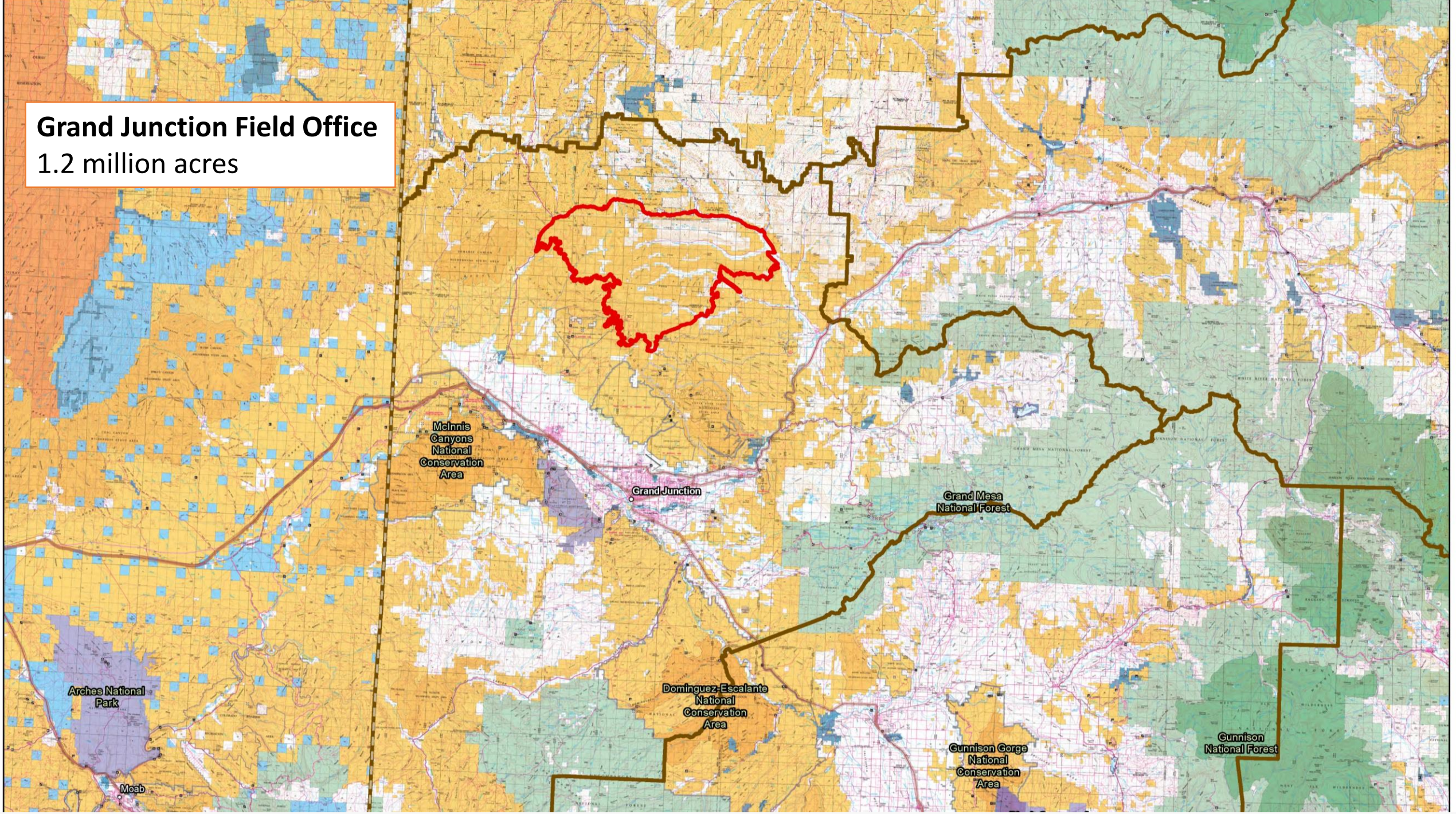
The Plan That Wasn't Planned
Working with People on the Land
After the Flames
Pine Gulch Fire BLM Grand Junction Field Office, 2020

Chris Holbeck – National Park Service

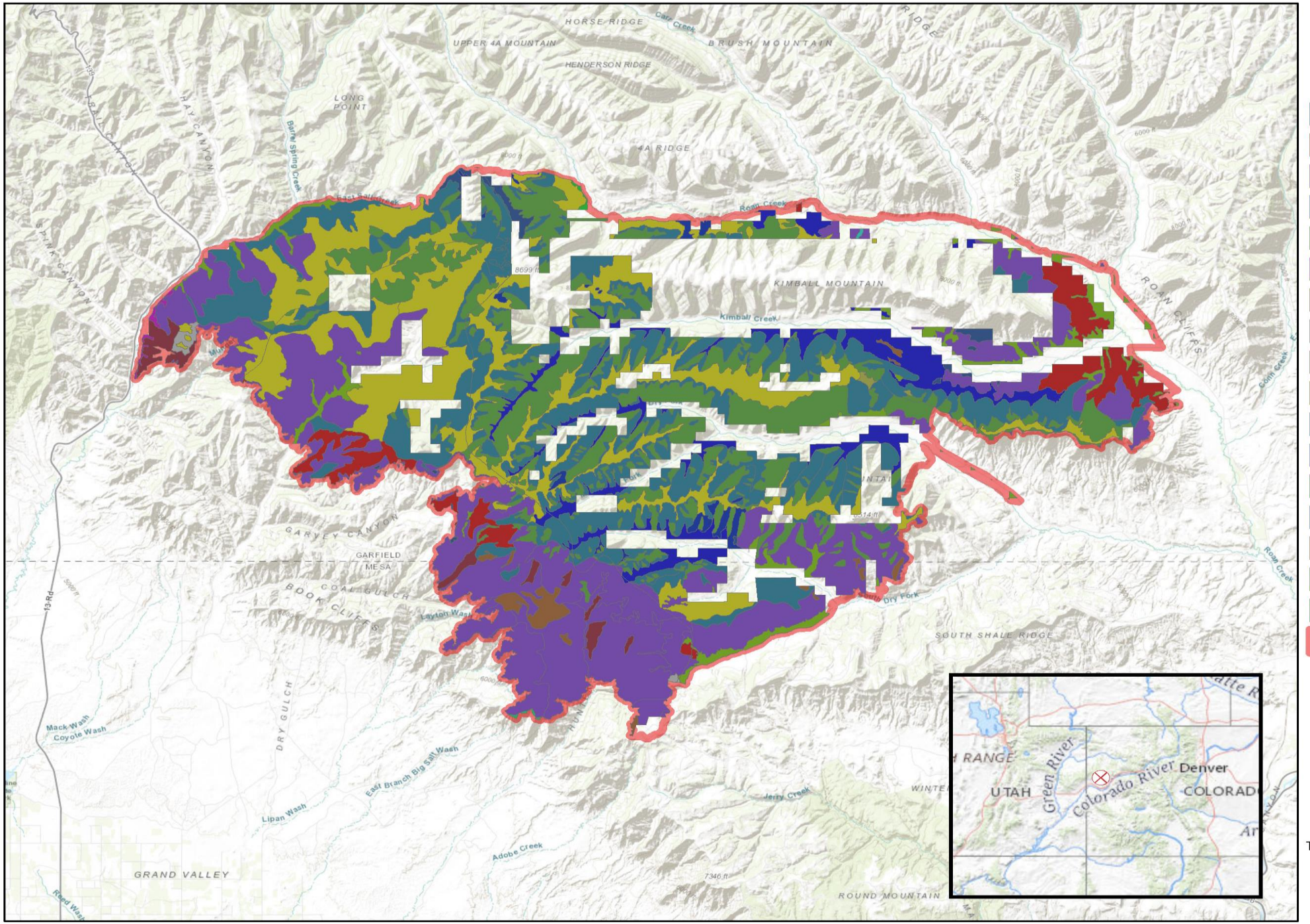
Erin Kowalski – Bureau of Land Management

Mary Ellen Miller - PhD, Michigan Tech Research Institute

Kevin Hyatt – Bureau of Land Management


Grand Junction Field Office
1.2 million acres
McInnis Canyons National Conservation Area
Grand Junction
Grand Mesa National Forest
Arches National Park
Moab
Dominguez-Escalante National Conservation Area
Gunnison Gorge National Conservation Area
Gunnison National Forest


139
Ignition
Corcoran Peak



2020 Pine Gulch Fire

138,846 Acres

Habitat Types on BLM Land

- Annual Flats
- Arid Juniper-Pinyon Mesas
- Arid Pinyon-Juniper Steep Lands
- Aspen Glades
- Douglas-Fir Ridge and Valley
- Greasewood Washes
- Mesic Grassland Highlands
- Mesic Pinyon-Juniper Mesas
- Mesic Pinyon-Juniper Steep Lands
- Mountain Shrub Bench, Mesa Top and Ridgetop
- Mountain Shrub Steep Lands
- Mountain Shrub Valleys
- Nonwooded Riparia
- Sagebrush Highlands
- Sagebrush Mesas
- Sagebrush Valleys
- Saltbush Eroded Lands
- Fire Perimeter

N

0 2 4 8

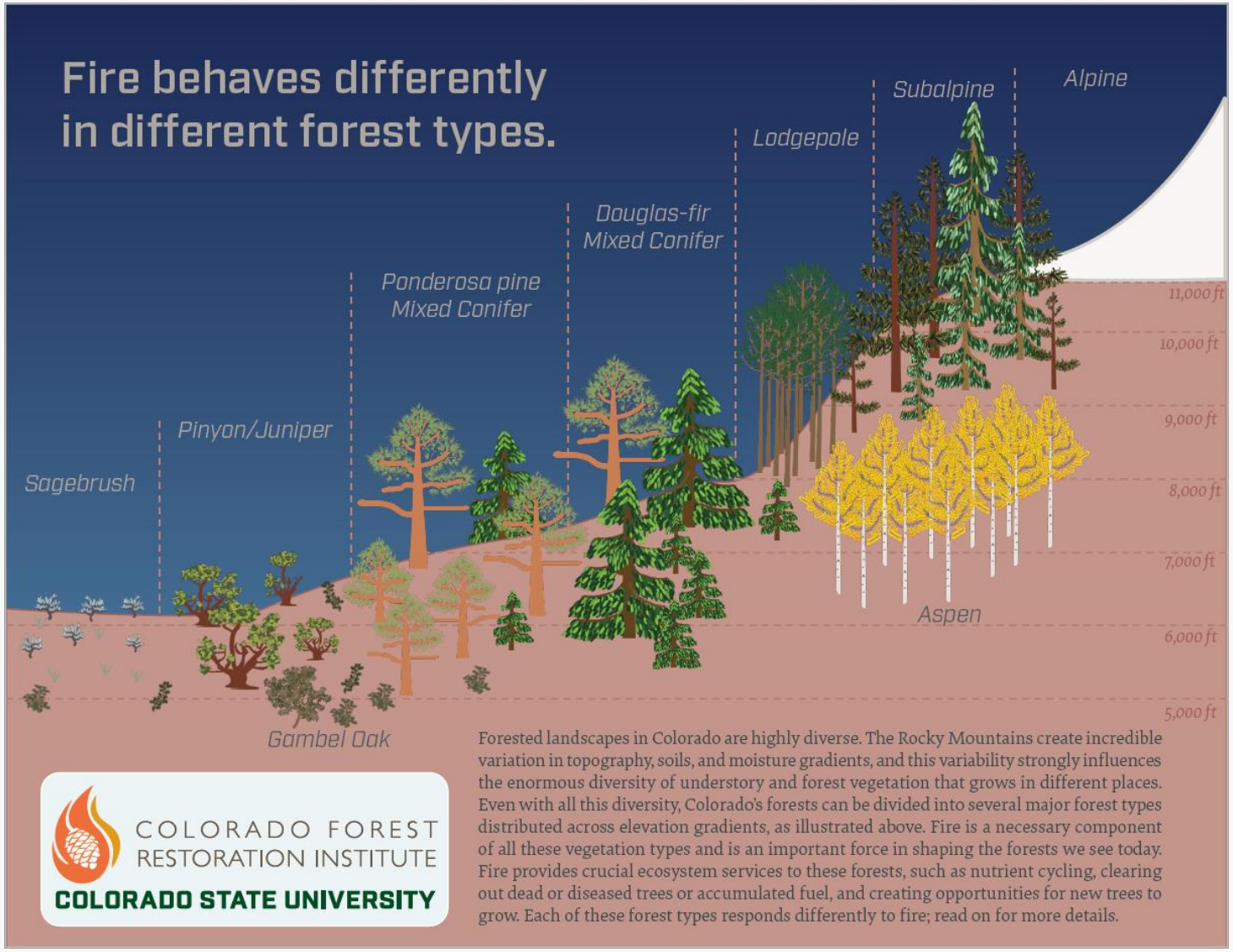
Miles

1:200,000

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

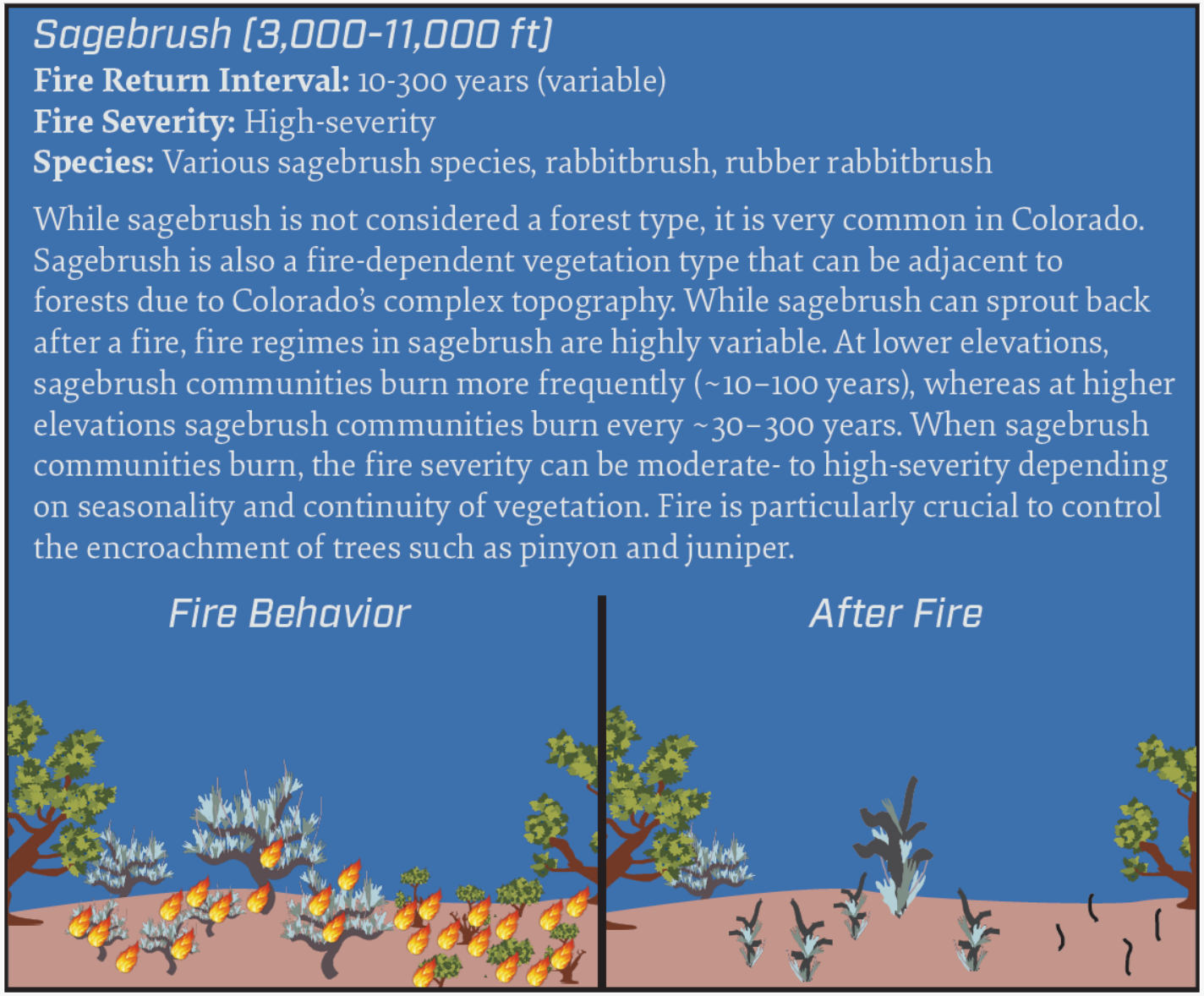
Fire Return Interval

- Pinyon/ Juniper Woodlands
- Oakbrush
- Greasewood and sagebrush



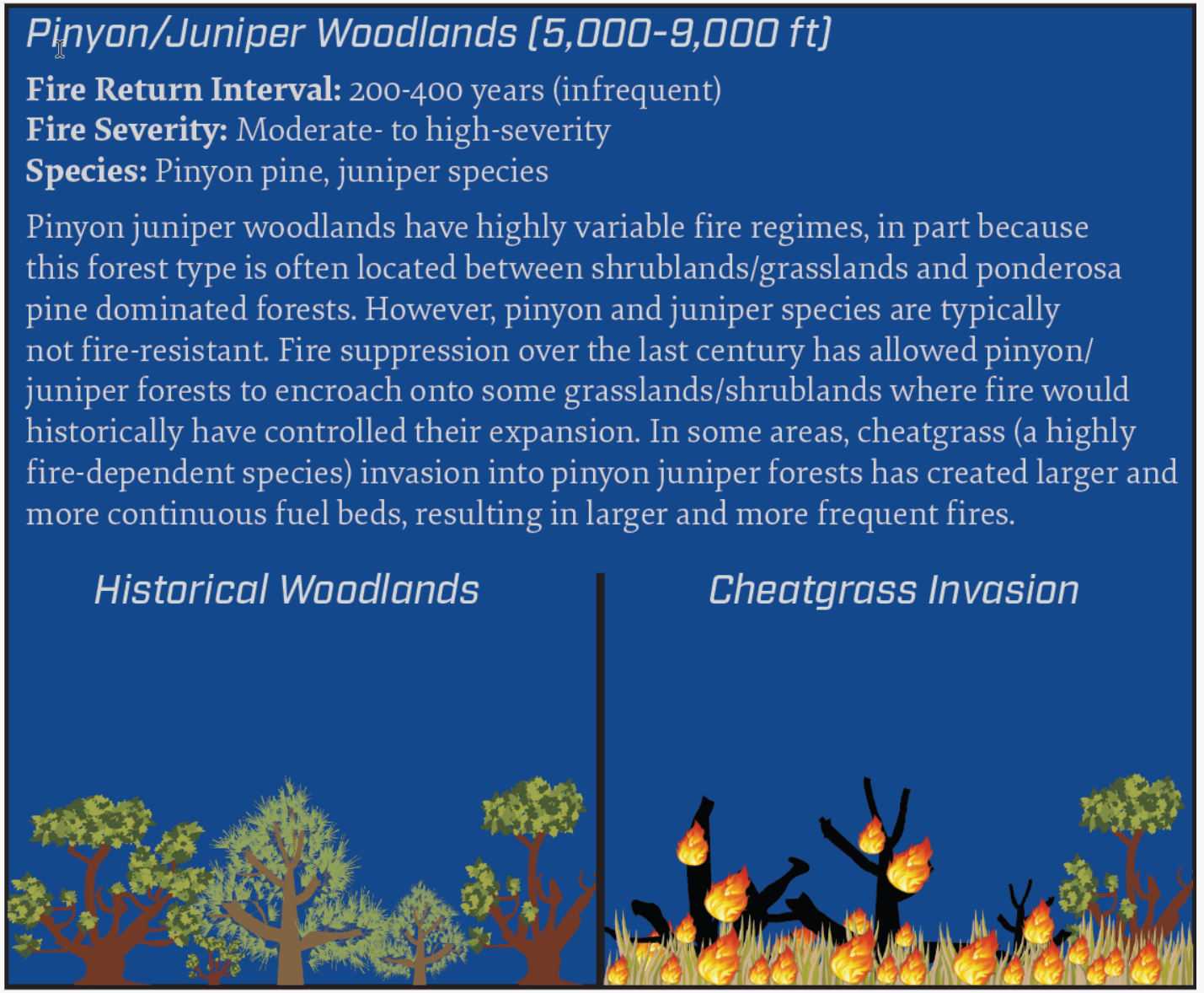
Sagebrush and Greasewood Flats

- 10-300 years
- Highly variable and high severity



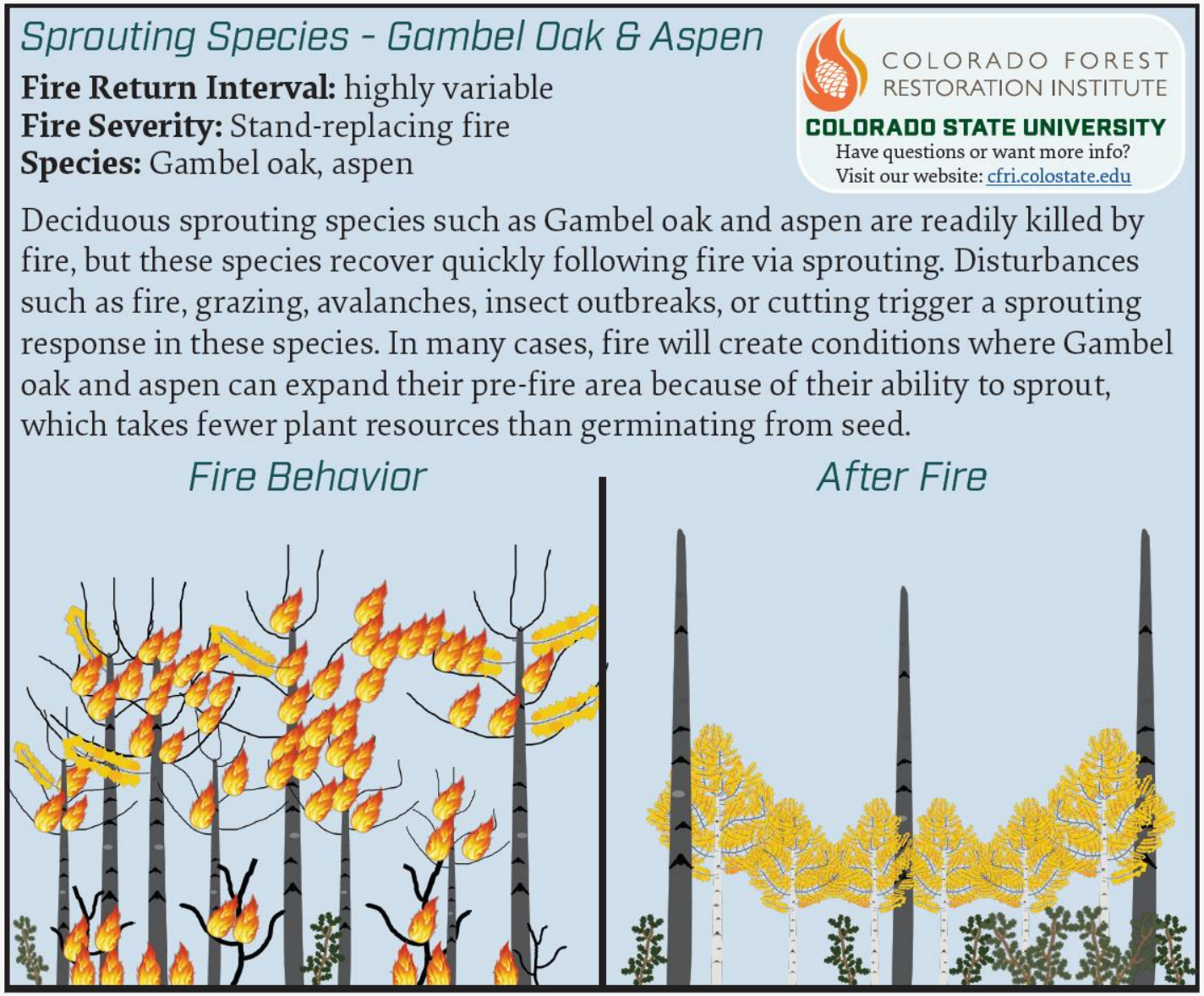
Pinyon and Juniper Woodlands

- 200-400 years
- Moderate to high severity



Oakbrush

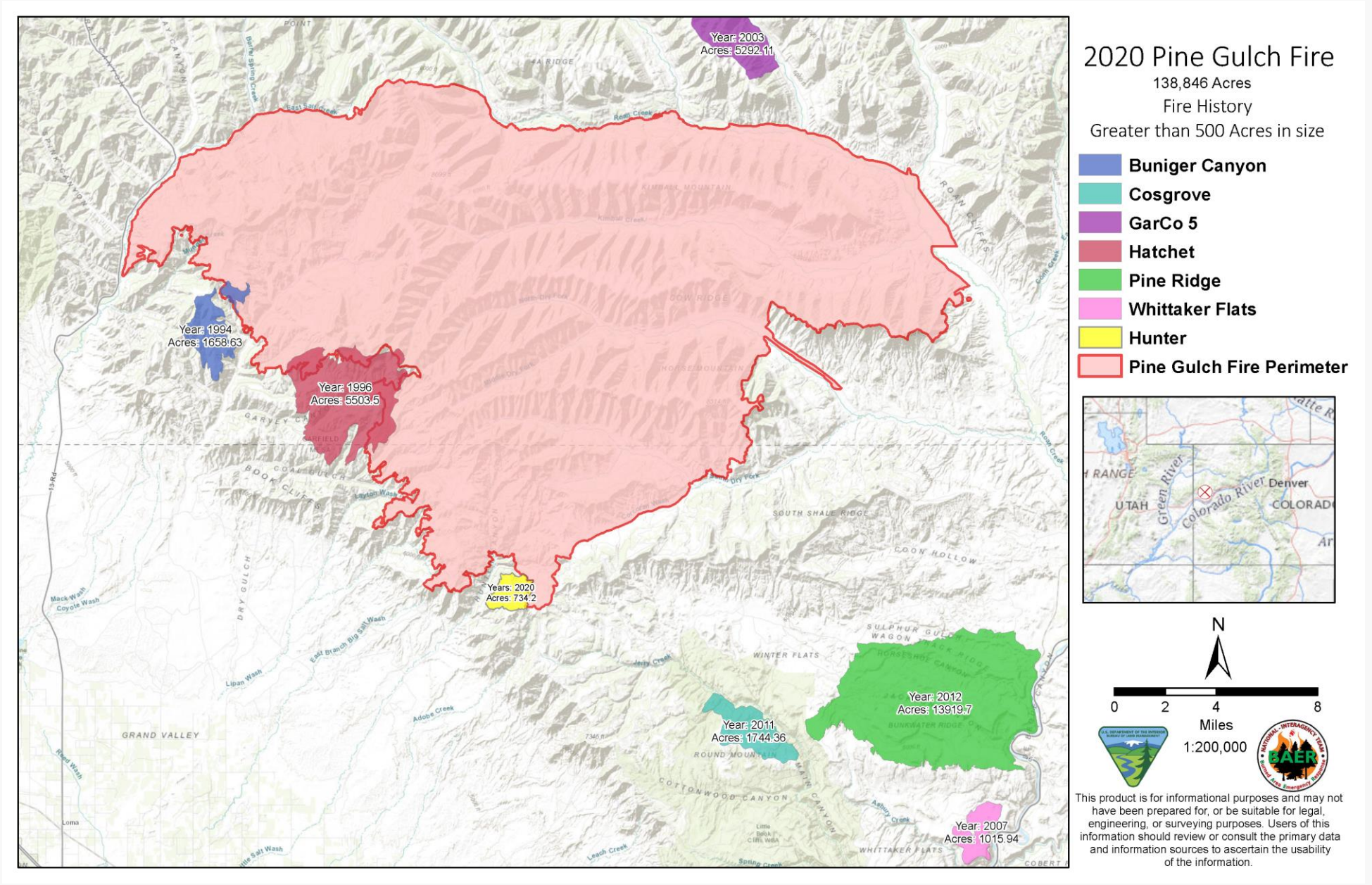
- Variable
- Stand replacing- readily resprout



Douglas Fir

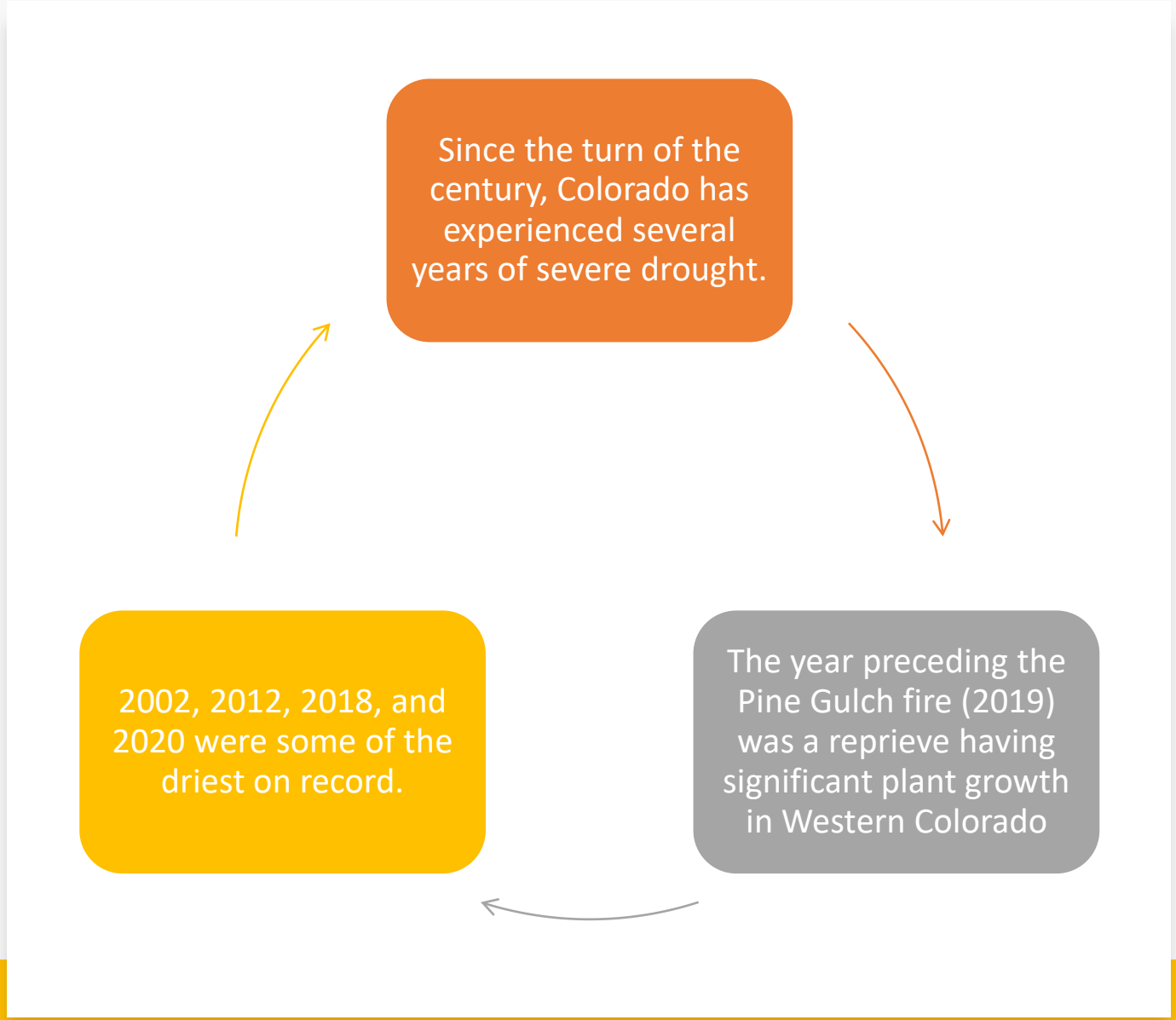
- 20-100
- Moderate with some stand replacing patches

Recorded Historic Fires

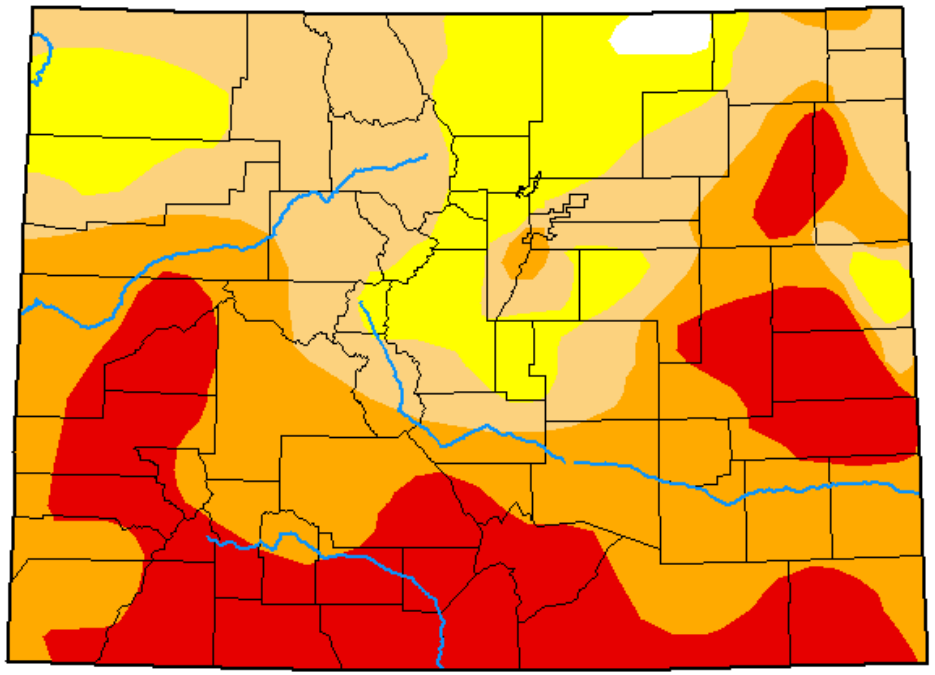


Steep and Rugged Terrain

Drought and Fuel conditions pre-fire



U.S. Drought Monitor
Colorado



July 28, 2020
(Released Thursday, Jul. 30, 2020)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.65	99.35	83.72	58.79	26.64	0.00
Last Week *07-23-2020*	2.95	97.05	73.99	60.34	31.76	0.00
3 Months Ago *04-30-2020*	24.47	75.53	56.64	32.72	0.00	0.00
Start of Calendar Year *01-02-2020*	31.72	68.28	51.19	20.11	0.00	0.00
Start of Water Year *10-03-2019*	30.14	69.86	27.53	0.00	0.00	0.00
One Year Ago *08-01-2019*	95.32	4.68	0.00	0.00	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Richard Heim
NCEI/NOAA

droughtmonitor.unl.edu

Pine Gulch Fire- DeBeque, CO
July 31st 2020

Ignition and IA

Pine Gulch was a lightning started wildland fire that was reported on the afternoon of July 31, 2020. Initial attack began that afternoon with multiple engines, crews, helicopters, and air attack platform

The fire transitioned almost immediately from an initial attack to an extended attack fire

Rocky Mountain Type 1 Team assumed command on August 14th

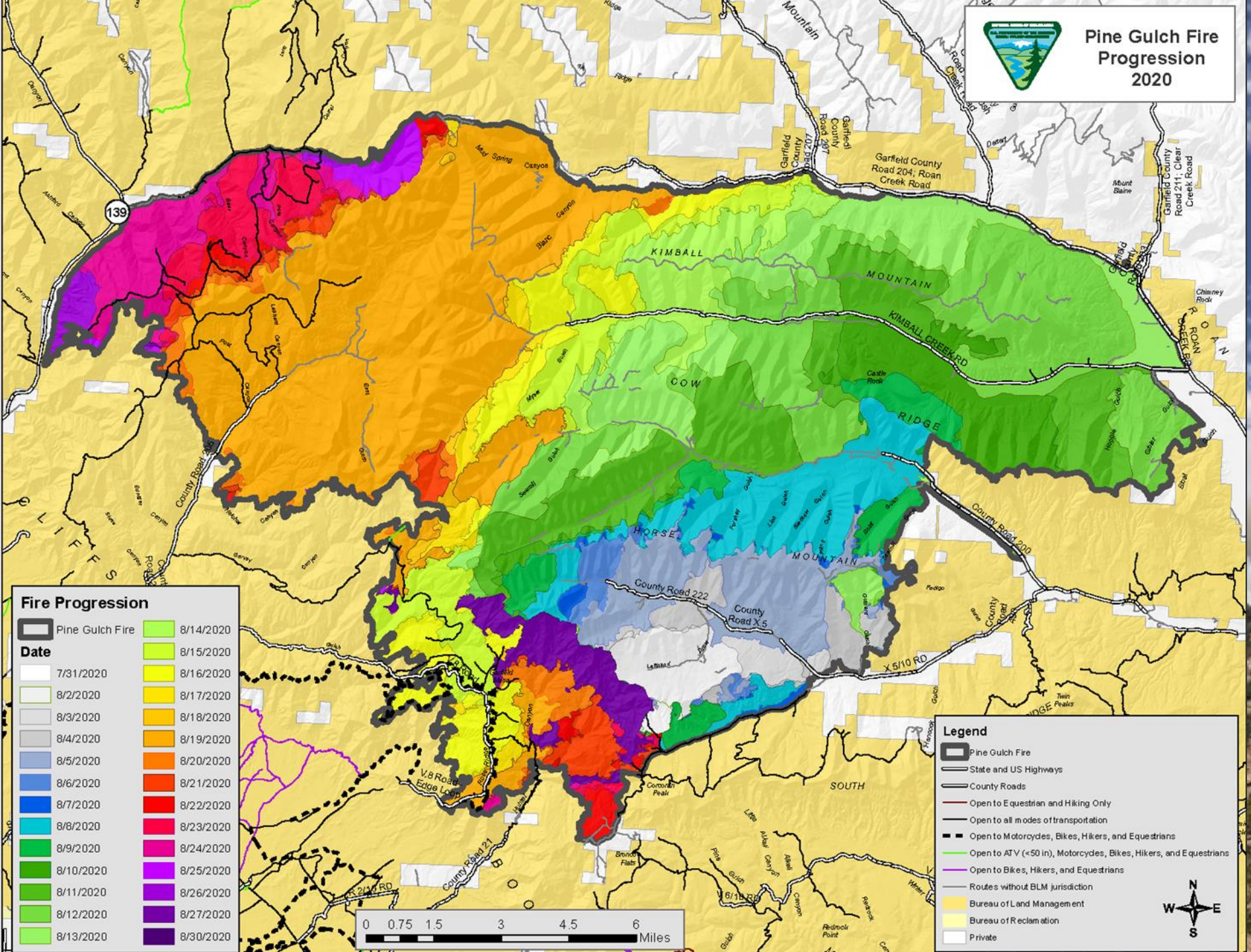
Initial fuels included greasewood and sage transitioning to pinyon and juniper slopes


2411
BLM FIRE
NM-TAD
2616
DIN-321

During the night of August 18, the fire grew quickly due to thunderstorm winds up to 40 mph for a three-to-four-hour period. As a result, the fire increased by more than **30,000** acres that night

As of August 27, 2020 the Pine Gulch Fire became the **largest** wildfire in Colorado State history (until Cameron Peak Fire ~208,000 acres)

138,000 total acres (102,000 BLM managed lands)


Pine Gulch Fire Progression 2020
KIMBALL MOUNTAIN
KIMBALL CREEK RD
COW RIDGE
HORSE MOUNTAIN
SOUTH
Garfield County Road 204; Roan Creek Road
Garfield County Road 207
Garfield County Road 211; Clear Creek Road
County Road 200
County Road 222
County Road X.5
X.5/10 RD
V.8 Road Edge Loop
County Road 21
R 2/10 RD
V 6/10 RD
139
Fire Progression
Pine Gulch Fire
Date
7/31/2020
8/2/2020
8/3/2020
8/4/2020
8/5/2020
8/6/2020
8/7/2020
8/8/2020
8/9/2020
8/10/2020
8/11/2020
8/12/2020
8/13/2020
8/14/2020
8/15/2020
8/16/2020
8/17/2020
8/18/2020
8/19/2020
8/20/2020
8/21/2020
8/22/2020
8/23/2020
8/24/2020
8/25/2020
8/26/2020
8/27/2020
8/30/2020
0 0.75 1.5 3 4.5 6
Miles
Legend
Pine Gulch Fire
State and US Highways
County Roads
Open to Equestrian and Hiking Only
Open to all modes of transportation
Open to Motorcycles, Bikes, Hikers, and Equestrians
Open to ATV (<50 in), Motorcycles, Bikes, Hikers, and Equestrians
Open to Bikes, Hikers, and Equestrians
Routes without BLM jurisdiction
Bureau of Land Management
Bureau of Reclamation
Private
N
W
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S


How much suppression?

PRIVATE LAND WITH HOUSES AND OUTBUILDINGS

WATERSHED

PRIME SAGE GROUSE HABITAT TO THE NORTH

OIL AND GAS INFRASTRUCTURE

WILDLIFE HABITAT

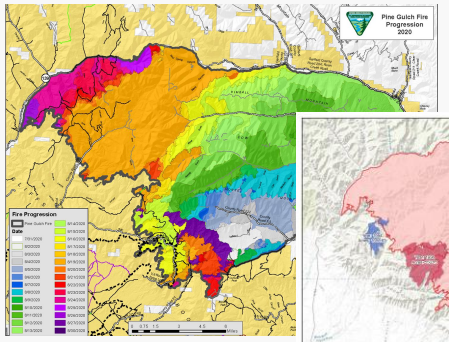
CATTLE ALLOTMENTS

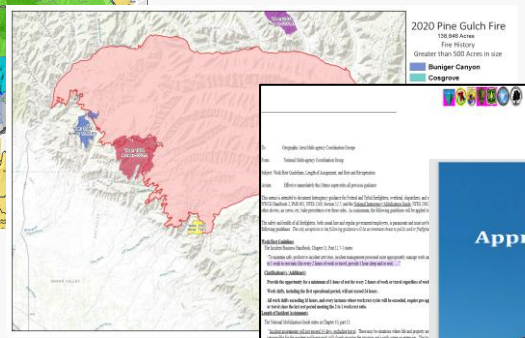
2020 WAS AN **EXCEPTIONAL** DROUGHT YEAR WITH **EXTREME** FIRE POTENTIAL…

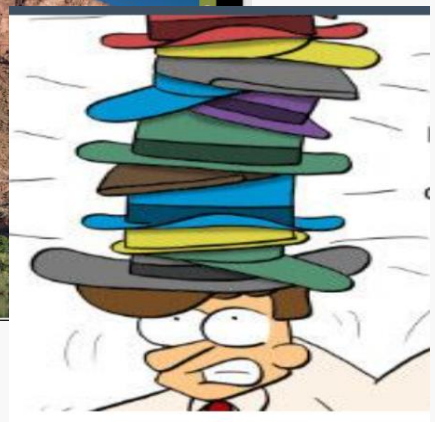
- When fires reach a certain size and growth and the risk to human life and safety is high, mechanical suppression, in the form of heavy equipment and air attack may be used
- Dozers, excavators and masticators can be implemented to create full breaks to back burn from
- When heavy equipment is used, Resource Advisors (READs) are deployed to minimize impacts to the resource
    - Waterways and fish habitat
    - Threatened and Endangered plants and animal habitat
    - Archeological sites


MULE
PRO-FXT

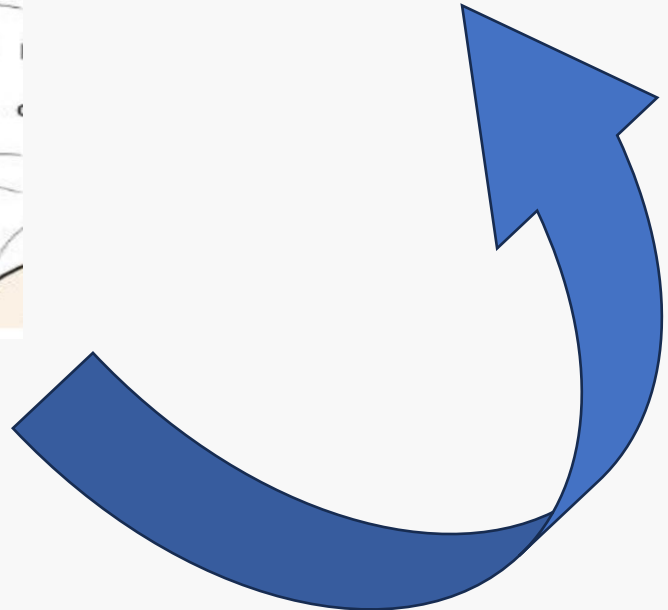
Calling the Team



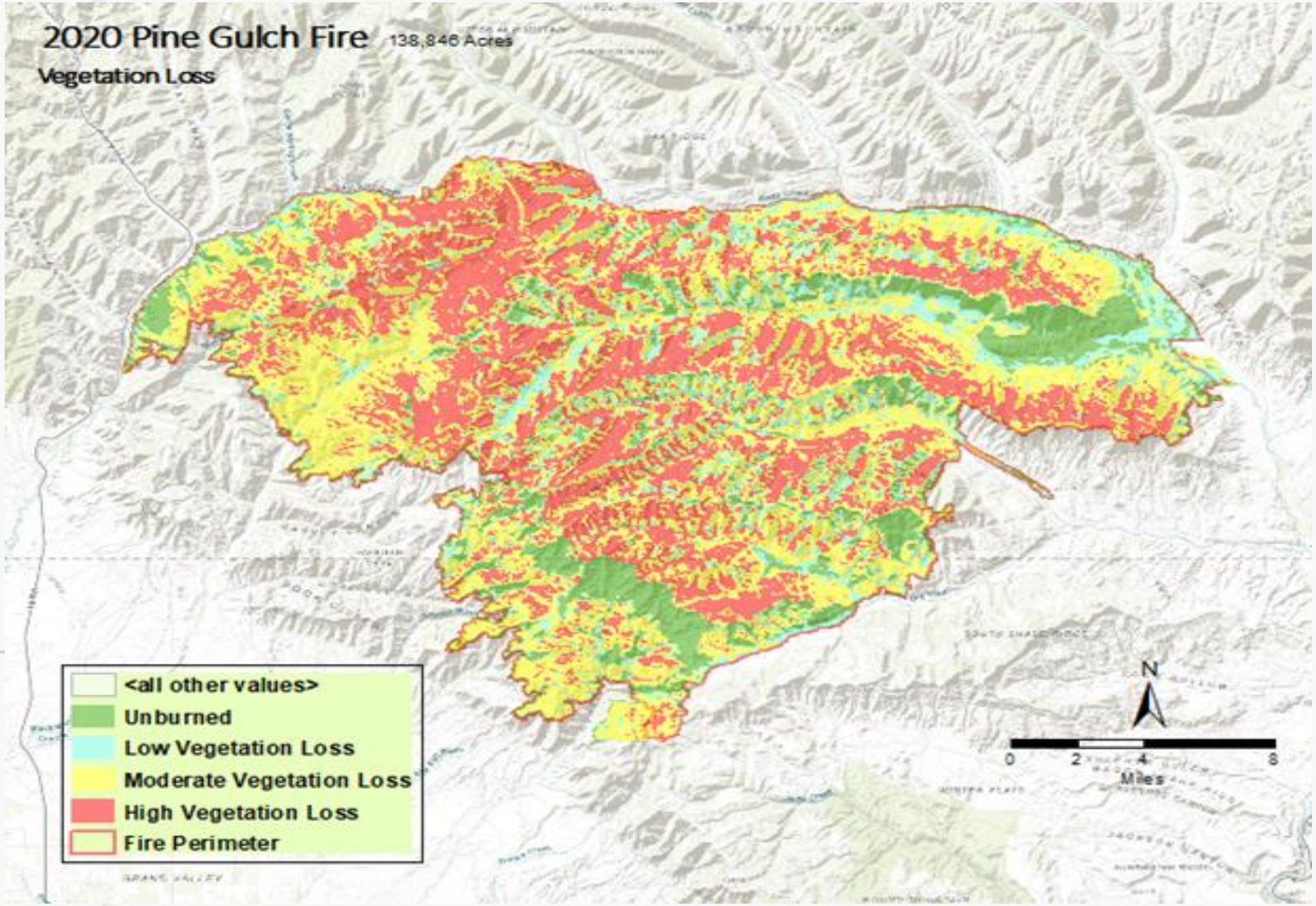




- Long fire duration
- Largest or large fire in FO
- Local resource staff running out of gas working
- Local workload
- Suppression, READ, REAF, Suppression Repair, ES&R
- After the fire dealing with working groups, AG, REC, O&G



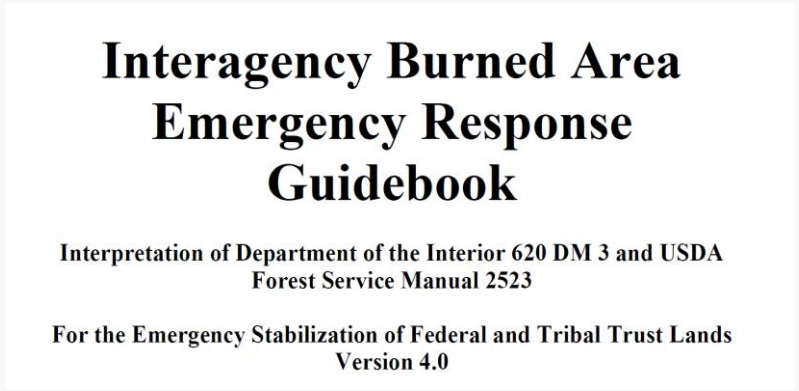
BARC


2020 Pine Gulch Fire
138,846 Acres
Vegetation Loss
<all other values>
Unburned
Low Vegetation Loss
Moderate Vegetation Loss
High Vegetation Loss
Fire Perimeter
N
0
2
4
8
Miles

BAER Response, Process and VARS

- Policy
- Team
- Time
- Issues, Observations, Findings, Recommendations

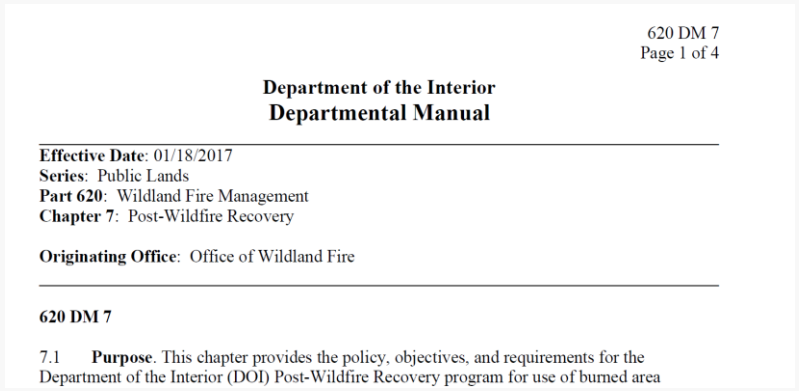
Policy and Guidance



Interagency Burned Area Emergency Response Guidebook

Interpretation of Department of the Interior 620 DM 3 and USDA Forest Service Manual 2523

For the Emergency Stabilization of Federal and Tribal Trust Lands
Version 4.0



620 DM 7
Page 1 of 4

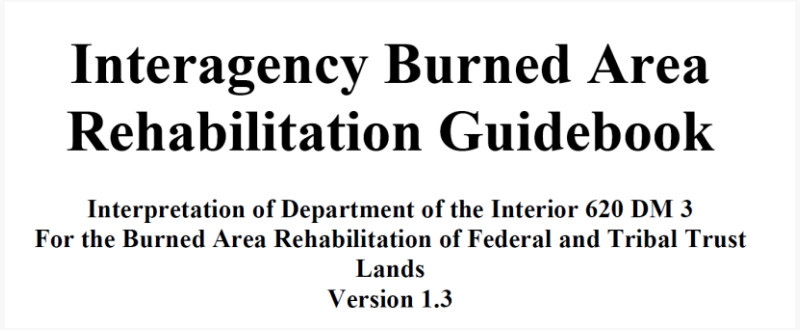
Department of the Interior
Departmental Manual

Effective Date: 01/18/2017
Series: Public Lands
Part 620: Wildland Fire Management
Chapter 7: Post-Wildfire Recovery

Originating Office: Office of Wildland Fire

620 DM 7

7.1 **Purpose**. This chapter provides the policy, objectives, and requirements for the Department of the Interior (DOI) Post-Wildfire Recovery program for use of burned area



Interagency Burned Area Rehabilitation Guidebook

Interpretation of Department of the Interior 620 DM 3
For the Burned Area Rehabilitation of Federal and Tribal Trust Lands
Version 1.3

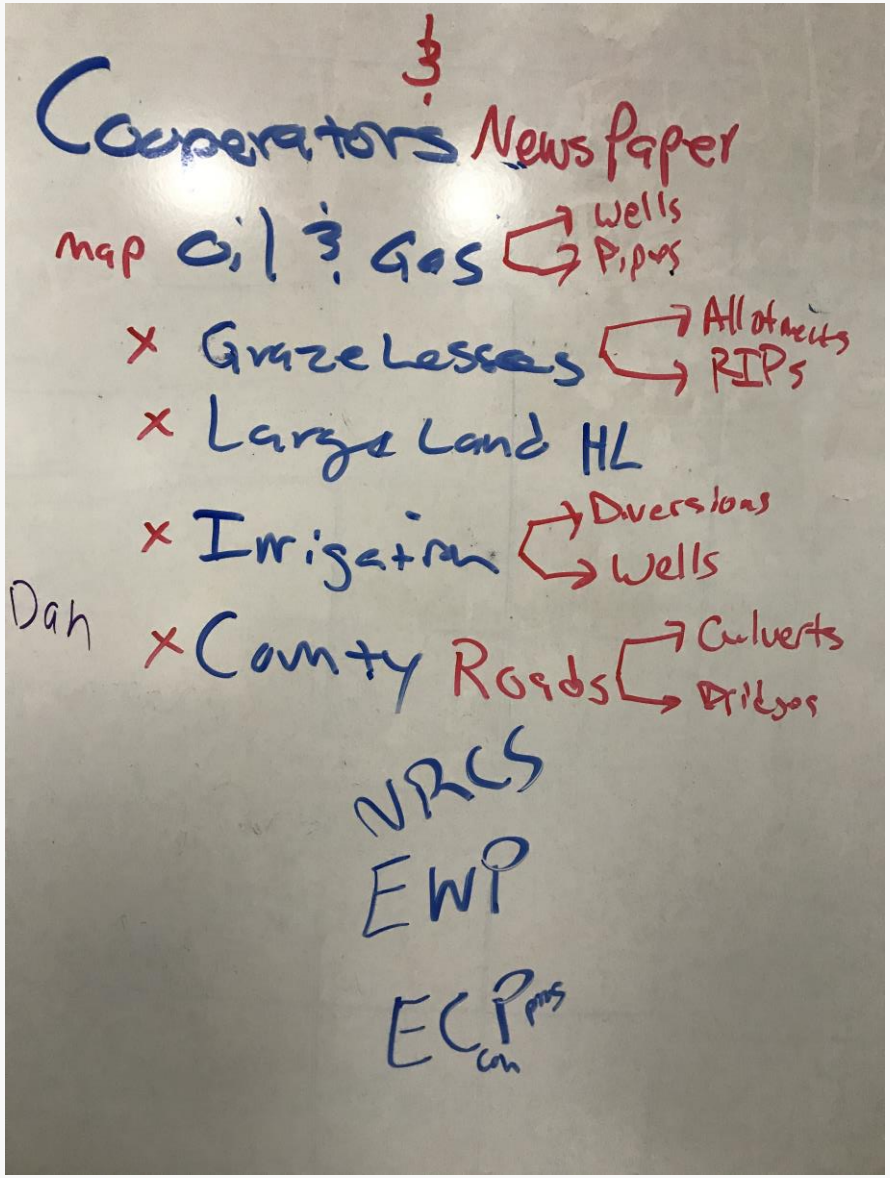
Funding Mechanisms for BLM include and Emergency Stabilization and Rehabilitation (ESR) funds for immediate use and Burned Area Rehabilitation (BAR) funds for years proceeding years

Interdisciplinary BAER Team

Position	***Name & Affiliation***
Team Leader	Chris Holbeck, National Park Service
Deputy Team Leader	Ken Griggs, U.S. Fish & Wildlife Service
BLM BAER Coordinator	Brad Jost, Bureau of Land Management
Hydrologist	Kevin Hyatt, Bureau of Land Management
Vegetation	Anna Lincoln, Bureau of Land Management
Range/Weeds	Erin Kowalski, Bureau of Land Management
Range	Robert Price, Bureau of Land Management
Modeling	Mary Ellen Miller, Michigan Tech
Wildlife	Diane Mastin Dixon, Bureau of Land Management
Public Information	Eric Coulter, Bureau of Land Management
Wildlife	Russ Knight, Natural Resource Conservation Service
Recreation/Roads	Dan Gourley, Bureau of Land Management
Hydrologist	Scott Sheppard, Bureau of Land Management
Hydrologist	Shauna Jensen, U.S. Forest Service
Fish Biology/Hydrology	Rich Pyzik, U.S. Forest Service
GIS	Kenny Elsner, U.S. Fish & Wildlife Service

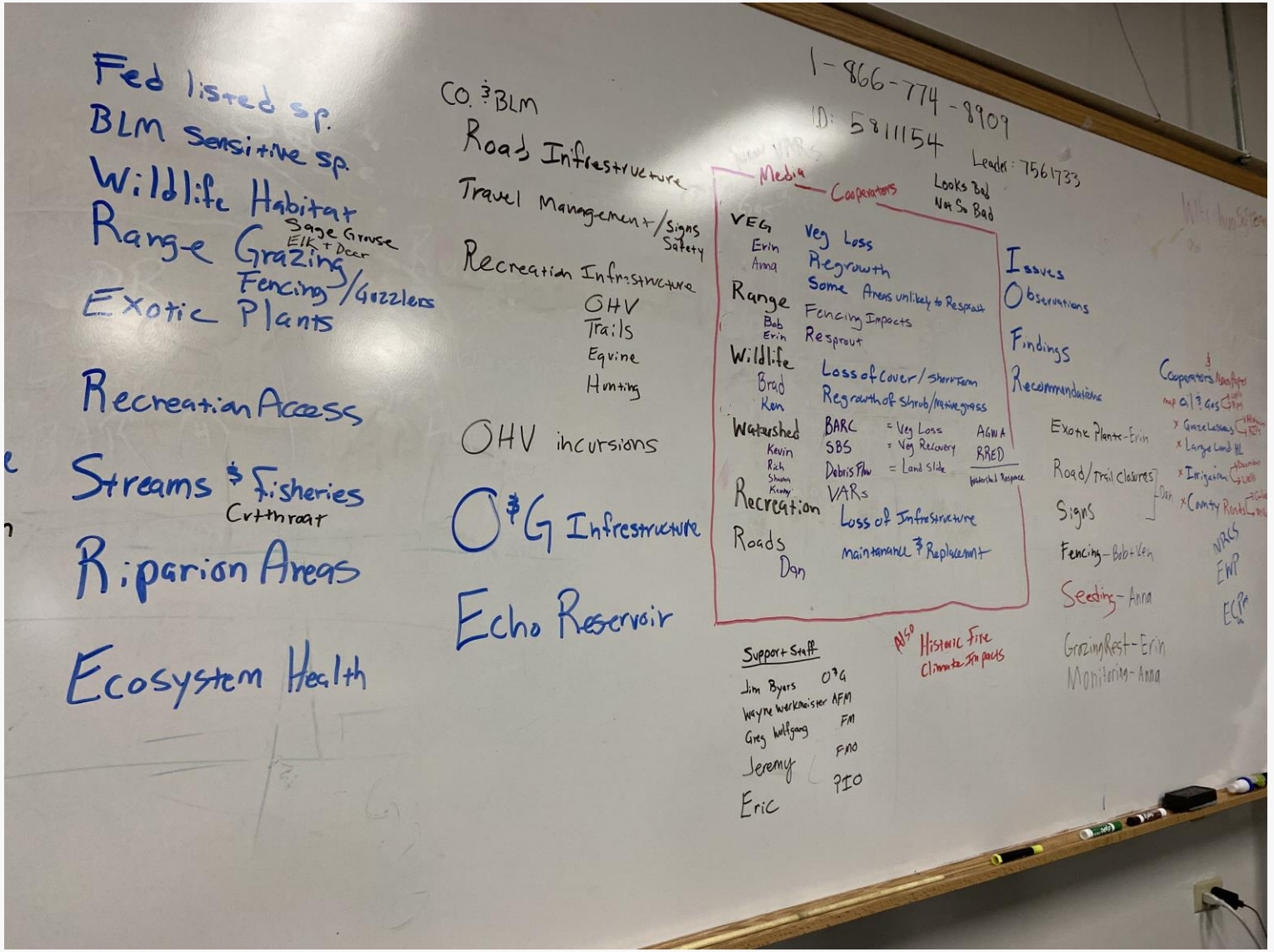
Private Land Owners, Partners, Stakeholders

- Livestock lessees
- Oil and Gas developers
- County roads
- Irrigators
- NRCS (EWP)
- Down stream assets (city, highway)
- Large land owners
- Small land owners
- State Colorado river



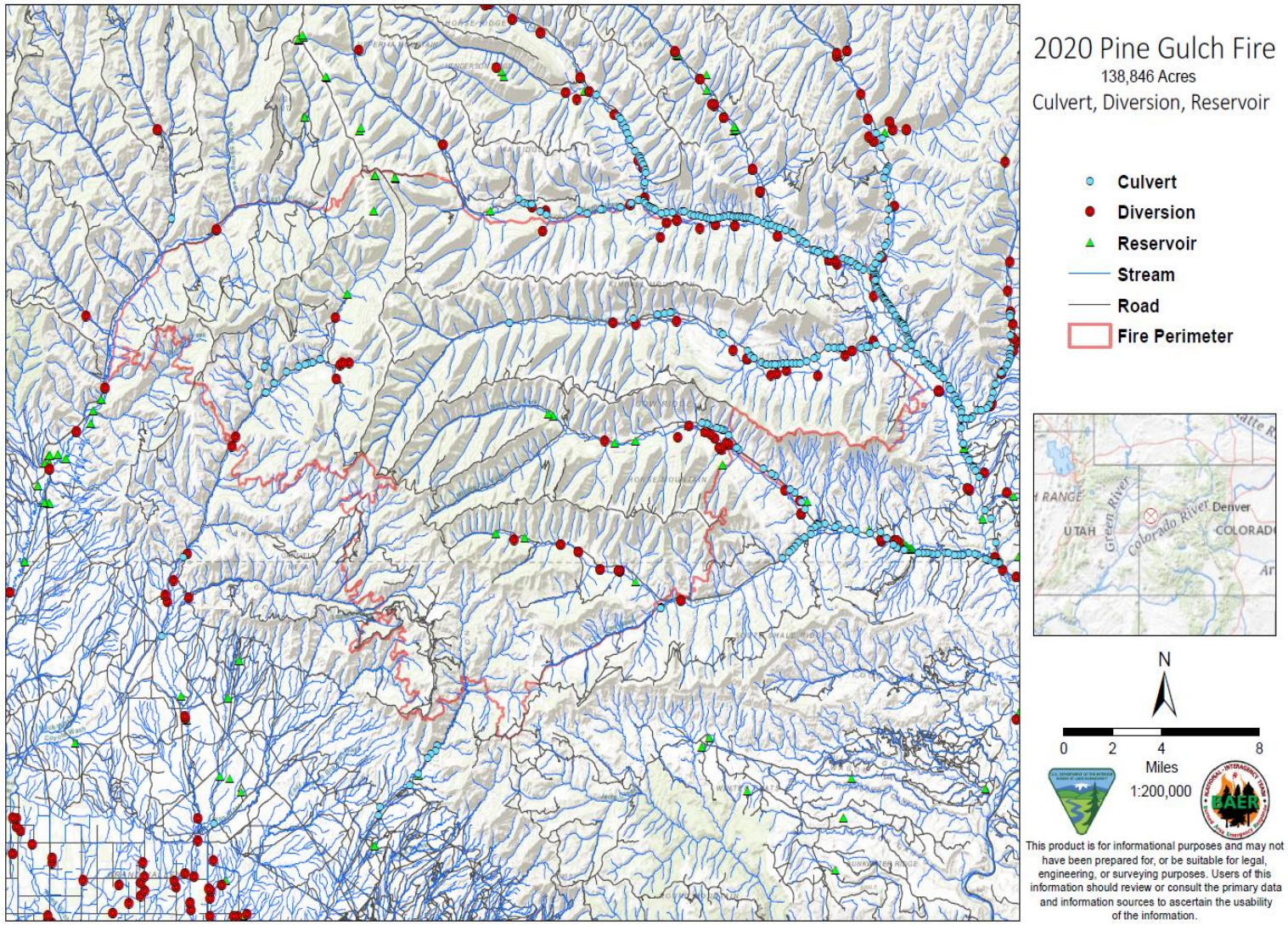
The BAER assessment process

Issues
Observations
Findings
Recommendations



Values at Risk

- Range
- Recreation
- Roads
- Watershed
- Echo Lake
- Homes
- Oil and Gas Infrastructure
- Culvert



E-Table

Plan Organization

Spec #	Title	FY 21	FY 22	FY 23	FY 24	FY 25	Total	Funding Account
1	Noxious Weed Treatment	$186,027	$118,859	$118,859	$75,565	$75,565	$574,875	ES and BAR
2	Aerial Seeding	$3,698,104					3,698,104	ES
3	Monitoring	$65,000	$50,000	$50,000			$165,000	BAR
4	Fence Repair	TBD	TBD	TBD			TBD	BAR
5	Supplemental Water Source Maintenance	$11,360	$11,360	$11,360			$34,080	BAR
6	Signage and Trespass Prevention	$11,740					$11,740	ES
7	Trail Repair	$16,150					$16,150	BAR
8	Road Drainage Improvement	$27,000					$27,000	ES
Total		**$4,015,381**	**$180,219**	**$180,219**	**$75,565**	**$75,565**	**$4,526,949**	

This plan includes a narrative summary of the Pine Gulch Fire, followed by in-depth resource or issue specific burned area assessments, and itemized specifications for BAER treatments and activities. Appendices are found at the end of the plan.

TINEL
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Low 57
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Up from the ashes

Cory Gardner addres
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and debates Saturd
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Court

By CHARLES

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Republicans who
U.S. Senate to do w
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a U.S. Supreme Co
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Republicans w
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Antonin Scalia
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Barack Obama
him.
At that time, G
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named until after
As a result, Republ
controlled the Sena
they do now decline
confirmation hearin
Obama's nominee,
next president shou
say in that decision
Scalia died nine m
before that year's el
But instead of rep
those sentiments on
before this year's pr
election, Senate Ma
er Mitch McConnell
said the Senate wou
any nominee that th
chooses to appoint.
To date, Gardner
whether confirmati
should be held unti
election. He declin
a direct question o
during Saturday's
bates in Grand Ju
"I hope that be
tics begin, becau
plenty of time fo
have some time
to reflect on the

Photos by CHRISTOPHER TOMLINSON/The Daily Sentinel

Burnt areas from the Pine Gulch Fire engulf an oasis of beginning fall colors in the cottonwood trees off Kimball Road in Garfield County. An emergency response team is evaluating the effects of the fire and assessing the soils to determine how to start restoring the 139,000 acres.

Team assesses aftermath of Pine Gulch Fire

By DENNIS WEBB
Dennis.Webb@gjsentinel.com

Heading west up Kimball Creek Road northwest of De Beque into the near-heart of where the Pine Gulch Fire burned, visitors see charred and denuded slopes that extend for miles. It's a scene arguably starker than what is visible driving on Interstate 70 through Glenwood Canyon, where the Grizzly Creek Fire shut down the interstate for two weeks in August.

The nearly contained Pine Gulch Fire is far bigger — at about 139,000 acres, the biggest in Colorado history — and it ap-

Burning shale may require winter snows to extinguish it, experts say. **See more photos of the burn area on Page 8C and on GJSentinel.com.**

that their engines are on fire, but it turns out they're passing oil shale outcrops still smoking from the blaze.

The Pine Gulch Fire was a transformative event, even when looked at through the eyes of experts trained to evaluate fire impacts, such as the Burned Area Emergency Response team that has been doing just that.

"Visually, when you come out here, you go, 'wow, it looks terrible,' " said Shauna Jensen, a team member who also is a hydrologist for the San Juan National Forest.

Mapping that the team did as part of its assessment only reaffirmed that gut feeling. Using pre- and post-fire aerial imagery, it shows widespread swaths of red indicating high vegetation loss, especially on north-facing slopes that had been home to greater growth of species such as Douglas fir. Much of the remainder of the map shows moderate vegetation loss, with fairly little of it depicting minimal losses or areas that went unburned.

"That's really alarming, that's frightening," Chris Holbeck, leader of the BAER team, said of the amount of red

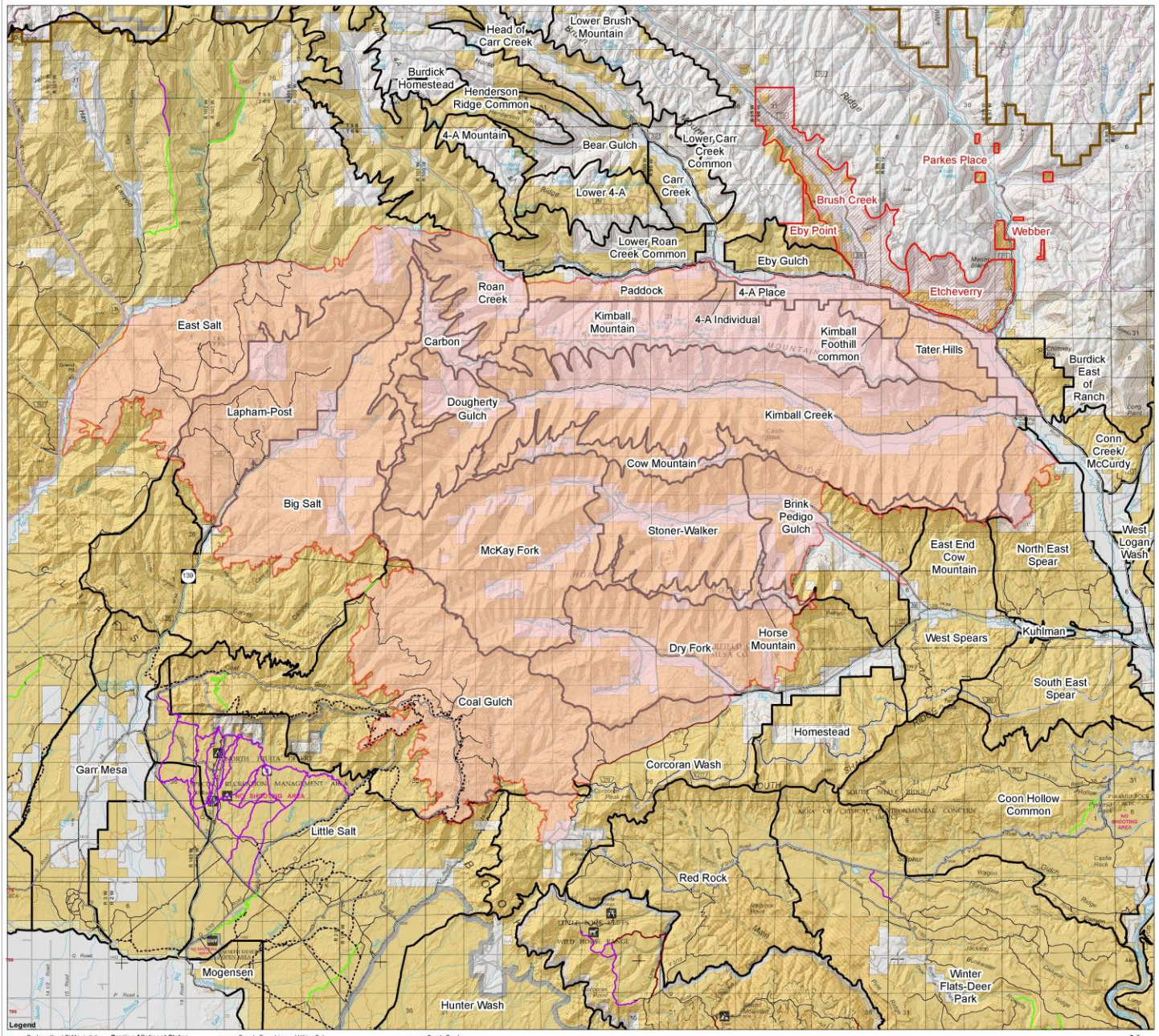
As it turns out, it did. Motorists driving up a steep road leading to the Kimball

Community Interest and Media

Range

- 23 allotments partially or completely burned (~5700 AUMs (Animal Unit Months)
- Burned Infrastructure
- Noxious weeds released by fire

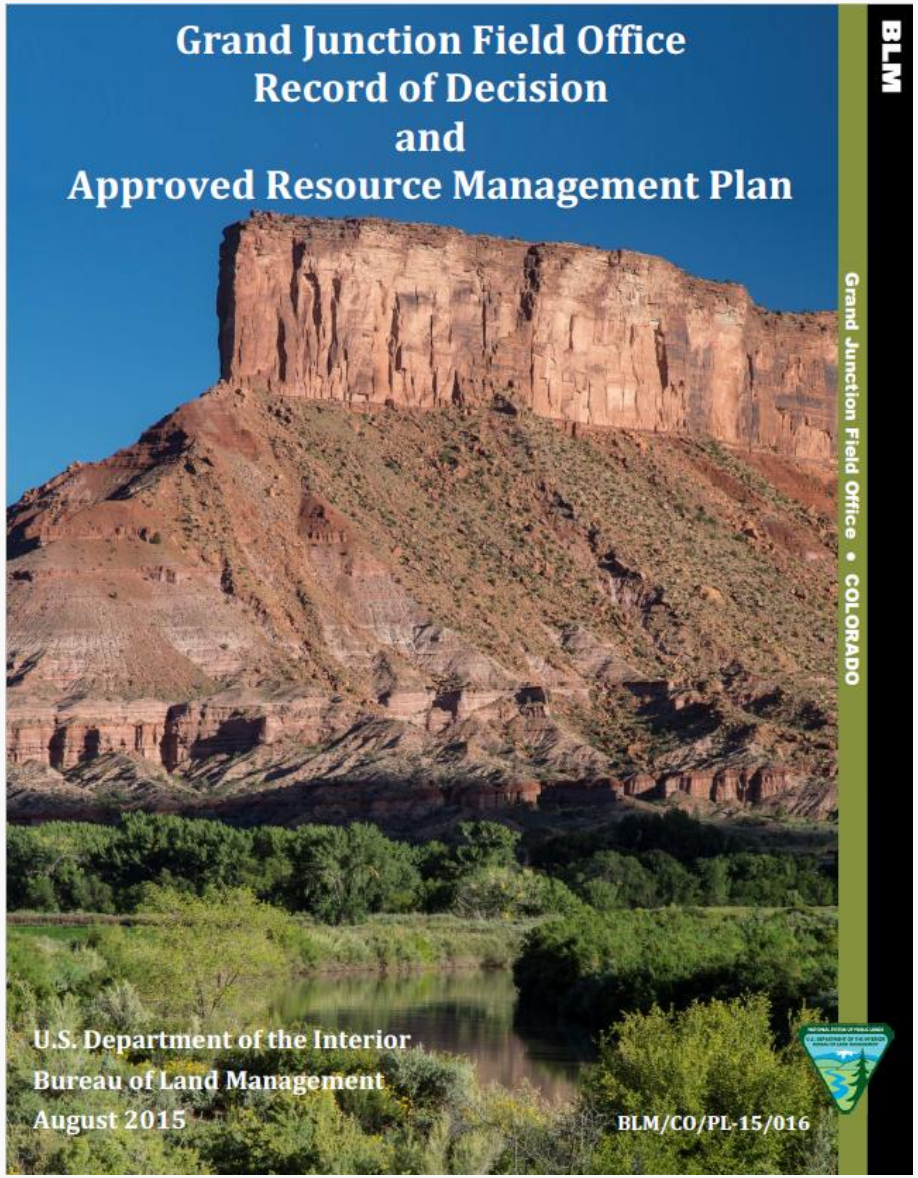
Pine Gulch Fire - Grazing Allotment Map



RMP and ESR guidelines

Design Emergency Stabilization (ES) treatment actions based on the severity of the wildfire impacts. ES priorities include, but are not limited to, areas where:

- Soils are highly susceptible to accelerated erosion or water quality protection is required.
- Perennial grasses and forbs are not expected to provide soil and watershed protection within two years.
- Unacceptable vegetation, such as noxious weeds, may invade and become established.
- It is necessary to quickly restore threatened, endangered, or special species habitat populations to prevent adverse impacts.



RMP and ESR guidelines

Design Burned Area Recovery (BAR) treatment actions based on the severity of wildfire impacts. BAR priorities include, but are not limited to:

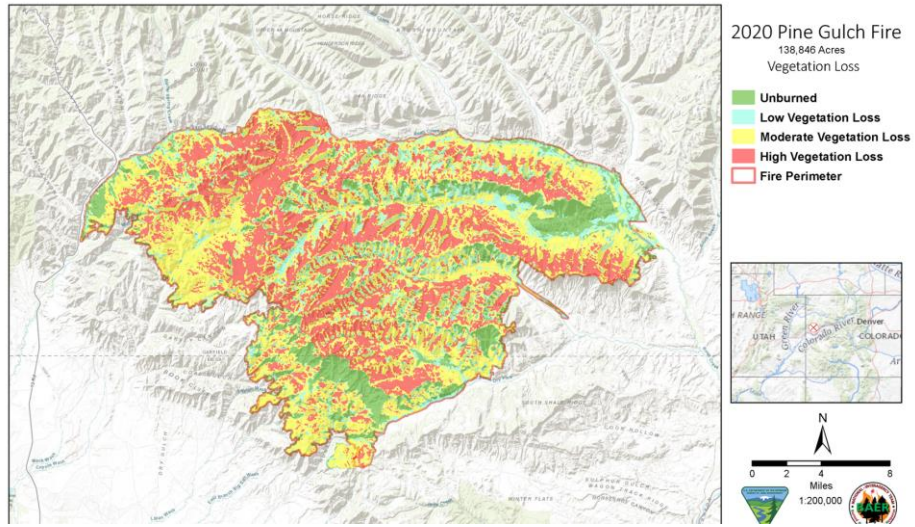
- **Repairing or improving lands unlikely to recover naturally.**
- Implementing weed treatments to remove invasive weeds and planting native or non-natives to restore or establish healthy ecosystems.
- Planting to reestablish native trees.

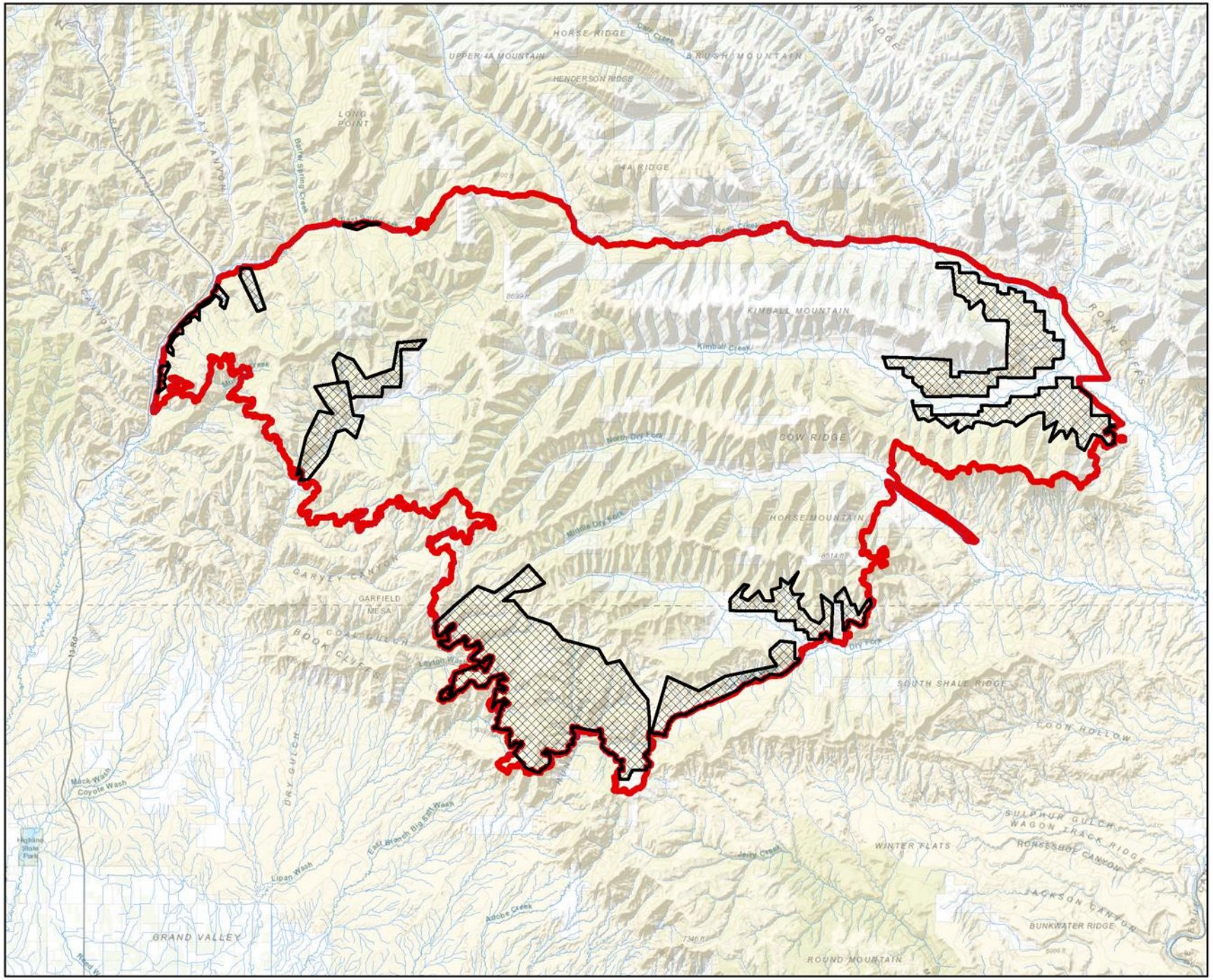
ESR/BAR Funds

- Awarded money for
  - Fence and water improvement project replacement (not including labor)
  - Seeding native plants
  - Funds to hire and implement noxious weed treatments

Where to seed?

- Land Health Assessments
  - Areas with known cheatgrass infestations, low native cover
  - Ecological Site Descriptions, pinyon juniper woodlands vs. oakbrush stands
- Slopes <25%
- Vegetation Loss Model





2020 Pine Gulch Fire

138,846 Acres

Seeding Areas

- Seeding Areas
- Stream
- Fire Perimeter
- BLM
- Private
- LG
- USBR

N

0 2 4 8

Miles

1:200,000

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.


N2067E
JCB

Range

RMP mandated a 2-year closure to grazing- especially important for seeded areas

Infrastructure was replaced the following seasons

Monitoring was conducted, but was insufficient for returning to grazing

Recreation

Recreation Impacts

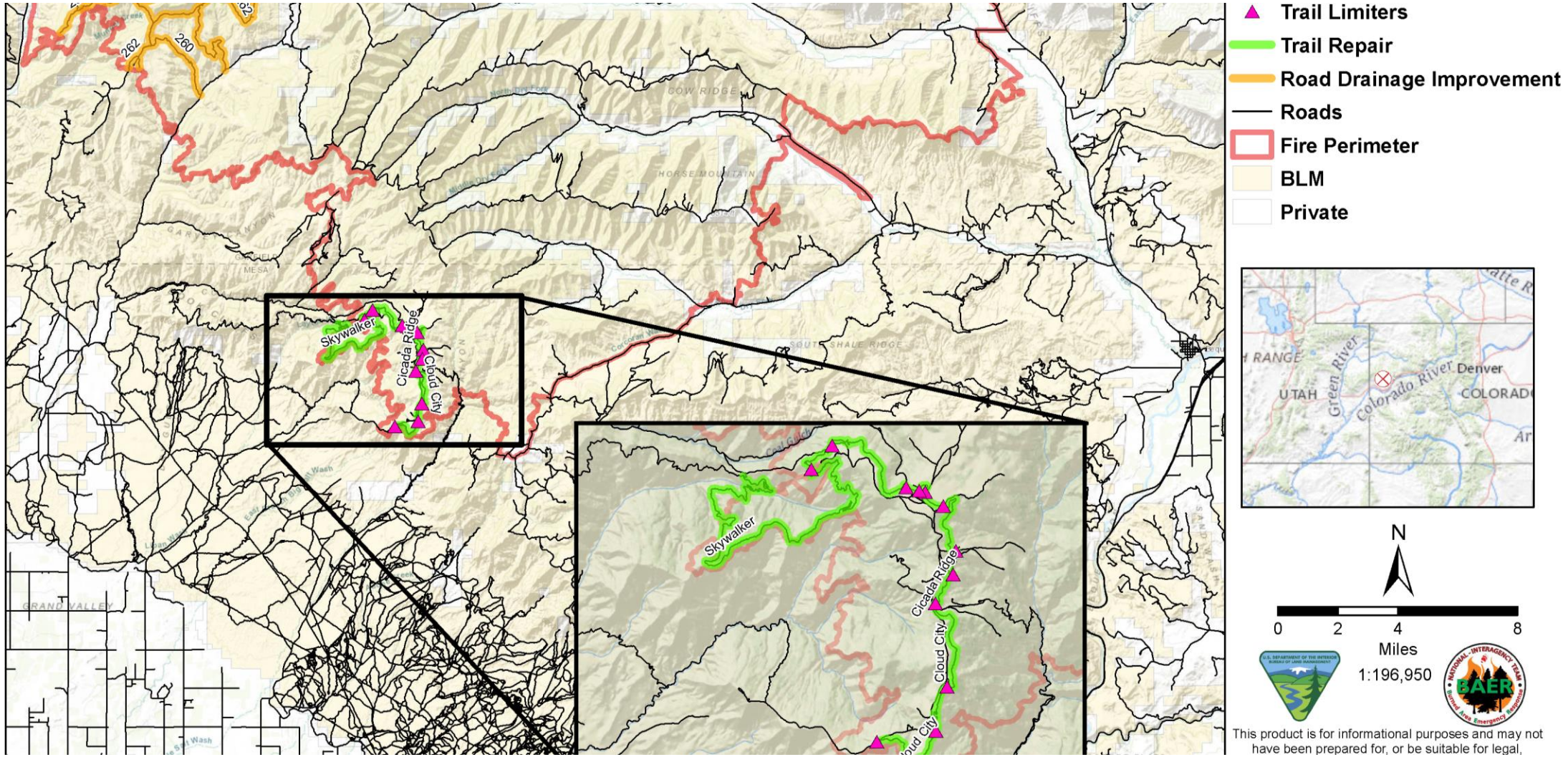
Immediate closures (Biking, 4X4-ing, Hunting)

Trail damage (~90 miles within burn area)

Damage to signs/infrastructure

Existing vegetation to keep users on trail

Post fire erosion


Trail Limiters
Trail Repair
Road Drainage Improvement
Roads
Fire Perimeter
BLM
Private
Skywalker
Cicada Ridge
Cloud City
Denver
UTAH
COLORADO
Green River
Colorado River
N
0
2
4
8
Miles
1:196,950
BAER
This product is for informational purposes and may not have been prepared for, or be suitable for legal,

Economics

- Economic impact
  - The total impact of outdoor recreation in Mesa County is 7.2% of GDP (gross domestic product) and 11 % of jobs
  - 4.8% direct outdoor recreation economic impact is higher than the state average of 3.1%

Source: The Economic Impact of Outdoor Recreation in Mesa County, Colorado Mesa University 2022

Recreation

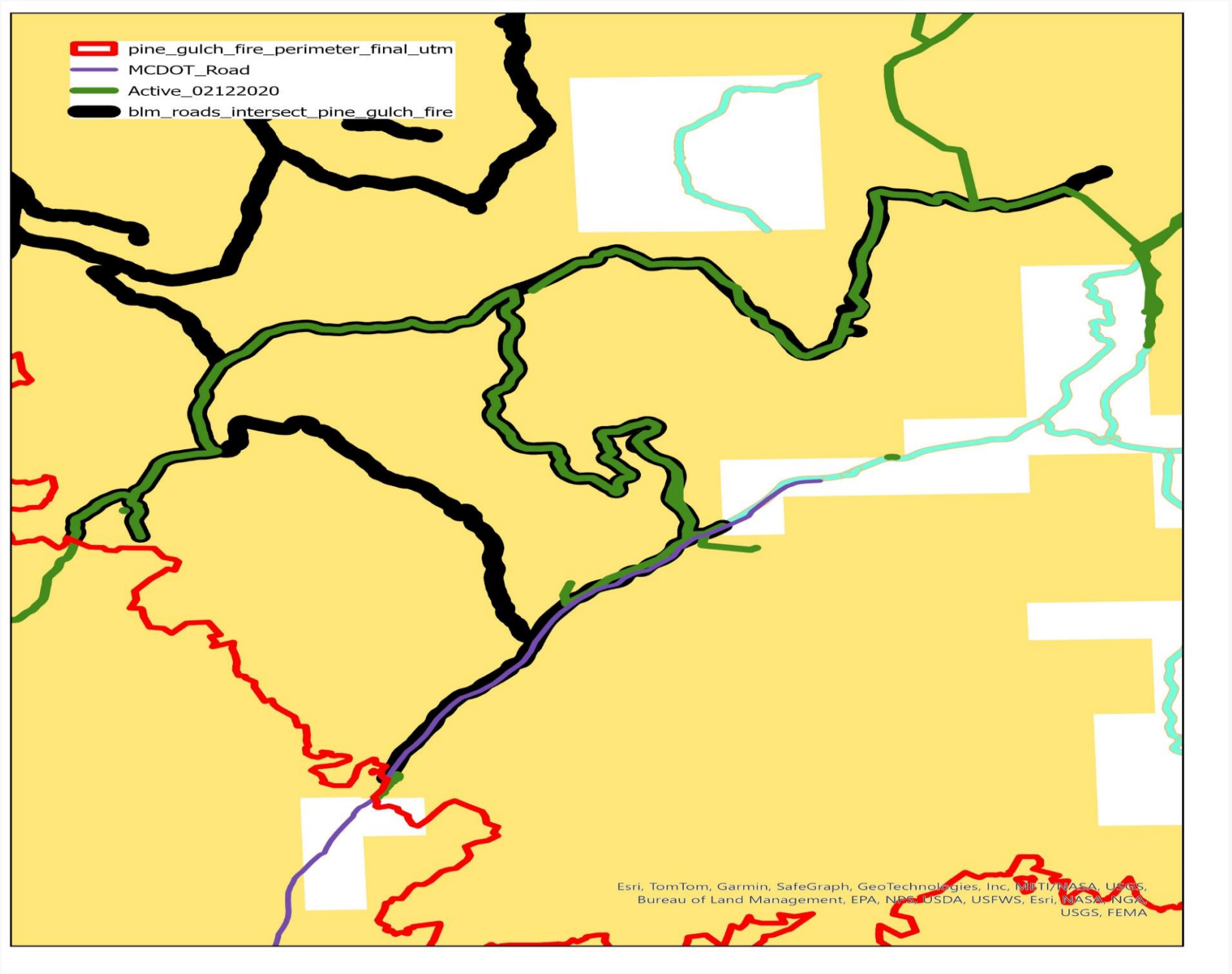
- Awarded money for
  - Sign replacement
  - Limiter infrastructure
  - Repairing trails (more damage after 2021 rains)

Before and After Picture of fenced limiter leading to existing vegetation.

Oil and Gas

- Access to facilities
- Cooperation
- Payments

Roads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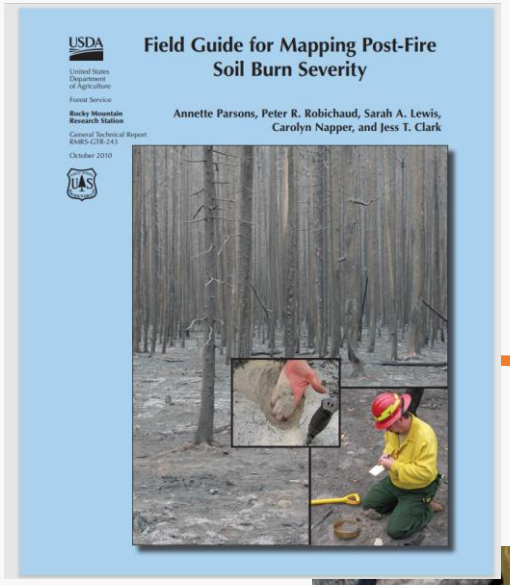
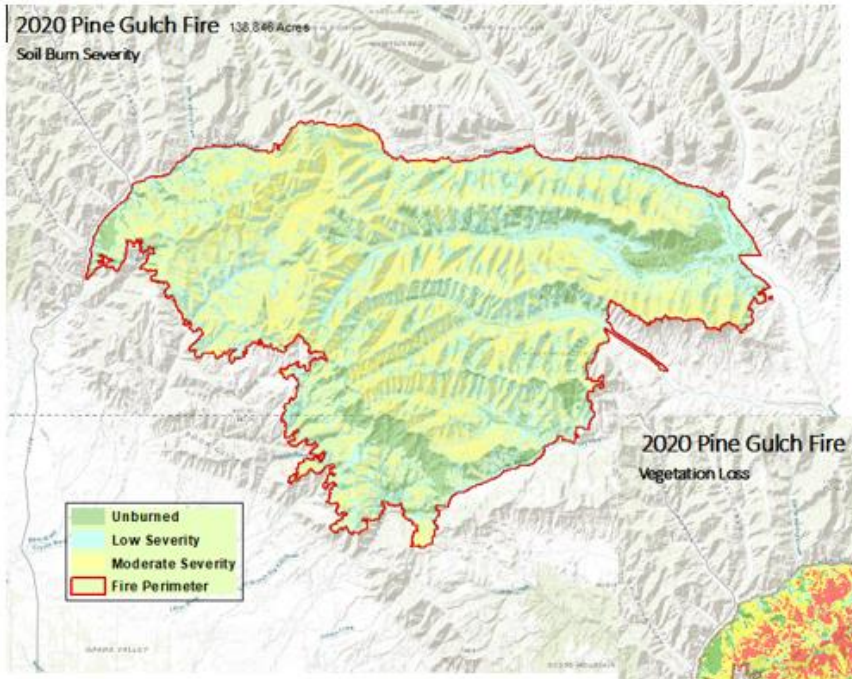
MCDOT_Road
Active_02122020
blm_roads_intersect_pine_gulch_fire
Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS,
Bureau of Land Management, EPA, NPS, USDA, USFWS, Esri, NASA, NGA,
USGS, FEMA

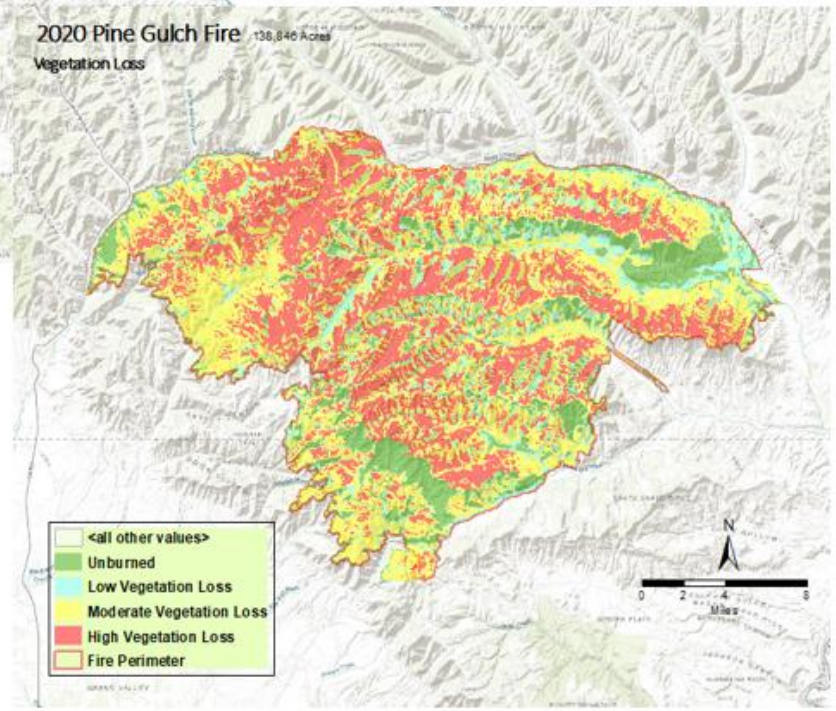
Watershed





Soil Burn Severity and Vegetation Mortality

Sprouting Grass in Kimball Creek
9/12/2020



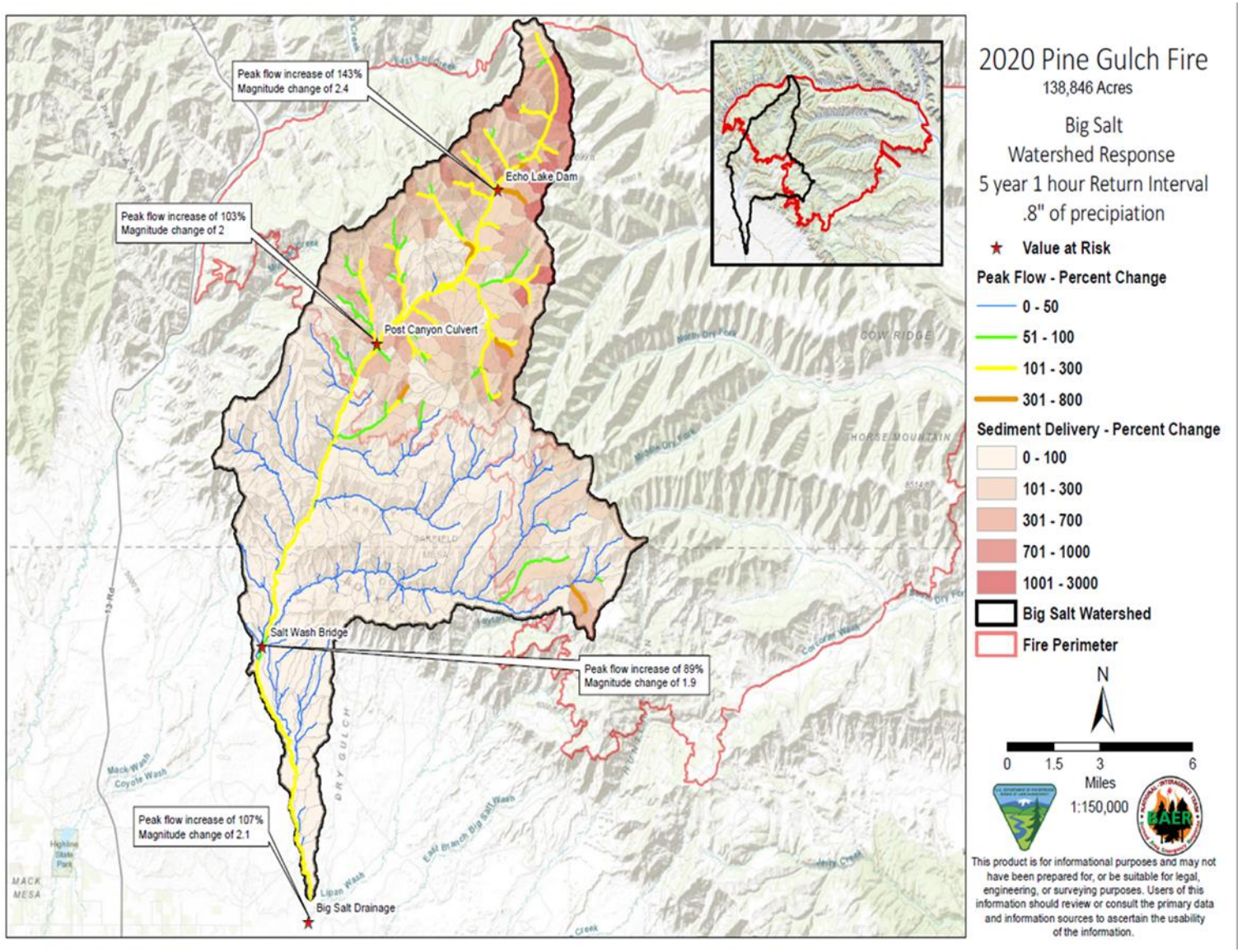
Modeling and Interpretation

"All models are wrong, but some are useful".

George E. P. Box

Modeling and Interpretation

- Percent Increase
- Magnitude of change
- Precipitation



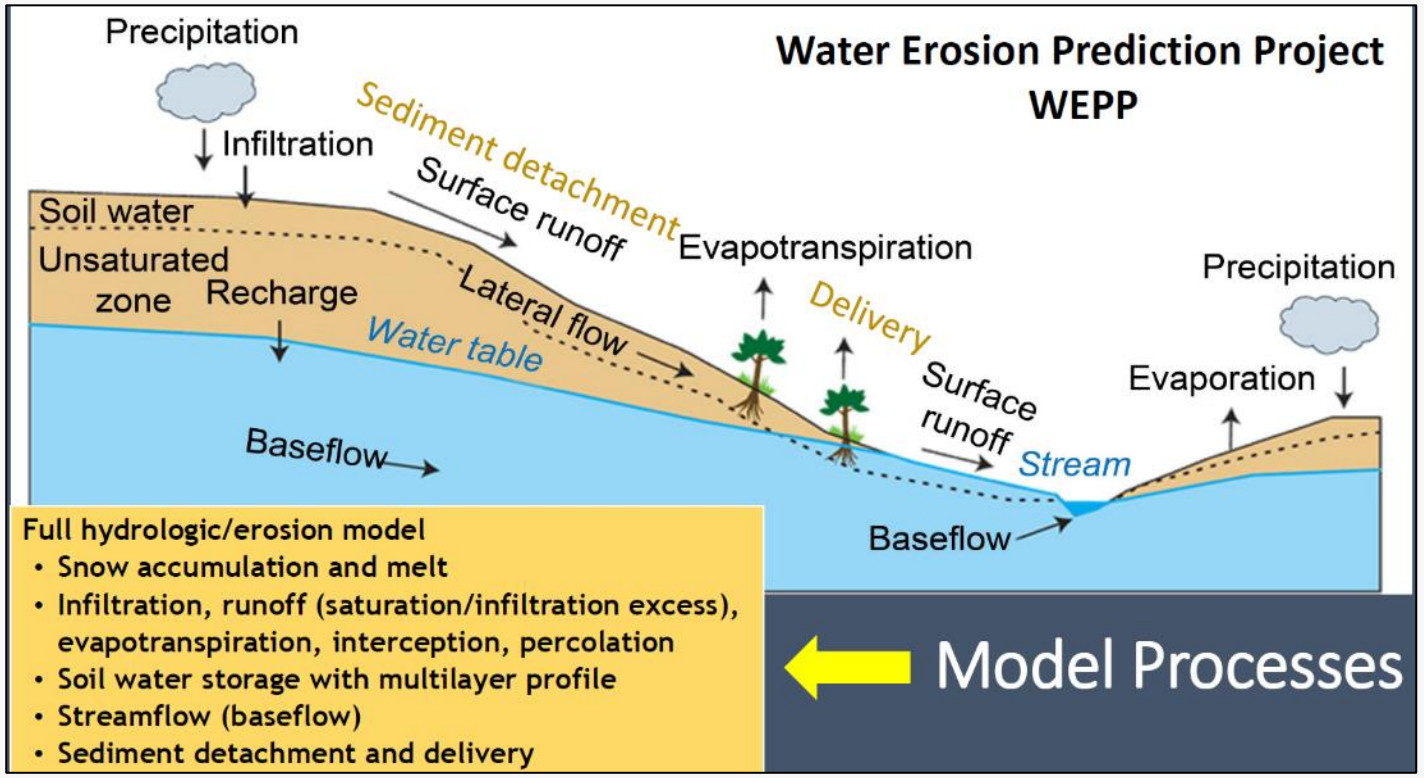
Why Model?

Quantify risk based on burn severity, soils, topography and climate
Triage VARs within the fire and determine risk
Determine post fire watershed condition
Validate level of Risk to the Values at Risk
Prioritize VAR protection
To support taking action or not
To substantiate a legally defensible process that will standup in court
To identify threats to values at risk to make decisions to protect life and property
Support hydrologist's professional opinion
Parse out the fire in high, med, low watershed response

The Water Erosion Prediction Project (WEPP)

- **Hillslope Version**
  - **Models a 1-m wide strip with a complex slope distribution**
  - **For a field, harvest unit, hillslope polygon or road segment**
- **Watershed Version**
  - **Watershed = hillslopes + channels + impoundments**
  - **For watersheds up to about (1000 acres / 400 ha / 1.5 sq miles)**
    - **Bigger with distributed climates**
    - **10 – 20 sq miles**

- Hillslope interfaces
  - WEPP Windows
  - Forest Service FSWEPP Interfaces
    - Disturbed WEPP, ERMiT, WEPP:Road
    - Batch interfaces for multiple runs
  - ARS online for Ag Applications

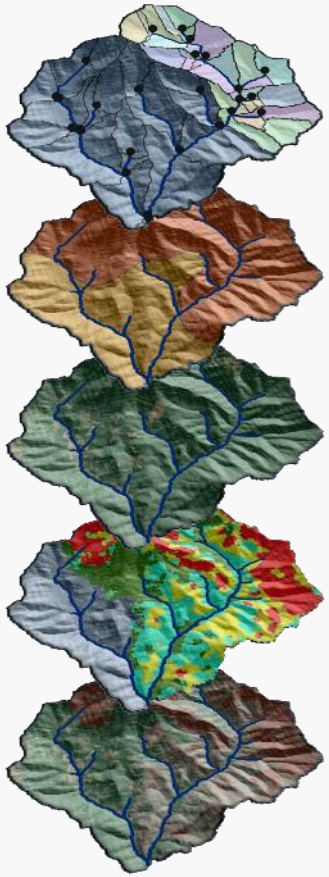


- Watershed interfaces
  - WEPP Windows
    - For terraces or other construction planning
  - GeoWEPP in ArcMap 10.4 and earlier
  - QWEPP in QGIS
  - WEPP Cloud online

https://forest.moscowfsl.wsu.edu/fswepp/

AGWA/KINEROS2 Automated Geospatial Watershed Assessment/Kinematic Runoff and Erosion Model (K2)

AGWA uses GIS information to assign parameters to K2 and provides a framework to run and view K2 model results.

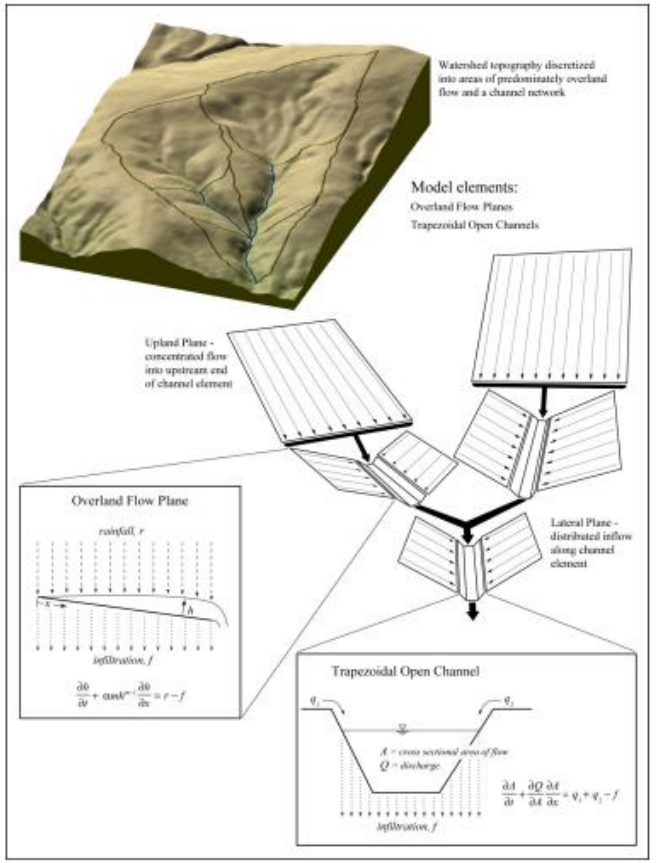


DEM defines watershed and model elements

NRCS and NLCD are used to assign model parameters within AGWA

Soil burn severity is used to alter landscape parameters to burned condition

KINEROS2 is a distributed runoff and erosion model that uses 1-D kinematic equations



- K2 only models infiltration excess runoff processes, and does not model lateral flow
- Multiple rain gage and radar precipitation inputs are possible for K2, but not within the AGWA framework
- Continuous (annual scale) versions of K2 exist, but post-fire threats are typically assessed at the event scale

https://www.tucson.ars.ag.gov/agwa/

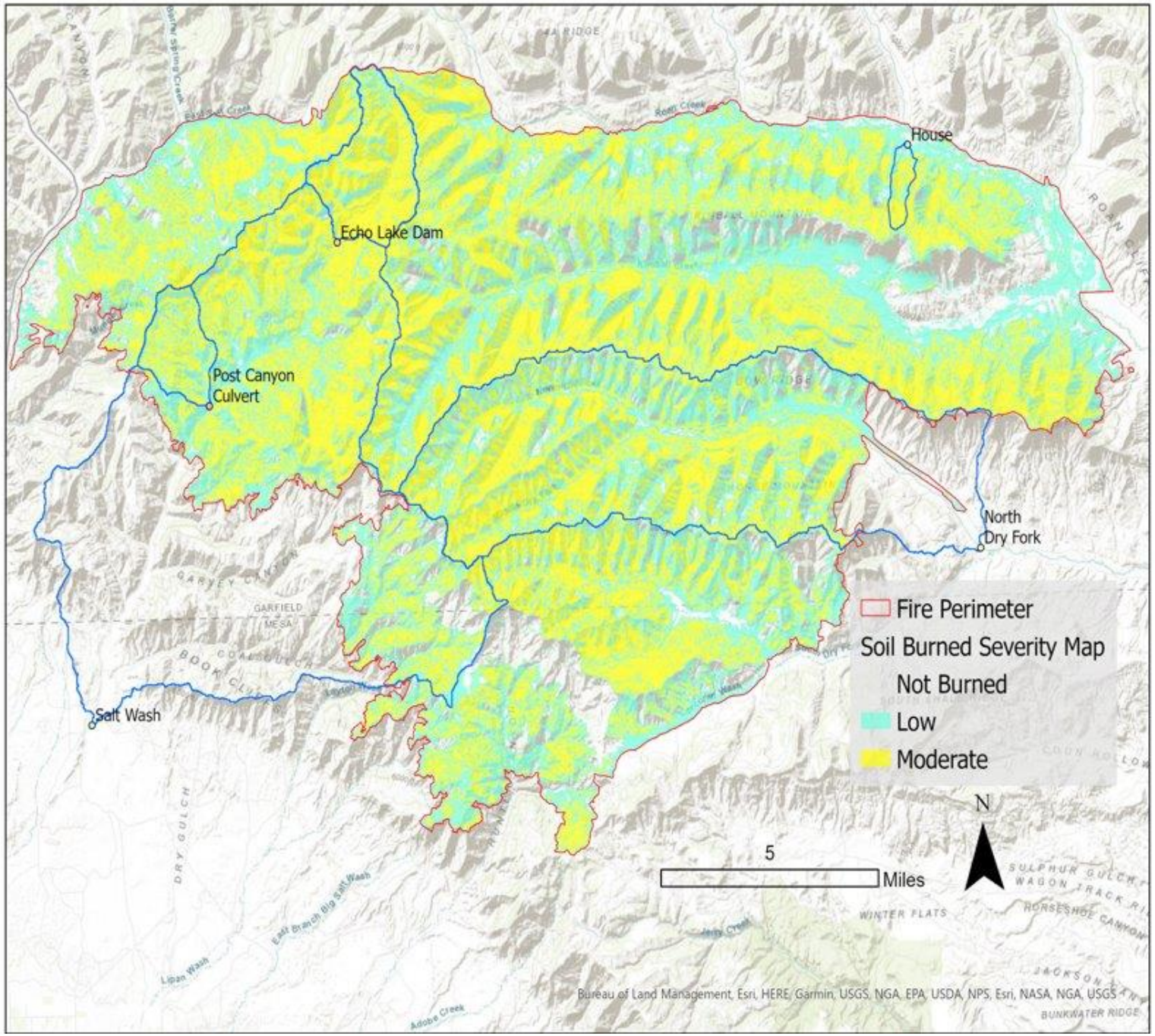
https://www.tucson.ars.ag.gov/kineros/

USGS Post Wildfire Debris Flow Hazard model

- The USGS Post Wildfire Debris Flow predictions rely on empirical models to gauge the probability and magnitude of debris flows. Models were built using historical debris flow occurrences and magnitudes.
- Model Inputs:
  - differenced normalized burn ratio image (dNBR),
  - Soil Burn Severity data
  - Digital Elevation Model
  - Soils data
  - Precipitation
- Model outputs:
  - Probability of debris-flow occurrence given a peak 15-minute rainfall intensity.
  - Debris-flow volumes at the basin outlet and along the drainage network in cubic meters.

VAR Modeling Examples

- Post Canyon Culvert
- Big Salt Wash
- North Dry Fork
- Echo Lake Dam
- Residence

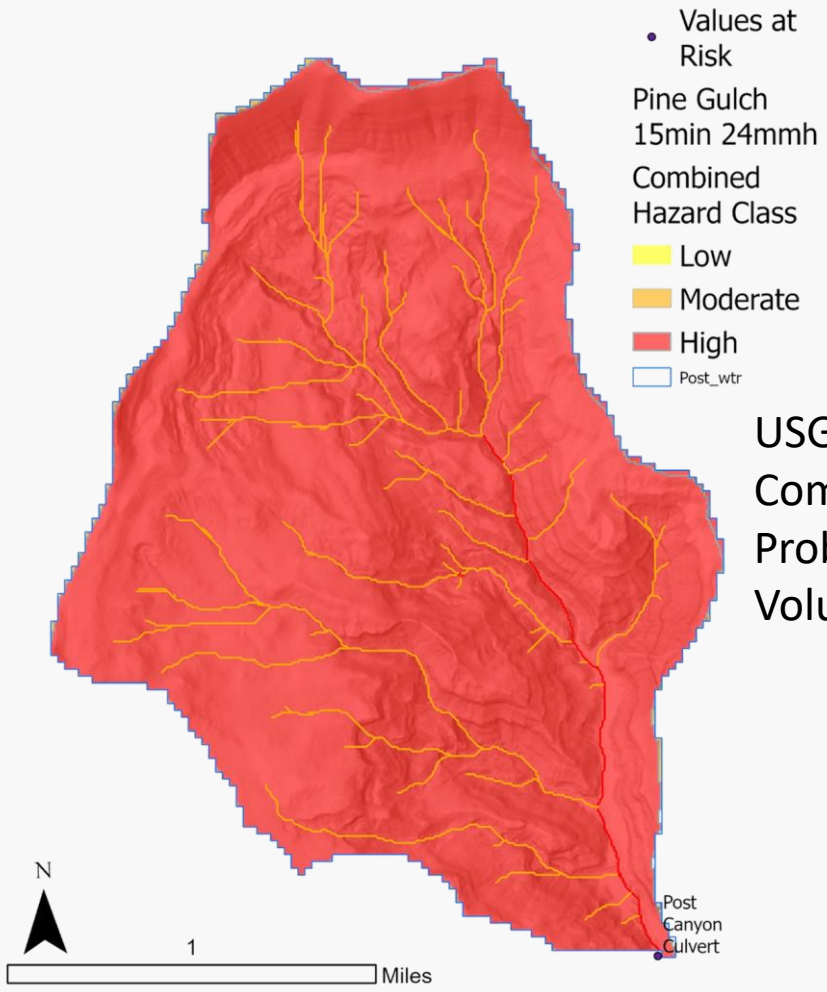


Post Canyon Monitoring

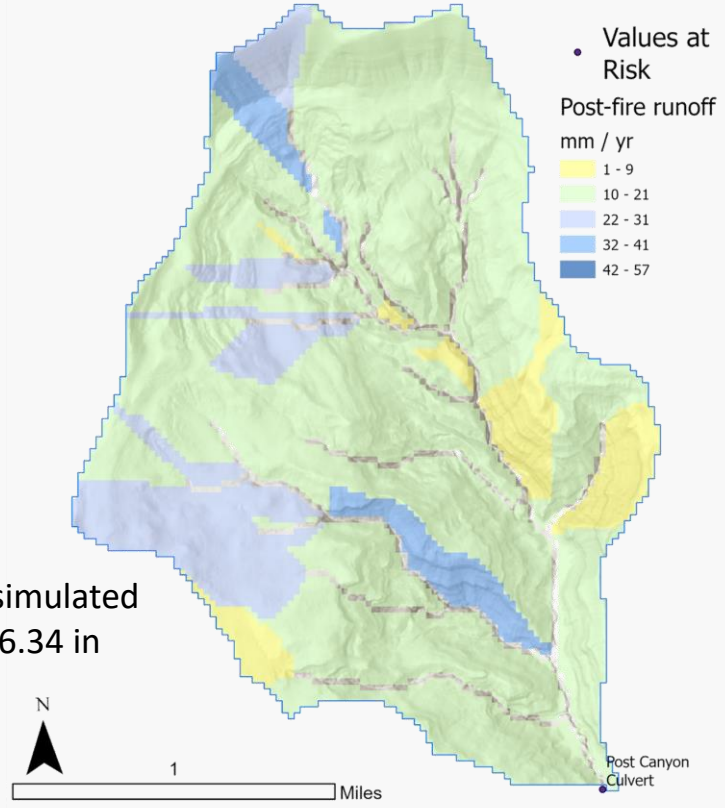
- 06/23/2021
- 08/13/2021

Post Canyon Culvert

WEPP		% Change	Magnitude Change
5 year return period	peak flow (cfs)	132%	2
	sediment delivery (tons)	0%	0
10 year return period	peak flow (cfs)	121%	2
	sediment delivery (tons)	0	0
25 year return period	peak flow (cfs)	85%	2
	sediment delivery (tons)	0	0
AGWA		% Change	Magnitude Change
5 year return period	peak flow (cfs)	103	2
	sediment delivery (lbs)	145	2.5
10 year return period	peak flow (cfs)	73	1.7
	sediment delivery (lbs)	108	2.1
25 year return period	peak flow (cfs)	63	1.6
	sediment delivery (lbs)	68	1.7



USGS Debris Flow
Combined Hazard Class: High
Probability: 60 – 80%
Volume Class: 10,000 – 100,000 m^3



WEPP Watershed area: 1,705 acres
Average annual post-fire runoff for 50 yrs of simulated
Climate: Altenbern CO annual precipitation 16.34 in
Post fire cover: Low 75%, Moderate 40%

Post Canyon Culvert

- July 27th, 2021
- County Road (Garfield)
- Oil and Gas Right of Way
- Access to private land

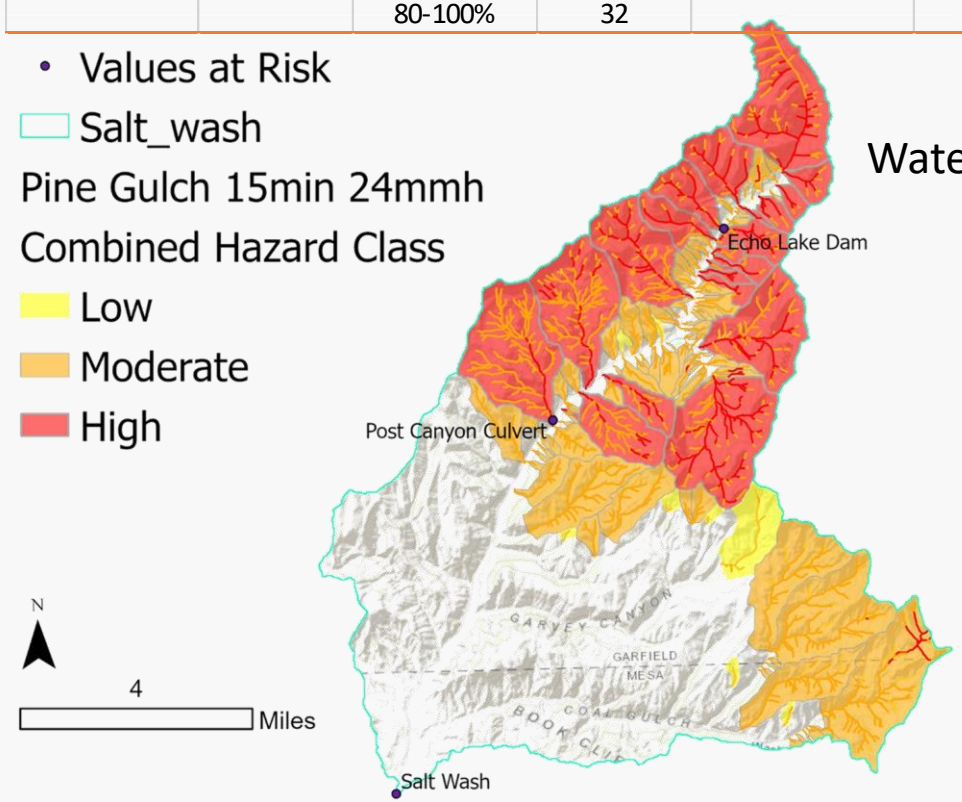
Big Salt Wash @ 16 road

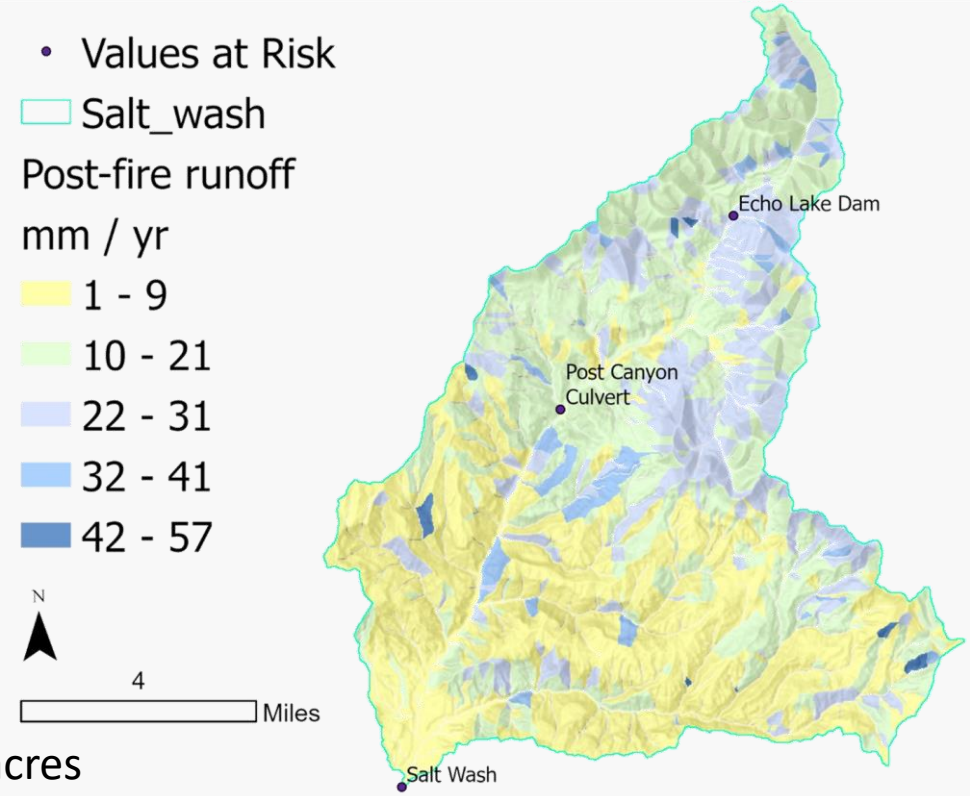
- Minor Flooding
- High Ash Content
- August 4th, 2021

Big Salt Wash

USGS Debris Flow Model: 127 Basins

Combined Hazard Class	Number of basins	Probability	Number of basins	Volume Class	Number of basins
Low	10	< 20%	2	<1,000 m^3	63
Moderate	95	20-40%	14	1,000 – 10k m^3	49
High	22	40-60%	33	10k – 100k m^3	15
		60-80%	46		
		80-100%	32		





Watershed area: 44,656 acres

WEPP		% Change	Magnitude Change
5 year return period	peak flow (cfs)	95%	2
	sediment delivery (tons)	232%	3
10 year return period	peak flow (cfs)	112%	2
	sediment delivery (tons)	98%	2
25 year return period	peak flow (cfs)	84%	2
	sediment delivery (tons)	28%	1
AGWA		**% Change**	**Magnitude Change**
5 year return period	peak flow (cfs)	89	1.9
	sediment delivery (lbs)	74	1.7
10 year return period	peak flow (cfs)	74	1.7
	sediment delivery (lbs)	55	1.6
25 year return period	peak flow (cfs)	57	1.6
	sediment delivery (lbs)	45	1.5

N. Dry Fork

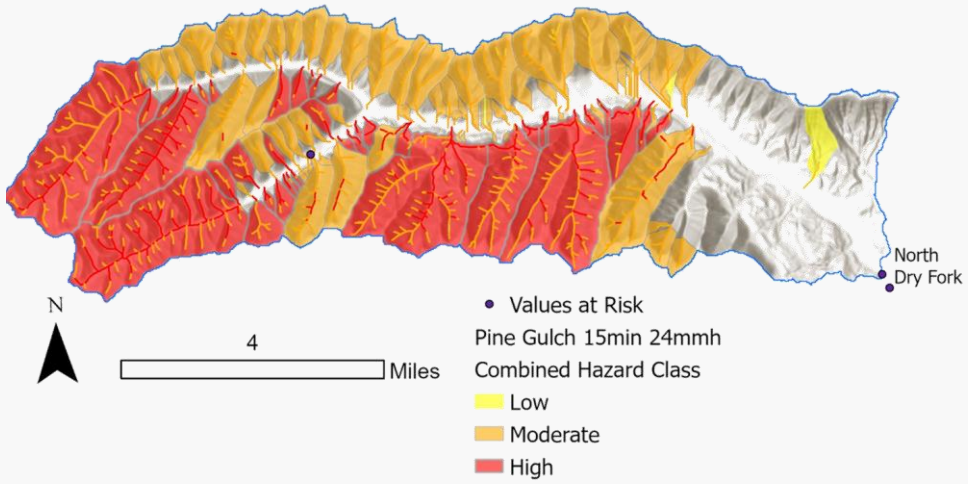
- Plugged Box Culvert
- Flooded agricultural field
- Down stream erosion
- 8/16/22

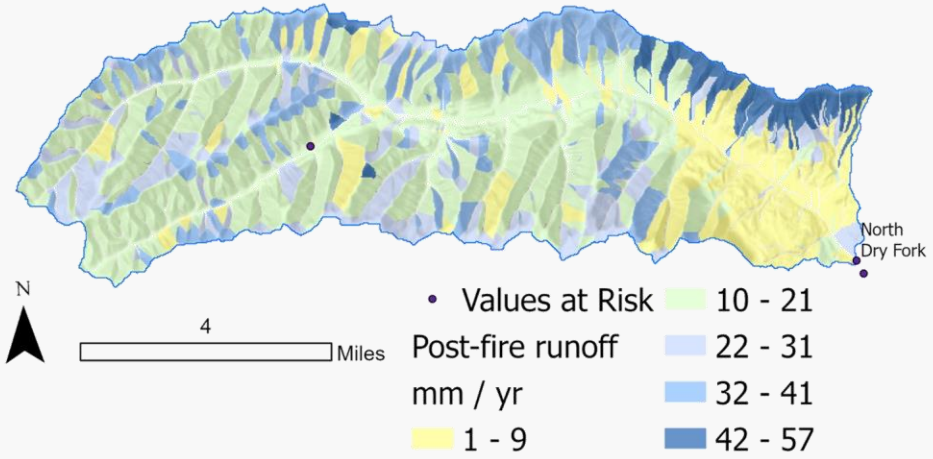
North Dry Fork

Watershed area: 25,493 acres
Average annual post-fire runoff for 50 yrs of simulated climate
Climate station is Altenbern CO annual precipitation 16.34 in

USGS Debris Flow Model: 112 Basins

Combined Hazard Class	Number of basins	Probability	Number of basins	Volume Class	Number of basins
Low	3	< 20%	1	<1,000 m^3	22
Moderate	71	20-40%	17	1,000 – 10k m^3	84
High	38	40-60%	24	10k – 100k m^3	6
		60-80%	28		
		80-100%	42		

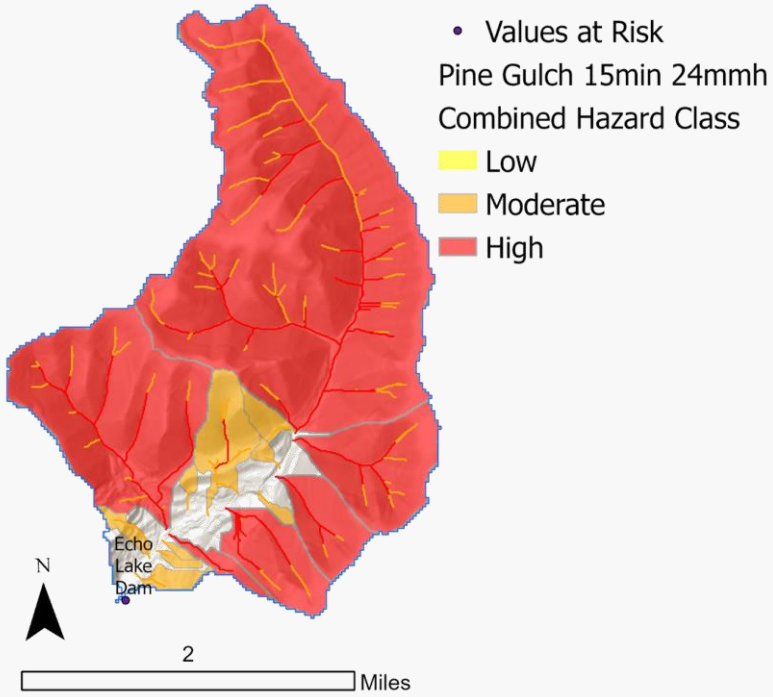




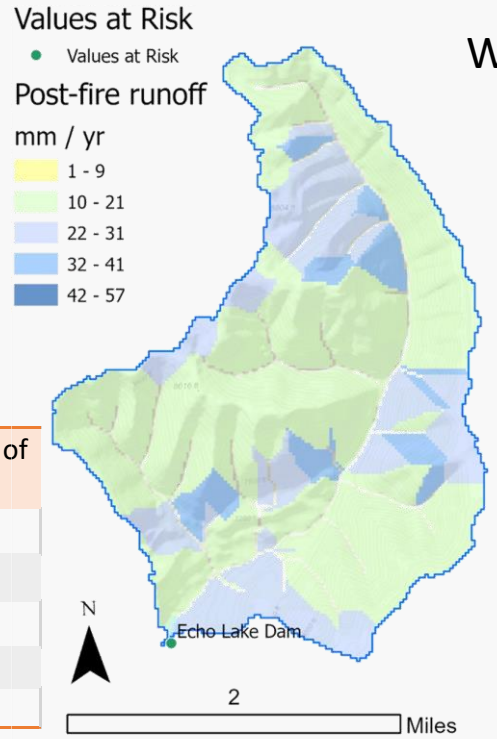
WEPP		% Change	Magnitude Change
5 year return period	peak flow (cfs)	64%	2
	sediment delivery (tons)	288%	4
10 year return period	peak flow (cfs)	49%	1
	sediment delivery (tons)	2218%	23
25 year return period	peak flow (cfs)	44%	1
	sediment delivery (tons)	3187%	33
AGWA		% Change	Magnitude Change
5 year return period	peak flow (cfs)	151	2.5
	sediment delivery (lbs)	195	3
10 year return period	peak flow (cfs)	89	1.9
	sediment delivery (lbs)	126	2.3
25 year return period	peak flow (cfs)	74	1.7
	sediment delivery (lbs)	87	1.9

Echo Lake

Echo Lake



WEPP		% Change	Magnitude Change
5 year return period	peak flow (cfs)	1375%	1500%
	sediment delivery (tons)	217%	300%
10 year return period	peak flow (cfs)	1000%	1100%
	sediment delivery (tons)	329%	400%
25 year return period	peak flow (cfs)	967%	1100%
	sediment delivery (tons)	12098%	12200%
AGWA		% Change	Magnitude Change
5 year return period	peak flow (cfs)	143	2.4
	sediment delivery (lbs)	100	2
10 year return period	peak flow (cfs)	113	2.1
	sediment delivery (lbs)	80	1.8
25 year return period	peak flow (cfs)	93	1.9
	sediment delivery (lbs)	68	1.7



Watershed area: 3,347 acres

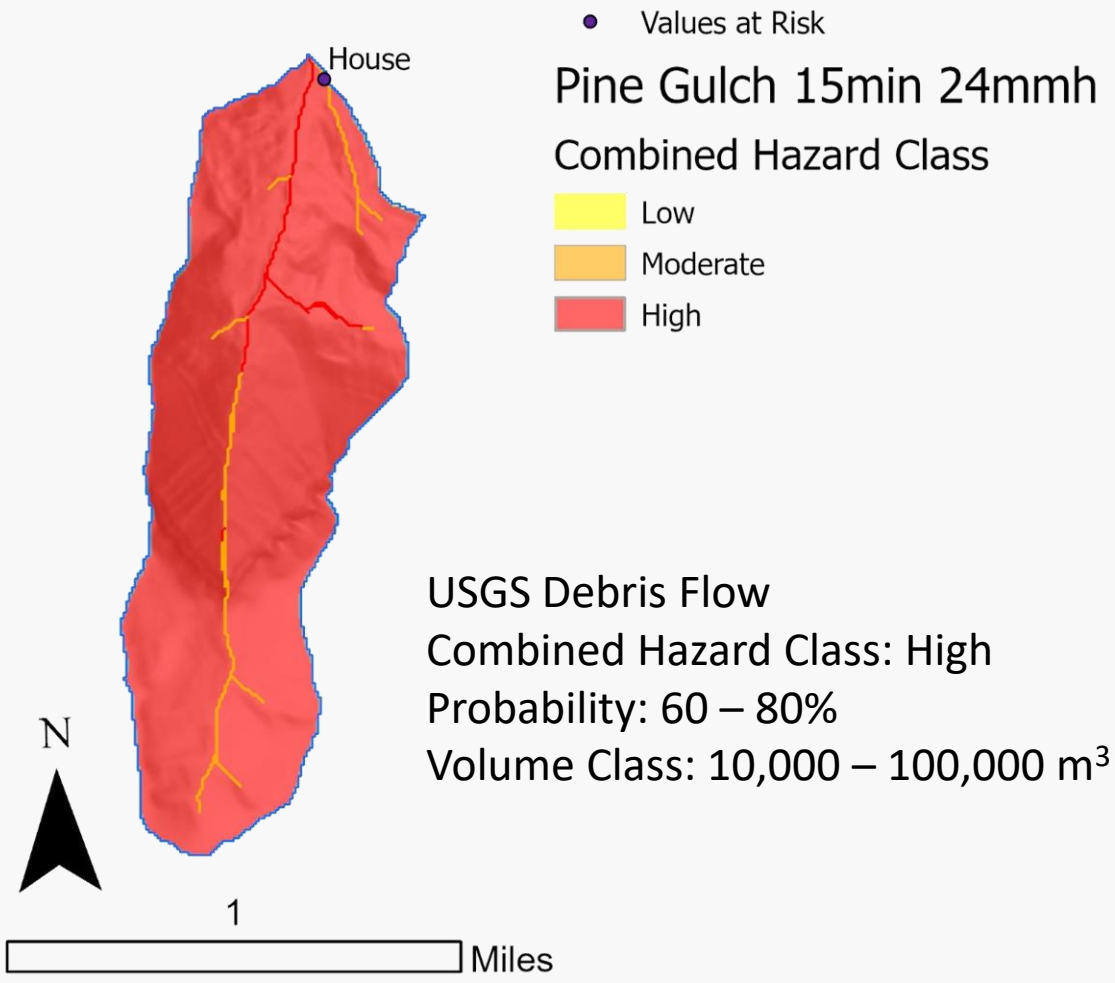
USGS Debris Flow Model: 16 Basins

Combined Hazard Class	Number of basins	Probability	Number of basins	Volume Class	Number of basins
Low	0	< 20%	0	<1,000 m^3	8
Moderate	10	20-40%	0	1,000 – 10k m^3	6
High	6	40-60%	0	10k – 100k m^3	2
		60-80%	2		
		80-100%	14		

		WEPP pre-fire	AGWA pre-fire	WEPP post-fire	AGWA post-fire
5 year return period	peak flow (cfs)	28	375	417	911
	sediment delivery (tons)	53	422,821	169	844,270
10 year return period	peak flow (cfs)	42	1,000	466	2,126
	sediment delivery (tons)	91	1,173,193	391	2,106,316
25 year return period	peak flow (cfs)	53	2,107	565	4,071
	sediment delivery (tons)	177	2,655,690	21,554	4,458,140

Residence

WEPP		pre-fire	post-fire	% Change	Magnitude Change
5 year return period	peak flow (cfs)	127	283	122%	2
	sediment delivery (tons)	19	62	226%	3
10 year return period	peak flow (cfs)	148	339	129%	2
	sediment delivery (tons)	129	133	3%	1
25 year return period	peak flow (cfs)	191	364	91%	2
	sediment delivery (tons)	226	456	102%	2



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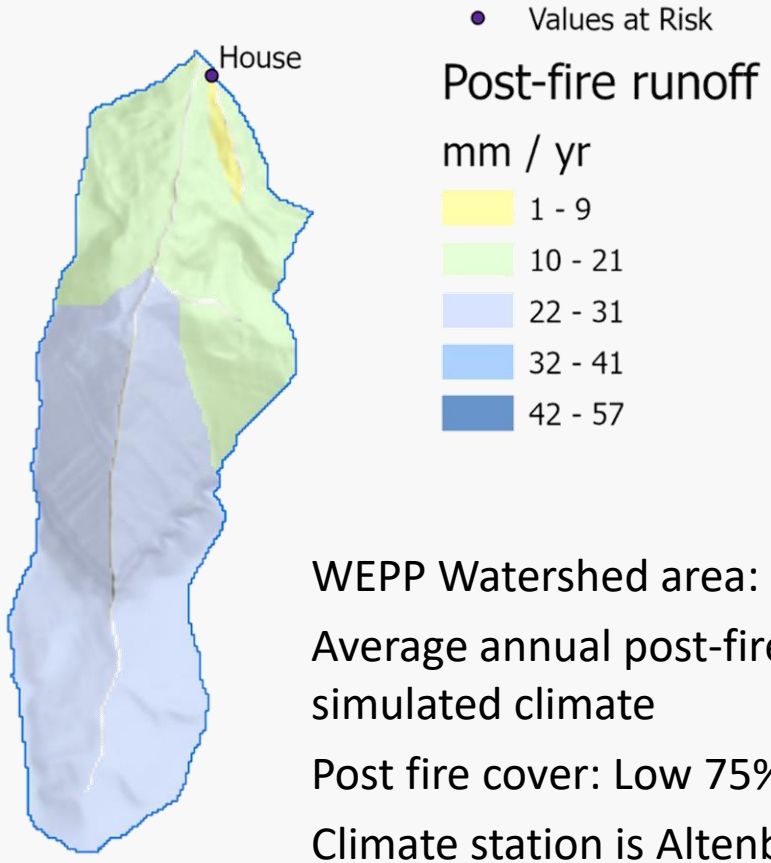

WEPP Watershed area: 441 acres

Average annual post-fire runoff for 50 yrs of simulated climate

Post fire cover: Low 75%, Moderate 40%

Climate station is Altenbern CO annual precipitation 16.34 in

Plans for Improving the Modeling Plan

- Model Calibration and Validation can improve models by highlighting needs & strengths
  - Version of WEPP used on Pine Gulch did not have base flows & hourly hydrographs
  - Kineros2 does not have subsurface lateral flows
  - Both models could benefit from spatially distributed precipitation & improved monitoring of post-fire recovery from earth observations
- WEPP & AGWA predictions similar on several fires
- Measurements Kevin has collected will be invaluable for improving models
- Collaboration between developers and users is VITAL

A new post-fire hydrology models is underdevelopment to improve accuracy and meet needs of end users for larger watersheds and predictions of ash loading.

Do you want to help?

Mapping and Modeling Post-wildfire Ash in Forested Environments to Protect Critical Water Sources

Drinking water intake currently threatened by ash and sediment from the Washburn Fire on the South Fork of the Merced River

Wrap-up

Q and A

How can we share info better

What info do you want

How are NGOs different than GOs or community

Do we need a cooperators meeting,

Post fire agreements with cooperators, pre planning