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RECLAMATION

Wildfire Research Needs Workshop Report (April 6-7, 2021)

Science and Technology Program
Research and Development Office



Mission Statements

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14. ABSTRACT The wildland fire management community is highly engaged in on-going research to improve agency and bureau response time and capabilities for preparation, active wildfire, and post-fire activities. Several potential partnerships were discovered, and knowledge gaps identified between regions. With the prevalence of research, tools, and the existing and potential partnerships, there is great opportunity in sharing expertise and experience to enhance many aspects of wildfire management.					
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Acronyms and Abbreviations

BORGIS	Bureau of Reclamation Geographic Information System
BAER:	Burned Area Emergency Response
BAR:	Burned Area Rehabilitation
CAC:	Civil Applications Committee
CAL FIRE:	California Department of Forestry and Fire Protection
CoP:	Community of Practice
DS&S:	Dam Safety and Security
ESR:	Emergency Stabilization and Rehabilitation
FSim:	Wildfire Risk Simulation Software
GIS:	Geographic Information System
GSSHA:	2D Gridded Surface and Subsurface Hydrologic Analysis Model
HEC-RAS:	Hydrological Engineering Center - River Analysis System
HEC-HMS:	Hydrologic Engineering Center - Hydraulic Model System
InFORM:	Interagency Fire Occurrence Reporting Modules
WHP:	National Wildfire Hazard Potential
OWF:	Office of Wildland Fire (DOI)
PODs:	Potential Operational Delineations
RDC:	Reclamation Data Council
ReGIS:	Regional Geographic Information Systems
CoMFRT	The Co-Management of Fire Risk Transmission Partnership
USACE:	United States Army Corps of Engineers
WAIEE	Water Availability Impacts of Extreme Events (USGS)
WEPP:	Water Erosion Prediction Project
WFDSS:	Wildland Fire Decision Support System
WiRē:	Wildfire Research
WFM:	Wildland Fire Management
WUI:	Wildland Urban Interface

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Executive Summary

Over the past decade, the western United States experienced some of the largest and most intense wildfires on record. Many of these wildfires affected Reclamation-managed infrastructure directly or through the burning of watersheds upstream of Reclamation reservoirs, dams, and water delivery systems (see Appendix 3). Reclamation's Research and Development Office is interested in understanding how the Science and Technology (S&T) Program could support activities to inform and improve Reclamation's preparedness for and response to wildfires. The S&T Program used this workshop to explore existing tools and identify the need for new tools and information to help manage wildfire impacts including sedimentation, water quality, debris flows, and operations. Additionally, Reclamation is interested in knowing what information would be valuable to partners and what information is available from partners to support Reclamation programs.

To identify the current wildfire research needs, the S&T Program hosted a two-day virtual Wildfire Research Needs Workshop on April 6th and 7th, 2021 with two main goals:

- Identify science and research needs to help Reclamation improve wildfire management.
- Convene groups of internal staff and external partners to share knowledge and explore possible partnerships to advance priority research needs.

The workshop included presentations from approximately 30 participants representing Reclamation and seven other federal agencies including the Burned Area Emergency Response (BAER) team, the Department of the Interior (DOI) Office of Wildland Fire (OWF), United States Geological Survey (USGS), United States Army Corps of Engineers (USACE), the National Oceanic and Atmospheric Administration's National Weather Service (NWS), and United States Forest Service (USFS). In total, 65 representatives participated in the workshop from these groups as well as specialists from the Bureau of Land Management (BLM), Denver Water, and the Northern Colorado Water Conservancy District. This report documents the presentations and discussions that occurred during the workshop.

The workshop included two presentations focused on recent wildfires that had direct impacts and unique challenges to Reclamation staff and infrastructure. On the first day, the presentation described the impacts to Whiskeytown Dam from the 2018 Carr Fire in northern California. The second day focused on the 2020 East Troublesome Creek Fire in northern Colorado and the impacts to Willow Creek Reservoir. Both fires led to several lessons learned for Reclamation response teams related to staff evacuation, continuity of operations, and post-fire impacts. Discussions after each presentation highlighted that in addition to short-term impacts to human safety and infrastructure readiness, sediment and water supply impacts

could lead to long-term challenges for Reclamation and our partners. Additional research could benefit and improve understanding of these issues on a multi-year temporal scale.

Beyond the discussion surrounding specific wildfires, the workshop's first day focused on internal and external experiences with wildland fire management and related funding opportunities. Reclamation's Wildland Fire Program and Dam Safety and Security contributed internal wildfire experiences. BAER team members, and specialists from the OWF, USGS, USACE, NWS, and USFS proposed ideas on the best paths toward future collaboration with Reclamation including access to Reclamation wildfire research funding opportunities. Internal funding is available through the [Reclamation S&T Program](#), while internal and external funding is available through the [Applied Science Program](#) in the Water Resources and Planning Office.

On day two of the workshop, participants formed breakout groups for discussing and developing collaboration opportunities. In preparation for the breakout groups and possible discussions about data and modeling needs, two presentations focused on the Reclamation Data Council, Reclamation GIS Program, and modeling capabilities at Reclamation's Technical Service Center (TSC). Three topics were the primary focus of these breakout groups: 1) pre-fire risk assessment and management prioritization approaches, 2) post-fire impacts on reservoirs, and 3) post-fire water quality. All breakout sessions generated and captured ideas for future research and collaboration opportunities. This report offers summaries of these sessions' discussion points.

The workshop discussions successfully generated ideas for collaborative research directions to address wildfire risks in water management. The discussions also revealed several takeaways for Reclamation wildfire research and program activities. Chief among them is that many offices and programs in Reclamation's regions and Denver directorates share a vested interest in science and tools advancements that would support improving Reclamation's management strategies in response to wildfire risks. Also, there are multiple opportunities for Reclamation to collaborate on wildfire research internally and with the external organizations represented.

Reclamation's Wildland Fire Program

Presented by:

Jason Kirby, Land Program Manager, Asset Management Division, Dam Safety and Infrastructure;

Kendra Fallon, Wildland Fire Management Coordinator (Acting), CPN Wildland Fire Management Program Coordinator;

David Krueger, Upper Colorado Basin Region Wildland Fire Management Program Coordinator;

John Hutchings, California Great Basin Region Wildland Fire Management Coordinator;

Justin DeMaio, Lower Colorado Basin Region Wildland Fire Management Program Coordinator; and

John Arkins, Missouri Basin Region Wildland Fire Management Program Coordinator.



Fire suppression crews at the Dollar Ridge Fire, Strawberry Valley Project, Upper Colorado Basin. July 2018

Within Reclamation's Office of Chief Engineer in Denver, Colorado, the Asset Management Division (AMD), is responsible for Reclamation Manual (RM), Policy, and Directives and Standards to help organize the agency's Wildland Fire Management (WFM) activities. The WFM program follows the guidance and responsibilities outlined in the DOI Manual (DM) 620 and RM, Policy, *Wildland Fire Management* (P14). This includes training, fire suppression agreements, fire management plans and budgets. The WFM program uses minimal resources and varying levels at the regional level of WFM program development. WFM activities are implemented across Reclamation at the Regional, Area, and Field office level with varying degrees of coordination.

In August of 2020, wildfire activity reached the highest level of [National Wildland Fire Preparedness, PL 5](#). The Secretary of the Interior issued a memorandum directing DOI Bureau Chiefs to make all wildland fire qualified individuals available to support the national wildland fire needs. This "all call" letter is a common occurrence when PL 5 is declared. The memo, along with locations of western fires supplied the catalyst for Reclamation to re-evaluate its response capabilities and current management of wildfire impacts to its assets and reservoirs, and seek to improve programs, activities, and partnership coordination.

Each Reclamation region has a designated WFM Program Coordinator to administer the program with the responsibility to engage the area and field offices. Out of the five regions, only two, California Great Basin (CGB) and Columbia-Pacific Northwest (CPN), have the benefit of this regional position staffed as a dedicated full time equivalent (FTE).

Currently, Reclamation utilizes agreements to support fire suppression activities. There are some positive elements to this approach including the fact that once agreements are in place; minimal administrative maintenance is needed. Unfortunately, these agreements do not include preventative fuels management or post-fire rehabilitation and may be more difficult for regions with much larger fires due to cost fluctuations.

Reclamation is looking for processes to improve management of wildfire impacts and communicate the information for Reclamation's assets and reservoirs. The main resource available to Reclamation is the Columbia-Pacific Northwest (CPN) wildfire platform, which is a GIS web application.

Reclamation Wildland Fire Program Goals

Setting goals for the Reclamation WFM program will enhance the program and the ability to protect critical infrastructure while meeting Reclamation's mission. Reclamation has engaged with the Department of Interior's Office of Wildland Fire (OWF) to provide guidance and support on how to optimize the WFM program. An initial response and program review from OWF provided suggestions on building an optimized WFM program that meets Reclamation's WFM program goals and objectives. Ongoing goals enhanced through this effort include:

- Ensuring the safety of stakeholders, customers, managing partners, employees, communities, and the public.
- Continuing to meet Reclamation obligations by protecting water and related resources, reservoir storage, and hydropower production from postfire impacts.
- Minimizing fire impacts to Reclamation's assets and infrastructure.
- Identifying and securing appropriations and effective funding mechanisms to meet program's needs.

Wildland Fire Management Elements

While working to optimize the WFM program, three focus areas essential to improving Reclamation's WFM program include pre-fire, active-fire, and postfire activities. Approaches to these situations are inconsistent between the five regions.

Pre-Fire: Proactive standards for Wildland Fire Management fuels treatment, prevention, and preparedness.

Active-Fire: The ability to certify and position staff to represent Reclamation’s management and interests on fire incidents; and added benefits include offering technical staff who can contribute to National Fire effort.

Post-Fire: The ability to certify and position staff to represent Reclamation’s interest on post-fire rehabilitation; and additional benefits include supplying technical staff who can contribute to the national wildland firefighting efforts and DOI Burned Area Emergency Response (BAER) teams.

Reclamation Regional WFM Programs Highlights

Five of the Reclamation regions presented unique perspectives for their region on the topic of wildfire management.

Upper Colorado Basin (UCB)

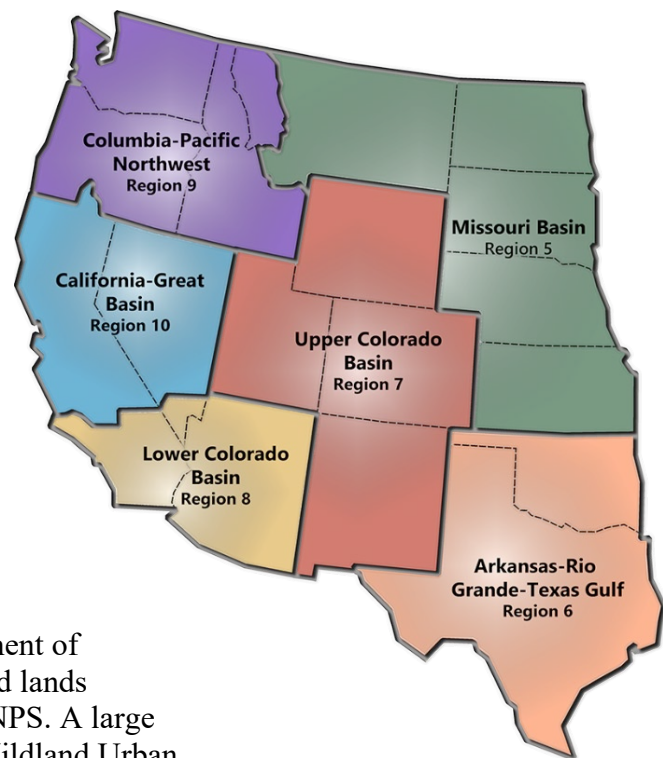
UCB management strategies include agreements with the BLM statewide in New Mexico and local agreements in Utah and are achieving statewide BLM Utah agreements.

Lower Colorado Basin (LCB)

LCB has three 5-year interagency agreements with the Bureau of Land Management (BLM) in southern California, southern Nevada, and southern Arizona.

California Great Basin (CGB)

WFM varies between the California Department of Forestry and Fire Protection (CAL-FIRE) and lands protected by the BLM, USFS, USFWS and NPS. A large amount of mixed jurisdictional land in the Wildland Urban Interface (WUI) leads to challenges meeting requirements to reduce vegetation/fuels near federal structures.



Missouri Basin and Arkansas-Rio Grande-Texas Gulf Region (MB & ART)

The MB Region has fire management plans in place and is working to supply consistent suppression agreements across the region. Significant fires in the Eastern Colorado Area Office (ECAO) highlighted the need to develop and formalize partnerships and proactively assess fire response, resources at-risk, and develop priorities for fire event responses.

Columbia-Pacific Northwest (CPN)

The CPN Region has agreements place with the Bureau of Land Management and the Forest Service to provide all fire management services covering Reclamation lands in OR, WA, and ID. The Region collaborates with the fire prevention programs established within the region along with cobranding fire restrictions orders to reduce the potential for human caused ignitions. S&T awarded funding to CPN for the development of an AGOL platform. The platform overlays current fire activity with Reclamation values and assets for near real-time assessment of threats and provides this information to Incident Management Teams (IMTs). This allows CPN to be proactive during fire season to better understand and communicate potential risks before, during and after a wildfire.



Las Vegas Wash Control Burn, Lower Colorado Basin Region.



East Troublesome Fire, Near Estes Park.



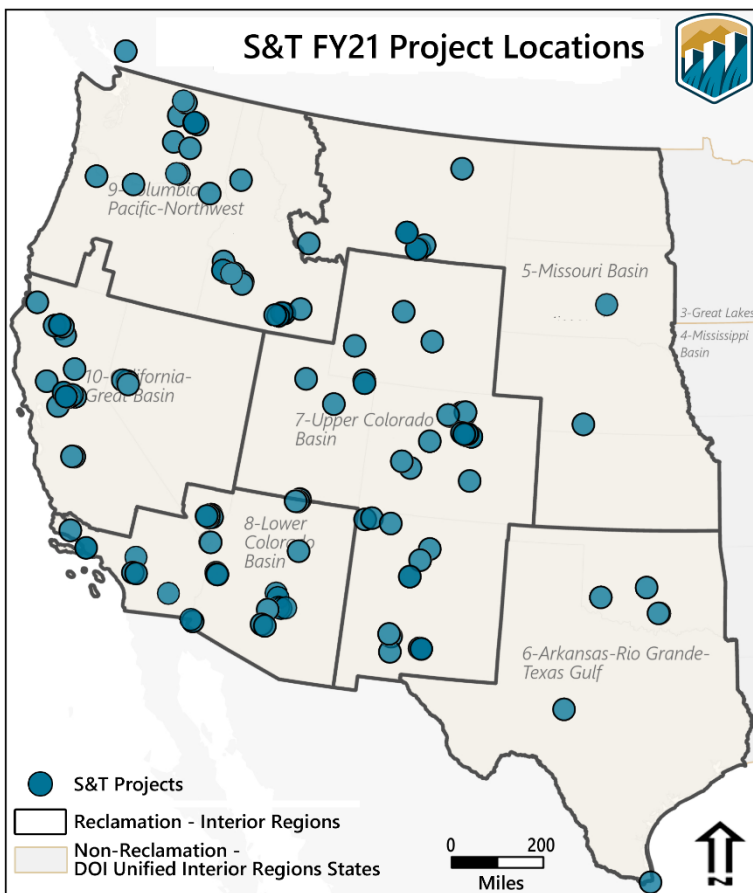
Whittier Fire, Lake Cachuma.

Reclamation Denver Programs

Reclamation Science and Technology Program: Supporting Wildfire Research

Presented by **John Whitley**, Science and Technology Program Coordinator,
Research & Development Office, Bureau of Reclamation

Reclamation’s Science and Technology (S&T) Program actively address mission topics including water infrastructure, power and energy, environmental issues in water delivery and management, water operations and planning, and developing water supplies.



S&T FY21 Project Locations Map.

The results of S&T research culminate in increased water delivery capabilities, and more efficient hydropower generation. Research projects also lead to reduced or avoided maintenance costs, improved worker safety, greater infrastructure longevity, and improved decision making while meeting environmental compliance requirements.

The S&T Program supports an annual call for proposals for internal staff to propose research projects that may also include funding for partners. Projects selected from the annual call for proposals are publicly announced and posted in various formats such as the Reclamation S&T website, a Reclamation news release, and social media. Research project results are also published in several types of outreach document on the S&T website.



Partially burned area with fire retardant. Napa County, California.

Currently Funded Wildfire Research

ID	Project Lead	Title	Description
20057	Jun Wang and Dan Deeds	Modeling effects of wildfire and fire retardant on nutrients downstream in a watershed scale	This project is intended to validate a model using data collected for recent fires around Lake Berryessa.
20019	Kendra Fallon	Development of a platform for wildfire incident support and evaluation of post-fire impacts	The goal is to improved Reclamation CPN Region GIS architecture for wildfires.
21008	Kendra Fallon	Resolving Spatiotemporal Distribution of Suspended Sediment Concentration over the Columbia and Snake River Using Remote Sensing	The project objective is to quantify the distribution of suspended sediment concentration (SCC) along Columbia and Snake Rivers over a multi-decadal time step, and includes collaboration with Boise State University, USGS and Idaho Power
NEW	Rob Hilldale and Kent Collins	Willow Creek Reservoir Sedimentation	Data will be collected at Willow Creek Reservoir in 2021 to track sedimentation impacts from 2020 East Troublesome Creek Fire (Contact: Rob Hilldale , TSC). Follows 2020 pre-fire survey and will help collect post-fire data to support a new FY22-24 proposal for wildfire research. Supports collaboration with Eastern Colorado Area Office, Missouri Basin Regional Office, and Northern Water.

Completed S&T Wildfire Research Projects



Cache Creek (CA) watershed showing 2015 wildfire area and modeling domain for PFHydro.

ID	Project Lead	Title	Description
7112	Jun Wang	Research and Development of a Watershed-Scale Model/Tool for Simulating the Effects of Wildfires on Mercury Contamination of Land and Water	Developed PFHydro model to simulate effects of wildfire on sediment & mercury transport in a watershed scale.
8111	Brian Urbick	Lake Berryessa Nutrient Loading Investigation Associated with Fire Caused Erosion.	The project collected data after fires around Lake Berryessa to determine nutrient loading impacts.

Future S&T Program Funding

The S&T Program will use the prioritized list of research needs from the workshop to inform the FY22 Call for Proposals, identify relevant research projects, and develop partnering opportunities for future work in this area.

FY22 Regional Director Needs related to Wildfire

As part of the FY22 Call for Proposals, Reclamation Regional Directors provided several wildfire related needs as their highest priority research needs. Three responses were related to wildfire.

- **CPN** - Improving Methods for Debris Removal at Reclamation Dam Intake Structures.
- **CGB** - Favorably stabilizing the flow and supply of water from public lands.
- **MB & ART** - Water Supply Impacts Caused by Wildfires, Colorado-Big Thompson Project, Colorado.

Project ID	Project Title	Lead Researcher's Name
22019	Potential impacts of phosphorous loading from wildfire-fighting retardants related to the East Troublesome fire on surface water quality in Willow Creek and Willow Creek Reservoir.	Lindsay Bearup
22077	Enhancing Reclamation's Watershed Model to Predict Post-Fire Sediment Delivery to Reservoirs and Assess Management Actions.	Benjamin Abban
22097	Evaluating watershed response and increases in sediment loading to Willow Creek and Willow Creek Reservoir due to East Troublesome fire.	Kent Collins
22056	Post-wildfire forecasting improvements using non-Newtonian flow processes with a high-resolution, integrated hydrologic model.	Drew Loney
22090	Favorably Stabilizing the Flow, Supply and Quality of Water from Public Lands During Forest Management.	Dan Deeds
22017	Evaluate and model economical, safe and effective methods to mitigate and remove debris from dam intake structures.	Juan Luna

Applied Science Program

Presented by **Avra Morgan**, Program Analyst, Water Resources and Planning Office, Bureau of Reclamation



The WaterSMART program is a framework for DOI to support water supply reliability for multiple water users. The focus is on better managing water supplies as the effects of climate change exacerbate the increasing/steady demand and reducing availability of water supplies throughout the west.

The WaterSMART Basin Study Program supports water supply planning and provides applied science tools, guidance, and information to improve water management across the West. Rather than research, this study program looks at tool/utility development. There are internal and external resources, and the program is currently open for external funding proposals.

The primary purpose of the Applied Science Program is choosing and funding projects that will develop applied science tools and information to increase water supply reliability.

Funded projects emphasize enhanced modeling capabilities, improved or adaptive forecasting tools, increased access and use of hydrologic data and/or development of new types of data to inform water management decisions.

There are three types of projects which receive funding:

- Project Type 1 - Projects to enhance modeling capabilities to improve water supply reliability and increase flexibility in water operations.
- Project Type 2- Projects to improve or adapt forecasting tools and technologies to enhance management of water supplies and reservoir operations.
- Project Type 3 - Projects to improve access to and use of water resources data, or to develop new types of data to inform water management decisions.

Federal scientists can partner within both the internal and external applied science program. For the external program, federal work cannot be counted as an in-kind cost share contribution. However, the recipient can "sub-contract" with a federal partner and use grant funding to pay for their time.

Resources

The [WaterSMART - Data Visualization Tool \(arcgis.com\)](#) provides interactive maps of WaterSMART Program and projects include Featured Project tours and shows program growth since 2010.

Websites to view funded proposals and the Reclamation contact for internal or external inquiries are:

- Past Applied Science awards:
<https://www.usbr.gov/newsroom/#!/news-release/3973>
<https://www.usbr.gov/newsroom/newsroomold/newsrelease/detail.cfm?RecordID=69483>
<https://www.usbr.gov/newsroom/newsroomold/newsrelease/detail.cfm?RecordID=72504>
- Previously selected Internal Applied Science proposals:
[usbr.gov/watersmart/appliedscience](https://www.usbr.gov/watersmart/appliedscience). Information on the external projects are not currently on the website but will be in the future.

Dam Safety and Security

Presented by **Kent Walker**, Dam Safety Program Manager, Dam Safety Office, Bureau of Reclamation

Dam Safety and Security (DS&S) manages Reclamation's portfolio of dams. DS&S activities routinely and intermittently maintain Reclamation's dams before, during, and after active fires occur near Reclamation assets or facilities.

- Routine activities
 - Annual Safety Inspections
 - Periodic Facility Review
 - Comprehensive Review
- Non-routine activates
 - Issue evaluations
 - Corrective Actions Studies
 - Modifications
- Post fire inspection
 - Inspections conducted immediately as safety allows.
 - Assessment of fire damage. Wildfire damage is unlikely on concrete dams, and unlikely on earth fill which protects the clay layer that prevents flow. Infrastructure damage is more likely.



BOR Whiskeytown Lake, 2018.

Wildfire Concerns for Dam Safety

DS&S have many wildfire related concerns including power interruption to a dam, limited operator access the dam, and general hydropower and outflows. Larger issues include impacts from increased rainfall such as increased runoff that could cause overtopping, and higher flows leading to more erosion. Sedimentation and landslides can reduce storage volumes, and obstruction of outlet works and spillways. To mitigate these concerns, dam safety managers may explore deploying reservoir debris booms, installation of upstream sediment retention structures, and precipitation gauges in the watershed above the dam. Managers discuss changes in risks and mitigation option to safely operate the dam.

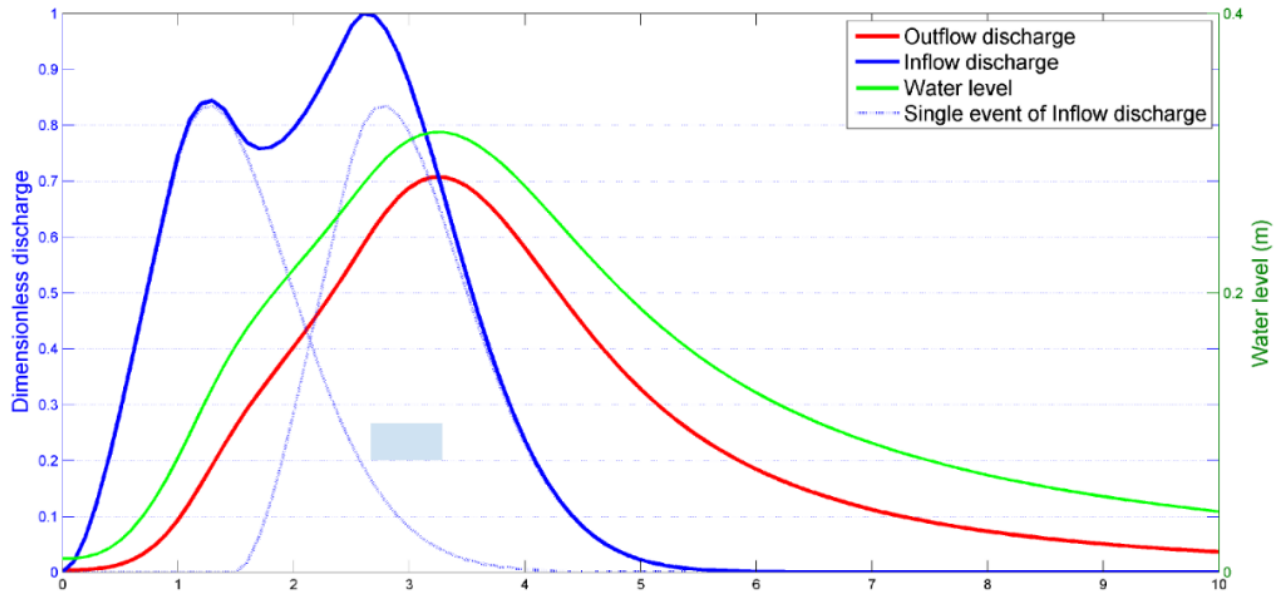


Chart: Technical Response Team Investigations – Routings.

Dam Safety Uncertainties

There are many unknowns in Reclamation wildfire response ranging from modeling sedimentation loads to precipitation forecasts, but DS&S actively strives to maximize protection and minimize damage. Research in the areas below, could help inform future wildfire response and recovery activities.

- Unknown watershed runoff response.
 - Soil type, curve number, infiltration, abstraction, heat, and intensity burns.
- Timing debris impacts.
- Current and future storage volumes.
- Operations for the reservoir (easiest to predict).

Non-Reclamation Federal Perspectives

Burned Area Emergency Response (BAER) Teams

Presented by **TJ Clifford**, Field Manager, Bureau of Land Management



BAER team inspects a burn scar.

The Burned Area Emergency Response (BAER) teams are deployed to complete post-fire assessments for Emergency Stabilization (ES) needs. Funded by annual fire management appropriation, BAER teams can design appropriate treatments for stabilization.

Emergency stabilization is planned within a year of the wildfire with the goal of protecting life, property,

and natural and cultural resources within five years of the fire event focusing on ecological damages and impacts. Budget constraints primarily due to increased spending on fire suppression in active fire years may not include rehabilitation.

BAER teams follow a strict process before responding to wildfire damage including initial assessment or ‘size-up’ of the rehabilitation area, a team in-briefing, field evaluation, treatment design, and final report completion. Size up is the first step for the design team before scheduling the in-briefing. During the in-briefing, the team determines the risk of the fire affecting identified high value assets. As part of Reclamation’s WFM activities and goals for program improvement, it has been recognized that it would be helpful for Reclamation to be a part of the in-briefing step in the process when Reclamation assets are in the affected area as the BAER team may not fully understand and address Reclamation relevant interests. Through field evaluation, the team assess risk, determines burn severity (low, moderate, or high), and selects treatments using a soil burn severity map or ground verified satellite mapping data. Costs and risk mitigation and part of the treatment design process. The final step is the finished report or funding request which supports treatment decisions. If funding is available, it is routed to the project area either locally or nationally.

DOI agencies have some latitude in policies to help with downstream actions and assessments on state and private lands. BAER teams, when deployed, are assigned to assess values at risk and propose funding for treatment on DOI lands and may identify cooperative funding opportunities for burned areas located within the affected wildfire perimeter but outside federal land management jurisdiction. Any treatments off DOI lands can be a joint effort. For instance, the BAER response may mulch a hillside on DOI lands above the susceptible resource area so that the downhill landowner has a measure of mitigation to wildfire threat on state/county/private land.

For additional information about BAER teams and policies, please use the references below.

- [Forest Service Manual 2500](#), Chapter 2523 Emergency Stabilization – Burned Area Emergency Response. (5/26/04)
- [Department of the Interior, Department Manual, Part 620: Wildland Fire Management, Chapter 7: Post-Wildfire Recovery](#). (1/18/17).
- [Interagency Burned Area Emergency Stabilization Guidebook](#)
- [DOI Burned Area Emergency Stabilization and Rehabilitation Guidebook](#)

Department of Interior: Office of Wildland Fire

Presented by **Jason Fallon**, Program Review Specialist, Office of Wildland Fire, Department of Interior

The Office of Wildland Fire's (OWF) mission is coordination of wildfire management within the Department of Interior (DOI). The OWF establishes legal and scientifically beneficial partnerships based on the DOI wildland fire polices and budgets and provides strategic leadership and oversight to national wildland fire programs.



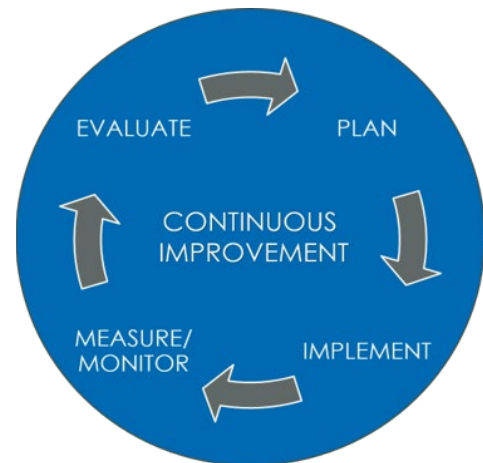
The OWF has policy oversight on wildland fire management and is the central point of contact with external agencies and organizations for wildland fire management. They ensure department-wide consistency by coordinating, consulting and collaborating with the DOI agencies and bureaus involved in wildfire management. Approximately 25 OWF staff are in Boise, Idaho, and Washington D.C.

Coordinating Fire Management

Fire management coordination includes developing and managing the budget, developing policy, pursuing technological innovation, and the coordinating multiple functions. Data and technology are used to make informed, coordinated fire management as fire conditions change and wildfires occur.

Science and Operational Alignment

The OWF relies on evidence-based informed decision making by using researched-based interventions, expert experience, and consideration of local priorities and culture to guide and inform the delivery of treatments and service. The program ensures that the vegetation treatments or services will have the most effective outcomes by considering earlier successes and current conditions. The OWF uses a foundation of data and technology to apply science in the decision-making process and consistently focuses on delivering towards the vision and mission of the DOI.



OWF continuous improvement cycle.

Resources

For more information and resources available, see

- <https://www.doi.gov/wildlandfire/joint-fire-science-program>
- https://www.firescience.gov/JFSP_exchanges.cfm
- <https://www.forestsandrangelands.gov/leadership/>
- <https://www.nifc.gov/>
- <https://www.nwcg.gov/>
- <https://www.doi.gov/wildlandfire/wfit>

United States Geological Survey (USGS) Wildland Fire Science

Presented by **Paul Steblein**, Wildland Fire Science Coordinator and **Brian Ebel**, Research Hydrologist



Photo: USGS.

The USGS Fire Science scope spans across 20% of DOI lands including many non-forested sites and involve projects. USGS focuses on fires in deserts, shrublands, grasslands, wetlands, tundra, and forests. The diverse themes involve fire history and management, fire ecology and recovery, post-fire risks, and geospatial, imagery and technology. The very active community of practice has about 180 scientists and distributes about 90 publications a year along with many data sets.



Photo: USGS.

The fire history and management science functions examine past, present, and future fire regimes, while also providing support to BAER teams. The USGS researches fuel treatment planning and assessing social and economic factors.

Wildland fire effects and restoration focuses on the impacts of wildfire and fuel treatments on species habitat, populations, communities, cultural resources. Using prescribed fire as a surrogate for wildfire, USGS assesses post-fire wildlife response which leads to conservation planning and factors affecting carbon dynamics. Studies also include wildfire interactions with biogeochemistry and permafrost.

Post-fire risk assessment considers the trace elements in stormflow, ash, and burned soil, and their effect on humans and wildlife. Wildfire and smoke characteristics and hazard assessments are performed to reduce flooding, sedimentation, and debris flow. Fire effects on water quality, quantity, and water supply infrastructure are included.

USGS uses emerging technology and models to produce actionable science. Remote sensing, for example, is used to produce national map data and feeds the National Satellite Land Remote Sensing Data Archive and Land Treatment Digital Library. Elevation products used include terrain models and LiDAR, while satellite imagery is collected Landsat, international charter, and CAC. Other technology research and use involves sensors and UAVs.



USGS scientists measuring infiltration rate.

USGS is interested in partnering with Reclamation. The USGS [Wildland Fire Science Strategic Plan](#) is stakeholder focused and includes the following four priorities:

- Produce state of the art actionable fire science.
- Engage stakeholders in science production.
- Effectively communicate USGS fire science capabilities, products, and information.
- Enhance USGS organizational structure and advance support for fire science.

Wildfire Impacts on Water Availability: USGS Water Mission Area and Water Science Center Activities

This mission area studies the water availability changes of extreme events (WAIEE) or post-fire hydrologic science. The three main areas providing a prediction of water availability impacts are:

- Integrated water science basins.
- Water quality drivers.
- Process-based research.

Integrated water science basins (IWSB) are a wide range of environmental, hydrologic, and landscape settings and human stressors of water resources to improve understanding of water availability across the nation. The three IWSB basins include the Upper Colorado River Basin, Delaware River, and the Illinois River.

WAIEE covers a broad variety of extreme events including wildfire, tropical cyclones, and extreme precipitation. Project objectives cover a variety of efforts such as establishing the state of the science for post-wildfire measurements and modeling, summarizing, and identifying best practices for model parameterization for post-wildfire water quantity and quality. WAIEE seeks optimal approaches for post-wildfire model performance evaluation and identification of gaps and target priorities while establishing magnitudes of initial response, and the timescales of temporal recovery for post-wildfire streamflow, soil moisture, water quality, snow effects, infiltration, and hydrologic model parameters.

Harmonized post fire water quality datasets include core measurements, site-specific ancillary measurements, discrete and continuous measurements suitable to calibrate and validate predictions in Oregon, California, and Colorado. In Oregon, there are newly proposed gauges in fire-affected areas. Also, early flood and debris flow warning gauges, composed of precipitation and/or non-contact velocity and stage radars, provide near real-time alerts via text message and satellite telemetry, which offers redundancy. Finally, there is process-based research, involving infiltration measurements, and Hydrologic Model Parameterization looking at soil-hydraulic properties.



Early warning gauge site on Big Branch Creek in the Spring Creek burn scar before (left) and after flooding (right) in 2020.

For more information about USGS wildfire resources, see the links below.

- [USGS Wildland Fire Research](#)
- [USGS Fire Science Fact Sheet](#)
- [12-year compendium of fire science at USGS](#)
- [USGS Fire Science Strategic Plan](#)

- **LANDFIRE** - 20 data products - <https://www.landfire.gov/>
- **Monitoring Trends in Burn Severity** - <https://www.mtbs.gov/>
- **Invasive Species Maps** - <https://eros.usgs.gov/doi-remote-sensing-activities/2019/usgs/mapping-cheatgrass-sagebrush-ecosystem-western-us>
- **Burn Severity Maps, USGS/USFS** - <https://fsapps.nwcg.gov/mtbs/birch/requests/list>
- **Debris flow assessments** - https://landslides.usgs.gov/hazards/postfire_debrisflow/
- **Stream gage Network** - https://www.usgs.gov/mission-areas/water-resources/science/usgs-streamgaging-network?qt-science_center_objects=4#qt-science_center_objects
- **JFSP Fire Science Exchange Network** - <https://www.firescience.gov>
- **Hazard Data Distribution System** –commercial satellite imagery (e.g., WorldView) obtained on fires - <https://hddsexplorer.usgs.gov/>
- **National Map Data** - https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/download?qt-science_support_page_related_con=0#qt-science_support_page_related_con
- **Lidar 3DEP** - <https://www.usgs.gov/core-science-systems/ngp/3dep/data-tools>

- **Landsat Data & Tools** - <https://www.usgs.gov/core-science-systems/ngp/3dep/data-tools>
- **Land Treatment Exploration Tool** - https://www.usgs.gov/centers/fresc/science/land-treatment-exploration-tool?qt-science_center_objects=0#qt-science_center_objects
- **USGS ScienceBase** - <https://sciencebase.usgs.gov/>

U.S. Army Corps of Engineers (USACE)

Presented by **Jeremy Giovando**, Research Hydraulic Engineer

The USACE has an existing post-wildfire mission combined with post-wildfire R&D program. The USACE are in seeking collaboration and potential opportunities for engagement.

Post-Wildfire and USACE Missions:

- **Emergency Management:** Significant hazards to life safety and infrastructure.
- **Flood Risk:** Peak discharge measured following wildfire were shown to increase by ~1.5 to 1000 times (plus) over pre-fire rates (Moody and Martin, 2001; Cannon and Gartner, 2005).
- **Sediment Management:** Increased sediment erosion and transport resulting in decreased flood capacity in downstream channels/reservoirs.
- **Infrastructure Risk:** Uncertainty in debris-flow frequency-magnitude relationships and affects to critical infrastructure.
- **Climate Change Impacts:** Continued temperature changes along with ecotone shifts potentially could change fire risk and impacts to life safety and infrastructure.
- **Ecosystem Impacts:** Significant ecosystem and environmental impacts may occur in the watersheds; water quality changes.



Highway 22 near Detroit, Oregon. Photo Courtesy Oregon Department of Transportation.

Post Wildfire Urban Flood Risk Management Program

The post-wildfire research and development program focuses on several critical aspects of urban flood risk management that are described in the following sections.

Hydrology Modeling:

Focuses on improvements to hydraulic modeling tools to easily incorporate energy and water balance changes due to wildfire, including development of a post-wildfire modeling guide Districts can use for assessing flood risk after a fire occurs.

- [Hydrologic Engineering Center, Hydraulic Model System \(HEC-HMS\)](#)
- [2D Gridded Surface and Subsurface Hydrologic Analysis \(HEC-RAS, GSSHA\)](#)
- Includes evaluation of non-USACE hydrology-based models (i.e., [KINEROS](#), [AGWA](#), [WEPP](#), [ERMiT](#))
- Empirically derived Sediment Yield Approaches

Hydraulic and Sediment Transport Modeling:

Focuses on improvement to hydraulic modeling tools to include heavy sediment and debris flow routines and includes development of non-Newtonian fluid methods in HEC-RAS.

Critical Zone:

Focuses on basic research questions related to infiltration changes and includes changes in water repellency, soil structure, and vegetation interception.

Vegetation Components of Water and Energy Balance:

- Less rainfall interception
- More effective rainfall
 - Shorter time to runoff
 - Larger runoff
- Less surface friction
 - Increase surface connectivity
 - Reduce runoff routing time
- Less Evapotranspiration
 - Possibly more soil moisture
 - Higher ground water level



Photo by USACE.

Effects on Soil and Sediments:

- Soil structure changes
 - Soil aggregates break down and fracturing
 - Surface sealing (layering)
- Reduction in soil permeability
 - Runoff increases (peak flow increases by up to 2-3 order of magnitude)
 - Difficult to quantify
- Hydrophobic layer (soil water repellency)
 - Formed under appropriate burn conditions
- Sedimentation
 - Reservoir and channel morphology

Rain-on-snow:

Focuses on changes in snow processes following wildfire, which includes timing, distribution and how melt-rates from rain-on-snow events may increase flood risk.

- Accumulation and Ablation rates change
 - Differences in sensible and radiative fluxes
- Albedo changes
 - Black carbon on snow surface changes energy balance
- Timing of peak and melt-out date changes
- Changes in snowmelt flood risk with rain-on-snow events

Ecology and Water Quality

Focusing on changes to water quality for reservoirs and streams after wildfires including ecological impacts to changes in sediment loading and debris flows.

Research and Development Collaboration

The USACE outlined topics of future collaboration to actively pursue potentially in Colorado and Wyoming. These collaboration topics include many from the focusses for post-wildfire actions in post-fire hydrologic modeling guidelines, post-fire debris yield prediction library, critical zone, snowmelt impacts, and sediment estimates for reservoirs.

Current and Future USACE Involvement in Wildland Fires

The USACE roles in wildland fire engagement include: ERDC (research), district technical, district silver jackets and emergency management. The USACE coordinates with USACE districts, divisions, labs, HEC and silver jackets. Coordination on the Federal level includes Reclamation, USGS, USFS, NRCS and NWS. On the local level, USACE coordinates with the state, city, county, and private groups. The technical goals in coordination is discovering the needs and gaps that exist and what in capacity the USACE can offer support. Areas the USACE currently evaluates are flow frequency changes in large subbasins, runoff volume impacts, sedimentation impacts in large subbasin, in-depth hydrologic modeling including post-wildfire impacts on snow, soil losses, transform, channel routing, site-specific detailed hydraulic analysis and instrumentation and data gathering.



Dead trout after 2009 Station Fire in California.
Photo USGS.

National Oceanic and Atmospheric Administration - National Weather Service (NWS)

Presented by **Katherine Rowden**, Western US Hydrology Program Manager, NWS

The NWS mission related to post fire uncertainties is to provide forecasts, watches, and warnings for weather and water events including flash floods for the protection of life and property. NWS works with partners, local communities, emergency managers, and residents with information on post-fire hazards. The program includes dam safety in relation to potential dam failures or uncontrolled releases.

Standard products issued by the NWS are short-term river predictions and water supply forecasts which relate to debris flow and flash floods post-fire and forecasting precipitations intensity and duration. Convection modeling is used for probabilistic hourly or sub-hourly flow predictions to determine forecast rainfall compared to debris flow thresholds. This modeling is not publicly available but could be shared. The duration need for rainfall observations for these models are 1-15 minutes, but data is often hard to find in the West. A common challenge is the lack of time between the fire and the rain, and there are instances of fire camp flooding that left firefighters stranded. Floodplain maps also do not represent the real dangers of debris flows in these events. The danger exists for the public on a body of water on land. In response, NWS is developing a new webpage to provide post-fire information.

Challenges associated with the effectiveness of post-fire forecasts/warnings include the intensity and duration of precipitation, forecasting and detecting the precipitation and for the public lack of time to gather information and prepare, and lack of understanding and awareness of the hazard. The danger is higher for households uninsured for floods, occupied homes not included in mapped floodplains, and people who don't understand the risk.

NWS operational and decision support tools in use include the external post-fire webpages such as the new NWS GIS-based webpage for post-fire expected to be live within a few months. There are also the ArcOnline dashboards displaying burn scar and flash flooding information for affected areas.

Despite the current tools, many post-fire science and data needs exist. NWS relies on other agencies, organizations, and individuals to do the research needed to integrate into operations due to lack of and internal NWS mechanism to investigate some of these questions. The lesson learned is for NWS to start thinking about the response before the fire. There is a potential opportunity for collaboration with NWS at specified locations to install rain gauges, etc.

U. S. Forest Service

Presented by:

Greg Dillon, Spatial Fire Analyst, Fire, Fuel and Smoke Science Program, Fire Modeling Institute,
Jeff Morissette, Program Director, Rocky Mountain Research Station Human Dimensions
Frank McCormick, Research Program Manager, Air, Water and Aquatic Environments

The Forest Service focuses on three science programs which include: Fire, Fuel and Smoke Science Program; Human Dimensions Science Program; and Air, Water and Aquatic Environments Science Program.

Fire, Fuel and Smoke Science Program

The fire, fuel and smoke science program has over 60 years of dedicated wildland fire research. The program scientists conduct research to improve understanding of all aspects of wildland fire. The program's development of tools and applications support fire management. Focus areas include physical fire processes, fuel dynamics, smoke emissions and dispersion, fire ecology, fire and fuel management, and synthesis and delivery. Spatial datasets and other resources enhance understanding of wildfire hazards and risk.

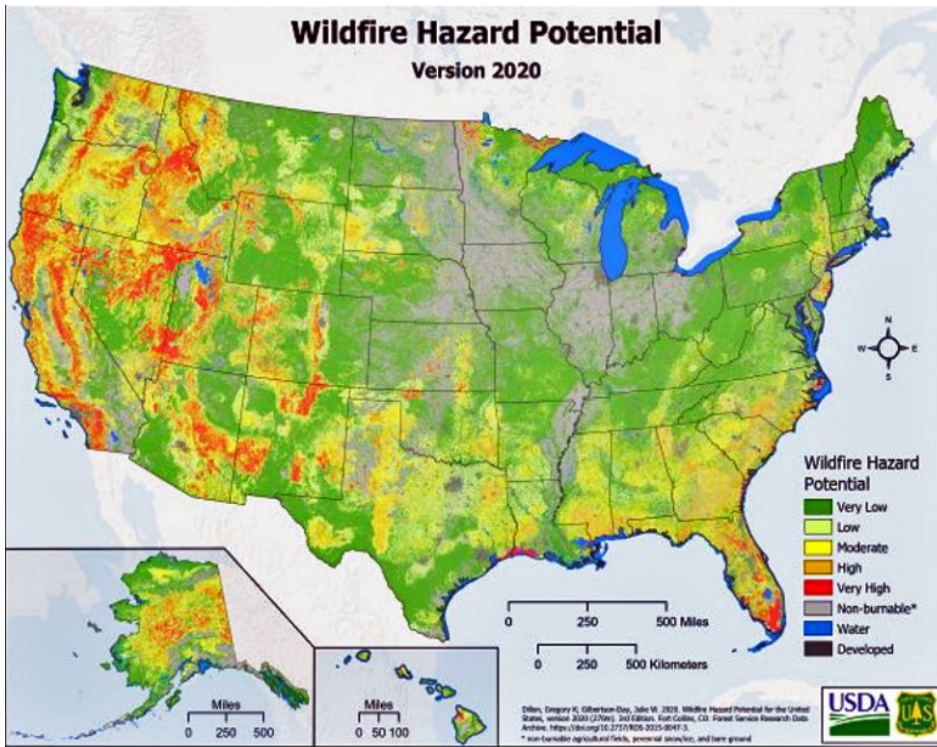
Tools

National modeling with the large fire simulator (FSim) evaluates wildland fire. It provides nationwide coverage with 270-meter raster data. It presents burn probability and conditional probability of intensity classes.

The National Wildfire Hazard Potential (WHP) is based on national FSim datasets. It combines likelihood and intensity into an index of wildfire hazards in a continuous index of a 5-class rating.

The Fireshed Registry is a geospatial dashboard and decision tool that identifies and maps the sources of wildfire risk.

The Fireshed Condition Framework is a parallel watersheds concept and supplies an organizing principle to manage wildfire risk. More research is ongoing to advance response time for fire and ways to give more time when large wildfires occur.



US Forest Service Wildfire Hazard Potential map.

Human Dimensions Science Program

Wildfire Research Team

The Wildfire Research (WiRē) Team is a combination of fire experts, Reclamation, and community partner engagement. The purpose is evaluating how experts think in comparison to how the public and our communities view wildfire. By combining rapid parcel assessments and household surveys, WiRē can build a better fire-adapted community. WiRē has several different current, potential and past partners.



- Current Partners
 - West Region Wildfire Council (CO)
 - Chaffee County (CO)
 - Fire Adapted Bailey (CO)
 - Grand County Wildfire Council (CO)
 - Ashland Fire Rescue (OR)
 - Chelan County Fire District 1 (WA)
 - Teton County/TAWPC (WY)
 - Santa Fe Fire Department (NM)
 - Wasatch Front (UT)

- Potential Partners
 - Fairbanks North Star Borough (AK)
 - Spanish Peaks Alliance for Wildfire Protection (CO)
 - Frenchtown Fire (MT)
 - Rapid City Fire Department (SD)

- Past Partners
 - Wildfire Adapted Partnership (formerly Firewise of Southwest Colorado) (CO)
 - Boulder County (CO)
 - Larimer County (CO)
 - Colorado Springs Fire Department (CO)

Co-Management of Fire Risk Transmission Partnership

The Co-Management of Fire Risk Transmission Partnership ([CoMFRT](#)) consists of interagency wildland fire experts including Reclamation. CoMFRT performed fieldwork in three case study sites by examining efforts leading to successful adaption to wildfire across multiple ownerships. During fieldwork, CoMFRT partners identify recommendations in support of solutions designed for and with communities and wildfire managers. Recommendations for support are composed through sub teams and methods within the CoMFRT.



USFS CoMFRT logo.

The sub teams and the methods include:

- Problem Analysis: Literature review and synthesis.
- Spatial Patterns of Wildfire Risk and Governance: All-lands social-ecological spatial analysis.
- Household and Parcel Analysis: Household and parcel surveys.
- Pathways to Community Capacity: Community interviews and focus groups.
- Fire Adaptation Social Network Mapping: All scales focus group and surveys.
- Cross-boundary Collaboration: All scale interviews and doc review.
- Co-Production and Integration: Workshops and conversations.

Risk-based, Value-informed Pre-fire Planning through Potential Operational Delineation



The Risk-based, Value-informed Pre-fire Planning through Potential Operational Delineation (PODs) consist of fire experts, the Bureau of Reclamation and values at risk and fire control strategic planning.

The main question that PODs is reaching to answer is what are the resources that exist within a management area. The main takeaways from PODs are:

- Both sedimentation and turbidity point to similar priority areas.
- Containing all wildfires to their POD of origin would reduce watershed area burned by 58.7%, total sediment load to the diversion between 50.3% and 55.2%, and water quality impairment between 13.1% and 31.7%.

Air, Water and Aquatic Environments Science Program

Water Erosion Prediction Project (WEPP), FSim, and FlamMap help forest managers link forest conditions to fire, erosion, and sediment delivery risk to surface water. FSim system models fire ignition, estimates burn probabilities, and fire sizes and intensity across large landscapes. FlamMap is a fire behavior mapping program that computes fire potential characteristics for a given landscape.

Post-Fire Lessons Learned

Williams Fork Fire, 2020

- Dramatic, short-term effects on chemistry (ash), erosion (days, months).
- Long-term changes in nutrient, C export both significant and common.
 - Signify shifts watershed nutrient retention (supply and demand).
- Sources of persistent change: higher soil and supply, hillslope leaching, associated with low plant recovery and demand (upland and riparian).
- In-stream productivity stays high, does not explain higher stream, but indicates a relaxation in limitation.



Williams Fork Fire, 2020.

Implications of Long-Term Effects for Restoration

- Watershed changes persist after post-fire rehabilitation ends.
- Water quality hot spot can guide and refocus restoration priorities.
- Long term data supplies an opportunity to evaluate benefits of riparian restoration for mitigating elevated stream.
- Many unknowns still exist about wildfire effects overlapping with other disturbances.

Watershed Moments

- Effects of repeat disturbances in forests subjected to multiple stressors including climate change, prolonged drought, insects and disease, fire, atmospheric deposition, and management history.
- The bark beetle outbreak provided a new ecosystem and new challenges: “grey phase” regeneration, seed viability, fire behavior.
- Research on water quality effects of landscape scale disturbance (Fraser EF, Hayman Fire, NoCoFireshed) now informs our response.
- Expect both short and long-term water quality effects from the 2020 fires.
- Mitigating the effects of severe wildfire on the scale of the Cameron Peak Fire will be challenging. Knowledge gap persist.
- High elevation watersheds are an integral part of our water infrastructure.

Resources

For more information and resources available, see the following links below.

- <https://wildfirerisk.org>
- <https://www.firelab.org>
- Human dimensions program: [WiRe](#), [CoMFRT](#), [PODs](#)
- Modeling tools: [WEPP](#), [FlamMap](#), [FSim](#)

Networking Sessions:

These sessions provided an opportunity for non-presenters to share information, handouts and network with other wildfire specialists for discussions.

- In response to Katherine’s presentation, John mentioned a tool available from Environmental Protection Agency that provides critical weather information for water utilities entitled “[Weather & Hydrologic Forecasting for Water Utility Incident Preparedness](#).” Katherine responded by sharing the NWS has a fire weather website currently available for use: <https://www.weather.gov/fire>.
- The Wildland Fire Leadership Council is working with EPA and CDC are looking at prescribed fire vs wildfire for air quality. Impact assessments would be great for water resources.

Dave Barnard, Research Agroecologist, USDA Agricultural Research Service

The USDA Agricultural Research Service, while typically not involved in source water areas, are interested in what comes out of irrigation into water systems. Specific areas are source-water, disturbance, recovery, and climate impacts on current and future agricultural water availability are of interest. Research goals include a better understanding of spatiotemporal variability on streamflow, ecosystem functioning, disturbance, and recovery dynamics. This data would lead to improved vegetation representation in hydrologic models. Currently, Agricultural Ecosystems (AgES) simulates soil-water and surface runoff variability in space and time across agricultural landscapes. Opportunities for collaboration exist in establishing long-term plots of recovery, microplastics, spatial modeling of conservation and restoration treatments, and to develop and test AgES’s basic scale dynamics.

Crosscutting Topics

GIS Program and Data

Presented by **Kenneth Richard**, GIS Program Coordinator, Bureau of Reclamation

The Reclamation Data Council (RDC) coordinates Reclamation enterprise data management activities develops policy and guidance and promotes data stewardship. The RDC strives to reduce potential redundancy of activity while increasing efficiency in the use of information and dissemination systems. This follows the DOI, OMB, and statutory requirements.

Developing a data inventory plan, evaluating, and planning to implement the DOI metadata guidance, and piloting the data standards process are the RDC priorities. The RDC also emphasizes evaluating the data theme structure and seeks to potentially set up more data theme groups. Setting up a wildfire data theme structure would help combine items in a central location and ensure the required information is supplied when needed. Additionally, the development of data governance priorities and implementation plan is a priority and in collaboration with AMD's data verification effort.

The GIS program is less than two years old and coordinates Reclamation activities and systems while overseeing the BORGIS investment, manages the Working Capital Fund, and coordinates and develops the GIS plan. Acquiring and improving infrastructure, such as modern system architecture and centralized storage, are the main goal along with data including enterprise geospatial data. The program aims to make geospatial data locatable, accessible, and interoperable. This data is stored in BORGIS under the control and management of highly trained personnel in the regional offices. The Geospatial Advisory Council (GAC) is made up of GIS coordinators and across Reclamation's regions.

The BORGIS cloud is in progress and will potentially come out in FY2021. It is an enterprise approach and will support a seamless transition to the field. This will include eGO delivering enterprise geospatial operations, Tessel which offers an online interactive mapping tool, and uses Reclamation and other agency data sets, and ESRI files. BORGIS can also develop project specific solutions.

The GIS program has designated funding for other application development with external coordination as next steps. Program personnel are establishing external coordination roles and responsibilities to better integrate information into WFDSS, INFORM, etc. as they develop the programmatic side of Reclamation fire. Security issues in in sharing GIS and data are addressed by program specialists. Another important community for data and geospatial support in Reclamation may be the USGS CAC. This committee has participation from many civil agencies, DoD, and the Intelligence Community.

Modeling Capabilities at Reclamation's Technical Service Center (TSC)

Presented by:

Kurt Wille, Manager, Water, Environmental, and Ecosystems Division,
Lindsay Bearup, Civil Engineer (Hydrologic), Water Resources Engineering and Management,
Amanda Stone, Civil Engineer (Hydrologic), Water Resources Engineering and Management,
Yong Lai, Hydraulic Engineer, Sedimentation and River Hydraulics, and
Ben Abban, Civil Engineer (Hydraulics), Sedimentation and River Hydraulics

Dam Safety and Water Quality Considerations

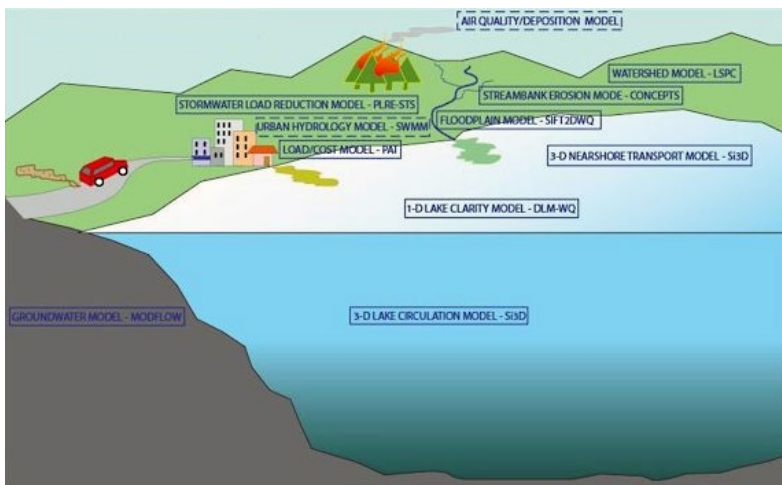
Dam Safety

Wildfire impacts flood risk characteristics through hydrograph timing, and hydrograph volumes. More “frequent” floods which involve conveyance and storage and continued rare flood events can lead to overtopping and risk of failure. In evaluating dam safety, the considerations include infiltration, snowpack characteristics, sediment plugging leading to loss of storage, changes in interception and stationarity (short-term and long-term change).

Water Quality

Water quality issues for post-fire activities revolves around post-fire nutrient loading to reservoirs. Water quality in reservoirs is diminished with increased runoff, increased sediment and associated contaminant transport, increased turbidity, and fire-fighting chemicals. Changes to in-reservoir water quality processes are needed, leading to increased treatment costs.

Water quality modeling is a way to help problem solve before and after the quality has decreased. Impacts are far reaching, requiring a range of different modeling techniques. The techniques include watershed and in-reservoir treatment. TSC has CE-QUAL-W2 and QUAL2K projects in place, which are non-fire related, as well as experience forested watershed biogeochemistry that can help the water quality post-fire.



[A study of 159 fires in the Rocky Mountain West](#) revealed that elevated phosphorus is common for five years after the disturbance of a wildfire (Rust et.al. 2019). Firefighting chemicals have high concentrations of phosphorus that may contribute to these studies and be the main problem with water quality post-fire.

Predicting Wildfire Impacts on Reservoir Sediment Loading

Research needs related to sediment include how wildfires will affect sedimentation at a reservoir and how to manage those affects. Looking at divergent responses among watersheds, researching the options available (local actions vs watershed-wide actions), and the comparison of cost and effectiveness, can lead to answers.

These challenges can be addressed by following the right approach using the right tools. By capturing the physics of watershed response to wildfire there is an opportunity to look at physical based models, the importance of processes and linkages across scales, and heterogeneity in landscape properties, and changes caused by fire. The benefits of this approach are to develop a holistic understanding of watershed response, evaluate watershed-wide management actions which can lead to better management of the wildfire.

Potential partnerships in water quality compliance include the USFS Rocky Mountain Research Station and the Missoula Technology and Development's Fire lab, and the USGS.

TSC Goals for Dam Safety and Post-Fire Water Quality

The TSC has two goals to help dam safety and water quality post-fire. The first goal is to extend Reclamation's SRH-W model to simulate wildfire impacts. The existing SRH-W model satisfies basic physics criteria and an extension to the model for fire impacts would add fire-related parameters and processes, simulate hydrologic and sediment response, and help with the quantification of wildfire impacts. The second goal is to help identify wildfire impacts on specific watersheds after a fire. This would currently include Willow Creek, Colorado, and others where observed data is needed at different scales. Timely sampling before a fire and at intervals after a fire is key to this goal.

Reclamation Facilities Impacted by Wildfire: Case Studies

Whiskeytown Dam Impacts from the Carr Fire

Presented by **Don Bader**, Area Manager, Northern California Area Office (NCAO)



Terrain Map of the Carr Fire, California.

During the Carr Fire in 2018, all six NCAO power plants went offline. In response to this catastrophic event, John Hutchings described the priority actions of mitigating hazards, keeping the water moving and maintaining access to facilities.

Post-fire lessons learned include ensuring contact lists are up to date, maintaining roadways, improving fire response, and assessing the reservoir impacts. During the fire, 70 NCAO employees evacuated, five lost

their homes, and it was difficult to contact everyone to confirm their safety. The phone lists were outdated, and some employees lost their phones when evacuating.

During the very dry summer., it started as a brush fire on the roadside caused by a flat RV trailer tire which was sparking. Future maintenance of area roadways in the future would potentially prevent a similar incident. Emergency power generation was needed and, if available, would have ensured a faster response time. In future dry winter years with low concern about runoff, clearing culverts of vegetation along roadways could reduce wildfire ignition risk. Fortunately, post fire impacts to reservoirs were minimal as vegetation reestablished in the following years before the bigger trees were cut.

Resources and Ongoing Research

After Don's presentation, several comments were made offering additional information and resources.

- Short term - volume (dilution) probably accounts for reduced water quality effects in the reservoir. Snags (tall dead trees) can take a decade or more to fall. https://www.fs.fed.us/rm/pubs_journals/2020/rmrs_2020_rhoades_c001.pdf.

- Rhoades et al. paper on post-beetle kill snagfall. Rhoades, C. C., R. M. Hubbard, P. R. Hood, B. J. Starr, D. B. Tinker, and K. Elder. 2020. Snagfall the first decade after severe bark beetle infestation of high-elevation forests in Colorado, USA. *Ecological Applications* 30(3): e02059. 10.1002/eap.2059. <https://doi.org/10.1002/eap.2059>
- Nelson KN, Turner MG, Romme WH, Tinker DB. 2016. Landscape variation in tree regeneration and snag fall drive fuel loads in 24-year-old post-fire lodgepole pine forests. *Ecological Applications* 26(8): 2424–2438. <https://doi.org/10.1002/eap.1412>
- Studying the reservoir sedimentation from watershed entering Whiskeytown: <https://www.sciencebase.gov/catalog/catalogParty/show?partyId=2677>

Research Needs

Research needs for Reclamation from the Carr Fire identified were primarily focused on the need for emergency generation, and the ability to bypass generation to keep water flowing in the river.

Willow Creek Reservoir Impacts from the East Troublesome Fire

Presented by **Patrick Fischer**, Deputy Area Manager, Eastern Colorado Area Office (ECAO), Bureau of Reclamation

Three of the largest wildfires in Colorado history occurred in 2020. Two of the three include the Cameron Peak Fire and the East Troublesome Fire. The Cameron Peak fire reported on August 13th, 2020, burned a total of 208,319 acres in the Canyon Lakes Ranger District of the Roosevelt National Forest and the surrounding Larimer County communities. The East Troublesome Fire, reported on October 14, 2020, north/northeast Kremmling on the Arapaho National Forest burned a total of 193,812 acres.



Photo: Fire area in the ECAO.

The impacts of these two fires, while active included public safety with evacuations, emergency management impacts with the Incident Management Team, continuity of Reclamation operations for power, controls, comms, and sensors, post-fire impacts were effects to the watershed, water quality, increased debris, and sediment, increases in Operation

and Maintenance (O&M) costs, and adjustments to priorities and work planning. While the fires were burning, fire managers and partners implemented immediate, mid-range and long-term response activities. The responses relied on strong partnerships, leveraging technical expertise, engaging in stakeholder meetings, and supporting recovery efforts.

A few lessons learned include the need for increased GIS capability, real time forecasting, additional-agreements, non-reimbursable funding, and more time saving efforts in fire response could have played a significant role in suppressing the fire.

Breakout Sessions

Workshop participants were invited to join one of three topically themed breakout groups to discuss research needs, current tools, and other resources of potential interest. The three groups were organized around themes of interest identified from the results of a pre-workshop survey (see Appendix 2). Many of the resources identified during the breakout groups compliment and add to a list of resources developed as a handout for the workshop (see Appendix 1).

Pre-Fire Risk Assessment and Management Prioritization Approaches

A. GIS: Overview and Notes

GIS enables fire personnel to conduct rapid and accurate damage assessment and rehabilitation requirements after an emergency. Wildfire staff use GIS platforms for the collection, analysis, and display of various types of wildland fire data.

1. Research Needs

- Identify opportunities to combine disparate or Regional data sets into a single data set within BORGIS.
- Centralize geospatial data related to burned areas from past fires.
- Identify opportunities to organize and gather wildfire data in a timelier manner.
- Identify data analysis need to support information requests.
- Develop partnership with NWCG / NIFC to add data into the EGP viewer.

2. Current Research/Tools:

- GIS overlaying, where there can be multiple filters to evaluate high risk areas.
 - [Strategic Hazard Identification and Risk Assessment \(SHIRA\) database](#)

3. Reference Links:

- <https://www.fs.usda.gov/rmrs/groups/wildfire-risk-management-science-team>
- <https://www.fs.usda.gov/rmrs/groups/wildfire-risk-management-science-team/potential-operational-delineations-pods>
- <https://wildfirerisk.org/>
- <https://egp.nwcg.gov/egp/default.aspx> (current fire spatial information)
- <https://pubs.usgs.gov/circ/1453/circ1453.pdf> (SHIRA Project report)
- <https://www.fs.usda.gov/rmrs/publications/assessing-watershed-wildfire-risks-national-forest-system-lands-rocky-mountain-region>
- <https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=e84fc83c8be542079d3c1d489d45be21>
- https://iftdss.firenet.gov/landing_page/
- <https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020GL092293>

B. Management Activities: Overview and Notes

CGB Region, acknowledging the difference between post fire mitigation vs pre fire risk, is focusing on field management. California is seeing a pattern of fires happening upstream before rain and the affected land isn't able to naturally recover. CPN is using GIS layer mapping to assess values at risk and the (EFDSS) Wild Land Fire Decisions Support System to help address the tactic decisions. If agencies and bureaus should assess facilities, know the risk, and communicate that risk for better response. No new research needs were identified in this discussion.

Current Research Tools:

- [Risk Management Assistance Dashboard](#)
- [Pre-Fire Modeling](#)

Post-Fire Reservoir Impacts

A. Watershed Hydrology: Overview and Notes

Burned watersheds display changes in hydrologic conditions creating different flow conditions entering reservoirs.

1. Research Needs:

- Investigate if wildfires create long-term state changes to watersheds and the possible fire characteristics that would lead to these state changes.
- Expand SRH-W to wildfires to determine critical locations of erosion and sedimentation and develop mitigation strategies for these locations. Need more data for development and use.
- Identify further research on impacts to snowpack in partnership with USACE
- Coordinate with USGS on expanding use of Basin Characterization Model to locations beyond California.

2. Reference Link:

- <https://www.usgs.gov/software/basin-characterization-model-bcm>

3. Current Research/Tools:

- Sedimentation and River Hydraulics – [Watershed \(SRH-W\) model](#) – physically based hydraulic model that can be applied to watersheds using the dynamic wave solver.
- [Basin Characterization Model \(USGS\)](#) – model used to evaluate the long-term impacts of climate change on hydrology.
- [Stationarity related to peak flows.](#)
- Reclamation's Dam Safety Office is working to incorporate climate change and rare floods.

B. Reservoir Sedimentation: Overview and Notes

Wildfires impacts to the watershed leads to debris flow and increased sediment transport which is ultimately delivered to reservoirs.

1. Research Needs:

- Investigate differences in sedimentation processes due to wildfire vs more typical sedimentation patterns using coring of reservoirs and develop methodologies to reduce costs associated with sediment coring of reservoirs.

- Compare types of sediments entering watershed pre- and post-wildfire.
- Use multi-beam sonar to investigate back scatter returns and understand sediment size of deposited material.
- Partner with USGS to research sediment sizes using coring and multi-beam sonar.
- Partner with Northern Colorado Water Conservancy, East Troublesome Fire impacted reservoirs in Colorado.

C. Water Delivery: Overview and Notes

Wildfires can affect water deliveries due to flood hydrology and debris flows.

1. *Research Needs:*

- Investigate differences in sedimentation processes due to wildfire vs more typical sedimentation patterns using coring of reservoirs and develop methodologies to reduce costs associated with sediment coring of reservoirs.
- Compare types of sediments entering watershed pre- and post-wildfire.
- Use multi-beam sonar to investigate back scatter returns and understand sediment size of deposited material.
- Partner with USGS to research sediment sizes using coring and multi-beam sonar.
- Partner with Northern Colorado Water Conservancy, East Troublesome Fire impacted reservoirs in Colorado.

2. *Current Research/Tools:*

- [The Sedimentation and River Hydraulics group and the TSC](#) has developed tool that uses longitudinal profile surveys to create reservoir bottom surfaces in locations without full bathymetric surveys.
- Predicting reservoir sedimentation rates using over 600 sites – investigating how sedimentation rates relate to other watershed parameters.
- Landsat analysis of reservoirs where drawdown is more pronounced and exposed sediments observed. [Risk Management Assistance Dashboard](#)

Post Fire Water Quality

A. Water Compliance Concerns: Overview and Notes

This breakout group discussed current tools and research related to post-fire water quality and how to mitigate the effects of wildfire in watersheds, downstream, and species inhabiting these areas.

1. Research Needs:

- Develop baseline WQ characterization of USBR reservoirs and upstream watersheds.
- Develop a centralized WQ data site for Reclamation (Note – this process has started, using RISE as the platform).
- Explore how to update existing modeling tools for post-fire WQ analysis.
- Investigate long term ecosystem recovery and the feedbacks to WQ.
- Investigate the impact of nutrient loading on HABs.
- Develop modeling tools to direct mitigation strategies to limit water quality impacts.
- Explore the impacts of fire suppressants on downstream water quality.

2. Current Research/Tools:

- [CE-QUAL-W2](#) – in reservoir water quality in East Troublesome area, possible Lahontan Reservoir application for Hg cycling, and other applicable areas.
- High frequency water quality sondes (turbidity, DO, N, Chl a, etc.) and autosampler/analyzer for P.
- Storm-based programmable sampling; Water Quality Impacts in the Animas and San Juan River Basins report ([S&T project 1790](#)).
- [VELMA](#) (EPA model) - watershed model.
- [WEPP](#) – watershed and erosion model with added modules for phosphorus and post-burn scenarios; modeling of soil stabilization activities - P loading reduction. (University of Idaho)
 - Report: [Extending WEPP Technology to Predict Fine Sediment and Phosphorus Delivery from Forested Hillslopes](#)

- [Remote Sensing Vegetation Maps from NASA](#) (Google Earth Engine)
- Research: Post-fire water quality impacts in Lake County (Cache Creek) and Lake Berryessa (Pope Creek) watersheds (USGS and USBR).
- Research: Nutrient, ash, and mercury sampling in Rocky Mountain National Park (NPS).
- Research: Prescribed fires, beetle kill, and wildfire studies in the Cache La Poudre and Laramie Basins (USFS).
- Research: Carbon quantity and quality pre- and post-fire in Oregon (USFS).

B. Harmful Algal Blooms (HAB): Concerns: Overview and Notes

Post-Fire Breakout group also shared information on Reclamation's efforts regarding the treatment of HAB including a case study on a Reclamation reservoir.

1. Research Needs:

- Explore the impact of ash on our reservoirs and effect on harmful algal blooms.
- Organic carbon and mercury (apply model for upper watershed).
- Develop baseline WQ characterization of USBR reservoirs and upstream.

2. Current Research/Tools:

WaterSMART project – low-cost HAB sensors and collaboration with researchers at UC Davis to understand how they respond to post-fire impacts. Research on phytoplankton and zooplankton; looking for collaborative opportunities.

3. Reference Link:

- NOAA work with HAB sensors - <https://ioos.noaa.gov/news/act-evaluates-new-portable-hab-sensors/>

Appendix 1:

Wildland Fire Management Resources



Wildland Fire Management Resources

Fire Intelligence and Information

National Interagency Coordination Center

- <https://www.nifc.gov/nicc/index.htm>

InciWeb

- <https://inciweb.nwcg.gov/>

National Interagency Fire Center

- <https://www.nifc.gov/fire-information/nfn>

Enterprise Geospatial Portal

- <https://egp.nwcg.gov/egp/>

Modeling and Fire Education

Watershed Erosion Prediction Project (WEPP)

- <https://www.fs.usda.gov/ccrc/tool/watershed-erosion-prediction-project-wepp>

Forest Service Rocky Mountain Research Station Tools

- <https://www.fs.usda.gov/rmrs/tools>

Burned Area Learning Network

- <https://www.conservationgateway.org/ConservationPractices/FireLandscapes/FireLearningNetwork/RegionalNetworks/Pages/BALN.aspx>

Fire Research and Management Exchange

- <https://www.frames.gov/>

Joint Fire Science Program Fire Science Exchange Network

- https://www.firescience.gov/JFSP_exchanges.cfm

Geospatial Tools

Topofire

- https://topofire.dbs.umt.edu/topofire_v3/index.php

National Interagency Fire Center Open Source Fire Perimeters and Data

- https://data-nifc.opendata.arcgis.com/search?tags=HistoricWildfires_OpenData

Hazard Explorer

- <https://hazexplorer.com/map>

Wildfire Risk to Communities

- <https://wildfirerisk.org/>

USGS Land Treatment Exploration Tool

- https://www.usgs.gov/centers/fresc/science/land-treatment-exploration-tool?qt-science_center_objects=0#qt-science_center_objects

Appendix 2:

Summary of Pre-Workshop Survey Results

Reclamation Science and Technology Program

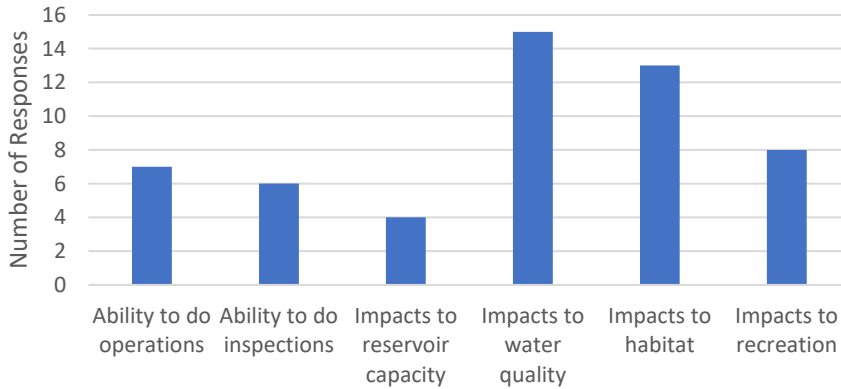
Wildfire Research Needs Survey - Summary of Responses



— BUREAU OF —
RECLAMATION

Number of responses: 28 from MB, UCB, LCB, CGB, CPN regions and DO

Experienced Direct Impacts due to Wildfires



Other direct impacts:

- Propagation of invasive species
- Post-fire nutrient loading
- Impact to ongoing research and data collection
- Reclamation infrastructure was inaccessible during evacuations
- Debris flow hazards

Wildfire-related concerns

- Poor **water quality**, including debris, may impact drinking water and damage Reclamation infrastructure
- Increased **sediment transport** may lead to loss of storage capacity and nutrient loading in reservoirs
- **Impaired habitat** due to wildfire impacts on water quality and sediment transport
- Impacts that lead to decreased or dangerous **recreational opportunities**

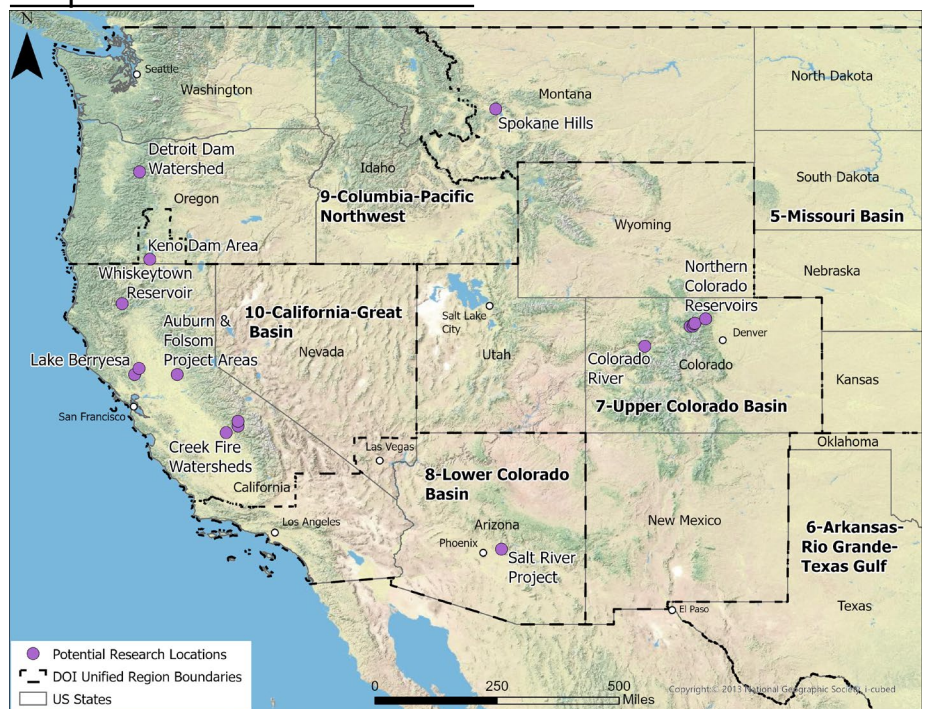
Planning tools needed to help with wildfire concerns

- Tools or strategies that support planning/implementation of wildfire mitigation/response and engagement with other agencies
- Rapid hydrologic models and reservoir routing
- Mapping of fire risks, fire severity, debris flow risk, and watershed habitats, including invasive and endangered species
- GIS layers needed: digital elevation models, pre- and post-fire land use/cover conditions, soil moisture content, burn severity, pre- and post-fire aerial imagery

Proposed research topics

- Pre- and post-fire hydrology
- Hillslope sediment erosion, transport and impacts to fish or other species' habitats
- Relationships between fire mitigation strategies and water yield or power generation
- Wildfire impacts to microbial and zooplankton communities
- Preemptive understanding of how wildfires and severity may impact watersheds and reservoirs
- Invasive species spread and control methods as related to wildfire
- Fuel loading and management
- Water quality, nutrient loading, and algal bloom investigations
- Wildfire effects on snowpack modeling

Proposed research locations



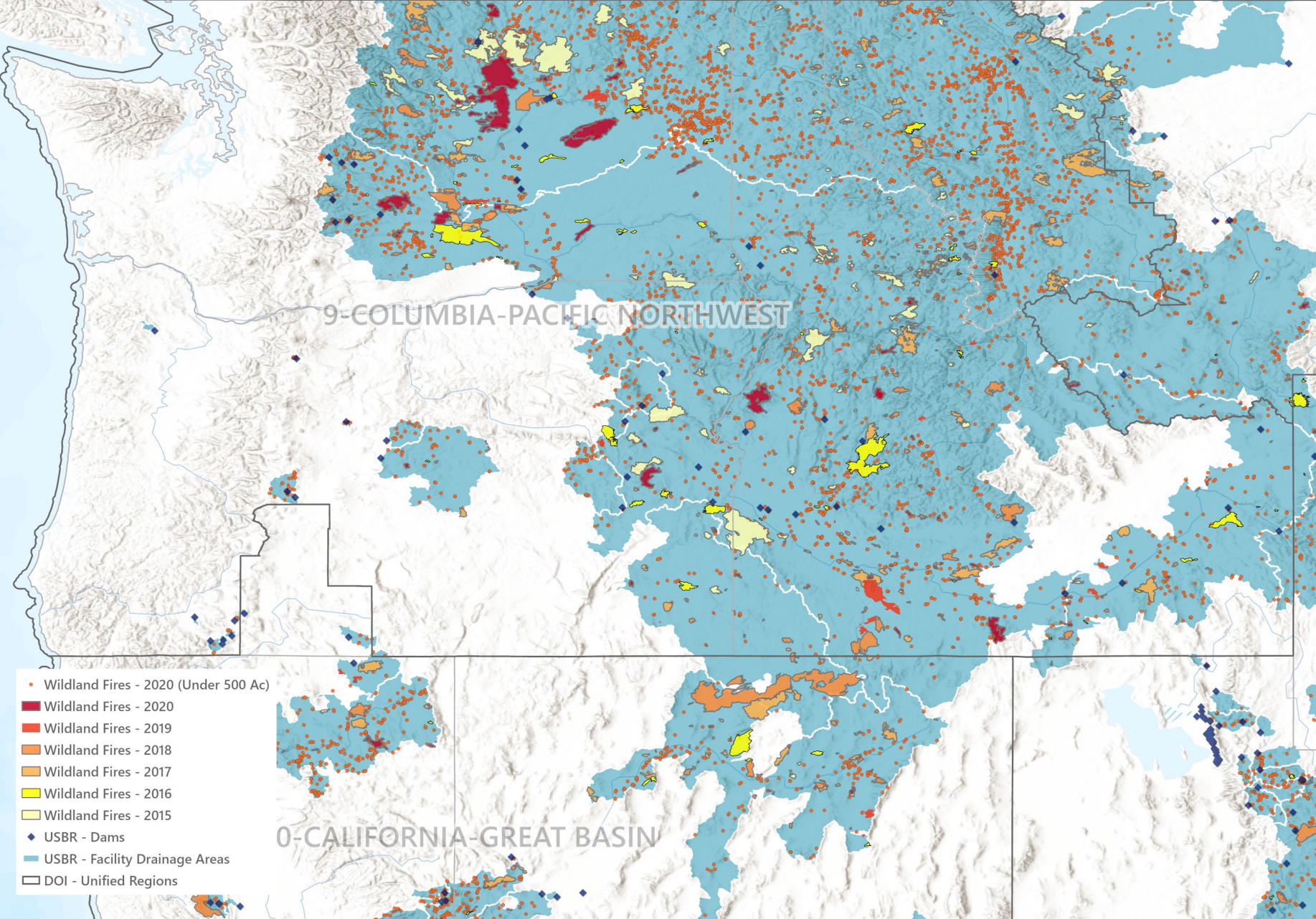
Appendix 3:

Regional Maps with Wildfire Burned Areas 2015-2020

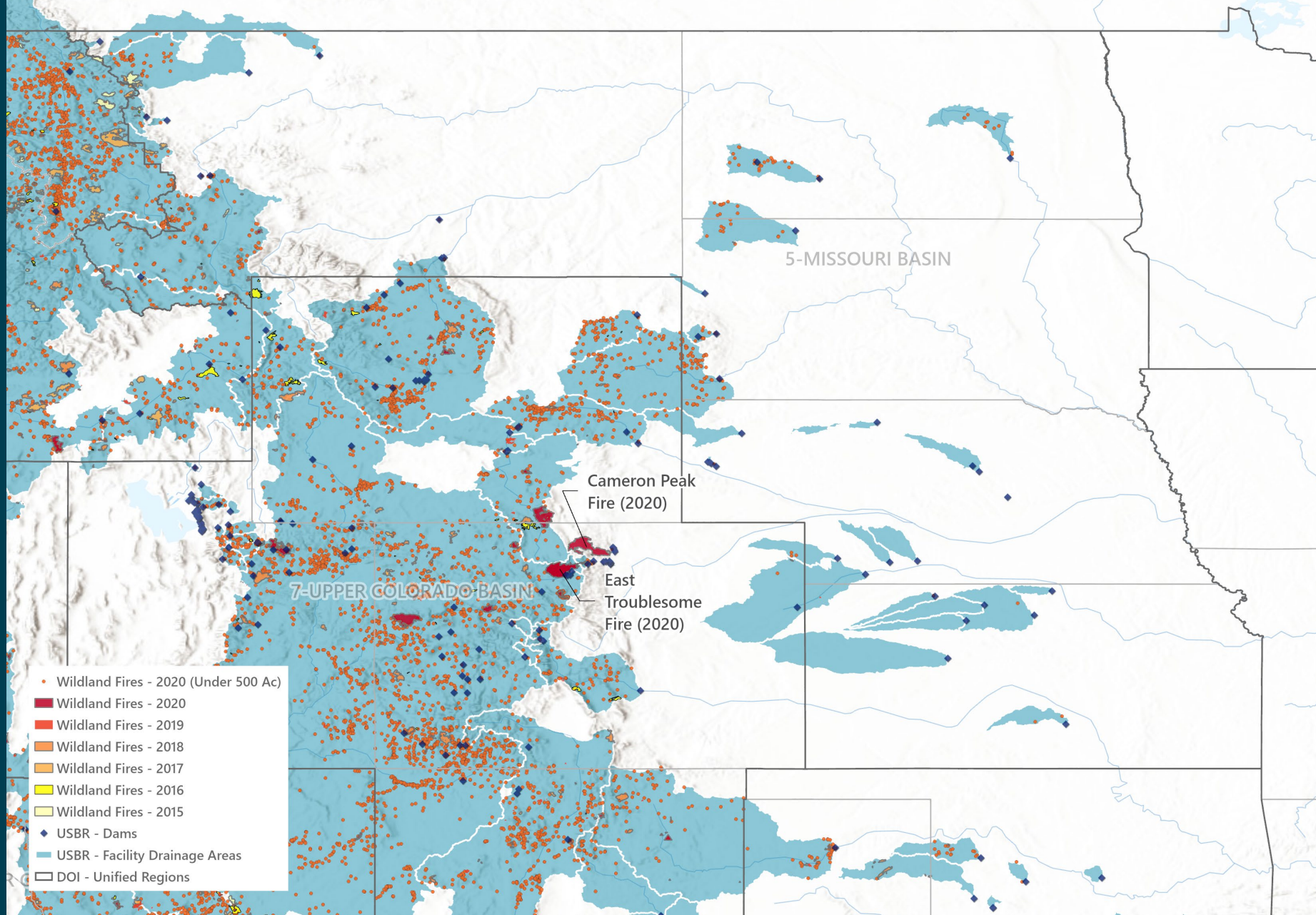
California Great Basin



Columbia-Pacific Northwest



Missouri Basin

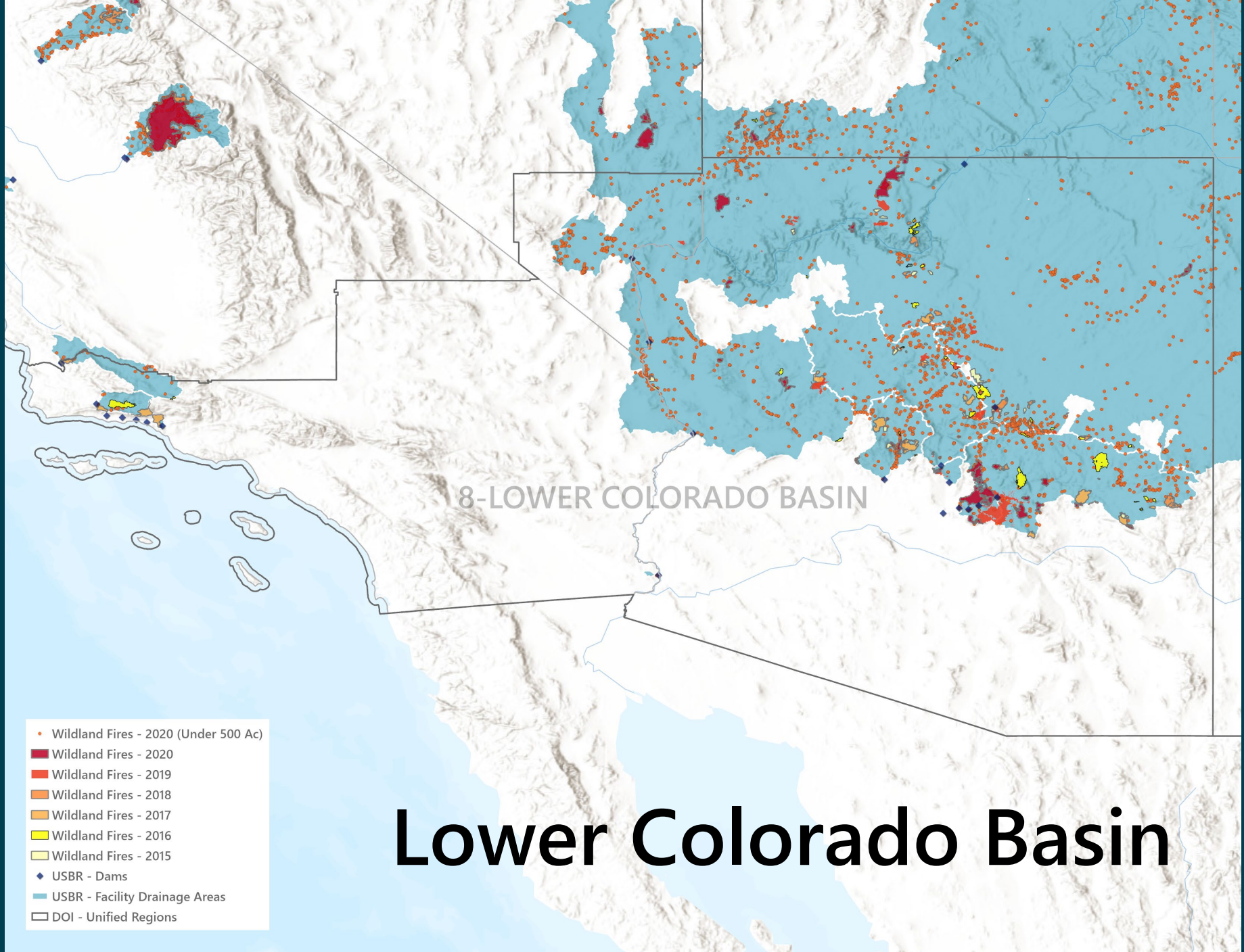


6-ARKANSAS-RIO GRANDE-TEXAS GULF

Arkansas-Rio Grande-Texas Gulf

- Wildland Fires - 2020 (Under 500 Ac)
- Wildland Fires - 2020
- Wildland Fires - 2019
- Wildland Fires - 2018
- Wildland Fires - 2017
- Wildland Fires - 2016
- Wildland Fires - 2015
- ◆ USBR - Dams
- USBR - Facility Drainage Areas
- DOI - Unified Regions





8-LOWER COLORADO BASIN

Lower Colorado Basin

- Wildland Fires - 2020 (Under 500 Ac)
- Wildland Fires - 2020
- Wildland Fires - 2019
- Wildland Fires - 2018
- Wildland Fires - 2017
- Wildland Fires - 2016
- Wildland Fires - 2015
- ◆ USBR - Dams
- USBR - Facility Drainage Areas
- DOI - Unified Regions

