moisture, **Surface Water**, Temperature, Vegetation
USFS	USFS Region 3 and 4 (AZ, NM, south)	**Fire and forestry management**	Grassland, Vegetation	Dry Conditions, Fire Risk, Other, Precipitation, Soil Moisture, Vegetation
USFS	Colorado, Wyoming, Nebraska, South Dakota	**Climate adaptation**	Disease, Forests, Grassland, Fire, Pests	Dry Conditions, Evapotranspiration, Fire Risk, Forest Health, Grassland, Precipitation, Snowpack, **Surface Water**, Temperature
USFS	Idaho, North Dakota, Montana	**Climate adaptation**	Aquatic Ecosystems, Forests, Riparian, Pests, **Surface Water**, Vegetation	Animal Behavior, Aquatic Species, Forest Health, Riparian, Snowpack, **Surface Water**, Temperature, Vegetation
USFS	Idaho, MT, Dakota Prairie Grasslands	**Science communication**	Alpine, Aquatic Ecosystems, Fire, **Surface Water**, **Wildlife**	Animal Behavior, Aquatic Species, Evapotranspiration, Fire Risk, **Surface Water**, Temperature, Vegetation
USFWS	National Wildlife Refuge	**Wildlife conservation**	Riparian, Pests, **Surface Water**, Vegetation, **Wildlife**	Dry Conditions, Fire Risk, Groundwater, Other, Precipitation, **Surface Water**, Temperature, Vegetation
USGS	Glacier National Park	**Freshwater ecosystems and species**	Alpine, Aquatic Ecosystems, **Surface Water**, **Wildlife**	Animal Behavior, Aquatic Species, Groundwater, **Surface Water**, Temperature
USGS	Rocky Mountains, MT and WY	**Wildlife conservation**	Vegetation, **Wildlife**	Animal Behavior, Dry Conditions, Precipitation, Snowpack, **Surface Water**, Temperature, Vegetation
USGS	Various US States	**Science communication**	Riparian, **Surface Water**, Vegetation, **Wildlife**	Animal Behavior, Soil Moisture, **Surface Water**, Temperature
USGS	Western US states	**Freshwater ecosystems and species**	**Wildlife**	Riparian, **Surface Water**, Temperature

4. Results

4.1. Impacts and Indicators

The most common impacts of ecological drought reported across all 25 interviews are wildlife and surface water, followed by aquatic ecosystems. These three impacts are cross-cutting, indicated by references from interview participants representing different agencies, scales, and management concerns (Table 1). Surface water was the most reported indicator, followed by temperature (air and water), precipitation, vegetation, and dry conditions. These common indicators are also referenced by interview participants representing a variety of agencies, scales, and management concerns (Table 1). These data suggest that wildlife and surface water are widely recognized as ecological drought impacts and that surface water, temperature, and precipitation are ecological drought indicators used widely across Montana.

Generally, the impacts and indicators reported by interviewees correlate both to each other as well as to the reported management concern. This may indicate existing management siloes that could be a barrier to a more integrated understanding, preparation, and response for ecological drought management. Although we asked specifically for both indicators and impacts, interviewees referenced more indicators of ecological drought than impacts, which may suggest a greater understanding of how to monitor for ecological drought than how to recognize its impacts. Alpine and grassland impacts were less common, suggesting that these impacts are important for specific managers rather than for holistic ecological management. Communication and collaboration were reported as indicators of ecological drought by three interviews and coded as "Other", pointing to the importance of communication and collaboration for effective ecosystem monitoring.

4.2. Responsive and Preparatory Drought Actions

Many interviewees engaged in responsive (18 interviews) and/or preparatory (17 interviews) ecological drought monitoring and management actions. In some cases, these actions were mandated by formal plans or policies that are triggered by natural resource conditions. In other cases, these actions were undertaken more informally. Both responsive and preparatory actions included: 1) adapting individuals' behavior, 2) modifying agency responses to drought, and 3) designing well-structured and flexible research. The following quotes exemplify adapting individual behavior in response to or in preparation for drought:

> *"I think [an] easy one for fire is we change the fire danger [level] and start to restrict what the public can and can't do. So, we have a low to extreme fire danger [levels]."* [responsive action]

> *"And the goal… would be if a tributary is dry or getting really dry, like close to being dry, that would incite the folks who live along that tributary to do a conservation action voluntarily that we've predetermined with them."* [preparatory action]

4.3. Policies, Plans, and Barriers to Drought Monitoring and Management

Most interviewees referenced formal plans or policies that are relevant for ecological drought monitoring and management (19 interviews). Formal plans and policies based at the federal level did not directly prioritize drought as a concern, whereas most regional and state level plans and policies directly prioritized drought. Non-mandated or informal plans and policies (e.g., community organized drought plans), which were often based at more local or community levels, also often directly prioritized drought.

Many interviewees cited barriers to drought monitoring and management in existing plans and policies (16 interviews). These barriers include plans or policies not directly prioritizing ecological

drought management or monitoring, plans or policies that are responsive rather than preparatory, and different problems using state-level plans and policies for local contexts. For example, as one interviewee stated:

> *"And so, what we use at the state level to trigger management actions is the US Drought Monitor drought classifications. Like -nothing through D4. And those will be attributed to, yeah, state response measures in this updated version of the state drought response plan. And that really, to me, is only feasible at the state or maybe county level because we may be in D2 in Park County, but folks in Park County aren't really seeing. They're like, 'Eh, what? We're in severe drought? Things are fine. I'm irrigating like I always do. These cottonwoods are-- [fine], there's seedlings growing, and the fish are fine. Water temperature is fine.' And so that that is not fine enough resolution, I think, to tie to local drought plans."*

4.4. Coordination and Collaboration

Most interviewees felt they engaged in both formal and informal collaboration for information sharing to manage and/or monitor ecological drought. Formal collaboration is directed by mandates or well-established working groups, whereas informal collaboration is not mandate-directed. Formal collaboration often only engaged government organizations and informal collaboration engaged more diverse audiences. As one interviewee described:

> "*We definitely have formal collaborations specific, for example, with the states or if you have a listed fish in Montana like bull trout, for example, they were specifically trying to look at how things like drought impact populations. So those are very definitive, targeted... But then there's also this kind of loose collaborations like some research to look at the effects of discharge in temperature on cutthroat trout. The state didn't necessarily ask for it, right? They're interested in our information. And now they're more interested in it. The more you show, you collect, the more they look at [and] see results. But they didn't necessarily ask for it.*"

5. Seasonality and Flash Drought

5.1. Seasonality of Concern

Interviewees reported having the most concern for ecological drought in spring and summer or late summer and fall. Interestingly, almost all participants reported multiple seasons of concern, while few suggested alternative seasonality, like the spring and fall shoulder seasons. These results suggest that the timing of concern for ecological drought is closely related to the primary impact(s) of concern of each interview participant. This potentially signals that interviewees may not be considering ecological drought holistically or beyond their primary management concern.

5.2. Flash Drought Management

Many interviewees commented that their organization manages drought with a rapid onset or flash drought differently than ecological drought (11 interviews). Some participants noted that management or monitoring of flash drought involved an increased frequency of condition monitoring and science communication with different collaborators and other audiences. Interviewees that did not indicate a difference in the way they monitor or manage for flash drought and ecological drought (5 interviews) were either not familiar with flash drought, did not know if they experienced flash drought, or noted flash drought wasn't a significant term in their plans and policies. As one interviewee noted:

"Yeah, I haven't heard that terminology used too much just in my limited time. I feel like when I hear, it's more eastern Montana that uses that terminology… how we define drought is based on our drought plan. And there's probably other definitions out there that others would use. So, when we say we're in drought, it's based on those triggers, the river flow, river temperature, which is probably different than what others might consider drought."

6. Needs and Tweaks

Interviewees were asked if there were any additional needs related to ecological drought management or monitoring. Reported needs and tweaks were coded into data resolution (17 interviews), 30m ET data (14 interviews), predictive modeling (12 interviews), science communication (7 interviews), data access (5 interviews), and other (11 interviews) (Figure 1). Interviewees were explicitly asked about the utility of 30m ET data; all other needs were reported organically by participants. The need for improved data resolution was often in reference to instrumentation such as stream gages, soil moisture probes, and SNOTEL sites rather than remote sensing or modeled data.

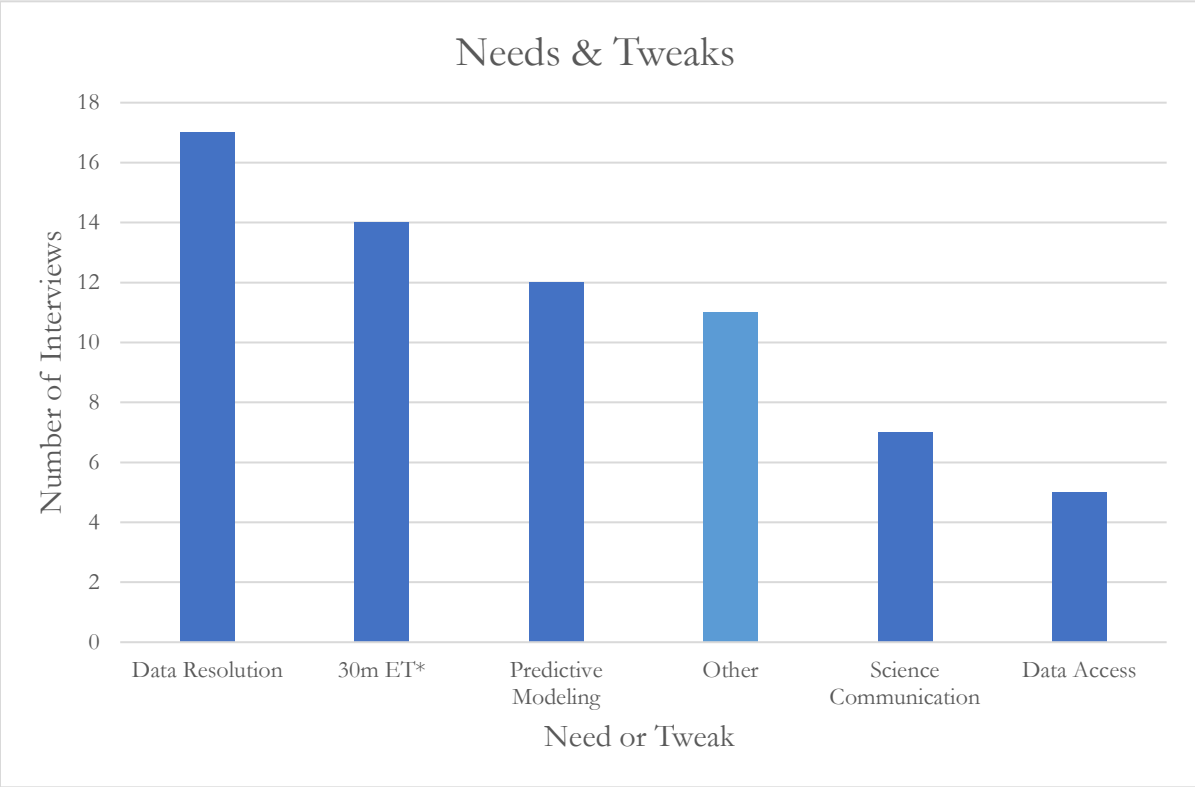

Figure 1 is a chart showing the number of interviews in which particular needs and tweaks for ecological drought monitoring in Montana were mentioned. Interviewees were prompted (*) to comment on the utility of 30m ET while references to all other needs and tweaks, including "other", were unprompted. This table shows the important need for improved data resolution for Montana drought monitoring.

The "other" code for needs and tweaks was used nine times and included references to novel tools or data ideas as well as existing challenges (e.g., how to account for the lag time between drought events and ecological impacts). Table 2 lists the "other" needs and tweaks referenced by interviewees. We report these here in hopes that it may generate awareness of our collaborative efforts to address these needs. Accounting for lag time was mentioned by six interviewees; citizen science, education, and outreach by two interviewees; and all other suggestions were mentioned only

once. Given the extent of these ideas and suggestions, a gap may exist between the drought monitoring and management tools available, and the indicators used and valued by the scientists, researchers, and managers who participated in these interviews.

Table 2 summarizes "other" suggestions for improved ecological drought monitoring, planning, and management tools provided by interviewees.

Idea/Suggestion for Improvement	Description	Example Quote(s)
Accounting for Lag Times	Connect ecological drought impacts to previous events when impacts do not manifest in real time.	"...it's really hard to bring an attribution to an impact from a drought that happened two years ago."
Citizen Science, Education, and Outreach	Education to promote enhanced public knowledge and participation in drought monitoring and reporting.	"...citizen science stuff where you can actually take pictures of dry stream channels. And that all gets collated so that it's time and space related. And kind of that whole data, where you pull together a bunch of data. Socialization and socialization."
Accounting for Climate and Weather Changes in Management	Strategies to remove the influence of climate and weather patterns from the effectiveness of management activities.	"...if we're going to determine how effective riverscape restoration project was, I need to separate out the signal of weather and climate from the signal of management."
Biodiversity Migration	Preparing for influx of biodiversity as habitat elsewhere declines.	"...not only should we be thinking about the rarest critters, but we should also be thinking about the ones that we're their last refuge and how do we support that? How do we maintain that and how do we take on that stewardship responsibility?"
Collaboration when Drought is not a Management Priority	Inter-agency or management collaboration that centers drought (e.g., bird and forest managers work together on ecological drought).	"Why can't we leverage the relationships they already have, and the collaborations and the coordination they're already doing, and just make [drought planning] a little part of that, rather than this whole new thing?"
Complete Projects for Use	Translating single analyses into usable tools.	"There is a tendency to get projects to research grade tools, but they're clunky and if not maintained, they just kind of go by the wayside. Or if they don't provide the complete workflow for answering a management question, they're often overlooked and kind of fall apart…we need to get them to operational and professional grades, so they stand the test of time."
Converting Tools to other Ecosystems	Forest specific tools for grassland management and vice-versa.	"And if you look at that Grasscast product, they really are trying to do that and to forecast, in that case, range production. I think that we could take some products like that and that could then be adjusted for a wider ecology than just range forage."
Ephemeral Wet Areas	Monitoring changing wet areas across the landscape and how they are used by birds/wildlife.	"...to know where the damp areas were on a weekly basis in Montana throughout spring and into the summer, that would be fascinating."

Floodplain Prioritization	Monitoring sensitive areas to prioritize restoration efforts to maintain connectivity.	"...the relative activity of the floodplain, kind of how accessible floodplains are to particular stream systems and maybe the trends that have been occurring over the years... could be helpful in determining and prioritizing restoration opportunities if we're seeing a stream system trending towards less connectivity where it's historically had some good connectivity."
Targeted Releases for Species	Making reservoir storage and release decisions to maximize reproductive or spawning habitat to promote species survival.	"How can you offset warm temperatures by releasing water during drought years to allow young year to rear in the river before they go back to the Lake?"

7. Surprising Findings

During the interview process it became apparent that many participants did not identify as "managers". Many interviewees identified as scientists, researchers, and with other roles related to natural resources. This trend was noted broadly, with interviewees from federal agencies distancing themselves from management most explicitly. For example, as one NPS employee stated: *"I'm not really a manager. I don't implement any actions on the ground. We monitor what's happening."* Similarly, a USFS representative said, *"I don't actually manage any land... we work to help managers make decisions about adaptation actions."* And a USGS scientist explained, *"USGS does no management... our goal is to inform, for example, how you manage or prioritize management of conservation."*

Interviewees representing state and local organizations distanced themselves from management in fewer instances, and more subtly, than those from federal agencies: "*I don't really have a decision-maker role. I provide information to the decision-makers. I certainly help in the development of management plans when they come along."* This suggests that more collaboration between scientists and managers occurs at more localized scales. These findings are surprising and important, indicating that the data we present here may actually represent understanding of ecological drought among scientists and researchers instead of the intended resource "managers" in Montana.

8. Next Steps

The research team is using information from these interviews to develop a survey to better understand how the 2021 drought affected ecological land management in Montana, which will be administered this winter. Finally, focus groups will be conducted with managers to understand how they prepare for and manage ecological drought, as well as drivers of their decision-making. Alongside these social science efforts, the team is exploring the utility of a novel 30-m resolution ET tool from NASA's OpenET project as an indicator and monitoring tool for ecological drought in Montana. At this point, we plan for this tool to be incorporated into focus groups to understand the tool's utility in ecological drought decision-making.