

Fish & Fire 2026: Bringing Restoration into Fire, and Fire into Restoration



43rd Annual Salmonid Restoration Conference
Redding, California, April 28 - May 1, 2026

Presentations



- **Fish and Fire – Key Past Workshop Insights, Josh Smith and Lenya Quinn-Davidson, Watershed Research and Training Center and UC ANR Fire Network.....Slide 4**
- **The Potential of Ecological Remediation for Post-Fire Soil Cleanup, Danielle Stevenson, Ph.D., Centre for Applied Ecological Remediation.....Slide 35**
- **Integrating Process-Based Restoration into Post-Fire Emergency Response Efforts, Gabrielle Bohlman, US Forest Service.....Slide 90**
- **Connecting Instream and Upslope Restoration in the Western Klamath Mountains, Will Harling, Mid Klamath Watershed Council.....Slide 123**
- **Fuels To Flows: Bringing Nature-Based Stewardship to the Headwaters, Brock Dolman, Occidental Arts and Ecology Center.....Slide 162**
- **Temporal Habitat Changes and Related Fish Response following Catastrophic/Landscape-Level Fires: Accounting for Impacts When Prioritizing Restoration Need and Location, and Fish Population Estimation(s), Patricia Bratcher, U.S. Fish and Wildlife Service.....Slide 222**
- **Riverscape Restoration – Habitat Resilience in the Face of Wildfire Along Whychus Creek, Central Oregon, Mathias Perle, Upper Deschutes Watershed Council.....Slide 270**

FISH AND FIRE

2023-2025 WORKSHOP INSIGHTS

Lenya Quinn-Davidson

UC ANR Fire Network Director

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Josh Smith

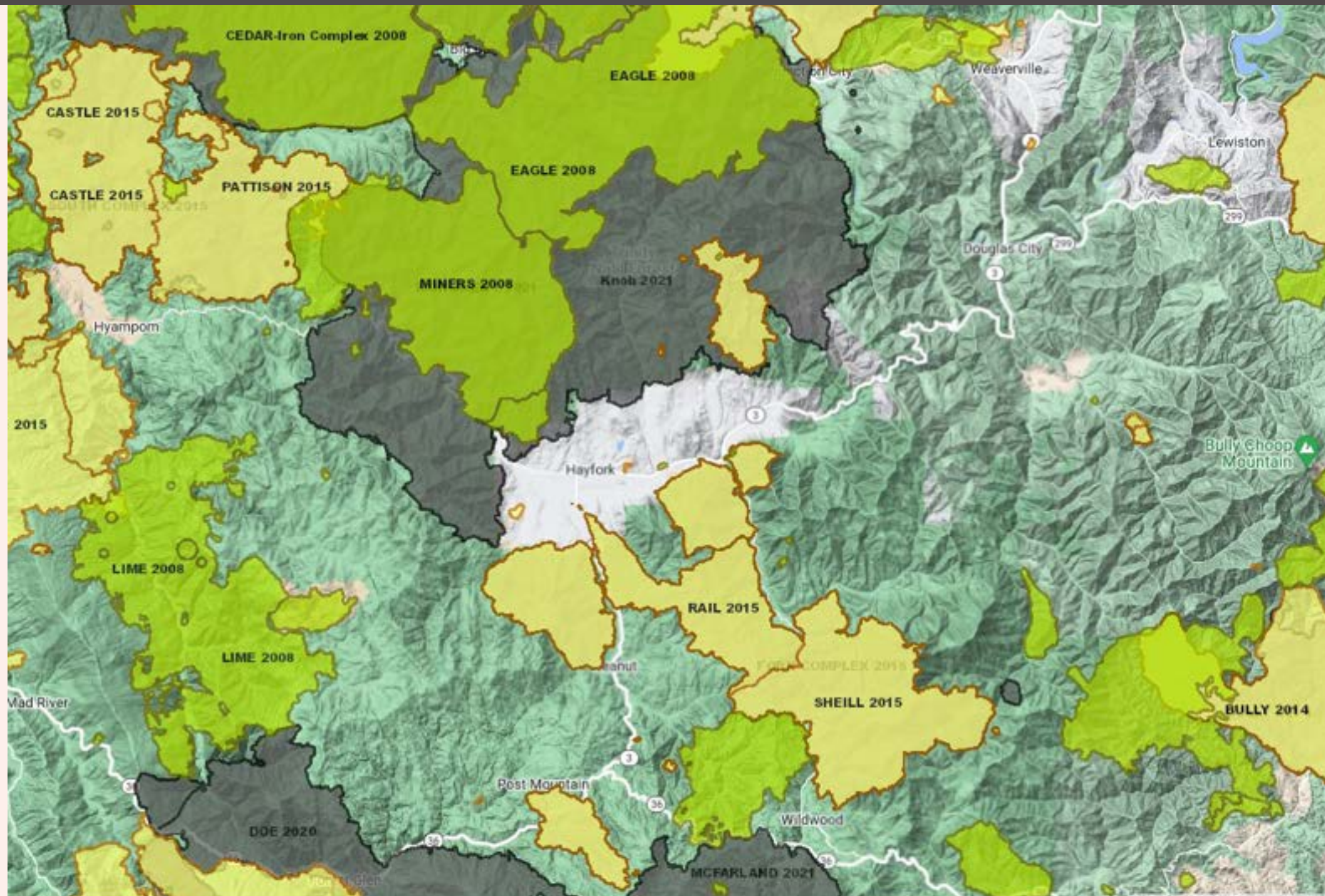
Director – Watershed Stewardship Program
Watershed Research and Training Center

josh@thewatershedcenter.com



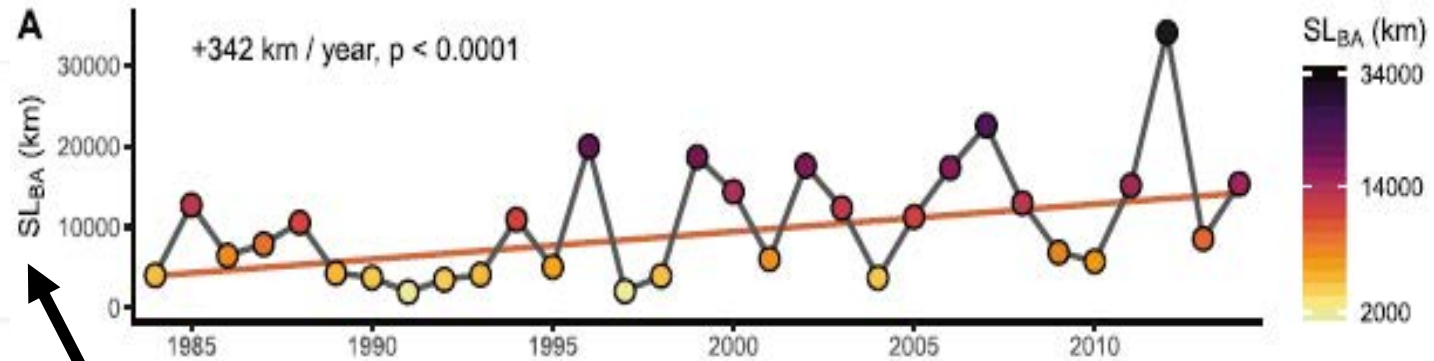
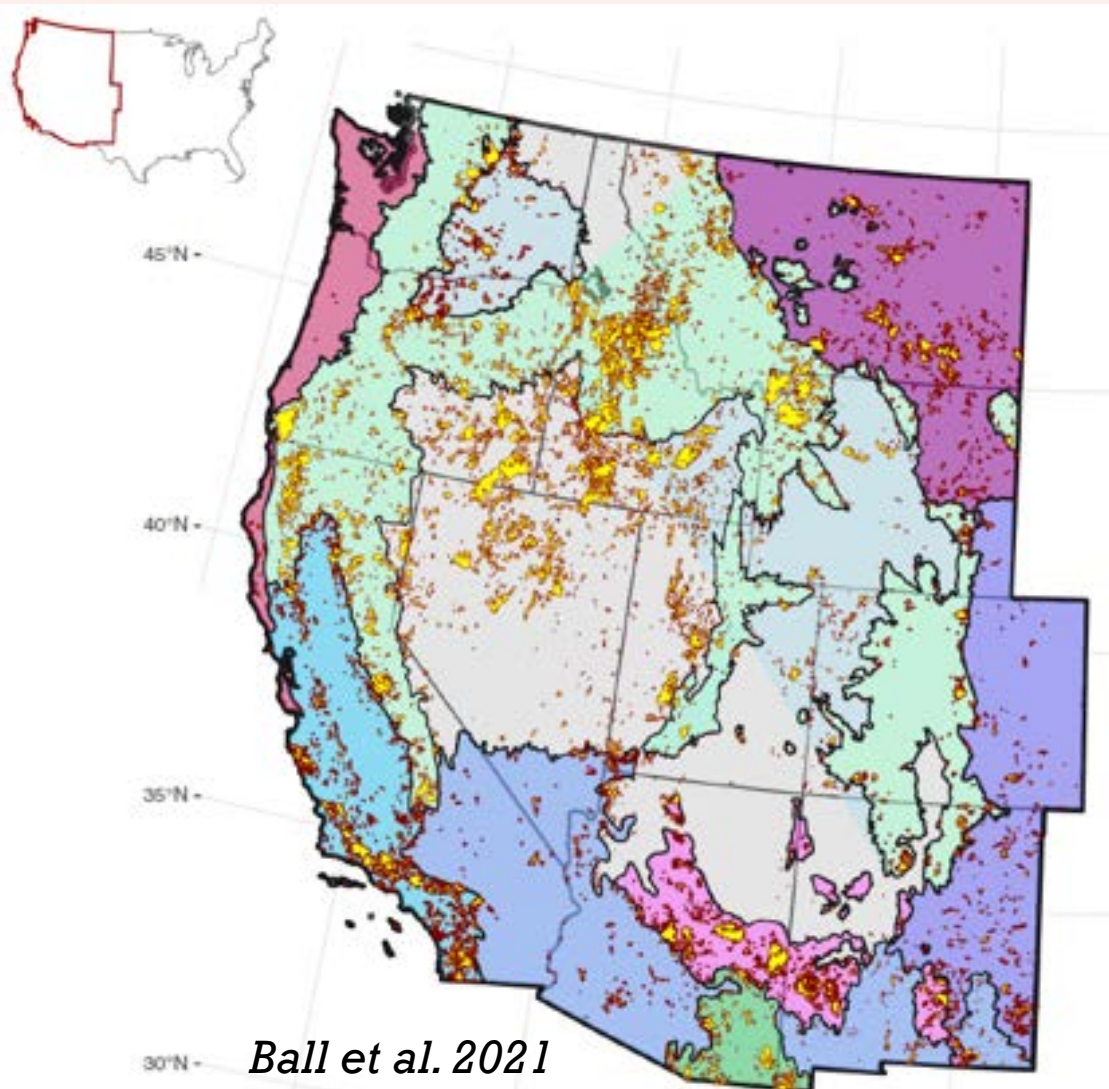
LENYA'S AND JOSH'S ROAD TO FIRE





WILDFIRES ARE INCREASINGLY AFFECTING AQUATIC SYSTEMS

(DAVID ROON, OSU COLLEGE OF FORESTRY)



Total stream length affected
by fire

IT'S A CATASTROPHE!

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WATER

Park Fire jeopardizing one of California's most iconic species: 'This species could blink out'



BY RACHEL BECKER

JULY 31, 2024



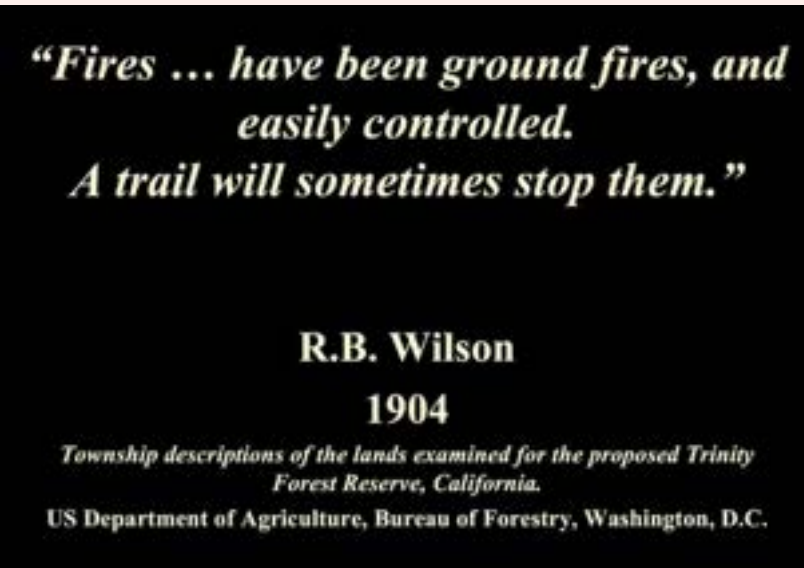
**POST WILDFIRE OBSERVATIONS =
A WHOLE LOT OF GRAY AREA**





(Photo Don Hankins)

FIRE ECOLOGY - CARL SKINNER



- Basic fire ecology (fire scars → fire return interval). 5-15 yr FRI
- We can expect more fire. We are going to see fire burning, the choice is what kind of fire do you want to get.
- Carl's intro to fish: Deer Creek and Mill Creek were most frequently burned watersheds in Sierra Nevada Ecosystem study area, but also had the most intact fish and amphibian faunas, still governed by natural processes" (Moyle)

CALIFORNIA FORESTS NEED FIRE

(WILL HARLING)

Historically fires ~5-50 acres all low severity

Today's fires ~ 50k-200k acres, mixed, but much higher severity

Fire suppression = deficit of fire → less vegetation burned... so in turn forests more dense → fuel buildup/more and higher severity wildfire.



2015 Shiel Fire

IMPORTANCE OF UNDERSTANDING PATHWAYS LINKING FIRES AND FISH (DAVID ROON, OSU COLLEGE OF FORESTRY)

- Fire can have complex effects on aquatic ecosystems and fish
- Fires influence fish via multiple physical and biological pathways
- **Whole-ecosystem approaches needed** to synthesize pathways and identify driving mechanisms

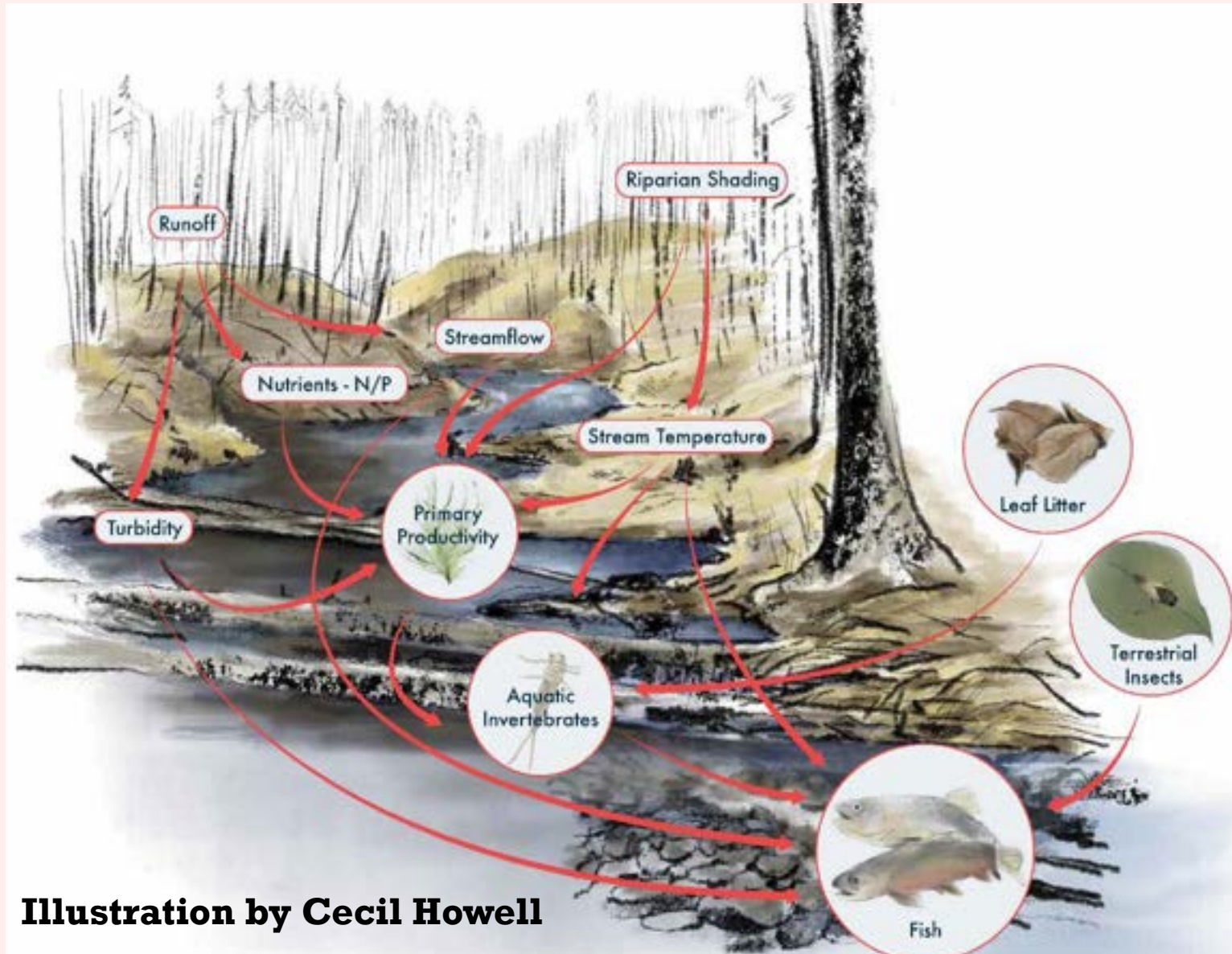


Illustration by Cecil Howell

FISH AND FIRE — GORDIE REEVES

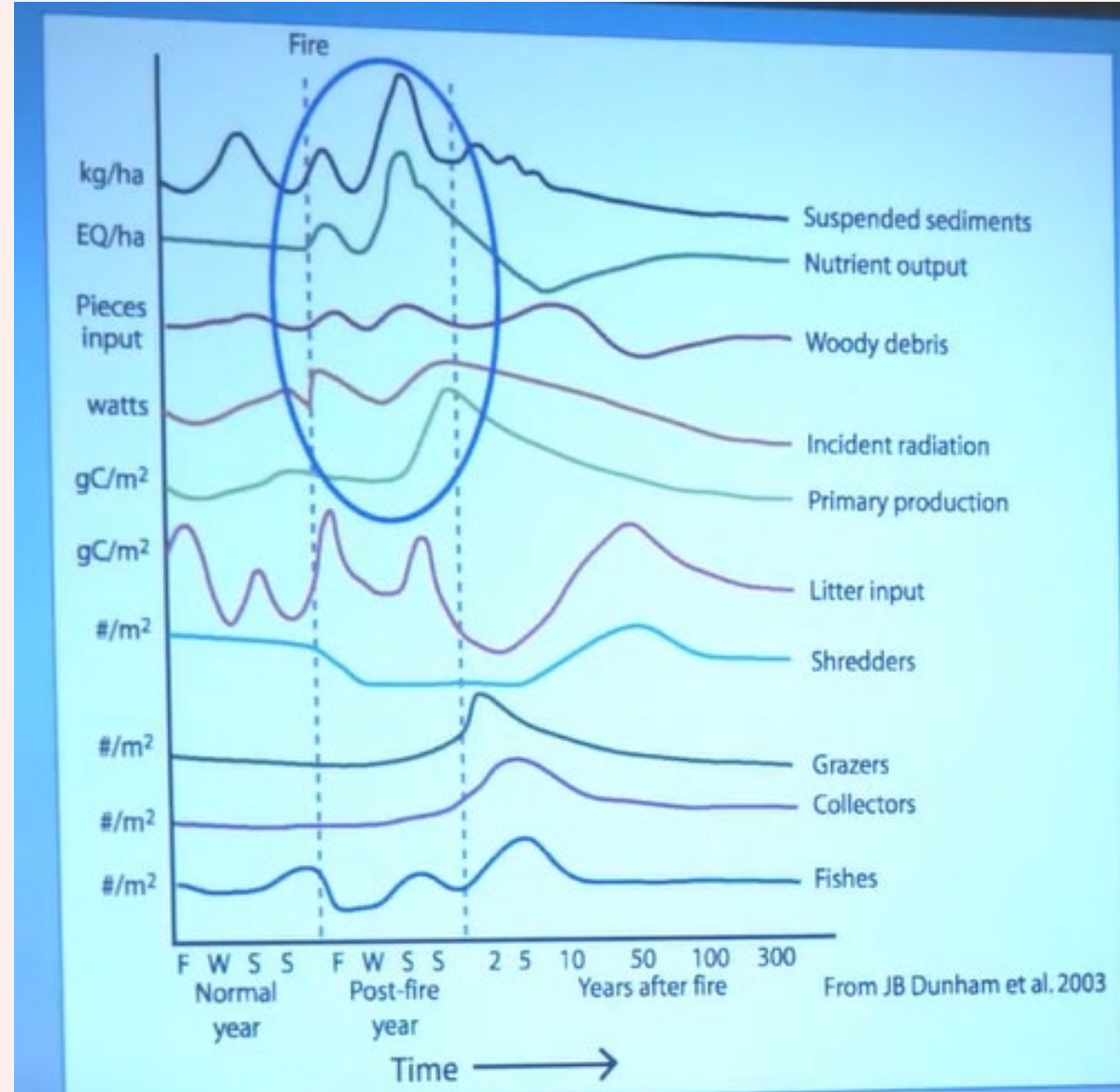
Fire comes with both “good and bad”, but **Gordie would argue a lot of good processes outweigh the bad.**

Ecosystems are not static, particularly aquatic.
Fish populations have persisted for millennia in fire prone landscapes.

Looking at the entirety of the salmonid life history stages, the overall post fire responses are positive for fish.

Primary production is up, woody debris is up, fish production (growth) is up, overall fish abundance numbers often go up (cites 3 studies)

We should use fire as a restoration tool.



MCKINNEY FIRE TOZ SOTO — KARUK TRIBAL FISHERIES

The bad fire example: homes burned, caused fish kills, several people even died.

Hottest day of the year, fast moving (30,000 acres in 8 hours). Burned into old fire footprint and plantations on decomposed granite. 5-10 inches of rain in just a few hours.

Dozens of debris flows → 1,000 ntu turbidity (aeration goes away, even eerie sounds like gurgling rather than bubbling or roaring whitewater).

DO was at 0 for 2 hours which killed everything (nit just a single species like disease does) so dace, lamprey, crayfish, and thousands of adult Klamath small scale suckers.

- At the same time, the sediment and wood fire inputs are causing good changes such as large geomorphic changes to the river
- Streams that were intermittent before are now flowing year round and have good fish habitat.

The New York Times

California Fire and Floods Turn a River to 'Sludge,' Killing Thousands of Fish



Dead fish found on a stretch of the Klamath River in Northern California on Saturday.
Karuk Tribe Department of Natural Resources, via Associated Press

WILDFIRE BENEFITS

- Stream flow ↑
- Stream temperature ↓
- BMI changes ↑
- Wood ↑
- Spawning gravels ↑
- *Juvenile production* ↑
- *Recent fire = best protection against future fire*



2020 August Complex Fires

STREAMFLOW AND FIRE (EVAPOTRANSPIRATION)

Dense forests (10x as much more forest biomass than 100 years ago)

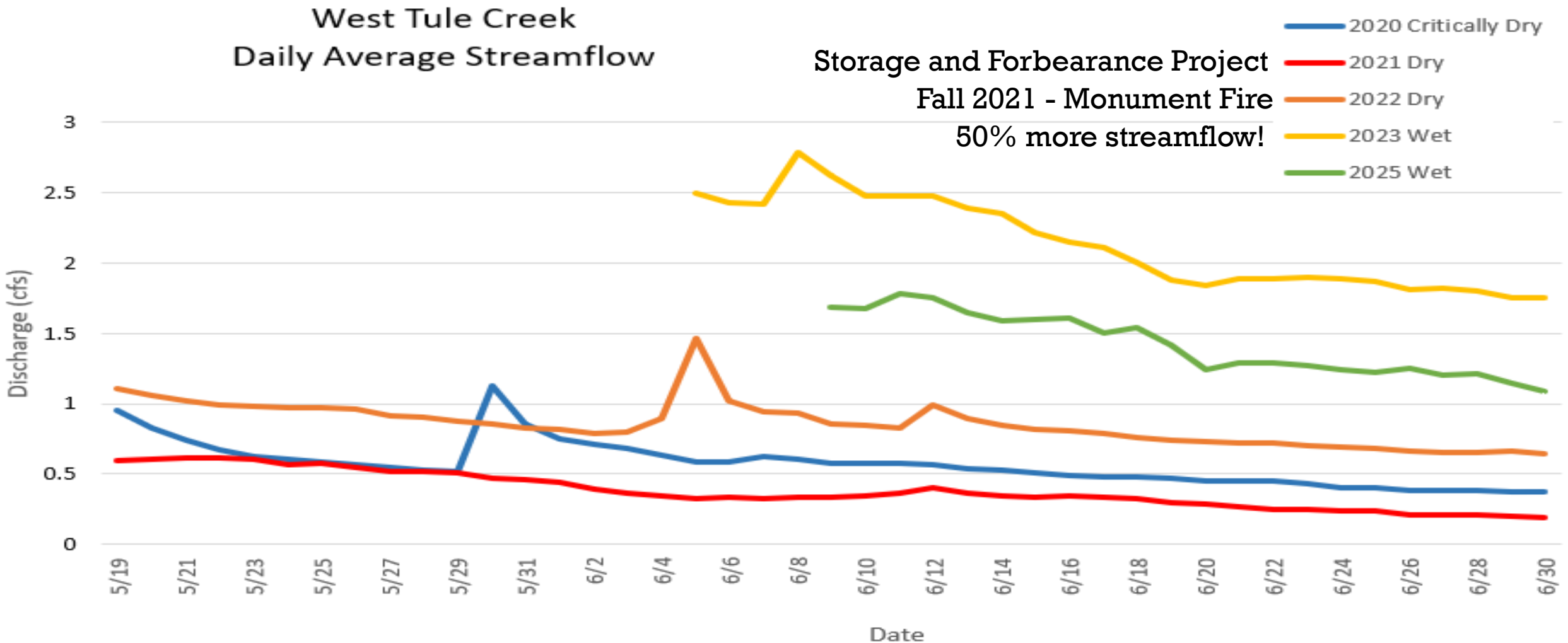
Burning creates more open spaces, less biomass, less transpiration (less pulling of water from the ground and evaporating it)

2020 August Complex - Forest Glen (SFTR)
~ 30% cfs flow improvement

Toz Soto (Indian Creek post slater fire
increase 42% overnight)

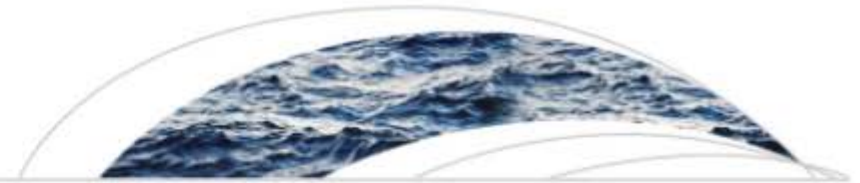


STREAMFLOW AND FIRE - TULE CREEK



SMOKE AND STREAMS

Eli Asarian



Water Resources Research

RESEARCH ARTICLE

10.1029/2018WR022964

Key Points:

- Wildfire smoke cools river and stream water temperatures by reducing solar radiation and cooling air temperatures
- For both air and water, smoke has a greater cooling effect on daily maximum temperatures than daily mean temperatures
- This smoke-induced cooling has the potential to benefit cold-water adapted species in fire-prone watersheds

Wildfire Smoke Cools Summer River and Stream Water Temperatures

Aaron T. David¹ , J. Eli Asarian² , and Frank K. Lake³ 

¹U.S. Fish and Wildlife Service, Arcata, CA, USA, ²Riverbend Sciences, Eureka, CA, USA, ³U.S. Forest Service, Pacific Southwest Research Station, Orleans Ranger Station, Orleans, CA, USA

Abstract To test the hypothesis that wildfire smoke can cool summer river and stream water temperatures by attenuating solar radiation and air temperature, we analyzed data on summer wildfire smoke, solar radiation, air temperatures, precipitation, river discharge, and water temperatures in the lower Klamath River Basin in Northern California. Previous studies have focused on the effect of combustion heat on water temperatures during fires and the effect of riparian vegetation losses on postfire water temperatures, but we know of no studies of the effects of wildfire smoke on river or stream water

DON HANKINS — RIPARIAN USE/BURNING NOT JUST PROTECTION



(Photo Don Hankins)



(Photo Don Hankins)

CATASTROPHIC FIRE?

- Large wood inputs
- Spawning gravels
- Raised groundwater table

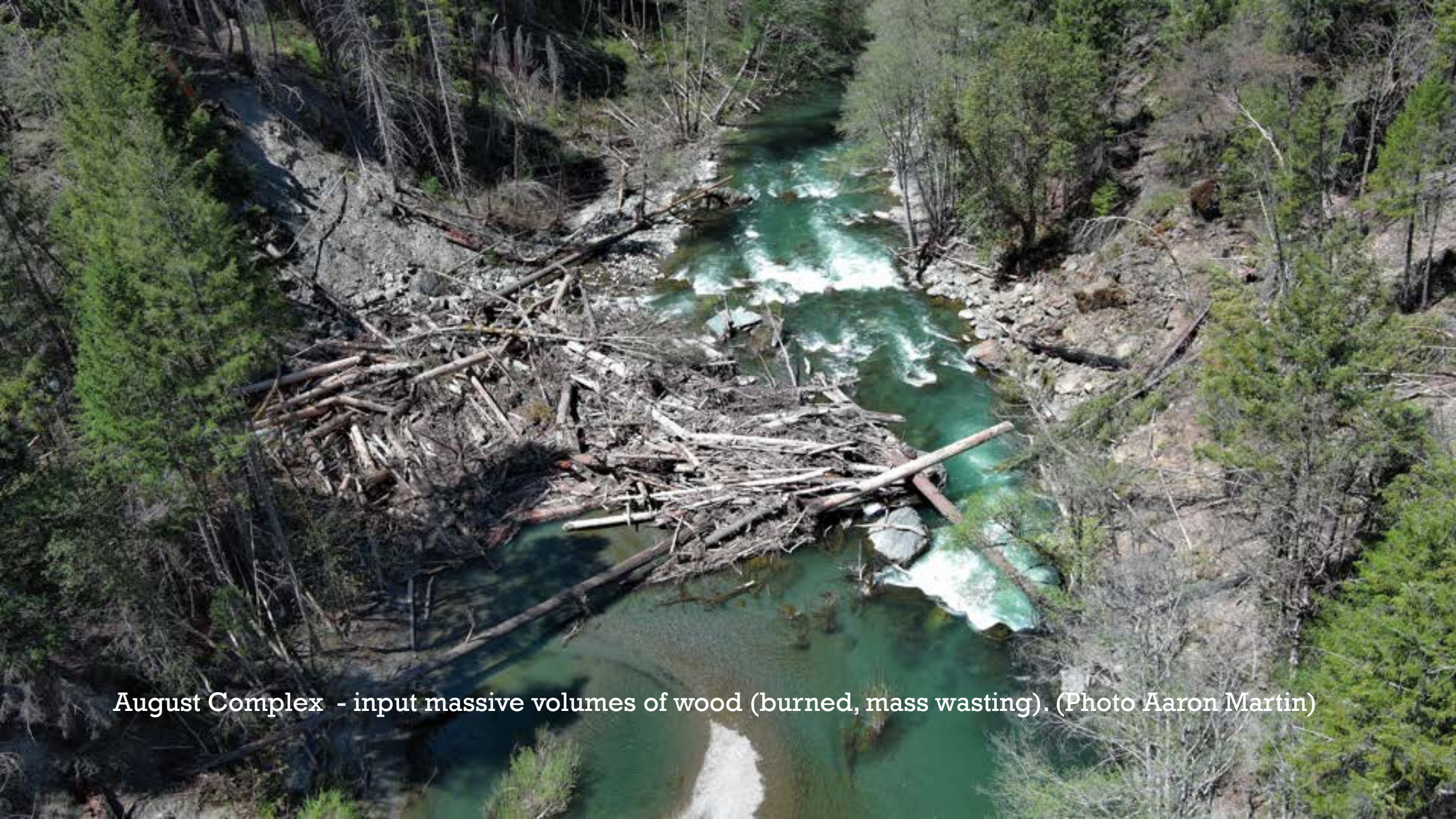


2008 Miners Fire – Bear Creek

Catastrophic Fire?

- Large wood inputs
- BMI production increases
- Juvenile growth and production increases





August Complex - input massive volumes of wood (burned, mass wasting). (Photo Aaron Martin)

BIOCHAR INPUTS

August Complex – South Fork Trinity River



INSTREAM RESTORATION FOR POST- WILDFIRE SEDIMENT CAPTURE

Karen Pope, Adam Cummings, Kate Wilcox, Jordin
Jacobs, Joe Wagenbrenner, David Dralle

USDA Forest Service, Pacific Southwest Research
Station



Suppression impacts

Photos from
Josh Smith, Watershed
Research and Training Center



2015 Shiel Fire



*Photo by
Holly Swan, Cal Trout*

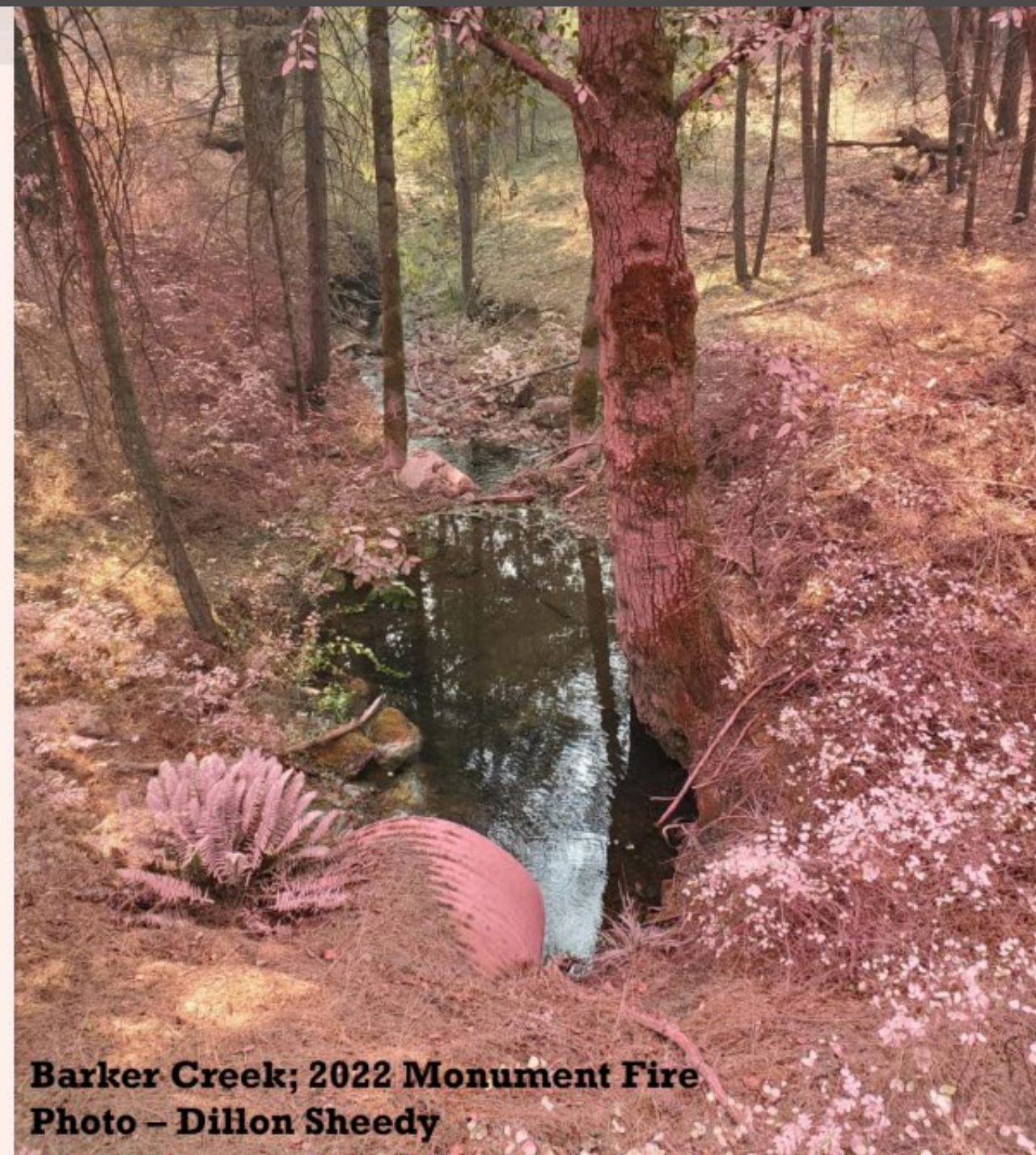


AIRCRAFT DELIVERED WATER AND RETARDANT

GALLONS WATER

GALLONS RETARDANT





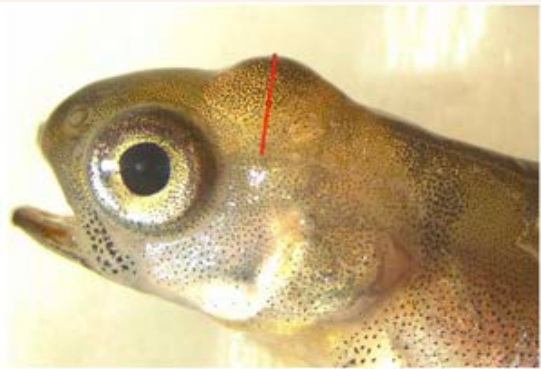
**Barker Creek; 2022 Monument Fire
Photo – Dillon Sheedy**

Toxicity of fire retardant often tested on juvenile rainbow trout

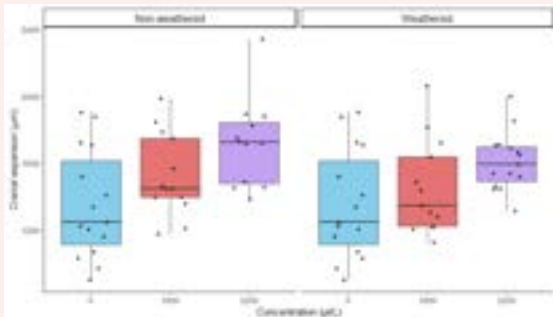


Oregon State
University

Louise Cominassi
UC Davis



Cranial expansion in
Rainbow trout
increased with higher
concentrations



- Active ingredient = **ammonia phosphate**. See changes in water pH. Recent research highlight **presence of metals**.
- Toxicity of Phos-Check is **species specific**, **Rainbow trout embryos are more sensitive** to fire retardant than Chinook Salmon
- Toxicity: **weathered** Phos-Check is more **toxic** than **non-weathered**
- Importance of looking into **sublethal effect**: **Behavioral** effect were observed at concentration 200x lower than their LC50
 - Surprising mortalities after 96h sublethal exposure in concentrations that were 10x lower than concentration used for LC50. The 96 h-LC50 might underestimate mortality.
 - Anxiety-like behavior and alteration in locomotion.



**It's clear that things need
to change...**

But how?

Bringing beneficial fire into the restoration toolbox

Lenya Quinn-Davidson
UC Agriculture and Natural Resources





THANKS FOR YOUR TIME

Lenya Quinn-Davidson

UC ANR Fire Network Director

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Josh Smith

Director – Watershed Stewardship Program

Watershed Research and Training Center

josh@thewatershedcenter.com



The Potential of Ecological Remediation for Post-Fire Soil Cleanup



Danielle Stevenson, PhD
Executive & Scientific Director

CENTRE FOR APPLIED
ECOLOGICAL
REMEDIATION



How Many Homes Were Destroyed by the 2025 LA Fires?

The 2025 LA wildfires burned over 57,000 acres and destroyed more than 16,000 structures. The two most destructive fires were the Palisades and Eaton fires:

Palisades Fire



6,833 structures lost
23,448 acres burned

Eaton Fire



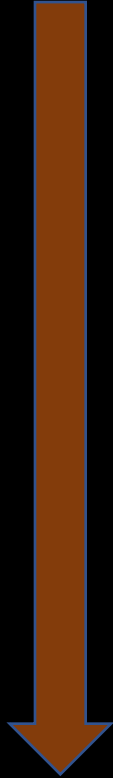
9,418 structures lost
14,021 acres burned

Source: [fire.ca.gov](https://www.fire.ca.gov)

- 
- Levels of heavy metals spiked in L.A.'s coastal waters after the January fires
 - Beryllium, copper, chromium, nickel and lead were found in concentrations well above established safety thresholds for marine life



Soil changes after high-severity fires



Low nutrient content (esp. N and P)
Low organic matter
Reduced soil structure
Low water and nutrient retention
Reduced plant & microbial diversity
– dominated by early successional
fungi and plants



Increased soil erosion (and
dust)
Elevated heavy metal and
other contaminants
Increased hydrophobicity and
water runoff
Increased soil exposures and
temperatures

Healthy soil is like a sponge



Fungal mycelium weaves soil and plant roots together!

Common Post-Fire Contaminants

Metals

- lead (Pb), arsenic (As), mercury (Hg), hexavalent chromium (CrVI)

Volatile Organic Compounds (VOCs)

- benzene, formaldehyde, acetone, etc.

Semi-volatile Organic Compounds (SVOCs)

- nitroaromatics, PCBs PAHs, phthalates

Dioxins and furans

Petroleum hydrocarbons

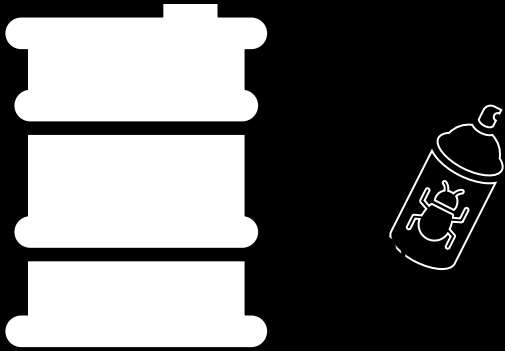
- gasoline-range (GRO)
- diesel-range (DRO)
- Oil Range Organics (ORO)
- total petroleum hydrocarbons (TPH)

Per- and polyfluoroalkyl substances (PFAS)

- PFOS, PFOA

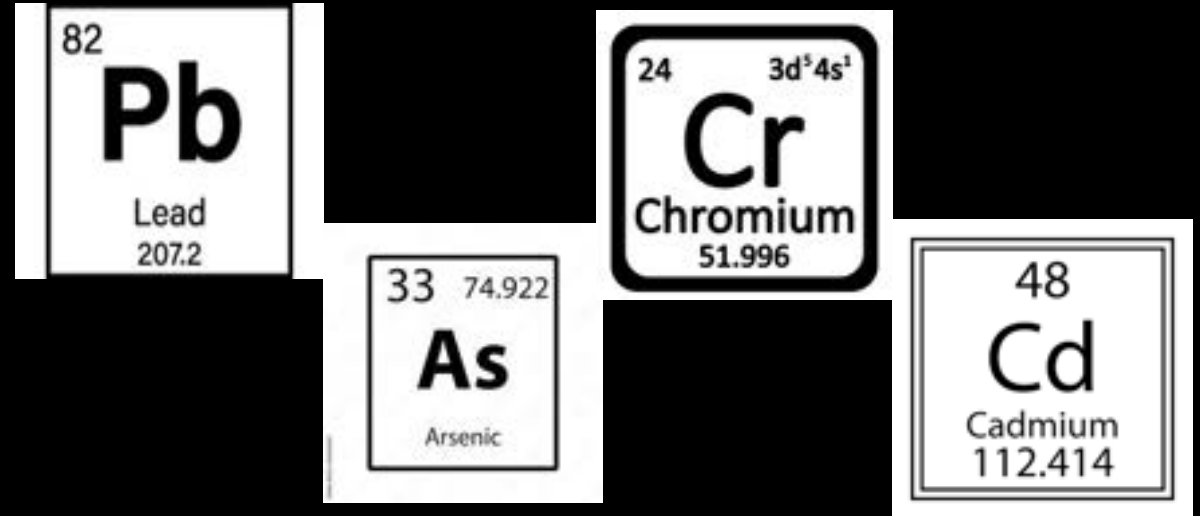
Asbestos

Most contaminated sites after WUI fires have mixtures of metals and organic contaminants



Organic contaminants

- Carbon-based
- SVOCs, VOCs, dioxins, petroleum hydrocarbons, PFAS
- Some may be **degraded through microbial metabolism**



Inorganic contaminants

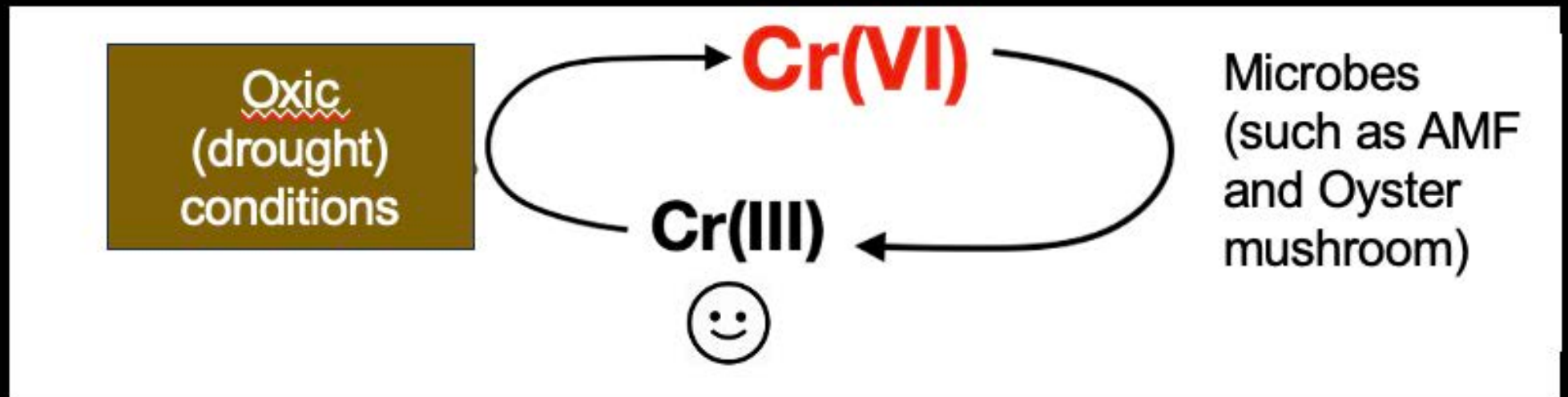
- **Cannot biodegrade**
- Heavy metals (lead, arsenic, hexavalent chromium), asbestos
- Difficult to remediate – can only be moved around or immobilized



**Wildfires can turn harmless
elements in soils into
contaminants, research shows**

Cr(III) = micronutrient 😊
Cr(VI) = toxic, mobile ☠️

Controls over chromium mobility



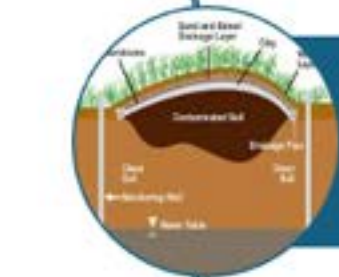
Reduction leads to immobilization and oxidation leads to mobilization

Remediation:

the **cleanup** of hazardous substances (i.e., contaminants / pollution) in the environment via their removal, treatment and/or containment



DIG remove and replace soil



CAP/STABILIZE cover or
stabilize soil contaminants



SUSTAINABLE TREATMENT
nature-based remediation aka bioremediation
to clean the soil in place

COST MAINTENANCE TIME

\$\$\$

None

Fast

\$

Ongoing

Fast

\$\$

None
once
complete

Slow



Needs monitoring and maintenance, impermanent

DIG



DUMP

> 1/2 million tons per year

“away”

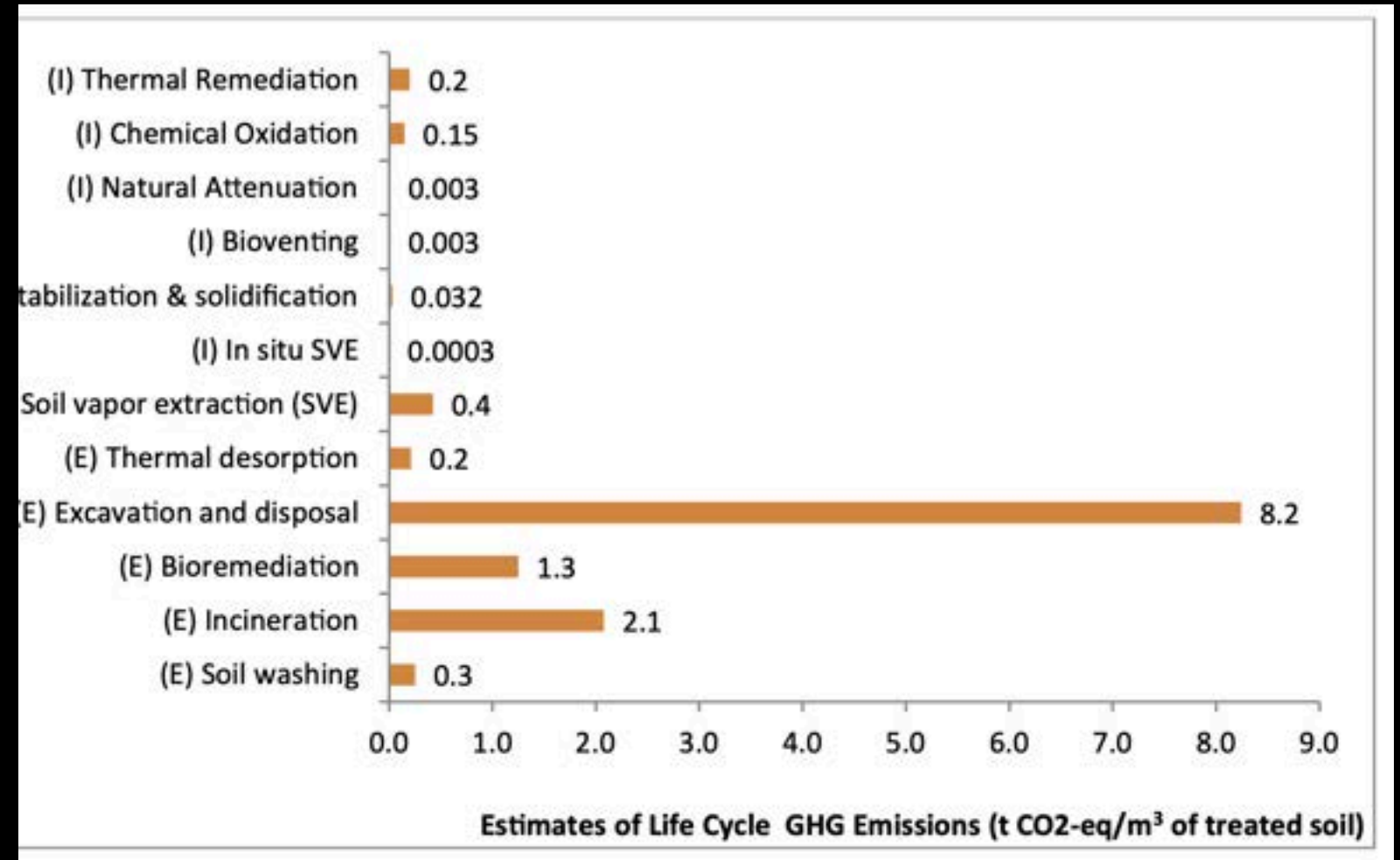
=

**in other
communities**



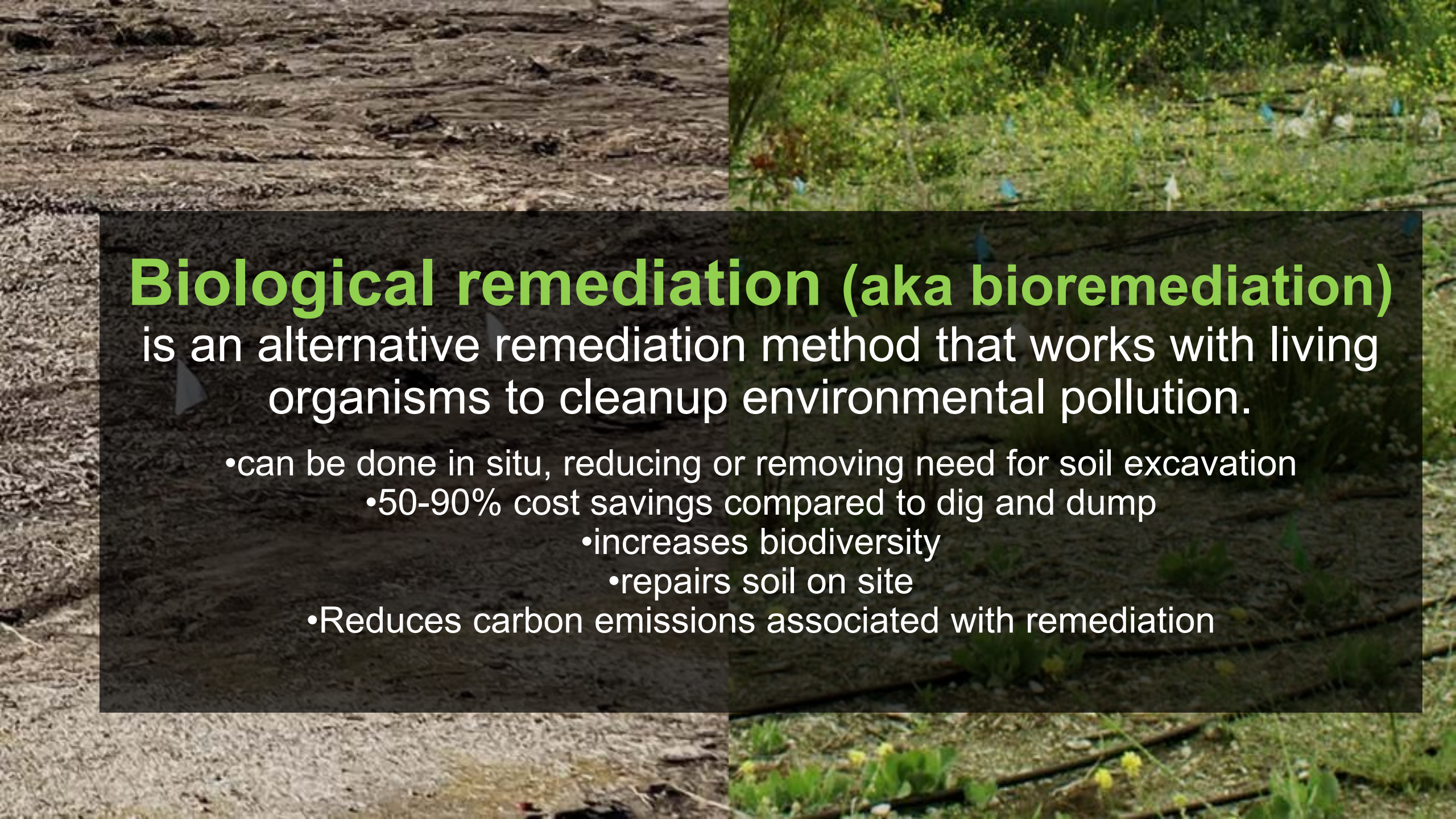
56% is shipped out of state for disposal

This releases
a lot of
greenhouse
gas emissions





What are other soil remediation and waste management options that are **more cost effective, environmentally-sound** and *actually address the pollution?*



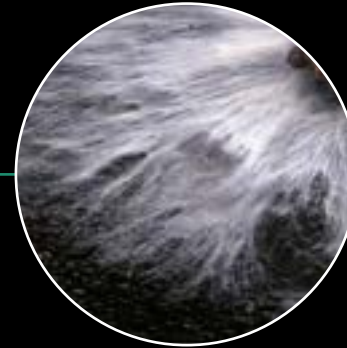
Biological remediation (aka bioremediation)
is an alternative remediation method that works with living organisms to cleanup environmental pollution.

- can be done in situ, reducing or removing need for soil excavation
 - 50-90% cost savings compared to dig and dump
 - increases biodiversity
 - repairs soil on site
- Reduces carbon emissions associated with remediation



PLANTS

Phytoremediation



FUNGI

Mycoremediation



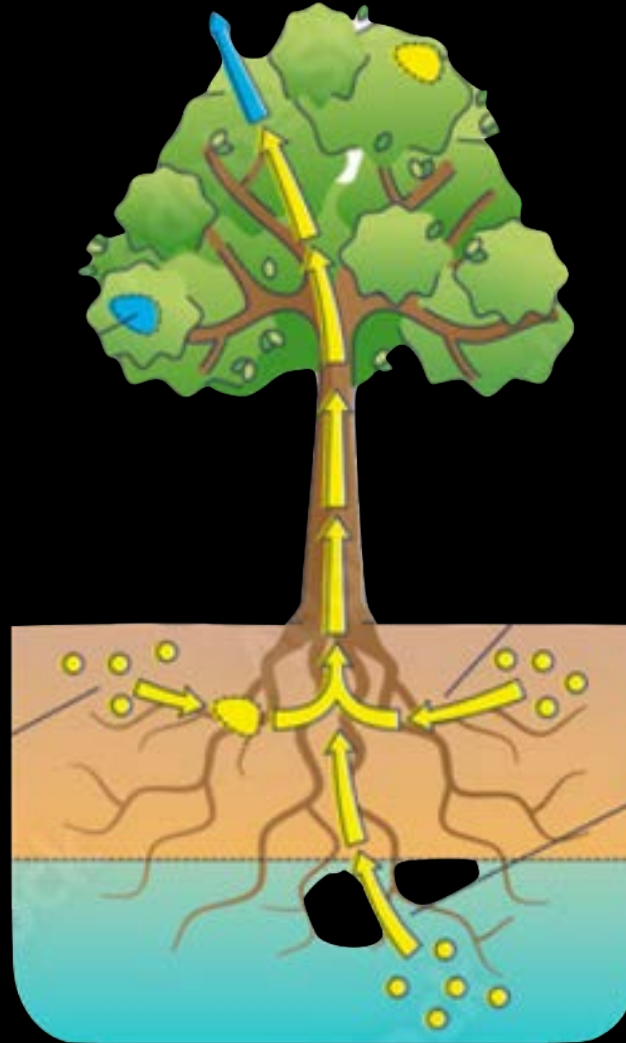
BACTERIA

*Microbial
remediation*

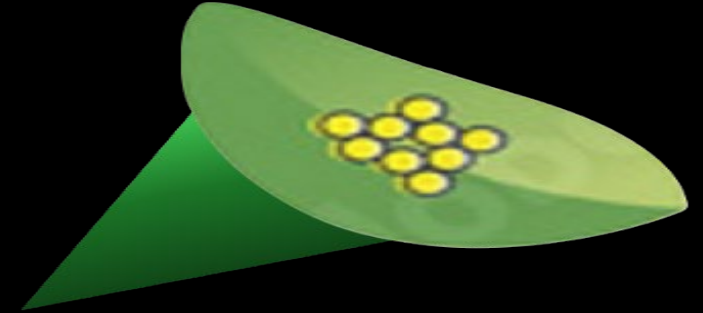
Types of Phytoremediation for metals



Phytostabilization

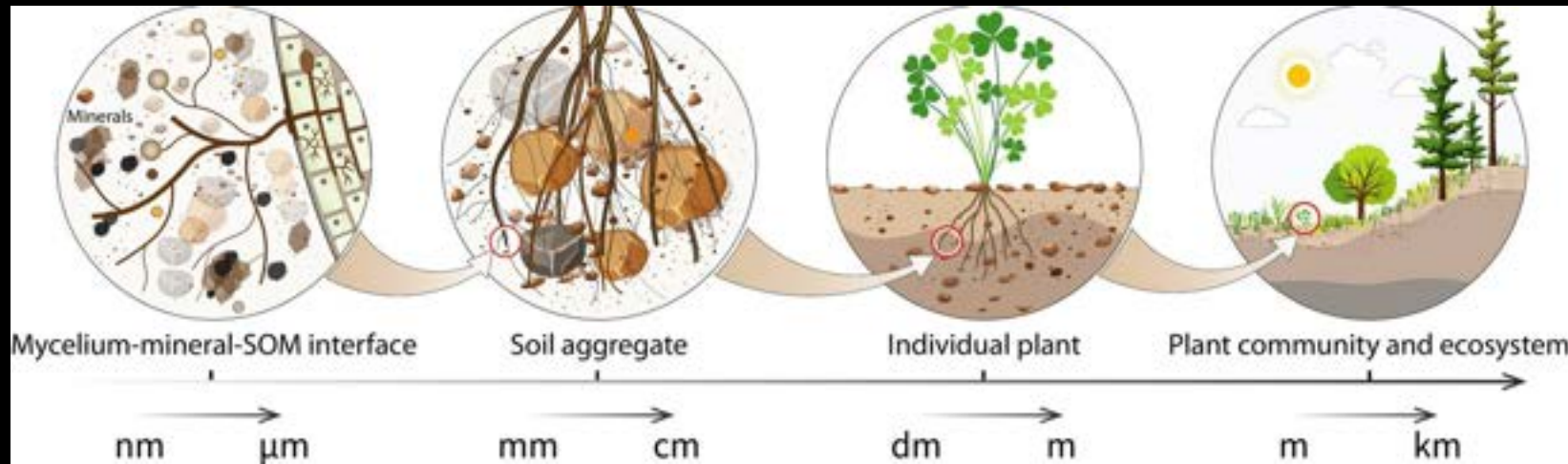


Phytoextraction



Fungi are biogeochemists

- **Biosorption**
 - Metals bind to fungal cell walls
- **Biomineralization**
 - Formation of stable mineral complexes (e.g., oxalates, phosphates)
- **Redox transformations**
 - $\text{Cr(VI)} \rightarrow \text{Cr(III)}$



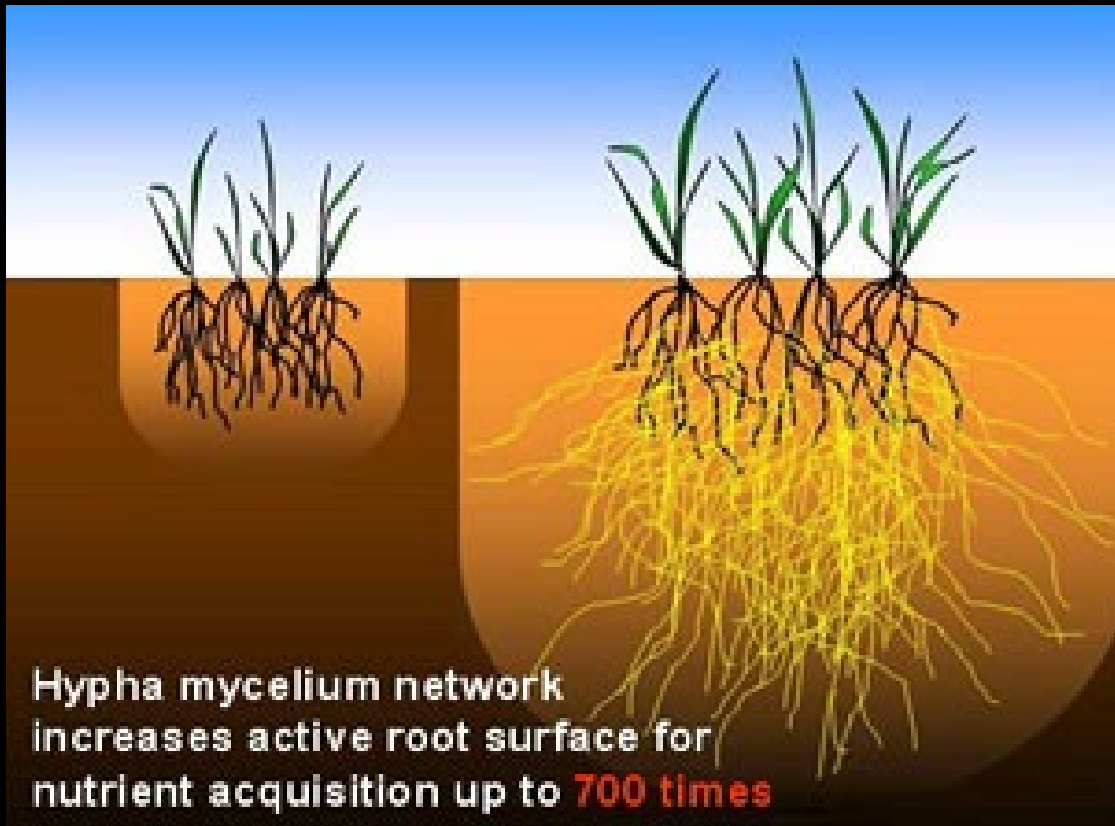
Chelation via organic acids

Oxalic acid mobilizes → then re-precipitates metals

Soil aggregation

Physically stabilizes minerals in microaggregates

Arbuscular mycorrhizal fungi (AMF) help plants grow and may help them extract more metals and enhance phytoremediation success



Thomas et al, 1998. Mycoremediation of Aged Petroleum Hydrocarbons in Soil.

Other fungi who are **decomposers** have been found to be able to break down complex, organic contaminants such as PAH's, diesel and more.

Rapid bacterial and fungal successional dynamics in first year after chaparral wildfire

[M. Fabiola Pulido-Chavez](#) , [James W. J. Randolph](#), [Cassandra Zalman](#), [Loralee Larios](#),
[Peter M. Homyak](#), [Sydney I. Glassman](#) 

First published: 29 December 2022 | <https://doi.org/10.1111/mec.16835> |

- wildfire led to large reductions in all fungal guilds:
 - EMF decreased by 68%
 - pathogens by 71%
 - saprobes by 86%
 - AMF by 98%
- in burned compared to unburned plots
- 1 year was insufficient for any guild to return to unburned levels



What actually happens in nature?

**Individually, none of these would address mixed metal and organic contaminants but together they do

1

Beneficial decomposer fungi break down complex carbon

Organic contaminants are carbon-based

3

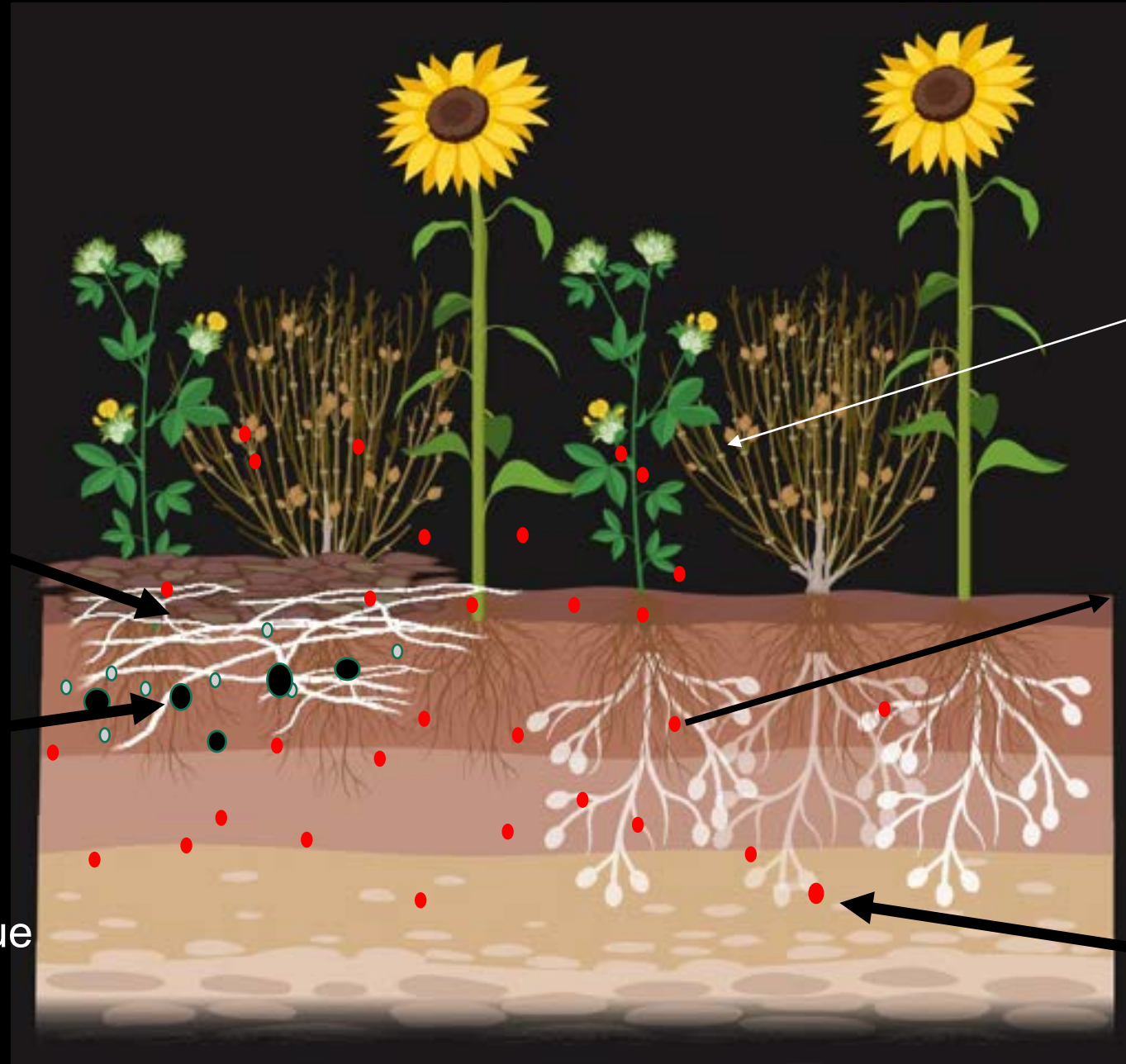
Bacteria and secondary decomposer fungi continue decomposition of simpler carbon-based chemicals

2

Plant uptake of metals

Arbuscular mycorrhizal fungi help plants take up elements

Metals are elements



Principles of Ecological Remediation

Mimic Succession

→ Starting the process often enables natural regeneration.

Diversity = Resilience

→ Addresses multiple contaminants while restoring ecosystem function and long-term stability.

Keystone Remediation Species

→ Enables effective and complete cleanup.

Waste as Resource

→ Diverts materials from landfills and supports circular systems.

Bioregional Approaches

→ No invasive species are used.

The background image shows a field of green, leafy plants, possibly a cover crop or remediation plant. Several orange survey flags are visible in the field, indicating specific points of interest or data collection. The sky is clear and blue.

What did we learn in our LA-based studies?

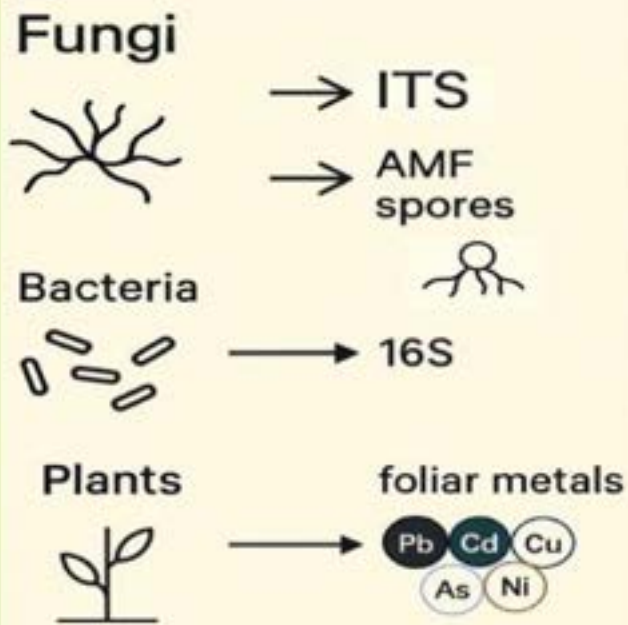
Towards an Ecological Approach to Soil Remediation

Soil Drivers of Fungal, Bacterial and Plant Diversity on Contaminated Sites in Southern California: Informing Bioremediation in Dryland Environments

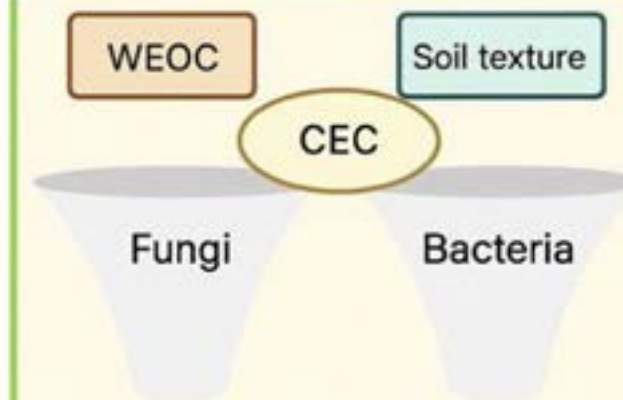
Study system



Methods



Key Findings



Novel dryland metal accumulators identified



Summary: Bioremediation candidates for arid and semi-arid environments identified.

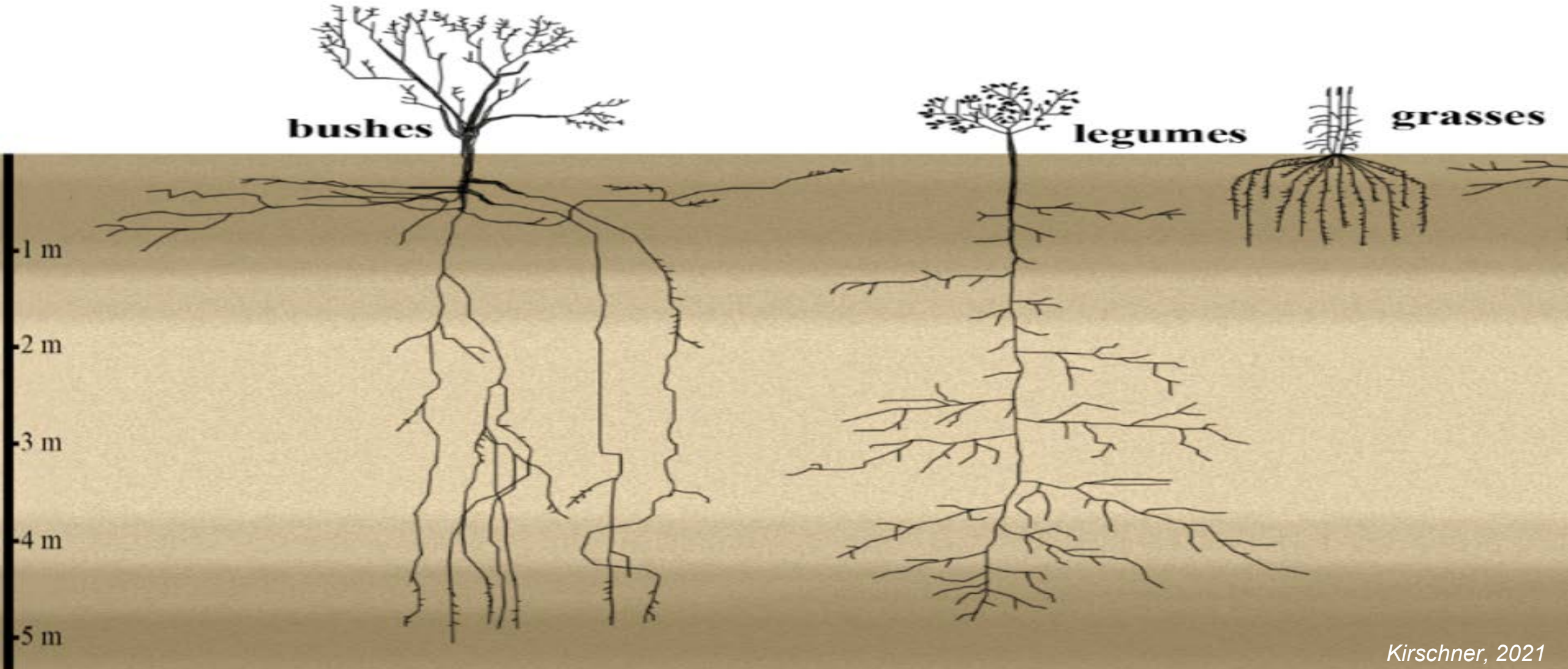


ELSEVIER

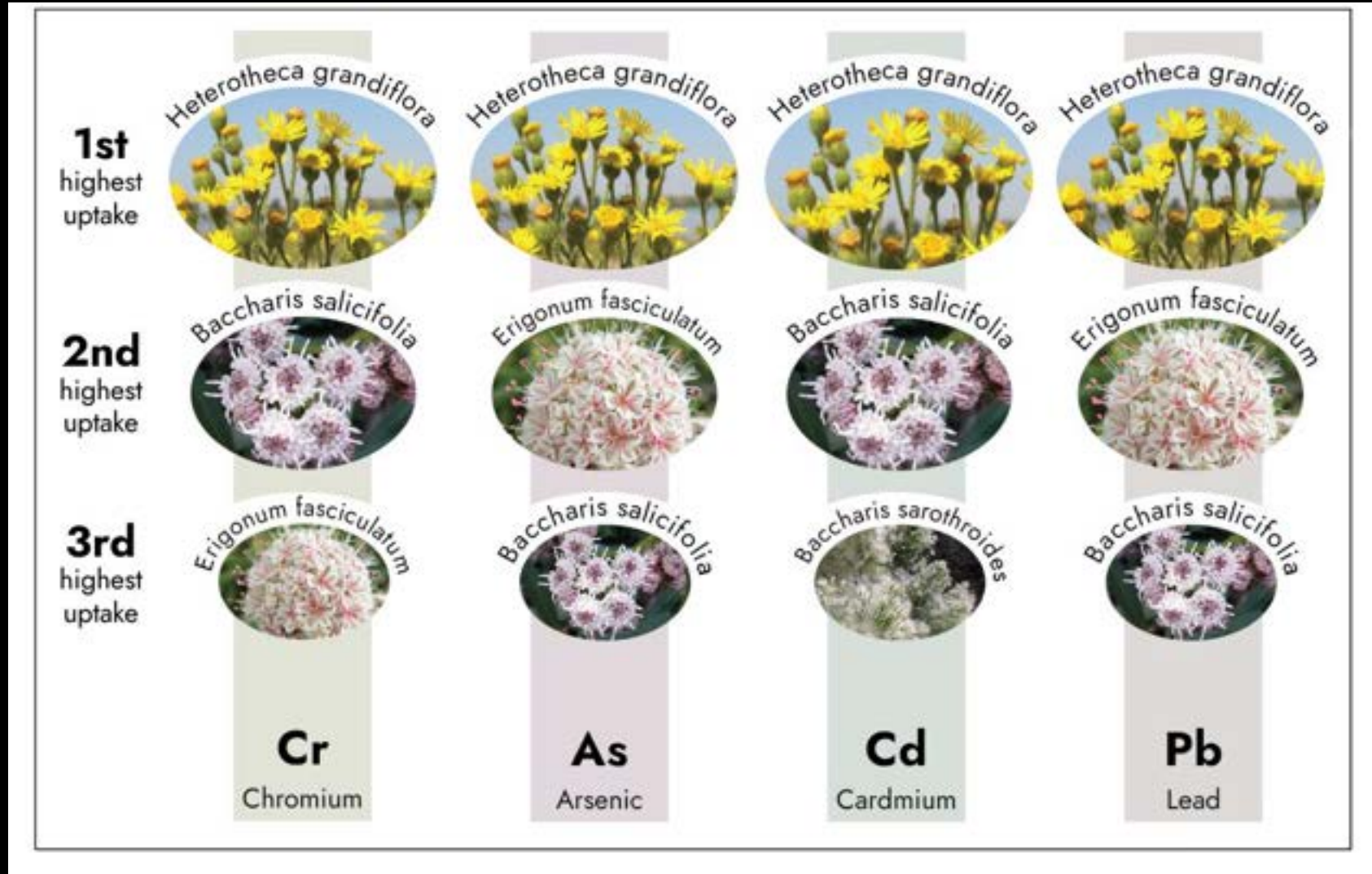
Stevenson, D., Ying, S., et al., University of California Riverside (2025)

Southern California native plants

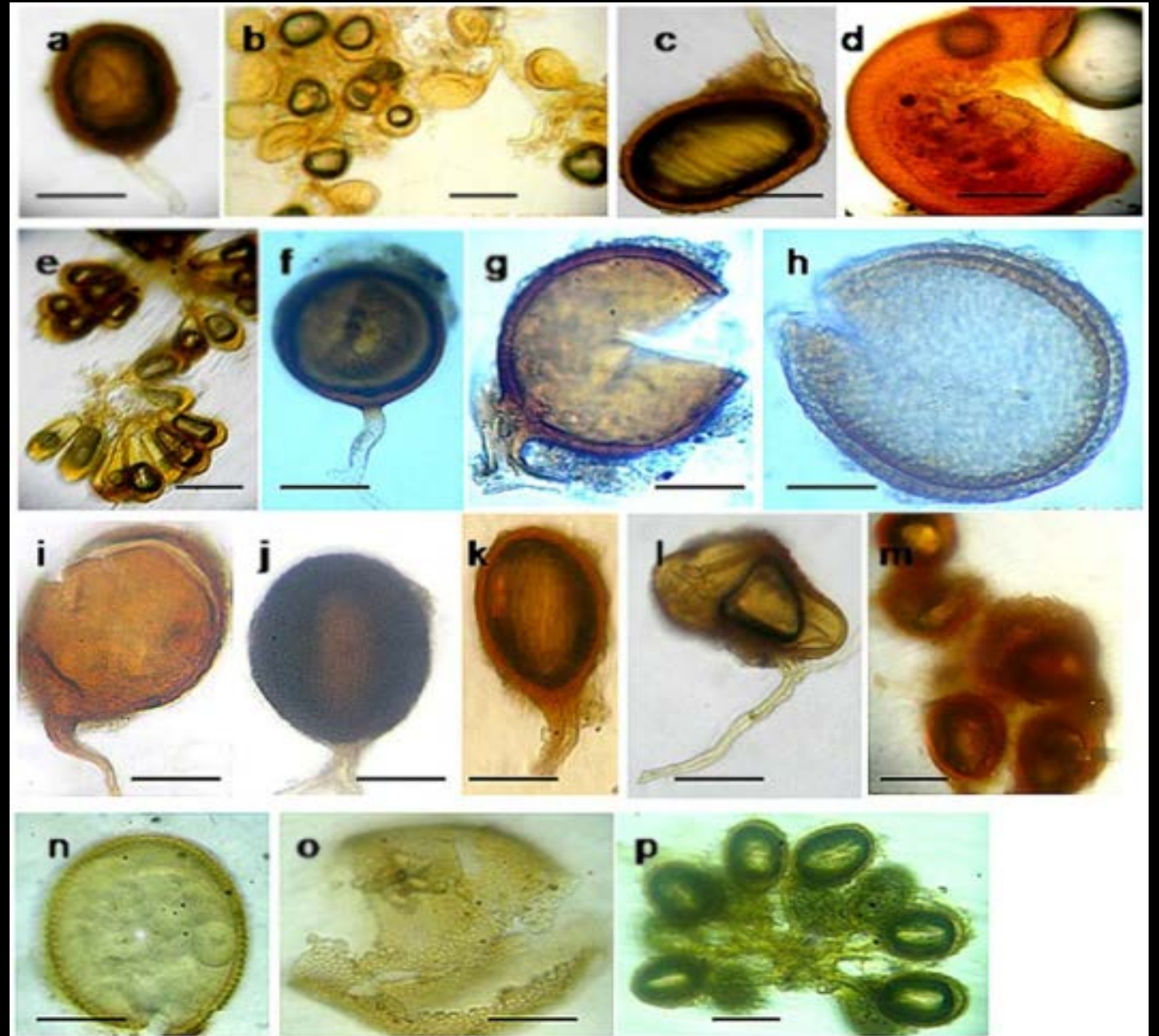
Native plants are an under recognized potential remediation tool because they are already adapted to drought/arid conditions of SoCal and they have deep roots!



California native plant metal accumulators identified



The most contaminated sites had the lowest arbuscular mycorrhizal fungal spore counts and diversity.



Field Testing of Myco- phytoremediation of Contaminated Sites in LA County

Environmental Toxicology
Soil Biogeochemistry Group





LA Ecovillage – Songs

- Lead
- Copper
- Cadmium
- PAHs and diesel

Future urban garden and community space / housing



Taylor Yard – G2 parcel

- Lead
- Arsenic
- PAH's and diesel

Future park



Slauson and Wall

- Lead
- Hexavalent chromium
- Petroleum hydrocarbons

Future green space, housing, shopping and community centre

Different ways to myco- or bioremediate



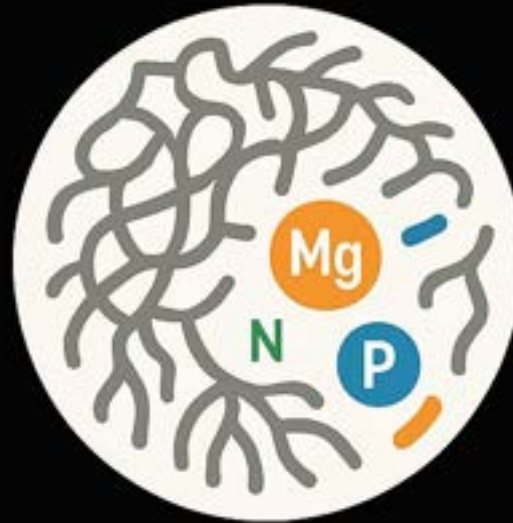
Natural attenuation

Slower degradation



Bioaugmentation

Enriched/engineered
degraders



Biostimulation

Increasing
growth/bioavailability



Plant-microbe

Co-metabolic tolerance
Higher stability/capability

Ecoremediation treatments tested over 12 months

With and without irrigation

Natural attenuation

- controls with no treatments

+ 6 replicates
/treatment
combination
per site
X 3 sites

= 552 plots

Biostimulation

- Endogenous AMF only (no inoculum + plants)
- Endogenous decomposer fungi only (wood chips and irrigation)



Biaugmentation

Native decomposer fungus as spent blocks from mushroom farm (Smallhold)



Commercial AMF inoculum



Plant-fungal interactions

Novel, Native Plant Metal Extractors

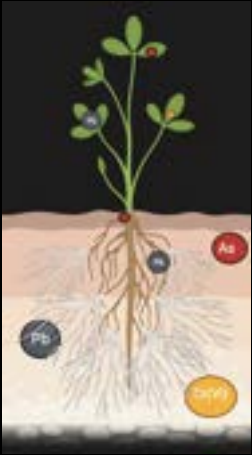


Proven, Non-native Metal Extractor

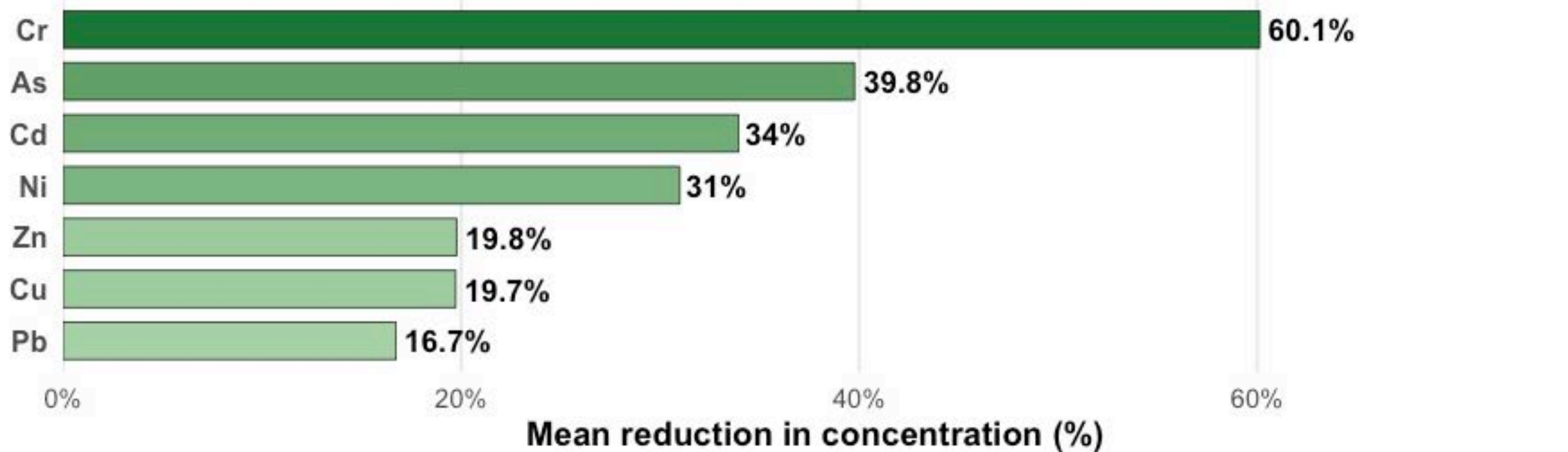


Various fungal inocula:

- Indigenous fungi only
- Commercial AMF inoculum
- Decomposer fungus spent blocks
- Both decomposer and AMF inoculum



Plants and fungi together **reduced soil metal concentrations significantly** in 12 months



Negative change values converted to absolute percent reduction for visualization.

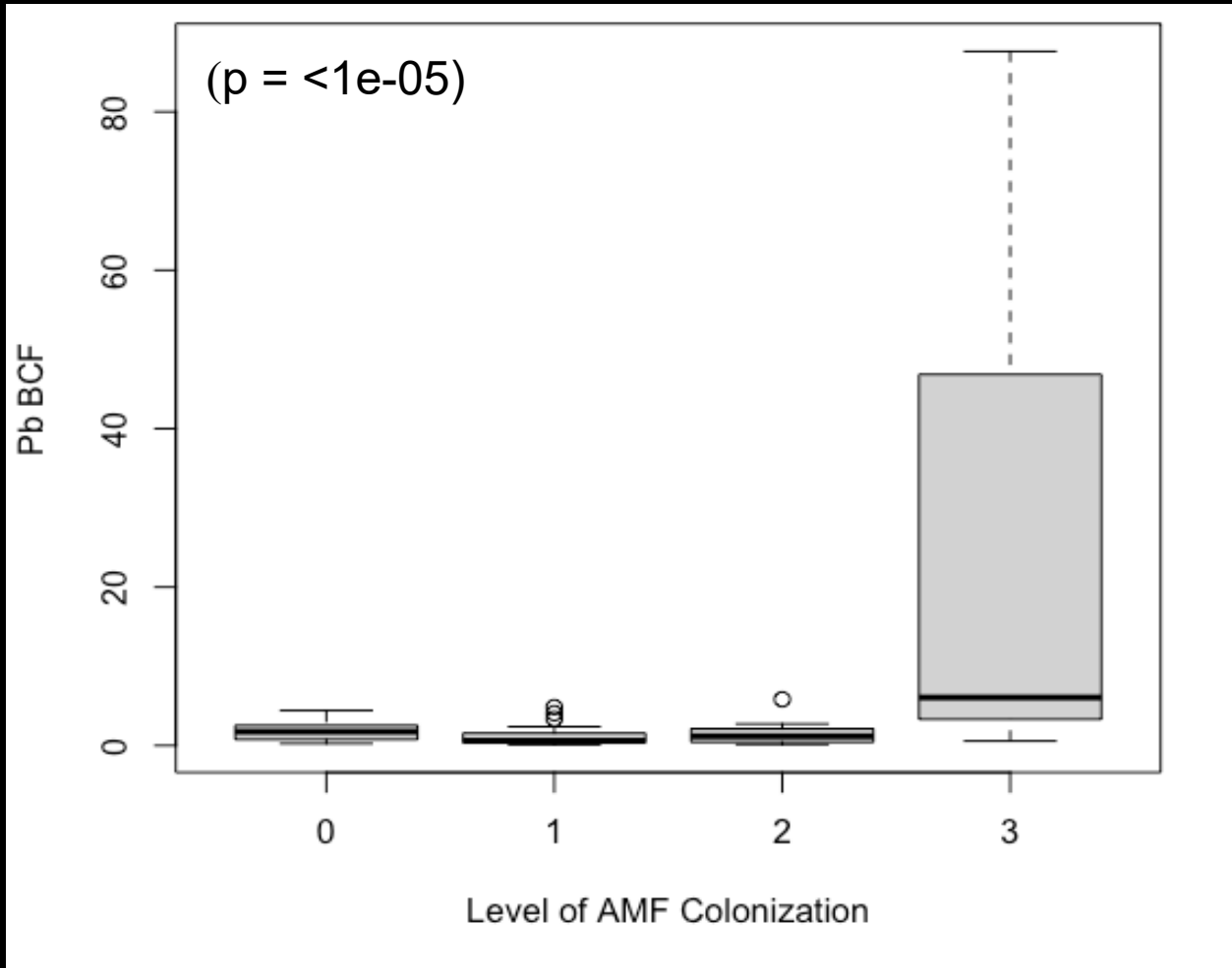
AMF inoculation increased plant survival and biomass

$p = 0.0543$





Arbuscular mycorrhizal fungi
was *the most significant
contributor to plant metal
removal from soil*



The **level of AMF root colonization** was the most significant predictor of plant accumulation for lead, arsenic and chromium

0 = none
level 1= trace, 1-10%
level 2= 11-50%
level 3 = >50 %



Cross section of mycoremediation treatment



99.75% average
reduction in all
hydrocarbons with *P.*
ostreatus

**With AMF
inoculation**



was reduced
significantly by

45%

on average

**Without
AMF**



Cr(VI)
concentrations
increased by

61%

on average

AMF increased plant **biomass and height** in the presence of Cr, Cr(VI), and drought stress



High Cr, drought
condition, **no / trace AMF**



High Cr, drought
condition, **high AMF root
growth**

When you mimic nature...



Remediation & regeneration happens



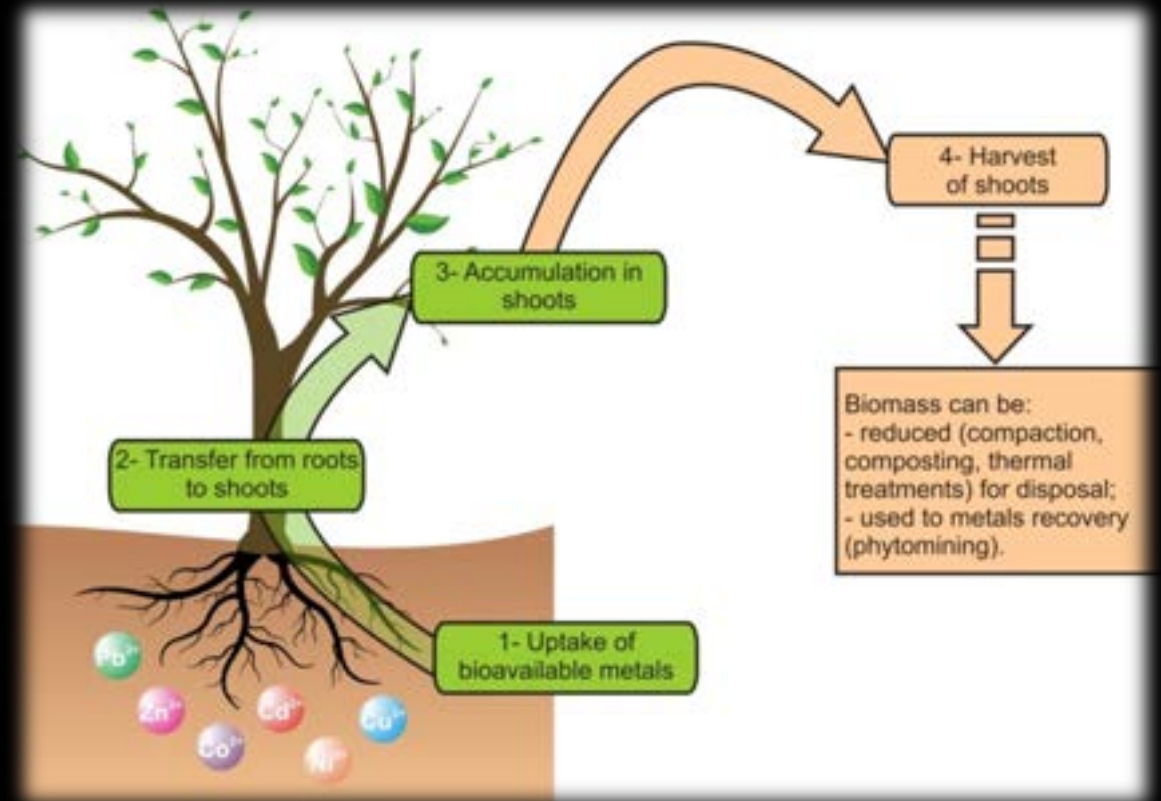
A photograph showing a dry, barren landscape with sparse, low-lying vegetation and a large metal transmission tower in the background under a clear blue sky. The ground is covered in dry grass and small shrubs. A few small blue and white flags are visible in the foreground.

BEFORE

A photograph showing the same landscape after restoration. The ground is now covered with dense, green vegetation, including tall grasses and small shrubs. A large metal transmission tower is visible in the background under a cloudy sky. The overall scene is much greener and more lush than the 'before' image. A few small blue and white flags are still visible in the foreground.

AFTER

Byproducts (mushrooms, plants, etc.) of remediation efforts are hazardous waste and need to be tested, and plan for where you'll contain them or dispose of them!



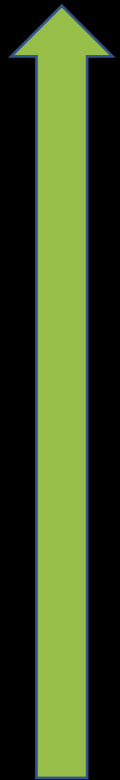
All byproducts of the myco-
phytoremediation study (plant
biomass and fungi) were collected
and used to test making:

myco-materials

biofuel



Soil repair possible with bioremediation



- increase available nutrients
- increase organic matter
- increase microbial biomass
- improve poor soil structure
- improve water retention
- restore plant and microbial diversity

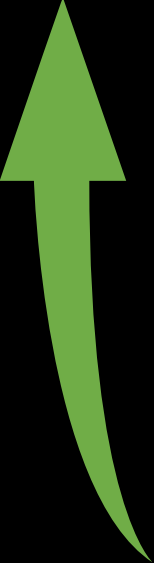


- prevent soil erosion (and dust formation)
- Treat heavy metal (lead, arsenic) and other contaminants
- Reduce water runoff
- Protect soil from high temperatures

Value Metrics



10x lower CO2 emissions per acre
50% cost savings



26 x soil carbon storage
40 x biodiversity increase
60% vegetation recovery at 12 months
circular outputs rather than waste

How can these methods be applied to remediate fire-impacted sites?



MYCO-WATTLES: FUNGAL-BASED EROSION CONTROL & TOXIN IMMOBILIZATION

Myco-Wattles are erosion control structures infused with mycelium to stabilize soil, prevent runoff, and break down harmful contaminants. By leveraging fungi's natural filtration and remediation properties, these wattles help reduce erosion and improve ecosystem recovery after wildfires.



SOIL BIOREMEDIATION: MYCOREMEDIATION & PHYTOREMEDIATION

Soil bioremediation integrates **mycoremediation** (using fungi) and **phytoremediation** (using plants) to restore contaminated and degraded soil. Fungi help break down toxins and bind heavy metals, while plants absorb and filter pollutants, creating healthier soil and supporting long-term ecosystem recovery.



BIOME LOGS FOR ECOLOGICAL REGENERATION TO REDUCE FUTURE FIRE RISKS

Biome Logs are a **natural erosion control method** that helps stabilize fire-damaged landscapes, reduce runoff, and promote ecological recovery.



CoRenewal

Centre for Applied Ecological
Remediation



CoRenewal

CAER is carrying out large-scale ecological remediation on fire-contaminated public & private sites in LA County

- 4 parks, including Eaton Canyon and parks in the Palisades
- 50 residential sites for high-need families with young children



Civic Bioremediation

Building a Network of Soil Practicioners



Bioremediation Workforce Development



- Bioremediation Certificate Program
 - Communities impacted by widespread contamination
 - 75 have completed the certificate
- LASD high school students
 - 50 youth have completed the certificate
- **The program is a mix of theory and hands-on experiential learning** and connects participants to support bioremediation research in Los Angeles area.

SUSTAINABLE BIOREMEDIATION



Reduced emissions from shipping soil with in-situ treatment



Regenerates soil such that it can support plants and trees



Reducing risks to fence-line communities from contaminated sites



Enabling contaminated site transformation into parks, green spaces, community gardens and other uses



Protecting and cleaning water resources



Building a regenerative economy and workforce with local jobs



Centre for Applied Ecological Remediation

www.caer.earth

info@caer.earth

[ig/ bluesky: @caer.earth](#)

Corenewal's Post-Fire Studies

Primary PFMI Methods

- (1) Use of an non-inoculated wattle to stimulate growth of microbes in soil at installation site
- (2) Inoculation of wattle with a single species of native saprotrophic fungi
- (3) Inoculation of wattle with soil from a reference habitat
- (4) Inoculation of wattle with a compost

***Note:** methods 2-4 have associated risks and caution must be used when implementing. Please see our detailed protocols (below) for best-practices.

***Risks we want to avoid:** the spread of invasive species (such as the common Golden Oyster mushroom from Eurasia) and soil pathogens (such as Phytophthora species that cause Sudden Oak Death and other blights).



<https://www.fenixsfungi.com/pfmi-tool-and-methods>

CoRenewal **BioStimulant Exploration Tool**

Welcome to the bioStimulant web tool. Please select from the following options below to see general recommendations based on your fire. Once all selections are made, click on 'Additional Recommendations' to see bioStimulant general guidelines based on all your choices as a whole. Hit the 'Refresh' button to start over.

Refresh

Did the burn happen on public or private land?

Private land

Was the fire a wildfire or prescribed fire?

Wildfire

On private land, management approaches can be more innovative. For example, you could use a PFMI method (e.g., a post-fire inoculant) to stimulate microbial growth after a fire.

Was there a structure that burned in the fire?

Structure

Wildfires can be low intensity and limited in range, but they are more often large and high intensity fires that can cause long-term negative impacts on soil organisms. Our PFMI study tested PFMI as an active restoration approach after high intensity wildfires in 3 areas from Southern California to Southern Oregon.

Did this fire take place in (or near) a wooded or forested area?

Wooded area

If the fire took place in or near a wooded or forested area, it's likely to have burned at greater intensity and the soil microbial community may benefit from active restoration with PFMI.

Where are you located?

Southern

You're in the North, we have three experimental sites for the PFMI study in your region. Burns in these areas tend to increase soil nitrogen, organic matter, total carbon and the carbon-to-nitrogen-to-microbes. These different starting conditions may impact the effect of PFMI treatments.

Choose the area you are working in by selecting it in the map below.

You're in the North, we have three test plots in your region. Burns in these areas tend to increase total nitrogen, organic matter, total carbon and the carbon-to-nitrogen-to-microbes. These different starting conditions impact different biological treatments.

Would you like to be contacted by a member of our team for a free 15 minute consultation?

☐ No thanks

☐ Yes, please email me

Additional Recommendations

Web-tool

- To use the tool, click the link embedded in the title above or the photo to the left, it will take you to an external web-page
- This web-tool is currently in beta-testing
- We encourage you to test it out for us and let us know what you think!
- We intend to improve this tool with user feedback and updated data from the findings of our study
- In the future, we will offer PFMI kits, consultations with our staff, and soil testing services

Integrating process-based restoration into post-fire emergency response efforts

Gabrielle Bohlman, US Forest Service
Region 5 Ecology Program



Credit: R. Wignall



Credit: Butte County Resource Conservation District



Credit: J. Petreshen



2026 Salmonid Restoration Conference
Fire and Fish Workshop



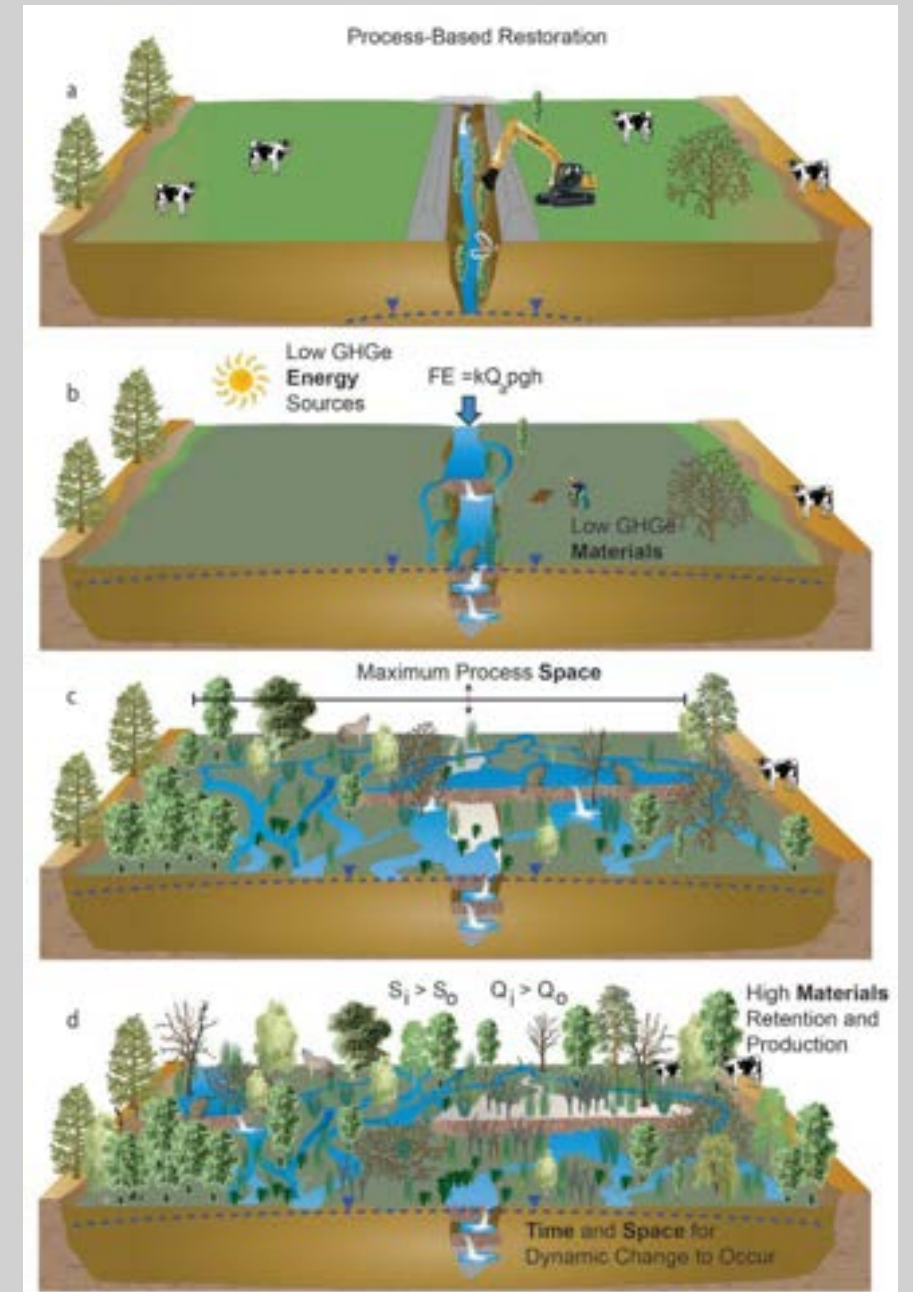
What is low-tech process-based restoration (LTPBR)?

- A practice of using **locally sourced materials** (e.g., wood, rock, sod) to add structure and **initiate key hydrological and biological processes**.
- Focus on **working with the system**, allowing stream energy to deliver sediment, and plant roots to lock in that sediment.
- Apply a conscious effort to use **cost-effective, minimal disturbance treatments**, allowing for efficiently scaling-up restoration efforts and to encourage a self-sustaining, dynamic ecosystem



Ecological Benefits of LTPBR

- **Improves ecosystem function**
 - Water retention
 - Water quality
 - Sediment capture
 - Soil formation
 - Carbon sequestration
- **Increases biodiversity**
 - Add complexity
 - Increase extent and productivity of riparian and wetland habitat for sensitive species
- **Increases ecological resilience**
 - Mitigate effects of climate change
 - Provide fire refugia
 - Mitigate effects of fire



Deep connection between fire and riverscapes.



- 🔥 Fire provides **periodic pulses of sediment and wood** key for system complexity
- 🔥 Fire can help **maintain or even increase stream flows** by modifying upslope vegetation
- 🔥 Smoke from fire can **cool water temperatures** when conditions are right



Deep connection between fire and riverscapes.

While still a critical ecological process...

Fire has become a major ecological disturbance.



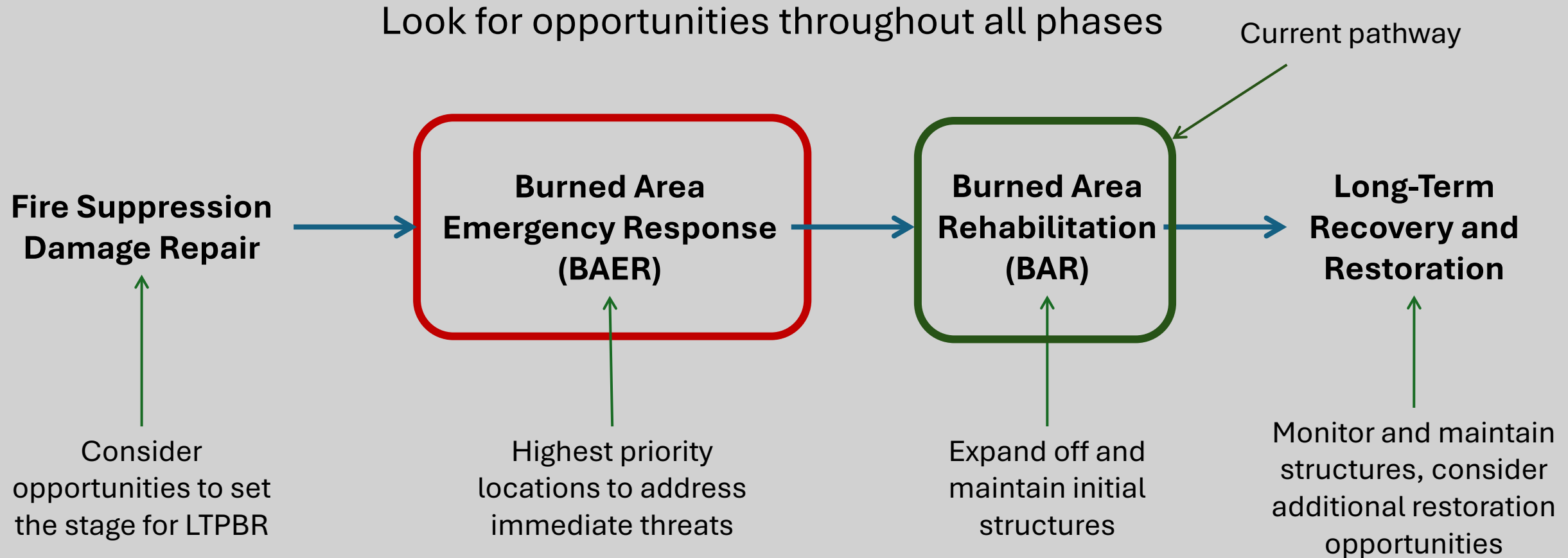
Fish kill in the Klamath. Credit: Karuk Tribe (Curtis et al. 2025)

Erosion due to high-intensity rainfall event after severe fire. Credit: Klamath National Forest

4 main phases of post-fire response on NFS lands:

	Fire Suppression Damage Repair	Burned Area Emergency Response (BAER)	Burned Area Rehabilitation (BAR)	Long-Term Recovery and Restoration
Timing	During and immediately after	Within 1 year, before the first major storms	Within 3 years	3-5+ years
Objective	Repair damage from suppression activities	Emergency stabilization to protect from post-wildfire events	Repair damage from the wildfire itself	Accelerate recovery of vegetation
Implementor	Resource Advisors and Incident Management Team	BAER teams and local staffing	Local staffing	Local staffing
Funding Type	Fire operations (suppression)	Fire operations (emergency stabilization)	Bipartisan Infrastructure Law (BIL) thru FY26	Regular program

4 main phases of post-fire response on NFS lands:



Burned Area Emergency Response (BAER)

Step 1: Identify **critical values** present on FS lands.

- **Human life and safety** – FS visitors, employees
- **Infrastructure** - roads, trails, campgrounds
- **Critical cultural resources** – sites potentially eligible for the National Register of Historic Places, Traditional Cultural Properties, sacred sites
- **Critical natural resources** – high value soil and water, critical T&E habitat, native plant communities



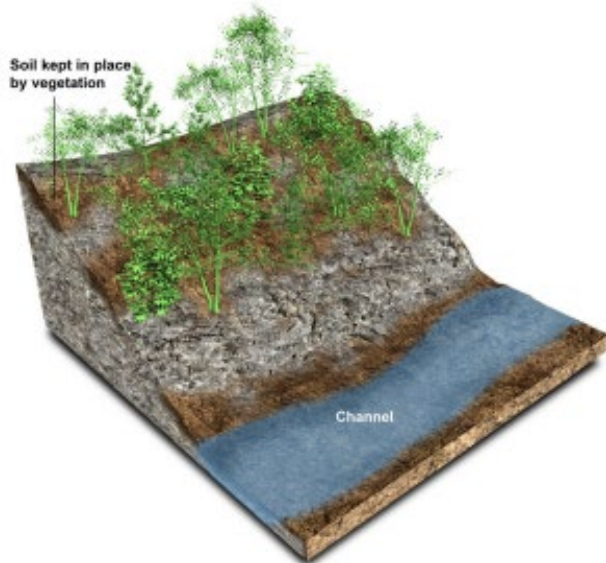
Burned Area Emergency Response (BAER)

Step 2: Identify and assess **imminent post-wildfire threats** to those values.

Biggest concerns are often: erosion, flooding, and debris flows

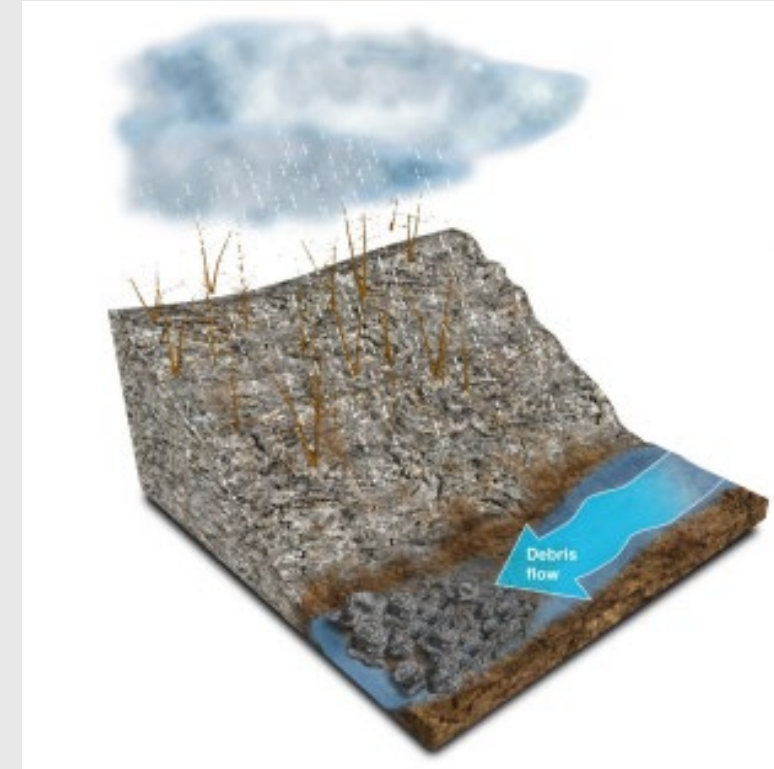
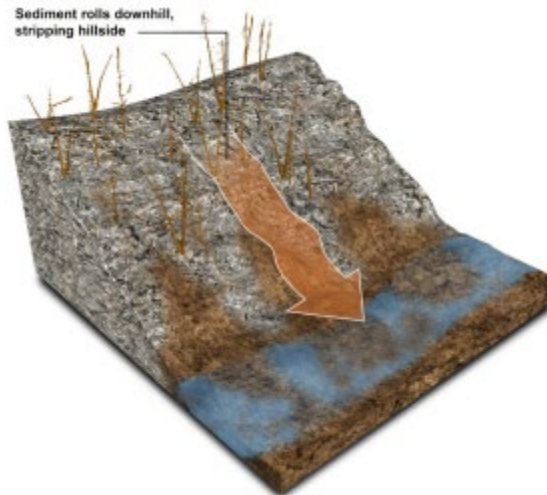
Before fire and rain

Soil is trapped on steep rocky hills by vegetation.



After fire

During summer's fire season, vegetation is burned, causing sediment to roll down steep hills. Within a few hours or days, channel bottoms are loaded with loose sediment.



Burned Area Emergency Response (BAER)

Step 2: Identify and assess **imminent post-wildfire threats** to those values.

Each BAER critical value and threat combination is evaluated for risk.

Probability of Damage or Loss	Magnitude of Consequences		
	Major (Life loss, substantial/irreversible damage)	Moderate (Injury of life, long-term resource effects)	Minor (no injury, recoverable loss)
	RISK		
Very Likely (>90%)	Very High	Very High	Low
Likely (50-90%)	Very High	High	Low
Possible (10-50%)	High	Intermediate	Low
Unlikely (<10%)	Intermediate	Low	Very Low

Risk assessment provides justification for use of emergency funding authority under BAER.

Burned Area Emergency Response (BAER)

Step 3: Select treatments to **manage unacceptable risks**.

Treatments need to be:

- ✓ Proven effective
- ✓ Require minimal action
- ✓ Reduce risk in first year to acceptable
- ✓ Cost is economically justified
- ✓ Can be completed before damage is expected



A landscape photograph showing a vast mountain range under a cloudy sky. The mountains are covered in sparse, dry vegetation, appearing in shades of brown, tan, and muted green. The sky is filled with large, white and grey clouds, with some blue visible between them. The overall scene conveys a sense of a rugged, natural environment.

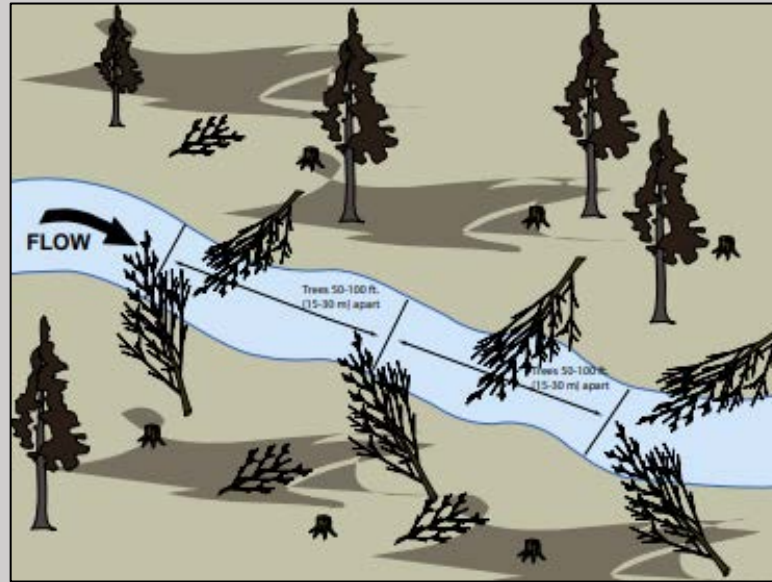
So how does low-tech process-
based restoration fit in?

Some LTPBR-type approaches are already included.

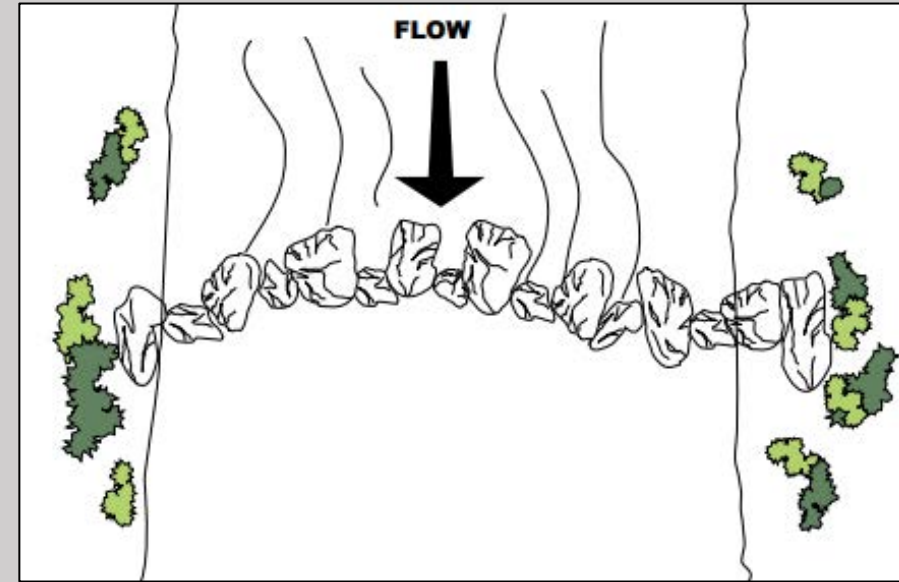
Check dams to trap sediment and slow water velocities.



In-channel tree felling to maintain channel stability and provide fish habitat.



Grade stabilizers to prevent channel incising and downcutting.



But the methods approved for BAER are limited and often considered to be ineffective at reducing risk to an acceptable level.

USING LTPBR TO CATCH POST-FIRE SEDIMENT

2024 PARK FIRE

Resource Conservation District, Butte County



Partners: Big Chico Creek Ecological Reserve, California Conservation Corps, Mooretown Rancheria, Streamwise, Symbiotic Restoration (trainers), Mechoopda Indian Tribe (cultural monitoring)



- Burned 75% of the Big Chico Creek watershed
- Big Chico Creek is an eastern tributary to the Sacramento River
- Important anadromous fish habitat
- Highly valued spring-run Chinook salmon population

Photo credit: FishBio

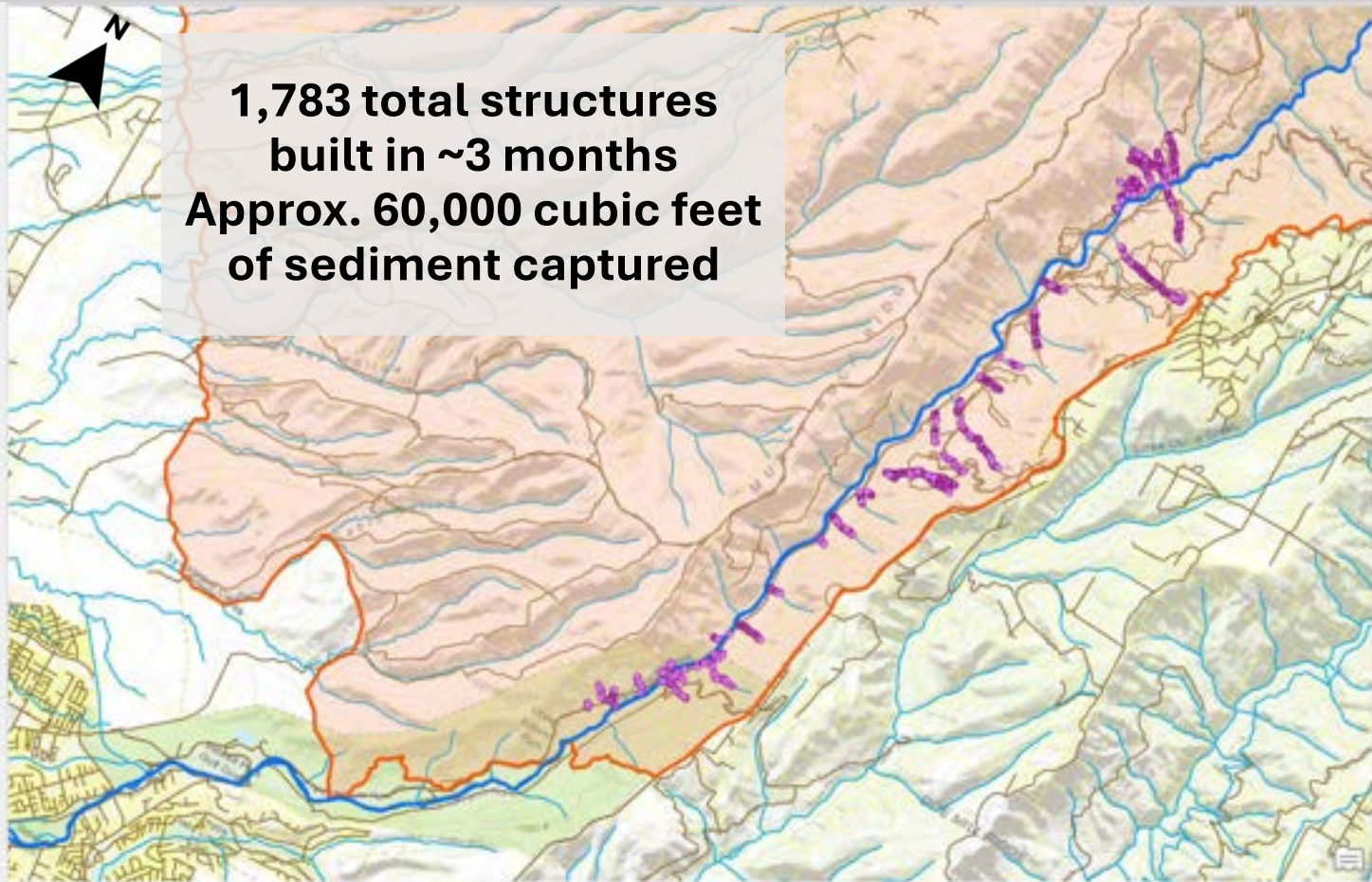
USING LTPBR TO CATCH POST-FIRE SEDIMENT

2024 PARK FIRE

Resource Conservation District, Butte County



Partners: Big Chico Creek Ecological Reserve, California Conservation Corps, Mooretown Rancheria, Streamwise, Symbiotic Restoration (trainers), Mechoopda Indian Tribe (cultural monitoring)



1,783 total structures
built in ~3 months
Approx. 60,000 cubic feet
of sediment captured

A topographic map of the Park Fire area in Butte County, California. The map shows a network of roads, rivers, and topographic contours. A blue line indicates the fire perimeter, and purple lines show the locations of structures built in the last three months. A north arrow is in the top left corner.

Photo credit: Jason Halley, CSU Chico

USING LTPBR TO CATCH POST-FIRE SEDIMENT

2024 PARK FIRE

Resource Conservation District, Butte County



Partners: Big Chico Creek Ecological Reserve, California Conservation Corps, Mooretown Rancheria, Streamwise, Symbiotic Restoration (trainers), Mechoopda Indian Tribe (cultural monitoring)

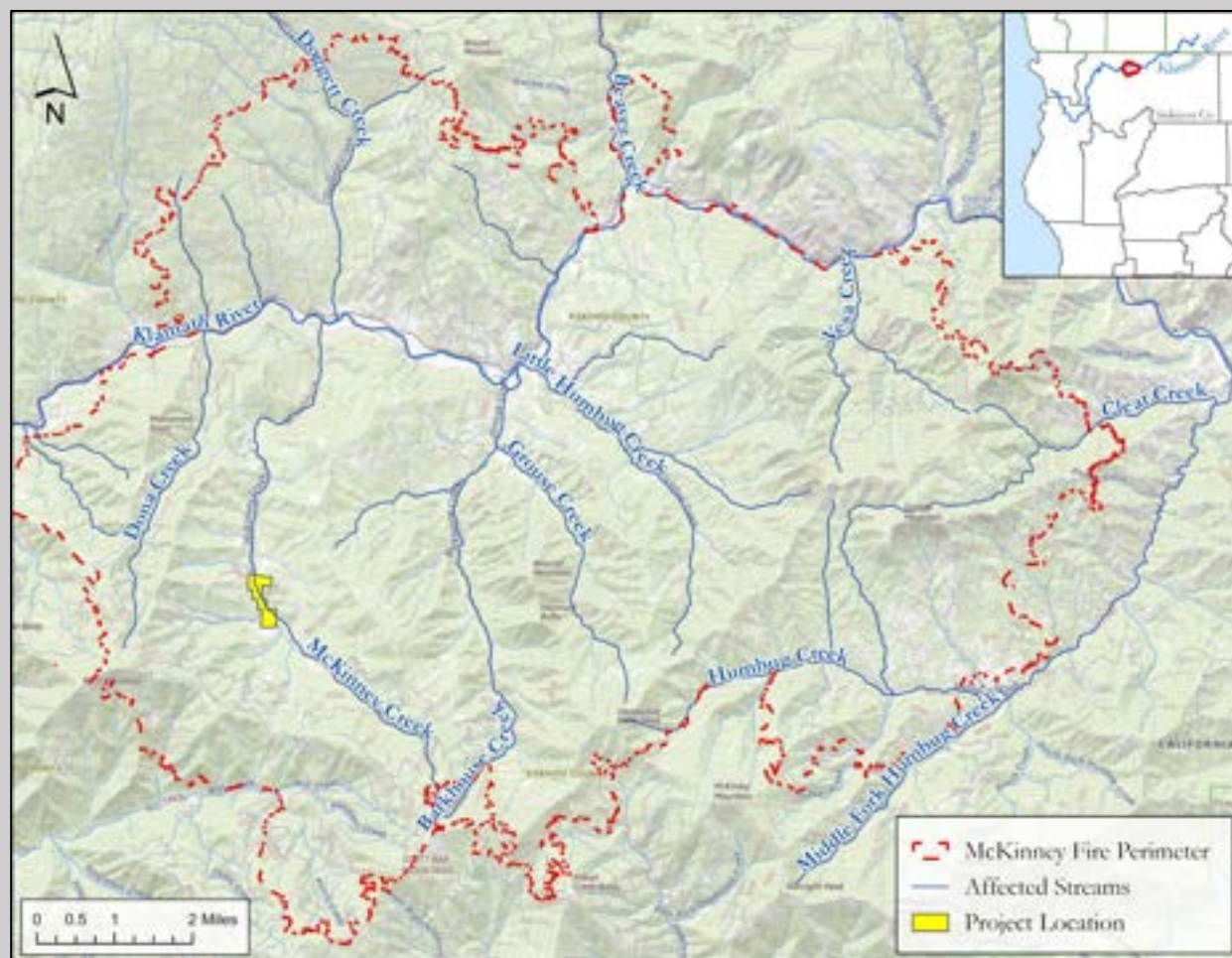


Structures capturing sediment and quickly becoming part of the system.

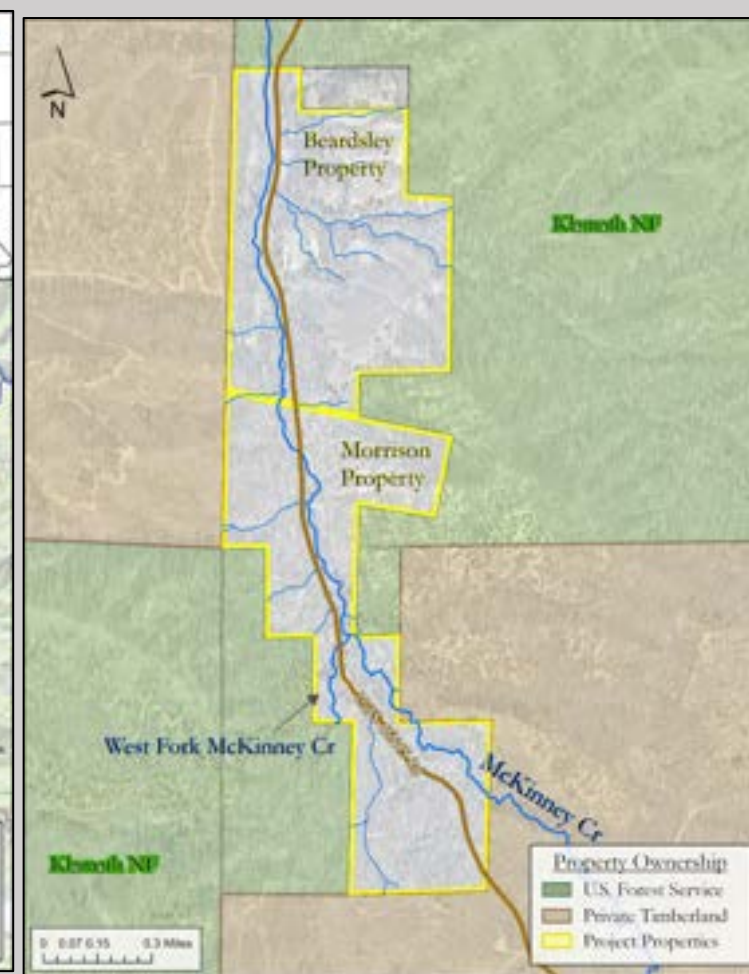
USING LTPBR TO CATCH POST-FIRE SEDIMENT

2022 MCKINNEY FIRE

Yurok Tribe and Mid-Klamath Watershed Council



Map of affected tributaries and location of LTPBR project in upper McKinney Creek



Project property overview.

- Private lands adjacent to Forest Service & private timber
- Upper McKinney Creek
- 4 miles upstream from Klamath River
- Located above anadromy

USING LTPBR TO CATCH POST-FIRE SEDIMENT

2022 MCKINNEY FIRE

Yurok Tribe and Mid-Klamath Watershed Council



Goals

- Capture sediment, reconnect floodplains
- Rebuild channel bed elevations
- Stop incision from propagating upstream
- Stabilize gully & head cut
- Accelerate recruitment of standing dead trees



Drone image of incising gully. Photo by MKWC.



14-foot head cut at the top of incising gully, near property boundary. Photo by J. Petreshen

USING LTPBR TO CATCH POST-FIRE SEDIMENT

2022 MCKINNEY FIRE

Yurok Tribe and Mid-Klamath Watershed Council



Photos by J. Petreshen

Immediate results with impressive sediment capture



Before/After head-cut stabilization in incising gully

USING LTPBR TO CATCH POST-FIRE SEDIMENT

2022 MCKINNEY FIRE

Yurok Tribe and Mid-Klamath Watershed Council



Photos by J. Petreshen

Sites will continue to be monitored – important to learn from them.



The opportunities for integrating PBR approaches are there.

The effectiveness of capturing sediment is apparent.

So why aren't we using these approaches as treatments in BAER more?

ATTEMPTS TO INCLUDE LTPBR IN BAER

2022 MCKINNEY FIRE

Klamath National Forest

Initial debris flows were not preventable in that immediate post-fire environment



But still need to assess additional risk to resources and to determine how to mitigate future impacts



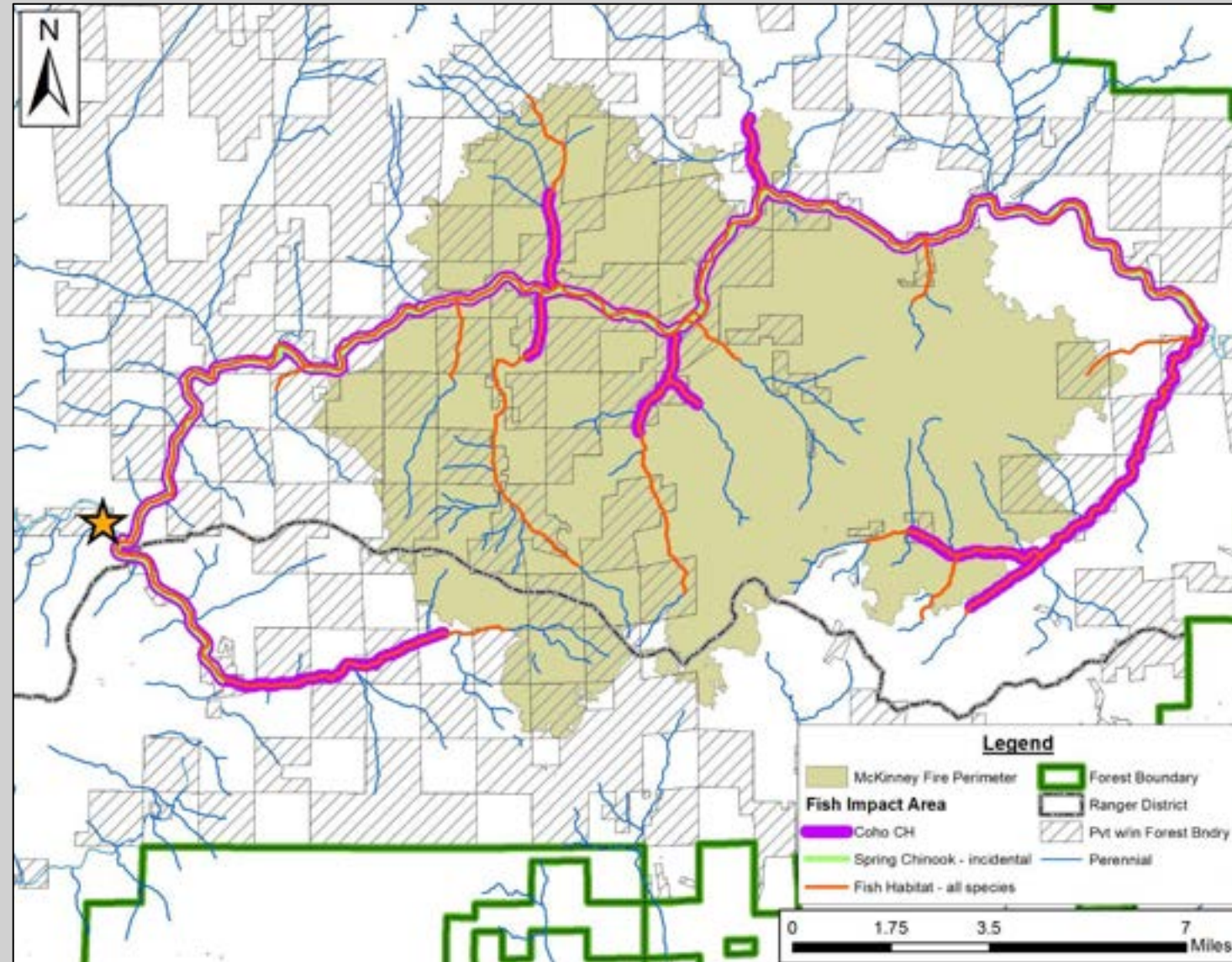
ATTEMPTS TO INCLUDE LTPBR IN BAER

2022 MCKINNEY FIRE

Klamath National Forest

BAER Team Assessment:

- Approx. 57 miles of Coho Critical Habitat and 76 miles of total fish habitat affected
- For risk analysis, if impacts were expected to affect:
 - 1 generation of fish were minor
 - 3 to 5 generations were moderate
 - >5 generations were major.
- “Very High” risk for impacts on listed T&E fisheries



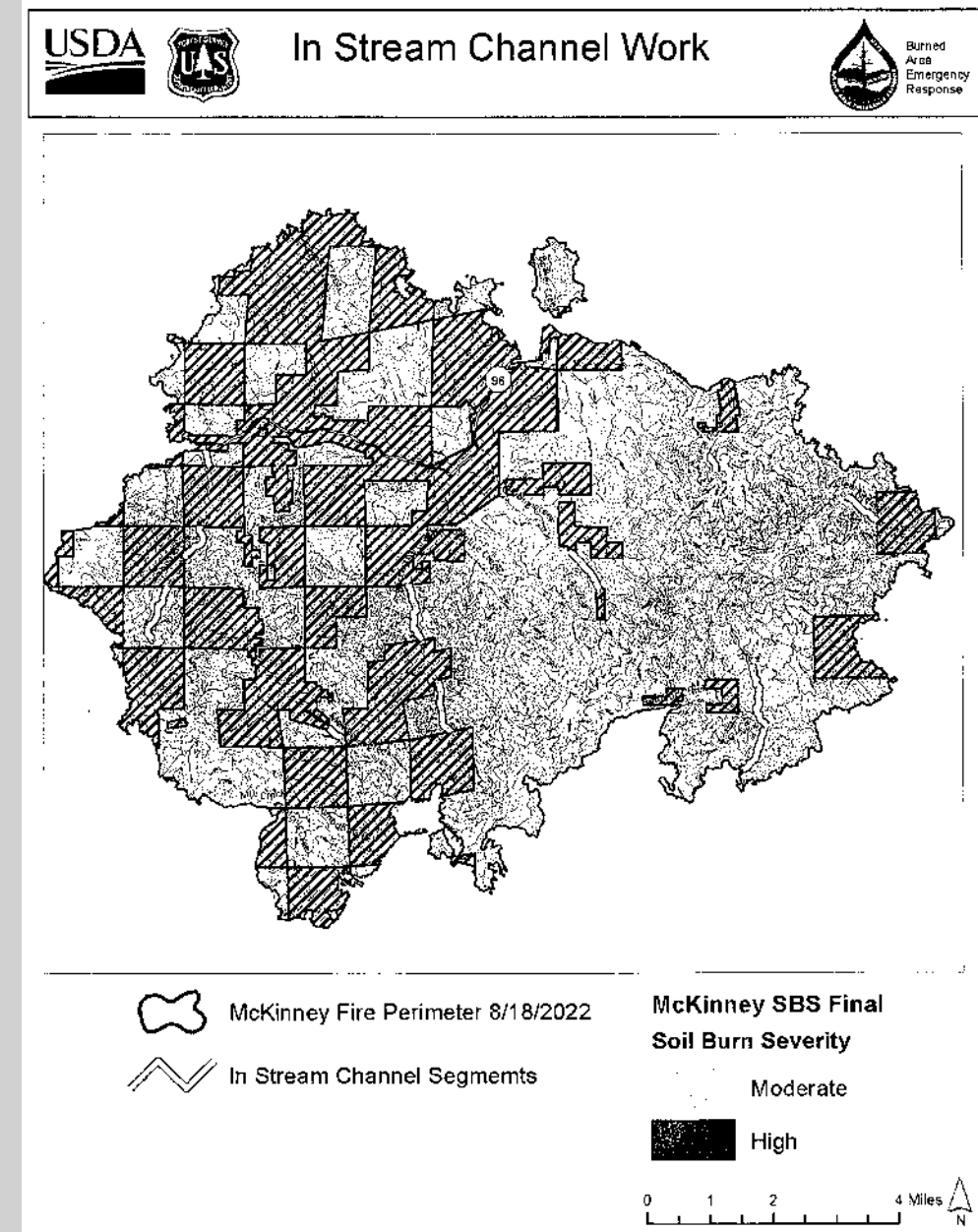
ATTEMPTS TO INCLUDE LTPBR IN BAER

2022 MCKINNEY FIRE

Klamath National Forest

BAER request:

- Large wood placement as treatment to stabilize banks and protect against further damage to Coho CH.
- Objectives:
 - Reduce rates of sediment transport during subsequent storm events
 - Capture debris and sediment during higher flows later in the year.
- Noted that efficacy of treatment relies on treating tributaries between high severity burn areas and spawning habitat
→ if greater than 50% of reaches can't be treated, treatment efficacy should be reconsidered.



2022 MCKINNEY FIRE

Klamath National Forest

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 - Capture debris and sediment during higher flows later in the year.
- Noted that efficacy of treatment relies on treating tributaries between high severity burn areas and spawning habitat
 - if greater than 50% of reaches can't be treated, treatment efficacy should be reconsidered.

Response from Washington Office:

- Large wood placement was not authorized.
- Based on the information provided, “the treatment does not address any unacceptable risk to BAER critical values.”
- “No analysis or evidence was presented demonstrating that the treatments would substantially reduce risk to the critical values.

ATTEMPTS TO INCLUDE LTPBR IN BAER

2022 MCKINNEY FIRE

Klamath National Forest

A **second** BAER request was then submitted highlighting the importance of addressing the concerns of tribal partners (incl. Yurok, Karuk, Quartz Valley, and Shasta) and the California Department of Fish and Wildlife.

Response from Regional Office to second request:

- request is “unusual in requesting authorization for a treatment that was already requested and not approved.”
- Not approved previously because “**not considered a BAER treatment that is likely to reduce unacceptable risks substantially within the first year (FSM 2523.03.2), nor is it demonstrated effective (FSM 2523.2.1c).**”
- ...”several available case studies of this treatment type under BAER demonstrated widely variable effectiveness, and in some cases were judged as making the situation and impacts worse.”

ATTEMPTS TO INCLUDE LTPBR IN BAER

2022 MCKINNEY FIRE

Klamath National Forest

A second BAER request was then submitted due to importance of addressing the concerns of tribal partners (incl. Yurok, Karuk, Quartz Valley, and Shasta) and the California Department of Fish and Wildlife.

Response from

→ request is “un
approved.”

“...I recognize your and the tribes’ desire to implement this treatment before another winter season. This particular treatment was requested and funded through the Burned Area Rehabilitation (BAR) program...”

→ Not approved previously because “not considered a BAER treatment that is likely to reduce unacceptable risks substantially within the first year (FSM 2523.03.2), nor is it demonstrated effective (FSM 2523.2.1c).”

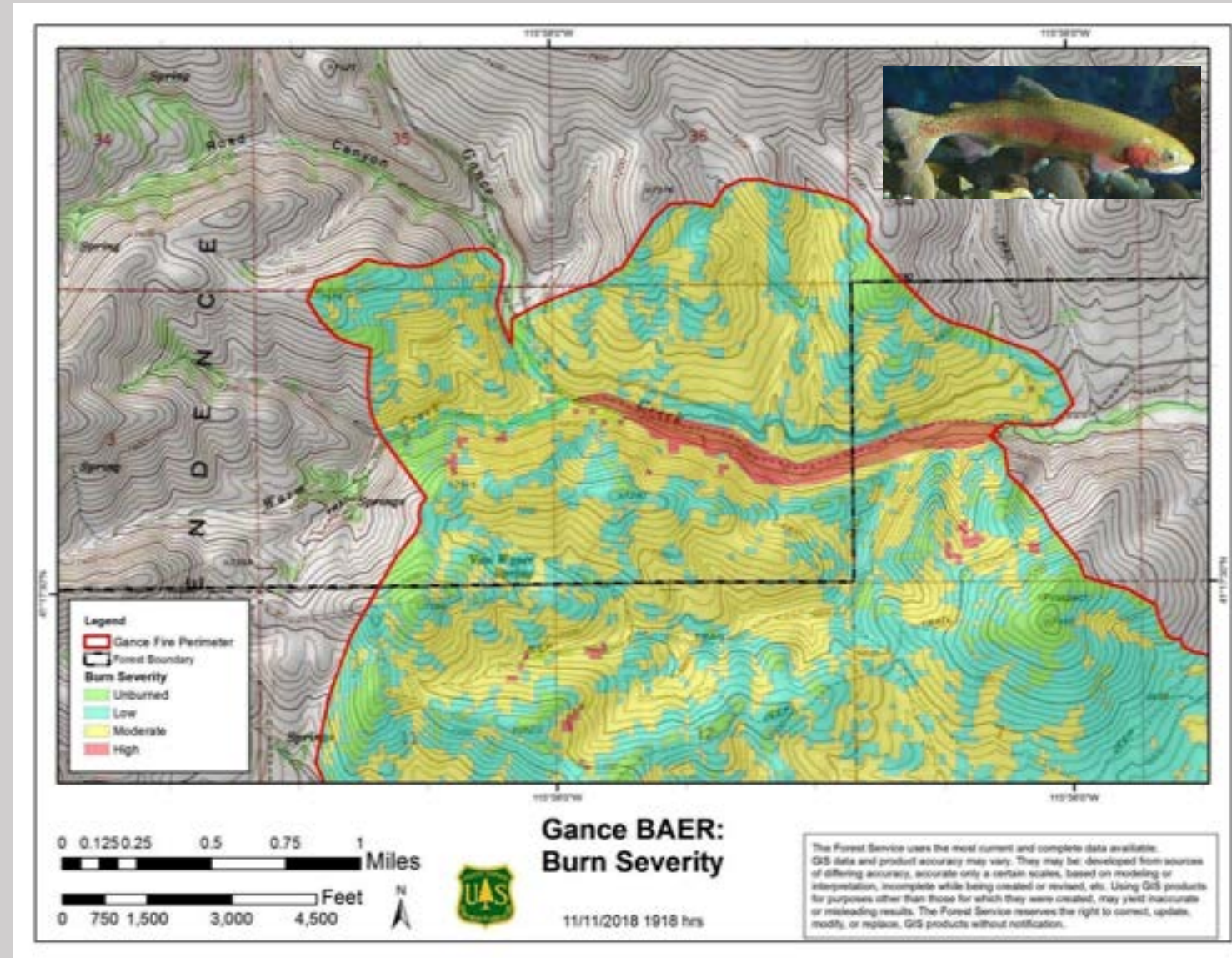
→ “...several available case studies of this treatment type under BAER demonstrated widely variable effectiveness, and in some cases were judged as making the situation and impacts worse.”

ATTEMPTS TO INCLUDE LTPBR IN BAER

2018 GANCE FIRE

Humboldt-Toiyabe National Forest

- Burned over a mile of the Gance Creek riparian area
- Occupied by Lahontan Cutthroat Trout (LCT), an ESA listed threatened species



ATTEMPTS TO INCLUDE LTPBR IN BAER

2018 GANCE FIRE

Humboldt-Toiyabe National Forest

**Beaver dam analogs approved
as pilot effort under BAER.**

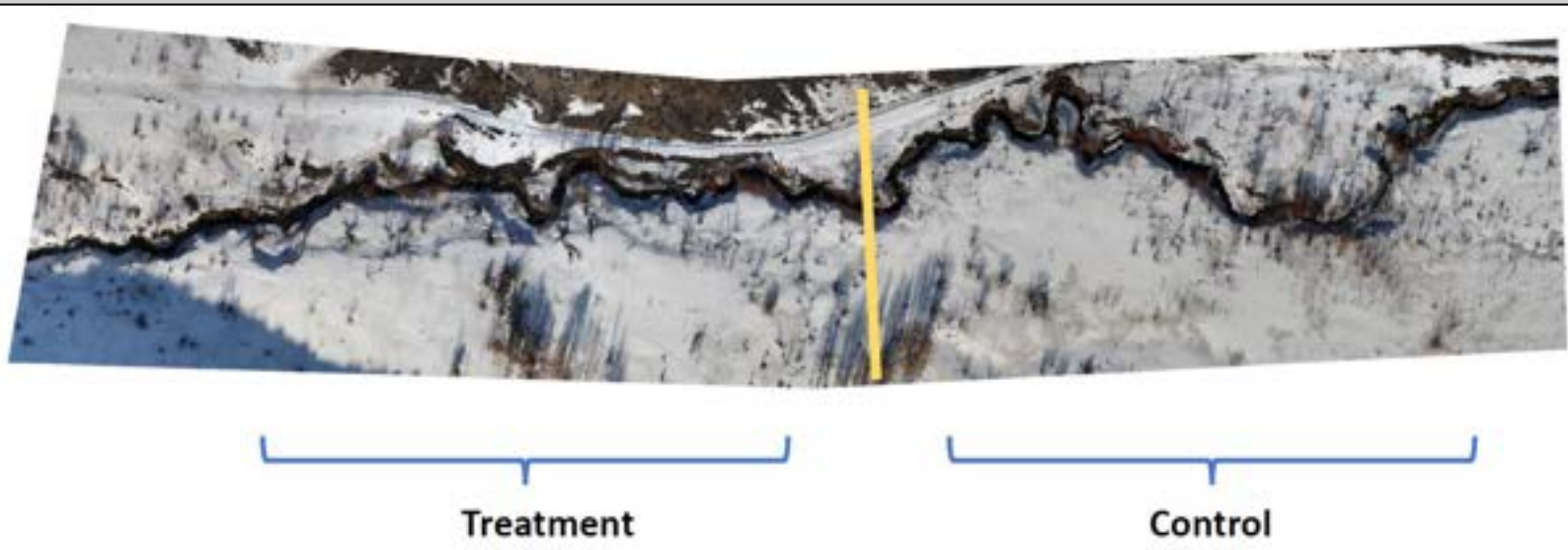
Objectives:

- Retain fisheries habitat integrity
- Increase inset floodplain connectivity
- Prevent additional downcutting of the stream system

Structures were first installed in December 2018



Images provided by Robin Wignall, HTNF



ATTEMPTS TO INCLUDE LTPBR IN BAER

2018 GANCE FIRE

Humboldt-Toiyabe National Forest

Beaver dam analogs approved as pilot effort under BAER.

Some major limitations...

- Funds only approved for materials - no funding for labor
 - Relied on volunteers and other available staff
- Support for monitoring was a challenge
- Ability to maintain/improve structures limited

Overall success in getting treatments approved!

- Step towards building understanding and support for use of LTPBR approaches in BAER when appropriate



Takeaways from using low-tech PBR to mitigate fire effects:

- Quick and effective way to capture sediment in upper reaches, reducing delivery to anadromous reaches
- Accumulating sediment and reconnecting floodplains promotes vegetation recovery
- A great tool but not a fit in every landscape (e.g., likely not appropriate in higher energy systems)
- Important to try to simulate local historical processes as much as possible.
 - Were beaver dams or large woody debris jams historically part of the system?
- Low-tech PBR is a great tool **ALONGSIDE** other critical tools!
 - Road storm proofing and contour falling dead trees are examples of other important and effective treatments.

Challenges and Opportunities within BAER

- Reducing risk to an acceptable level within the first year is difficult, especially after large fires.
 - BUT maybe easier to justify in smaller fires (e.g., Gance Fire)
- The word “Restoration” is a trigger that bumps treatments out of BAER
- New BAER treatment catalog drafted
 - LTPBR approaches included
 - Important to identify clear guidelines
- Recent examples provide opportunities to monitor in post-fire environments
 - Help us more fully understand effectiveness and/or potential risk.

Thank you!!

Special thanks to:

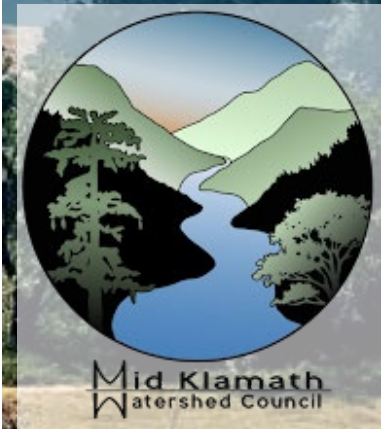
Wolfy Rougle and Faith Churchill,
Butte County RCD (Park Fire example)

Julia Petreshen, Yurok Tribe, and Mid-
Klamath Watershed Council
(McKinney Fire example)

Robin Wignall, Humbolt-Toiyabe NF
(Gance Fire example)



Connecting Instream and Upslope Restoration in the Western Klamath Mountains



Will Harling
Restoration Director - Mid Klamath Watershed Council
Co-Lead – Western Klamath Restoration Partnership
On-Call Firefighter – Karuk Tribe
CARX Burn Boss



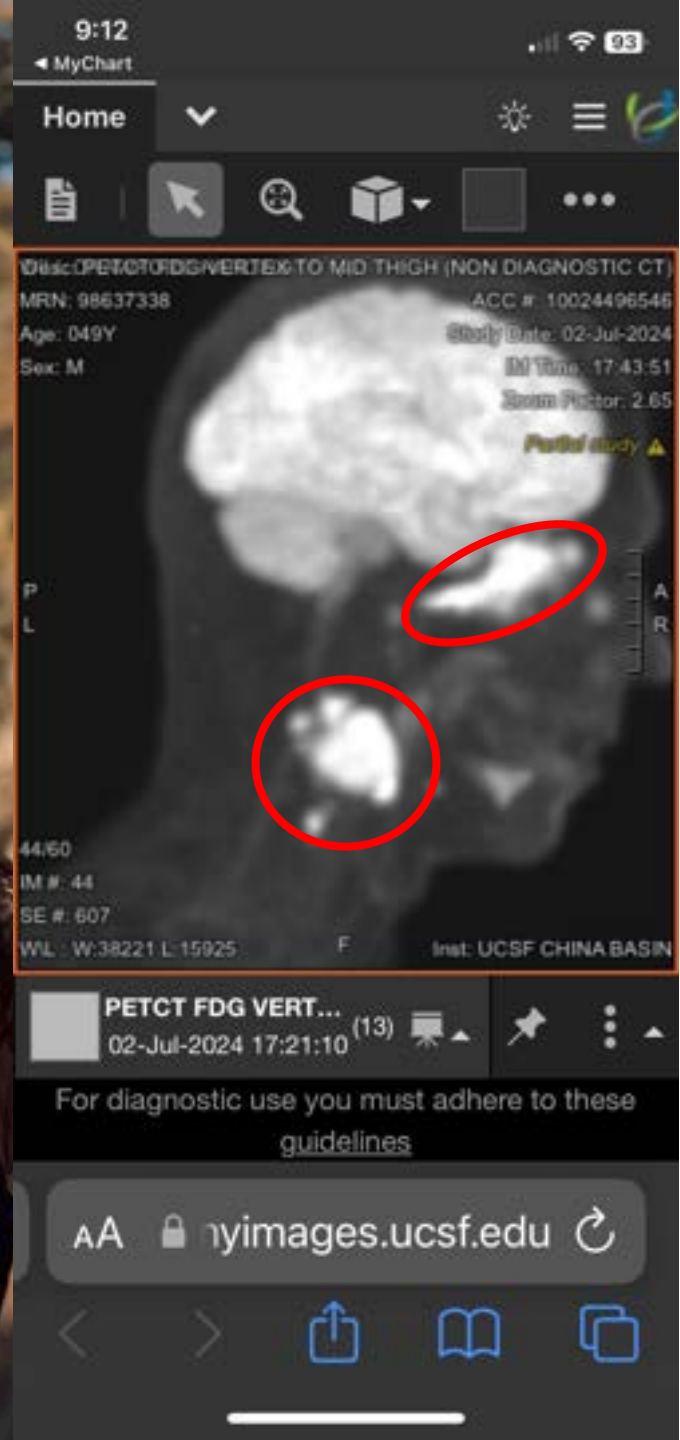
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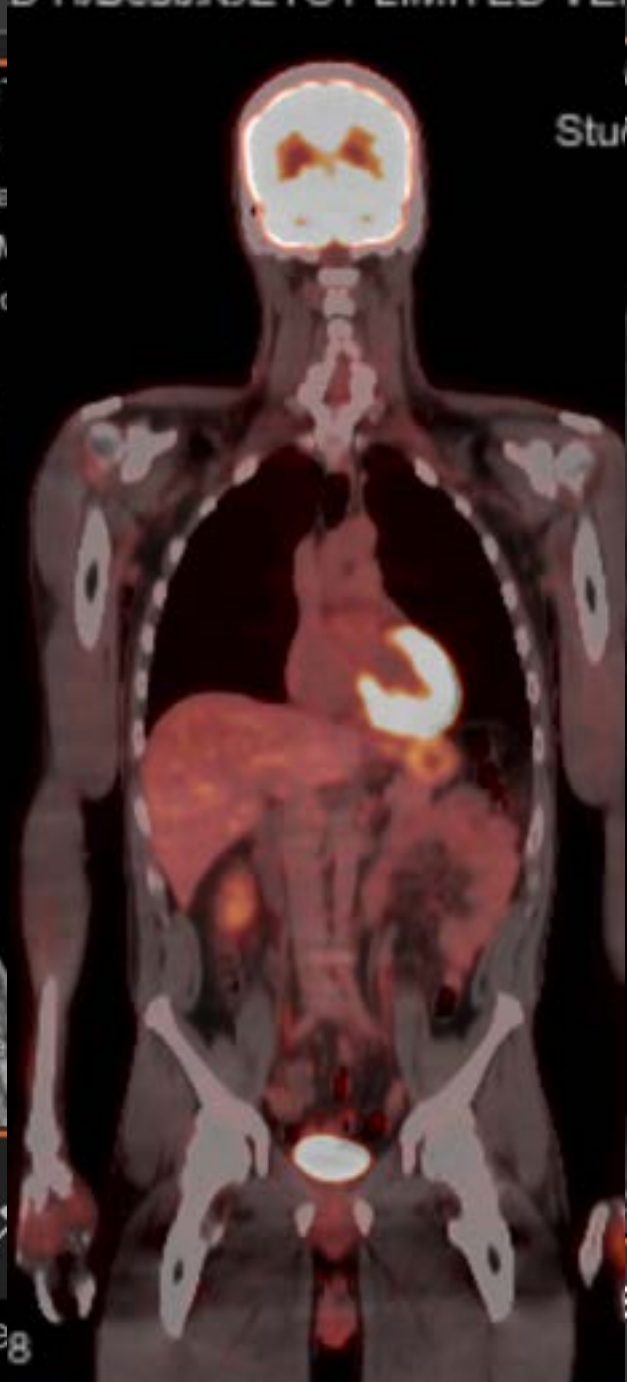
Luna Latimer Lake
Kathy McCovey







CT NECK WITH CONTRAST... (8)
 27-Feb-2026 10:30:14



PET/CT LIMITED VERTEX ... (11)
 27-Feb-2026 10:30:14

NECK WITH CONTRAST

For diagnostic use you must adhere to [guidelines](#)



Seiad Creek Coho Spawner Survey 12/30/2025

Existing Conditions



Selad Creek at Panther Gulch Habitat Enhancement Project FLOW INUNDATION

DATA SOURCES:
Roads, UTM, stream, USGS 2019
Hydrologic SWS 2022

MAP PROJECTION:
NAD 1983 UTM Zone 18N
Horizontal: NAD83

LEGEND

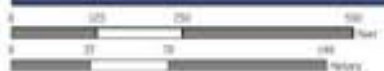
- Stationing
- In-stream restoration area
- 20% exceedance flow
- 252 cfs calibration inundation
- 2-year inundation
- 5-year inundation
- 10-year inundation
- 100-year inundation

Proposed Conditions



Stillwater Sciences

SCALE & NORTH ARROW



1:3,000 1 in = 250 feet

MAP LOCATION



Seiad at Panther Gulch Habitat Enhancement Project







Middle Sweet Coho Habitat Restoration Project



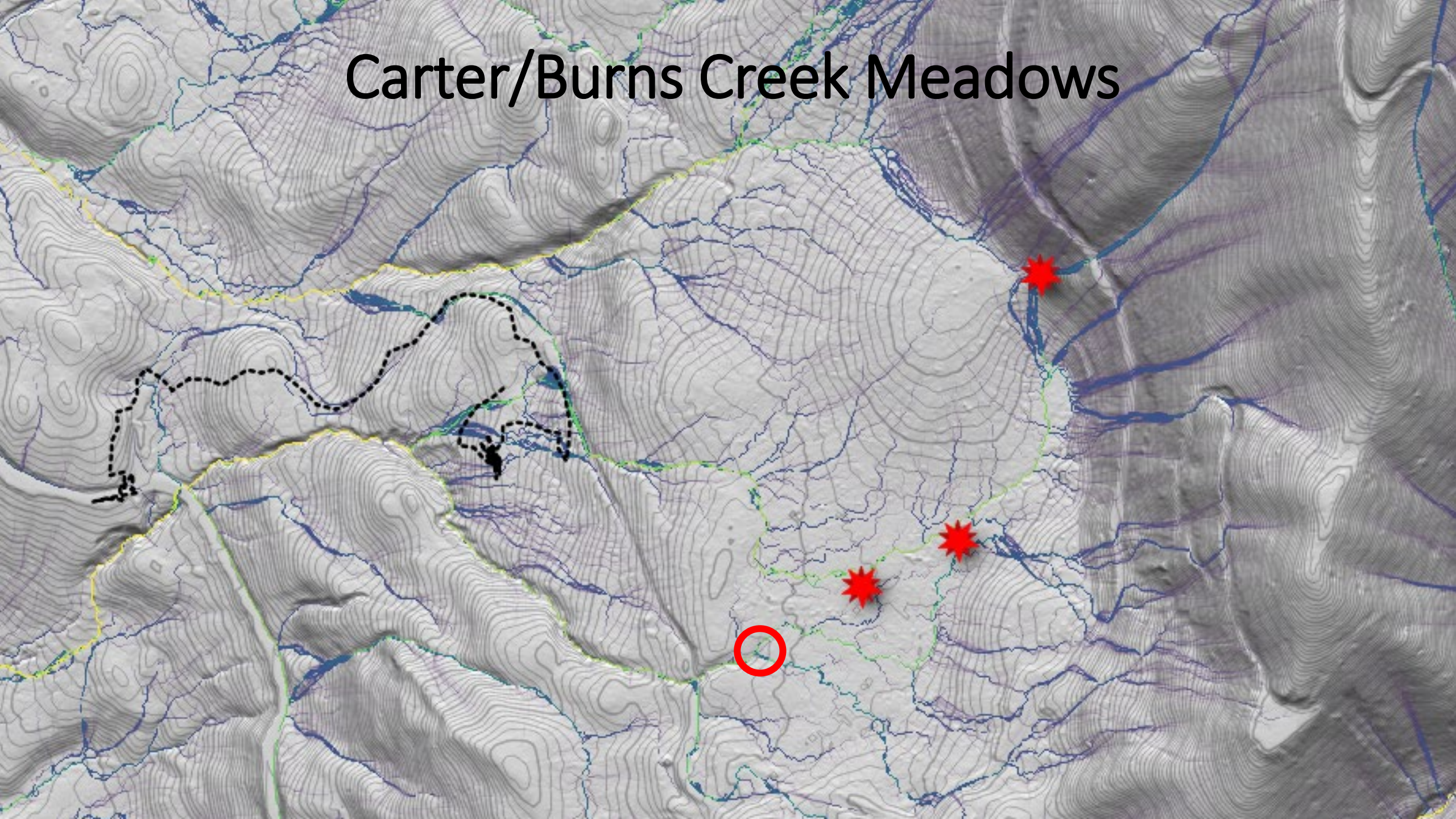
Doolittle Accelerated Wood Recruitment



Carter/Burns Creek Meadows



Carter/Burns Creek Meadows





MKWC Sandy Bar Creek Fish Passage Improvement Workday - 2002





Klamath River

Sandy Bar Creek

Klamath River

96





EXCLUSIVE: Trump Admin Axes Millions In Grants To Several DEI-Tied Environmental Organizations



(Photo by Ethan Miller via Getty Images)

DAILY CALLER NEWS FOUNDATION



TRENDING



Whiskey Business: After Daily Caller Report, French Foreigners Say They're No Longer Buying Jack Daniel's BUSINESS

REPORT: 52-Year-Old 'American Pie' Legend Earns Whopping Sum Of Money In First Week On

The Daily Caller News Foundation learned that the Department of the Interior (DOI) cancelled 79 grants to environmental organizations on Tuesday, totaling around \$14 million.

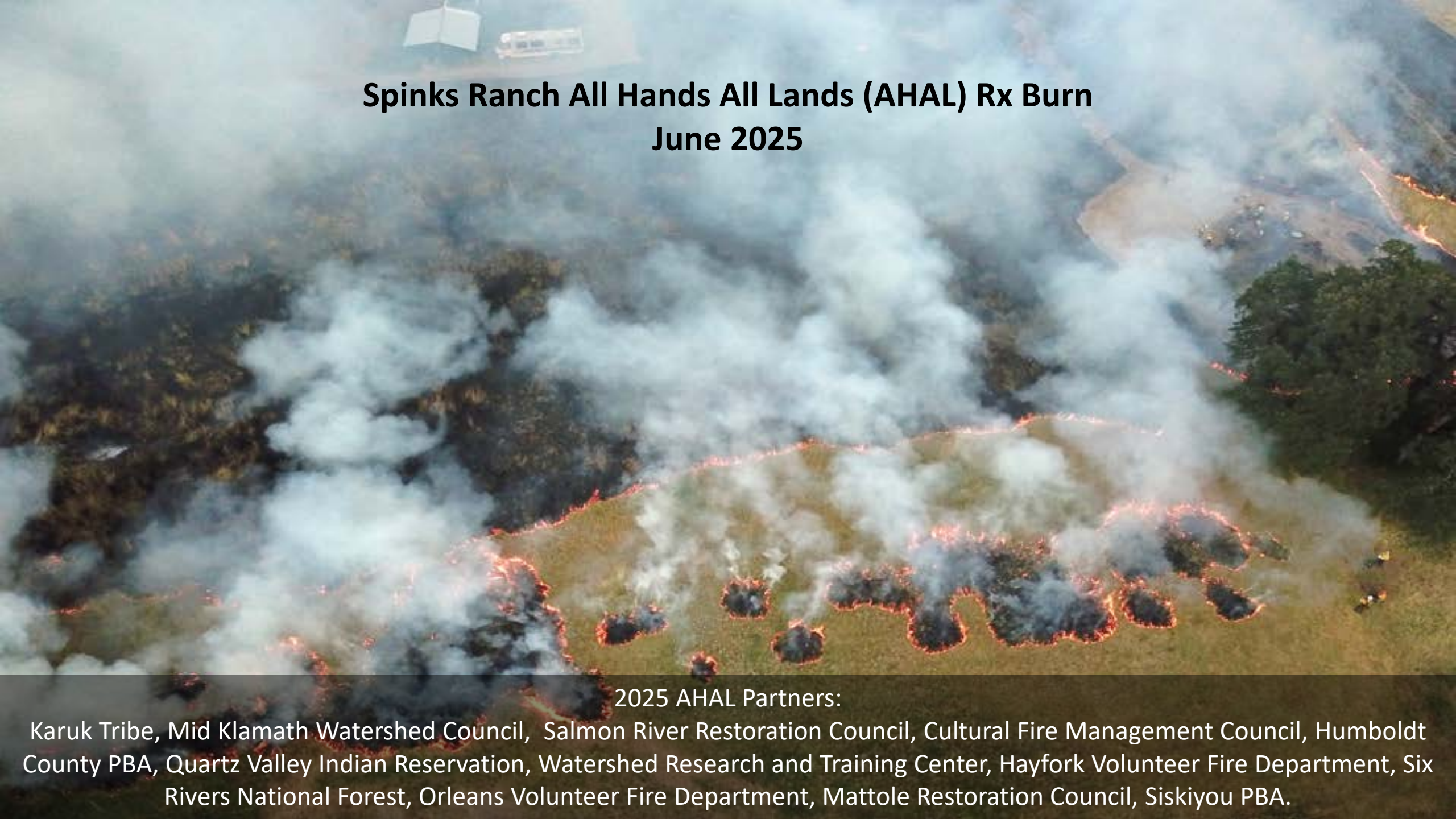


Funding Freeze!!!

We got this!!!



Upper Horse Valley Project



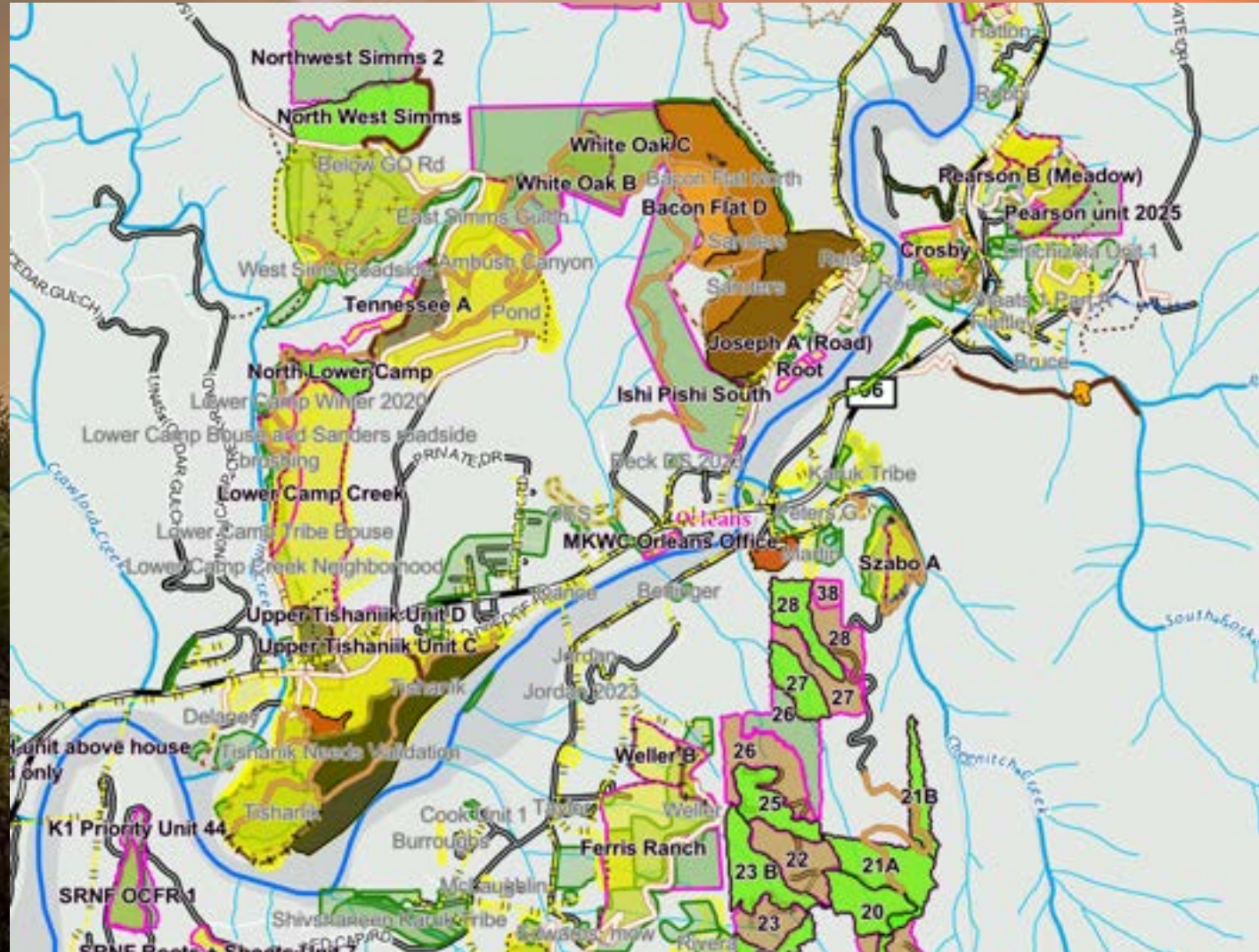
Spinks Ranch All Hands All Lands (AHAL) Rx Burn June 2025

2025 AHAL Partners:

Karuk Tribe, Mid Klamath Watershed Council, Salmon River Restoration Council, Cultural Fire Management Council, Humboldt County PBA, Quartz Valley Indian Reservation, Watershed Research and Training Center, Hayfork Volunteer Fire Department, Six Rivers National Forest, Orleans Volunteer Fire Department, Mattole Restoration Council, Siskiyou PBA.



Building Social Licence for Large Scale Beneficial Fire

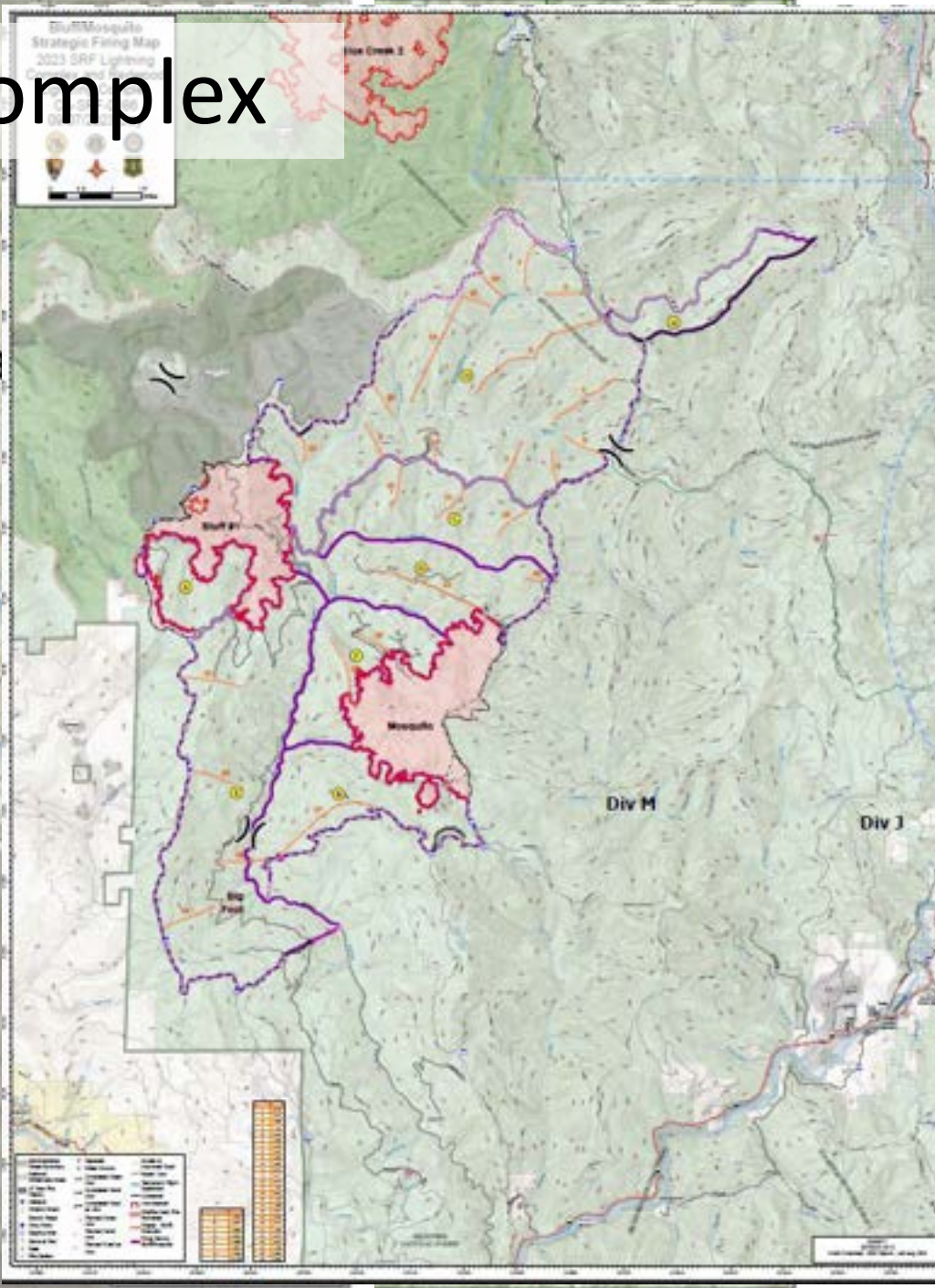
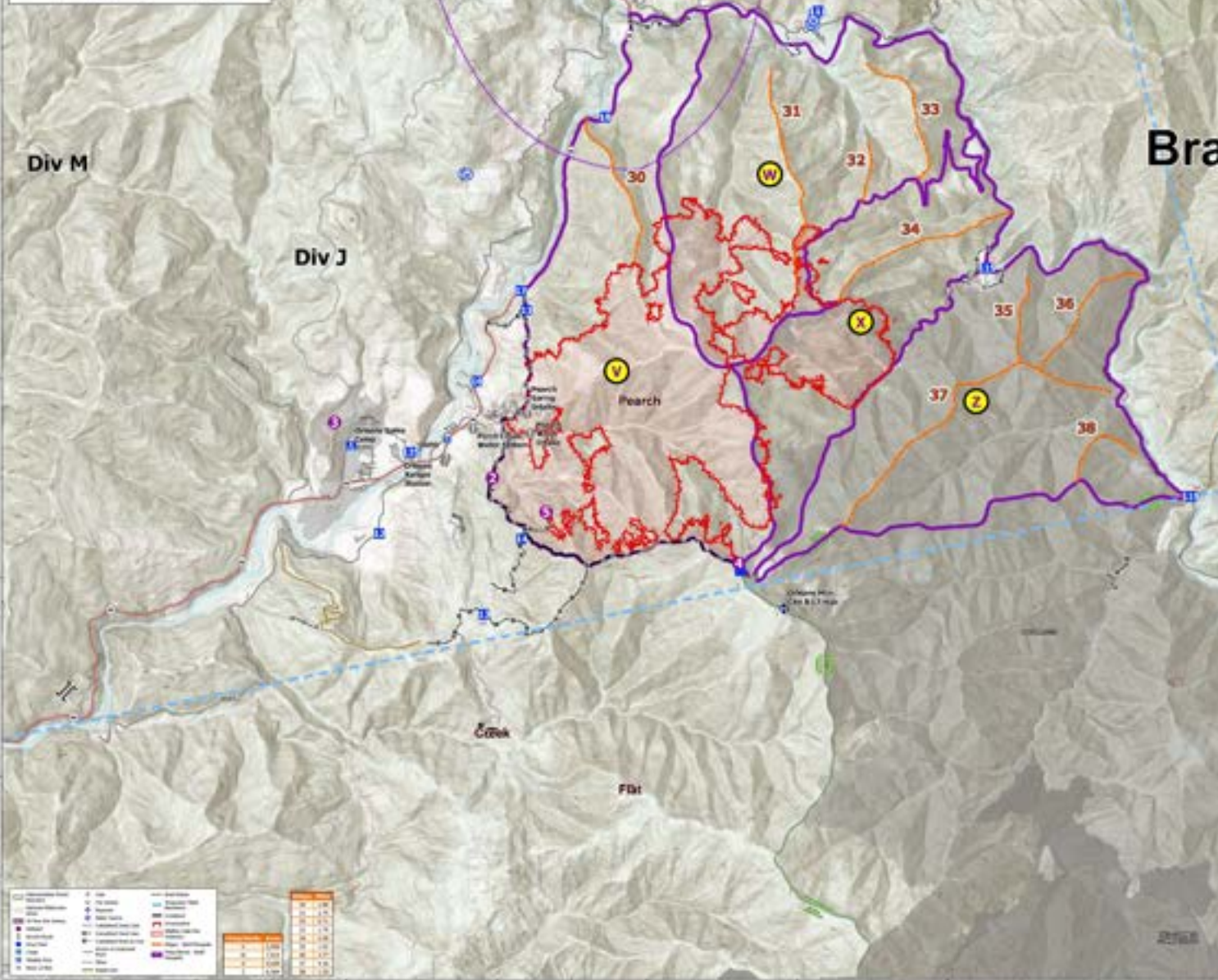


2023 SRF Lightning Complex – Peach Fire – Looking Down on Orleans from “Rocking Chair” Drop Point

Pearch
Strategic Firing Map
2023 SRF Lightning Complex and Redwood
Lightning Complex
CA-SRF-0666
06/14/2023 Day



2023 SRF Lightning Complex



California Vegetation Burn Severity Data Online Viewer

Use the filter tool below to search for a fire by name, year, size, or cause. Use the slider to view burn severity data. For further information, reference the [user guide](#), the [metadata](#), and the [FAQs](#).

California Fire Perimeters

Fire Name contains

Complex Name contains

Year is any of
0 Selected

Acres Burned is greater than

Cause of Fire includes
0 Selected

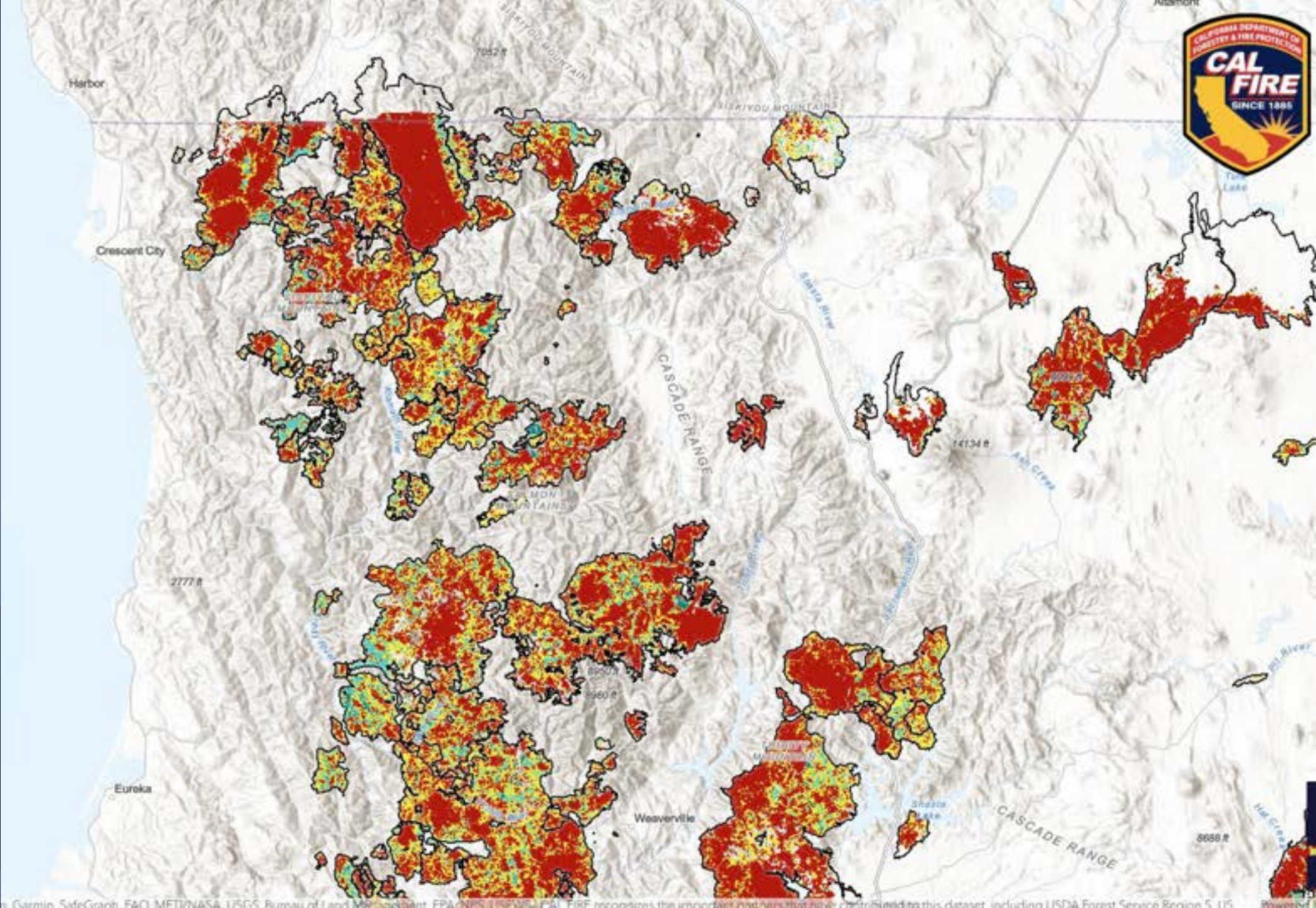
Composite Burn Index (CBI)

- Unchanged (0 - 0.1)
- Low Severity (0.1 - 1.25)
- Moderate Severity (1.25 - 2.25)
- High Severity (2.25 - 3)

CBI Key CBI Definition

Relative differenced Normalized Burn Ratio (RdNBR)
0 to 200

Turn On/Off Slider



2024 Boise Fire

2023 Pearch Fire

Div L

Div E

2013 Butler Fire

Div R

2024
Boise Fire

Div A

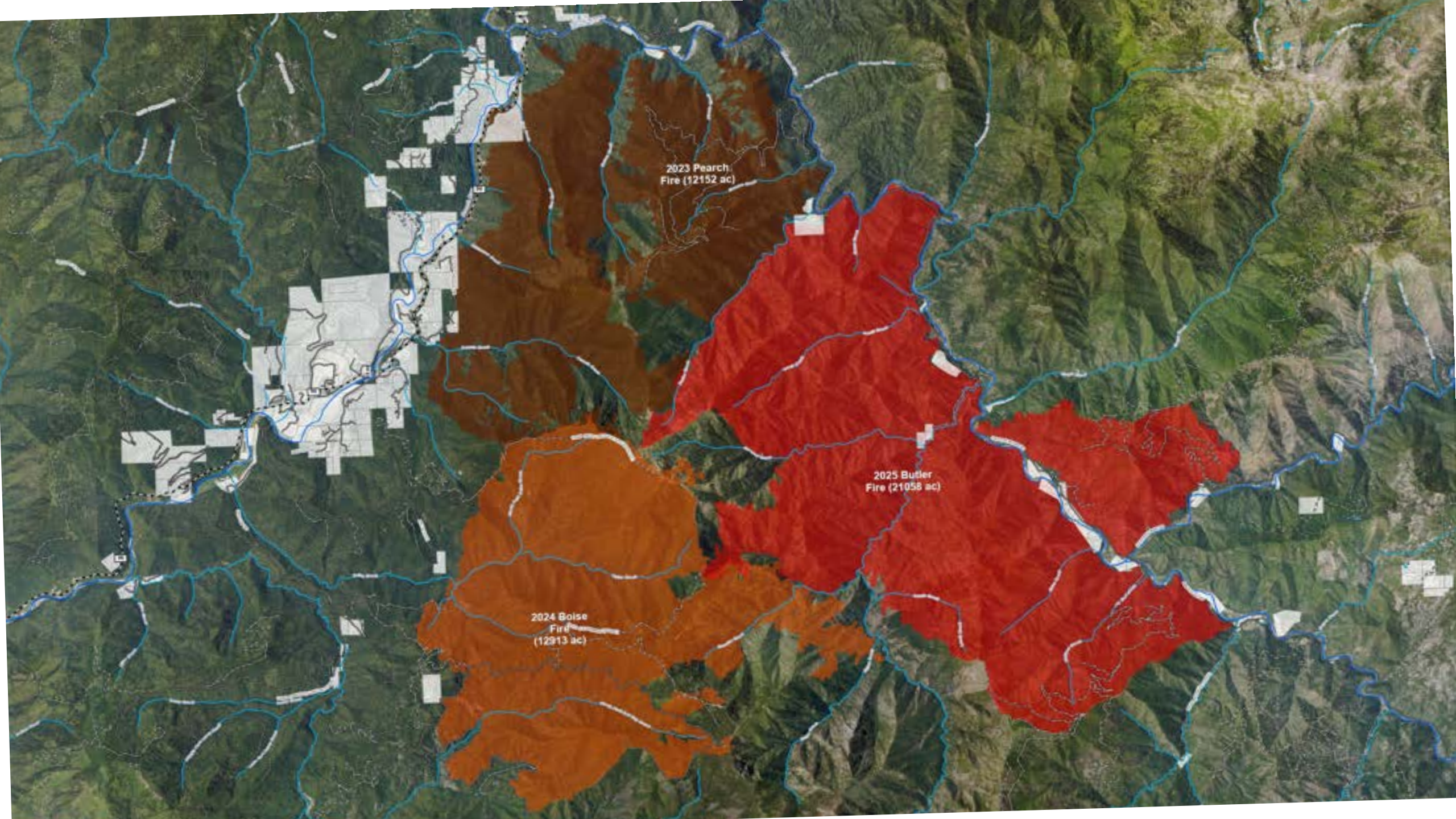
Div Y

Div U

Div T

2020 Red Salmon Complex





2023 Pearch
Fire (12152 ac)

2025 Butler
Fire (21058 ac)

2024 Boise
Fire
(12913 ac)

7:17



My Lightning Tracker



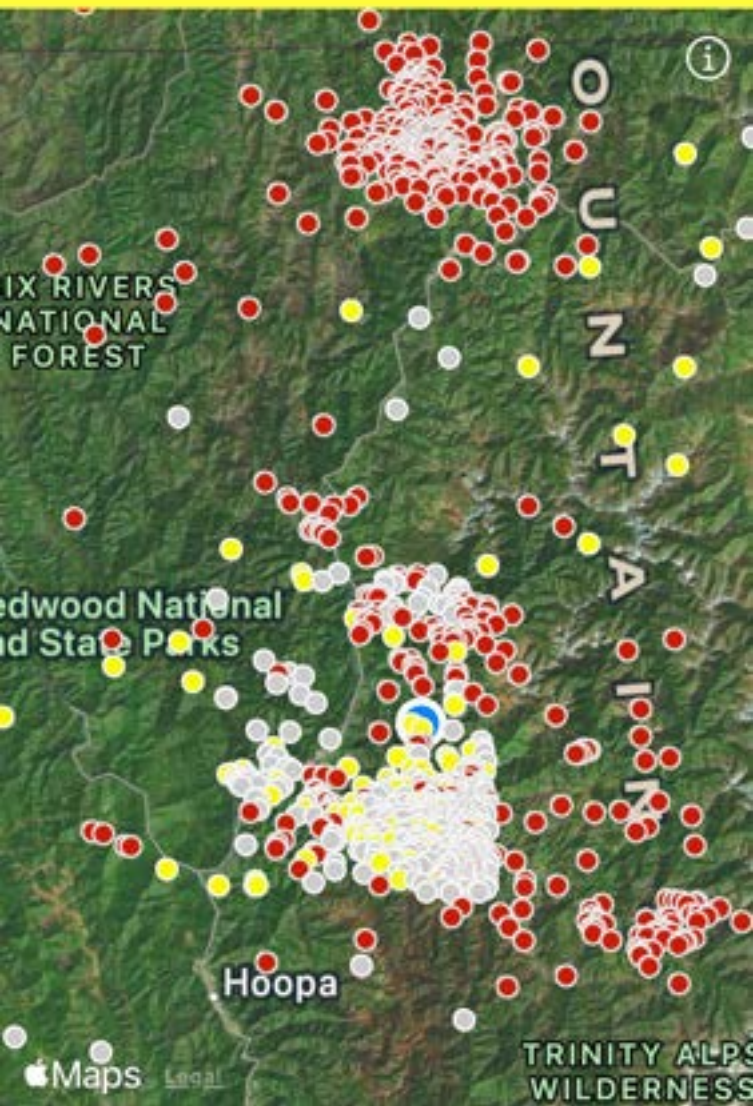
Latest



Hotspots



Radar

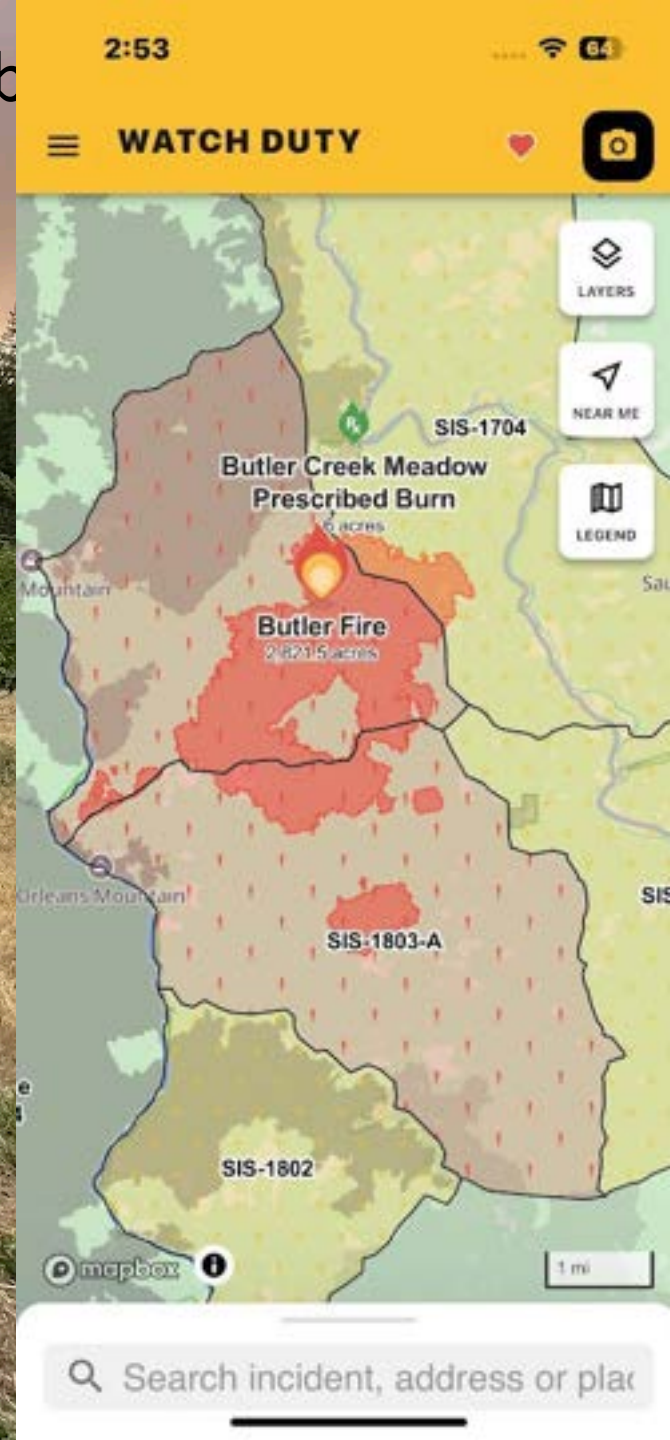




July 8, 2025 – Butler Creek Prescribed



← 2025 Butler Fire



A photograph showing a prescribed fire in a grassy field. In the foreground, a firefighter with a green backpack is using a tool to manage a small fire. In the middle ground, another firefighter is using a hose. A third person in a yellow shirt stands nearby. A white pickup truck is parked in the background. Large plumes of white smoke rise from the fire, partially obscuring a forested hill in the background. The sky is a mix of orange and grey, suggesting dusk or dawn.

Wildfire

Prescribed Fire

Cultural
Fire

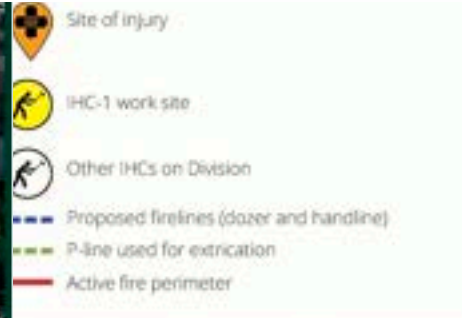
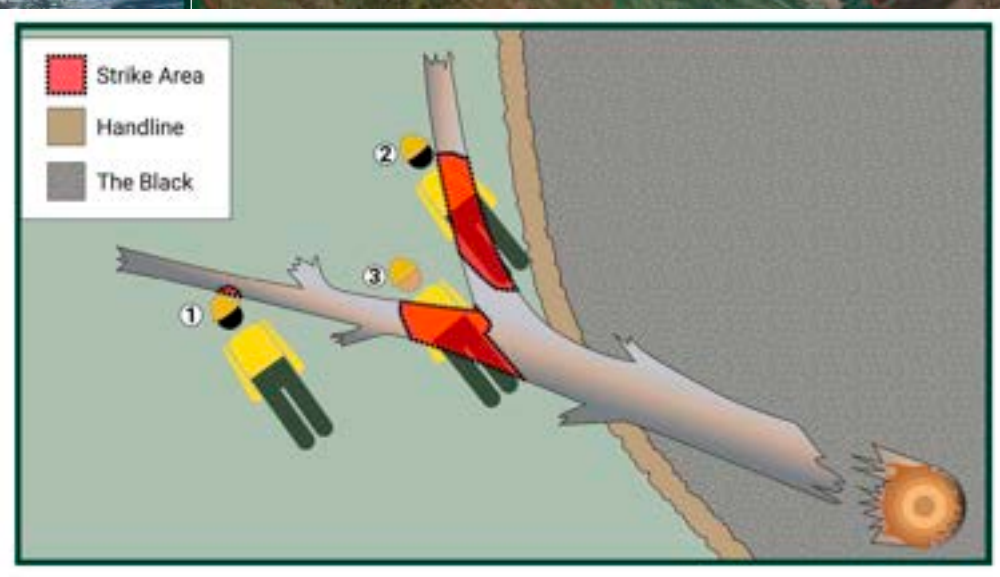








ACCIDENT SITE MAP*



*The map is approximate. Perimeter is based on infrared mapping from July 19, 2025 at 0230.

Pacific madrone tree (*Arbutus menziesii*) that fell, injuring three firefighters on the Butler Fire on July 18, 2025. The tree was later burned over in the fire. Photo by crewmember, IHC-1.



ONE DAY YOU
MIGHT HAVE
TO FIGHT FOR
WHAT YOU BELIEVE
IN.

BUT



Fuels to Flows for Fish & Fire



Photo: Brock Dolman

Yurok Salmon Bake at the 11th Annual Coho Confab on SF Smith River 2008



Fuels to Flows: Bringing Nature-Based Stewardship to the Headwaters

Brock Dolman OAEC – SRF - Fish & Fire– April 29, 2026



Photo: Sashaia Barrows



WATER
INSTITUTE

OCCIDENTAL ARTS &
ECOLOGY CENTER

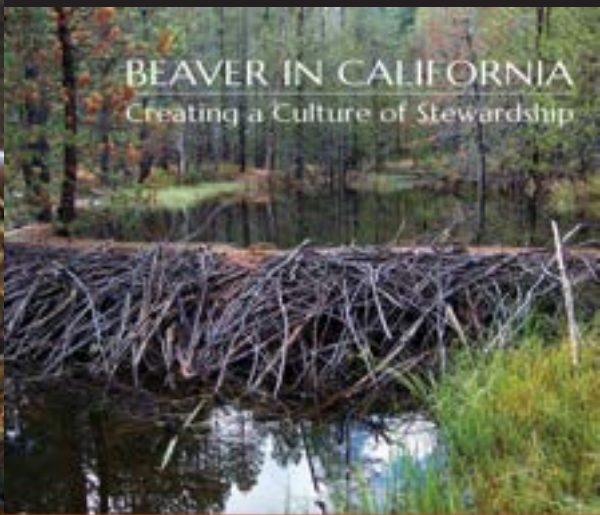


BASINS OF RELATIONS

*A Citizen's Guide to
Protecting and Restoring Our Watersheds*



WATER INSTITUTE
Occidental Arts & Ecology Center



BEAVER IN CALIFORNIA
Creating a Culture of Stewardship



KATE LUNDQUIST with BROCK DOLMAN
Occidental Arts and Ecology Center WATER Institute

Slow it. Spread it. Sink it!

A Homeowner's Guide to Greening Stormwater Runoff



First one in 2009 with the Santa Cruz RCD

Slow Water Movement Meme

Slow it. Spread it. Sink it!

A Homeowner's & Landowner's Guide to Beneficial Stormwater Management



Slow it. Spread it. Sink it. Store it!

Guide to Beneficial Stormwater Management and Water Conservation Strategies



An illustration from provided in the late 1970s as part of the natural resource network at Village House, subdivisions in Davis, California. Photographs by Brock Dolman.

Slow It, Spread It, Sink It ...
and Think It:
The Alchemy of
Watershed Restoration

2006

KATHARINE COOK with BROCK DOLMAN

Slow it. Spread it. Sink it!

An Okanagan Homeowner's Guide to Using Rain as a Resource



Practical and Eco-Friendly
Ways to Protect Your Property
and the Environment from the
Effects of Rainwater Runoff



Smokey the Beaver



“Smokey the Beaver:
beaver–dammed
riparian corridors
stay green during
wildfire throughout
the western USA”

Fairfax and Whittle,
2020

<http://doi.org/10.1002/eap.2225>



Coho Recovery in the Dutch Bill Creek Watershed



What is a watershed?

A watershed is all the land surface that collects water and drains it to a single exit point, like a local creek or lake, at the ocean. It's a catch basin which includes all the biological entities (including soil and physical features) involved within its boundaries. Everything we do occurs in a watershed. Water carries nutrients and energy through ecosystems, living everything. When water is healthy and clean, ecosystems—both human and non-human—thrive. When we mismanage our watersheds, everyone is impacted. A watershed is much more than just topography. It's a living, interconnected system.

Coho salmon is the keystone species for Dutch Bill Creek.

A keystone species is an organism upon which many other species in an ecosystem critically depend. Coho play a central role in the food web for hundreds of other plants, animals and microorganisms, and have sustained human culture in this area for millennia. When salmon swim up river to spawn, and die, they transport precious marine-based nutrients to fertile inland forests, contributing to the health of the forest and all the life it supports. Coho are the linchpin of restoration of this river/forest system. The presence of salmon in this watershed is an indicator of overall health of the watershed and all those who reside within it.

Fish need water all year round to complete their lifecycle.

During the summer season, juvenile coho need shaded pools in which to grow to maturity before swimming out to sea. Adults returning from the river need sufficient water depth to migrate back upstream to spawn. If pools dry out, both stages and become disconnected, and fish get crowded and die. In low median-stream flows, streamflow in DBC is abundant in the winter, mostly resulting from snow melt in the Dutch Bill Creek and May. But in the dry months between May and October, when both human and agricultural water needs are the greatest, human impact on DBC streamflow has left downstream insufficient to sustain healthy fish populations. Data conclude that there is more than enough total surface water available to meet both human and environmental needs annually, but not in the summer. Collecting and storing rainwater during the winter for use during the dry months could supply sufficient water for humans and provide water replenishing impact on summer streamflow.

In the early 2000s, coho nearly reached extinction.

Historically, tens of thousands of coho would return to spawn in the Russian River each year. Following agricultural industrialization that once blanketed this region resulted in peak up abundant winter rain, but these conditions from summer fog and keep the living springs of the land dryland—all of which resulted in a consistent release of water into the river during the summer months critical for raising salmon. During the gold rush, the sudden influx of European settlers and the subsequent rush for "red gold" reduced timber to build San Francisco, dramatically reduced the capacity of this living spring. 130 years of deforestation, building of railroads and roads, and development of towns and cities have resulted in altered drainage networks, increased sediment load, water diversion from rivers, pollution, and general degradation of the landscape. By the early 2000s streamflow dropped to a historic low. This trend of degradation and the parallel loss of biodiversity is increasing with climate change.



Lower Russian River Watersheds



This poster was produced by The Occidental Arts & Ecology Center WATER Institute, excerpted from the Dutch Bill Creek Streamflow Improvement Plan.



Scan this code or visit OAEI.org/water to download a copy of the Dutch Bill Creek Watershed Streamflow Improvement Plan, the Russian River Watershed Map or other OAEI WATER Institute publications.

The Russian River Coho Water Resources Partnership

Years of community organizing amongst diverse stakeholders and agencies resulted in the formation of the Russian River Coho Water Resources Partnership. Established in 2009, with funding from the National Fish and Wildlife Foundation and Sonoma Water, the Partnership works to improve streamflow for fish and water supply reliability for human communities in the Russian River watershed, critical to coho recovery, including Dutch Bill Creek.

Learn more or get involved! Visit the Russian River Coho Water Resources Partnership website at rcohopartnership.org.



1995 present

Occidental Arts and Ecology Center (OAEI) creates an 80-acre restoration watershed demonstration site in the DBC watershed, installing sediment control, gully reformation and riparian revegetation projects. Ask-friendly water, natural habitat, enhanced wildlife habitat, including birdwatching, groundwater, riparian habitat and other water conservation measures.

1997

Russian River Coho Water Resources Partnership (RRCWP) forms. Collaborative partnership of fish and water. RRCWP develops comprehensive Dutch Bill Creek watershed water conservation plan and water conservation watershed planning and fish management plans.

1998

Dutch Bill Creek Watershed Council meets for the first time. Dutch Bill Creek Watershed Council established. Dutch Bill Creek Watershed Council established.

2001

"Watershed Moment" takes place in Dutch Bill Creek Watershed. Watershed moment takes place in Dutch Bill Creek Watershed. Watershed moment takes place in Dutch Bill Creek Watershed.

2004-2005

Cooperates are involved with a future bridge at the Dutch Bill Creek crossing of Sonoma State University. Dutch Bill Creek crossing of Sonoma State University. Dutch Bill Creek crossing of Sonoma State University.

2006

West County Watershed Network (WCWN) Southern Sonoma State University. West County Watershed Network (WCWN) Southern Sonoma State University. West County Watershed Network (WCWN) Southern Sonoma State University.

2009-2010

Local Water Resources Conservation District and Pacific Watershed Association meet to discuss water and agriculture in the Russian River watershed. Local Water Resources Conservation District and Pacific Watershed Association meet to discuss water and agriculture in the Russian River watershed.

2009

Russian River Coho Water Resources Partnership forms. Russian River Coho Water Resources Partnership forms. Russian River Coho Water Resources Partnership forms.

2010-2011

Added water to the Dutch Bill Creek watershed. Added water to the Dutch Bill Creek watershed. Added water to the Dutch Bill Creek watershed.

2013-2014

Dutch Bill Creek Watershed Council. Dutch Bill Creek Watershed Council. Dutch Bill Creek Watershed Council.

2016

Restoration Watershed Council. Restoration Watershed Council. Restoration Watershed Council.

2017

Dutch Bill Creek Watershed Council. Dutch Bill Creek Watershed Council. Dutch Bill Creek Watershed Council.

2008

OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council.

2001

OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council.

2006

OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council.

2009

OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council.

2013 & 2014

OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council.

2019

OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council. OAEI develops the first Dutch Bill Creek Watershed Council.



Dutch Bill Creek Streamflow Improvement Plan



Prepared by:
The Russian River Coho
Water Resources Partnership

With support from:



March 2017

Russian River Coho Water Resources Partnership

Formed from a meeting at OAEC in 2008



Article

Restoring Summer Base Flow under a Decentralized Water Management Regime: Constraints, Opportunities, and Outcomes in Mediterranean-Climate California

Matthew J. Deitch ^{1,*} and Brock Dolman ²

Academic Editor: Matt Kondolf

Received: 1 November 2016; Accepted: 21 December 2016; Published: 6 January 2017

Mill Creek Streamflow Improvement Plan



Prepared by:
The Russian River Coho
Water Resources Partnership

With support from:



September 2018

Upper Green Valley Creek Streamflow Improvement Plan



Prepared by:
The Russian River Coho Water Resources Partnership



December 2019

Uplandscape (First Order/Class 3)

Firescape



Riverscape

River

Estuary

Bay

Tributaries

Headwaters

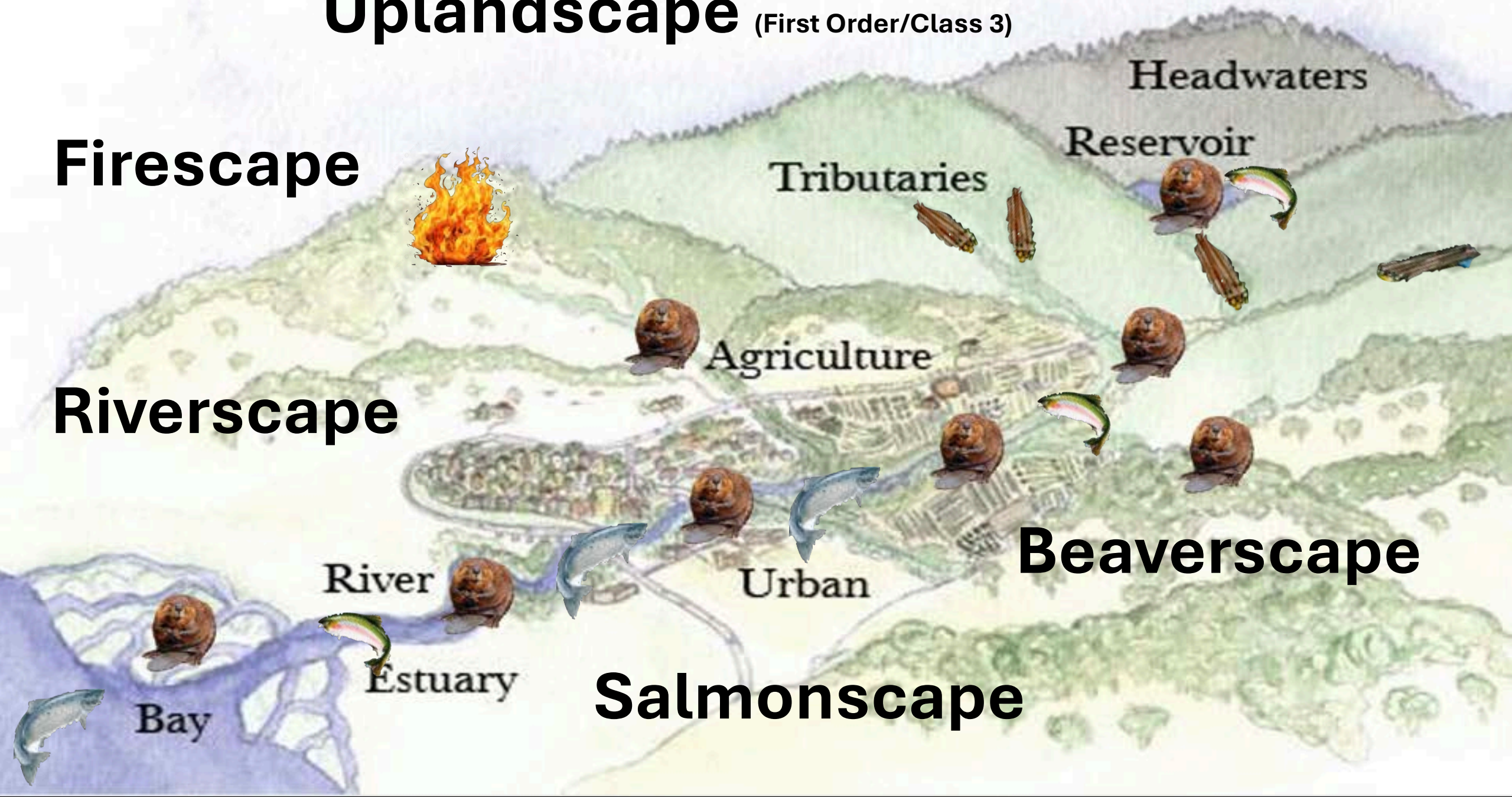
Reservoir

Agriculture

Urban

Beaverscape

Salmonscape



CALIFORNIA'S WORLD-LEADING NATURE-BASED SOLUTIONS BRING CLIMATE ACTION TO:



33.5 million acres of areas at risk of wildfire



11.9 million acres of forests



3.4 million acres of croplands



1.6 million acres of grasslands



1.5 million acres of deserts and beaches



233,000 acres of wetlands and seagrasses



"Governor Gavin Newsom's California Climate Commitment has 81 targets for nature-based solutions to help California achieve its world-leading climate goals, including reaching carbon neutrality by 2045."

April 22, 2024

That is a lot of acres in need of vegetation management!

**That will generate millions of tons of:
Slash as Trash?,
or is it Beneficial Biomass!**

**What is the plan to
Balance this Beneficial Biomass Budget
w/ this once-in-a-generation resource?**

What the targets call for by 2045:

- 33.5 million acres managed to reduce wildfire risk, mostly through beneficial fire
- 11.9 million acres of forest managed for biodiversity protection, carbon storage, and water supply protection

First prescribed burn at OAEC in 1997 in Peppergrass Prairie



2005



Diesel Free Pyro-intensive gardening



OAEC co-founded this in 2002 w/ BLM grant & became part of Fire Safe Sonoma in 2004.

BLM's Community-based Wildfire Prevention Grant

- Outreach/Education
- Defensible Space
- Chipper Days
- Demonstration Shaded Fuel Break

Formation of West County Fire Safe Council

- Regional Assessment + Planning
 - Increased Citizen Awareness + Involvement
 - Supporting VFD + CDF efforts in fire prevention
 - Restoring Watershed + Ecosystem Health
 - Secure funding to implement Fire Safe Plan + Projects
- More Ideas??

OAEC's 50 acres of over-stocked young Douglas Fir encroaching hardwoods due to legacy logging & modern fire suppression

Bracken pocket near bottom of Sunrise, 2004



Back North end, 2003



But before Prescribed Fire - Slash is not Trash - It is Beneficial Biomass!



“Since the achievement of our independence, he is the greatest patriot who stops the most gullies.” Patrick Henry 1776

Fewer Trees – More Forest – More Fire – More Flow – More Fish!

Stand Age & Forest Evapotranspiration: Implications for Forest Management, Streamflow, and Salmonid Recovery

Jeremy Kobor, MS, PG
Senior Hydrologist, OEI
jeremyk@oe-i.com

Matt O'Connor, PhD, CEG
CEO, Coast Range Watershed Institute
coastrangeceo@sonic.net



Decision Support Tool for Streamflow Enhancement Planning Green Valley, Atascadero, and Dutch Bill Creeks

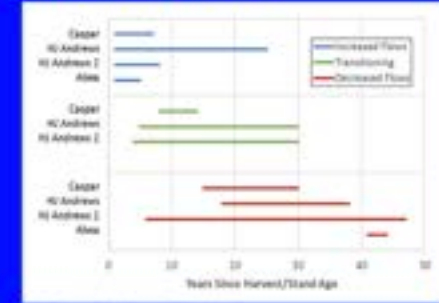
June 2025

Matt O'Connor, PhD, CEG
Jeremy Kobor, MS, PG



Forest Management & Streamflow

- Experimental watershed results indicate short period of increased streamflow followed by decades of decreased streamflow (25-60%)
- Indicates mature/old growth forests use much less water than young regenerating forests



data from Coble et al. (2020)

E.T. – Phone Home!

Cultural Fires for Cultural Waters since Time Immemorial



Credit: Sinead Santich

“Fire is about water,
but everybody always goes
I thought you guys were the fire guys,
but no we’re the water guys, we bring water back.
When you refresh the resources they are going to hold more water
and that’s the whole point in restoration.”

North Fork Mono Tribal Chairman Ron Goode

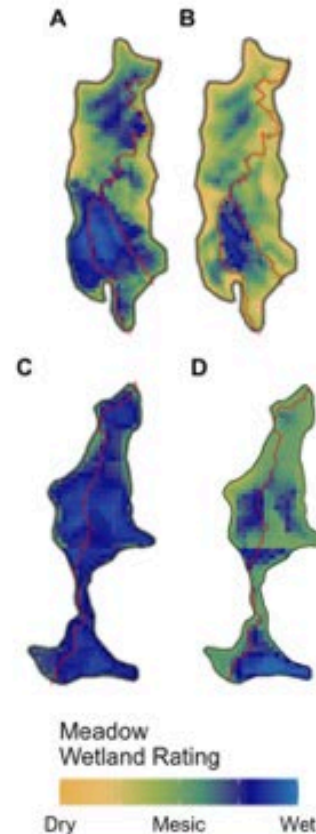
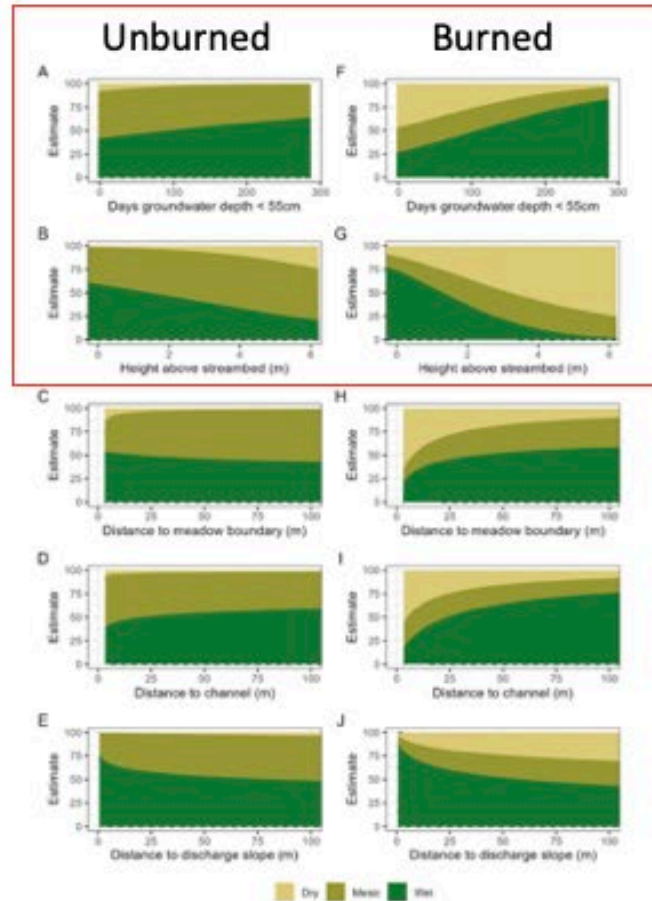


**“Water is Life.
Fire follows Water,
and Beauty follows
Fire & Water”**

Jeanette Acosta

Indigenous ethnobotanist & Cultural Fire Practitioner

Post fire without treatment, meadows lose ground to upland vegetation

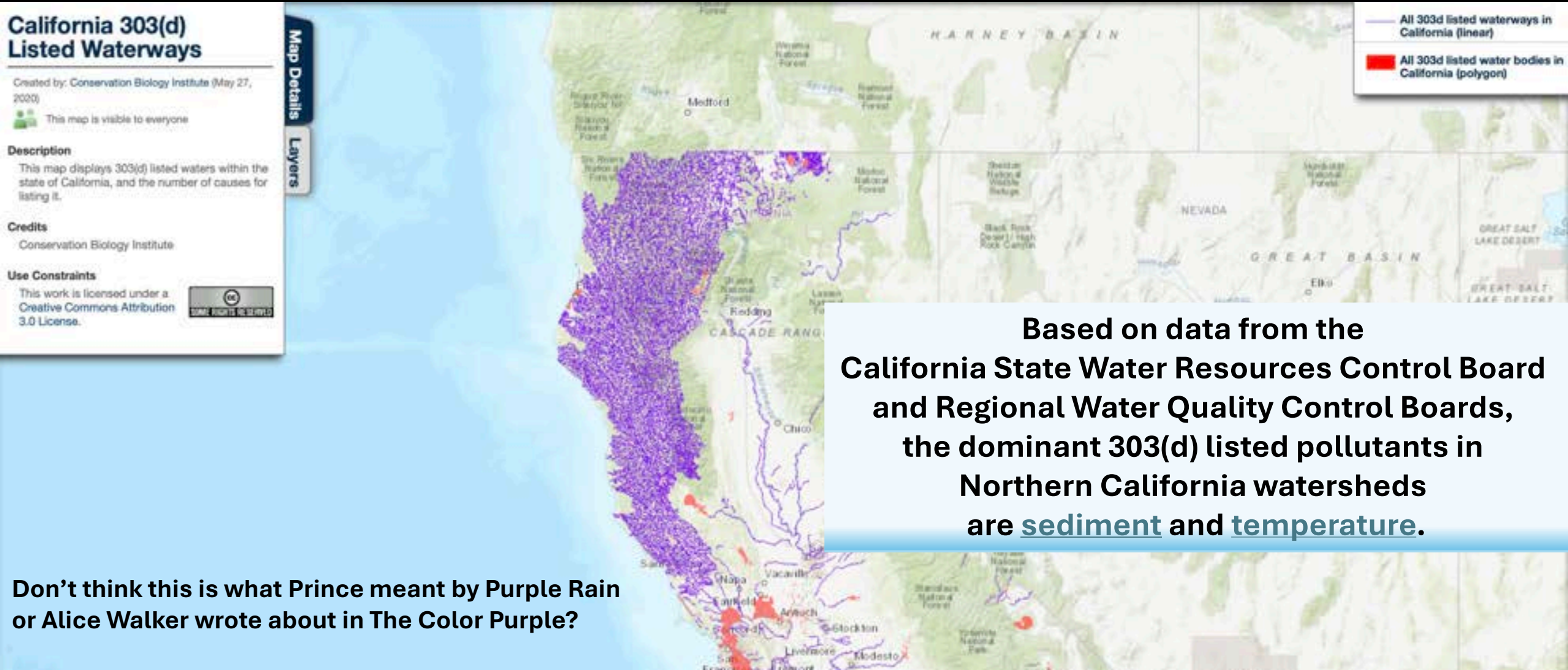


Slide by Dr. Karen Pope - Jordin Jacobs et al. In prep.

To regenerate wet meadows you have to re-wet them!
We must address the root causes of their dehydration & desiccation,
which are typically deranged hydrologic conditions and incised de-watering channel morphologies.
Good fire alone will not get us there, as this study appears to show it hastens their demise.

"Fishable, swimmable, and drinkable"

A core mandate of the U.S. Clean Water Act (CWA) of 1972,
aiming to restore and maintain the chemical, physical, and biological integrity of the nation's waters.





First Flush of Dutch Bill Creek meeting Russian River!

Photo: David Berman

Poorly designed & installed Culverts act like Hydraulic Mining Devices.

These Culverts are Perverts - Driving Derangement, Desiccation and Delivery of Salmon Slaughter Sediment

Monte Rio Redwoods Site C 1A

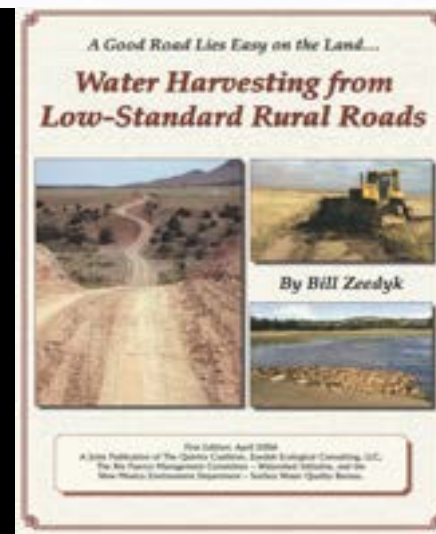
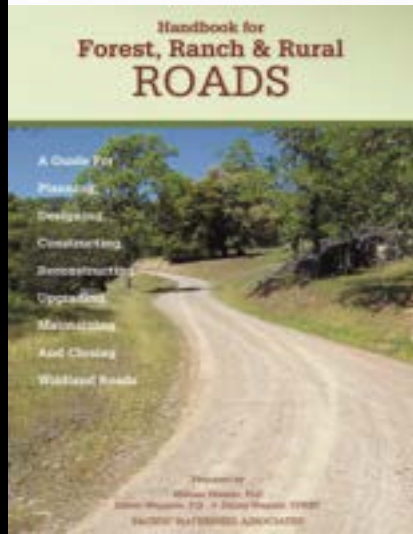
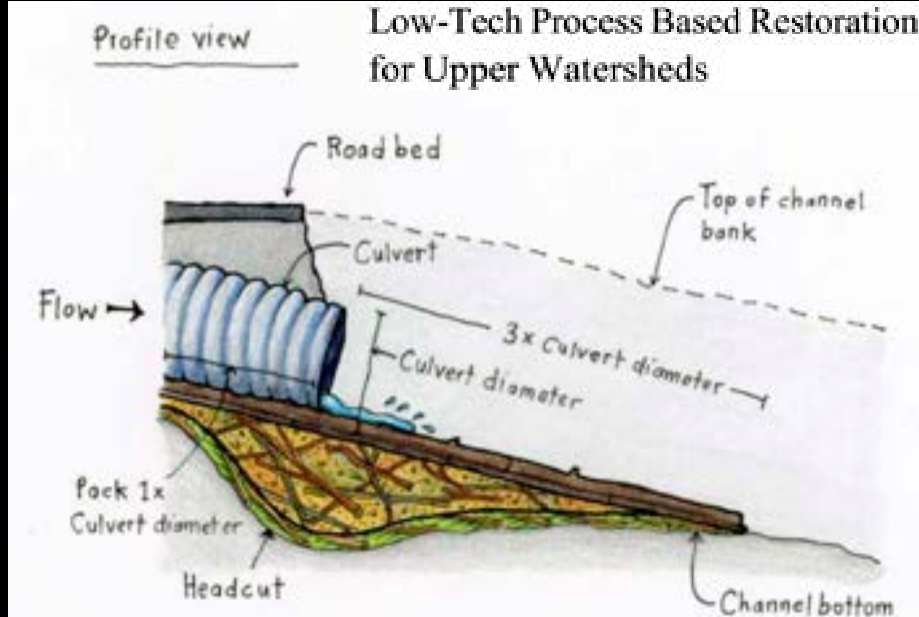
June 2023 – Pre-Implementation



January 2024 – Post-Implementation



Photos by Minona Heaviland/SCRPs





Resilience Works and North Bay Jobs with Justice stuff a gully at Monte Rio Redwoods Regional Park to mitigate the impact of a problematic road culvert that was causing significant erosion. Photo: OAEC/Brock Dolman



**Incised upland gully
directly delivering dirty
water to Coho stream**

Burn Piles

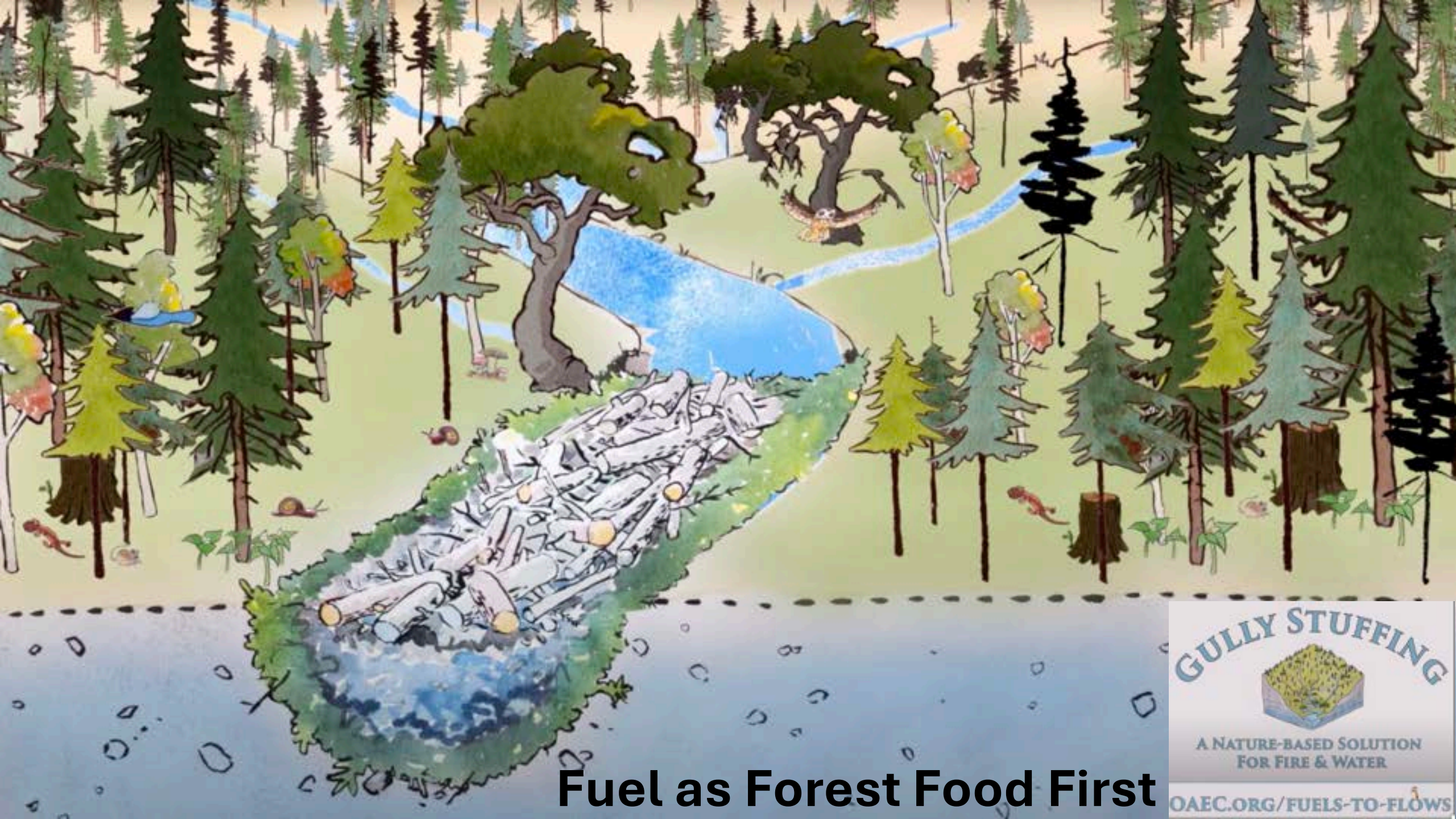
Burn Piles

**Is this considered a
Pile It Project?**

Spare the Air & Stuff the Gully to Save Salmon & Salamanders!

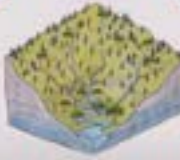


Photo: Sashwa Burrous



Fuel as Forest Food First

GULLY STUFFING



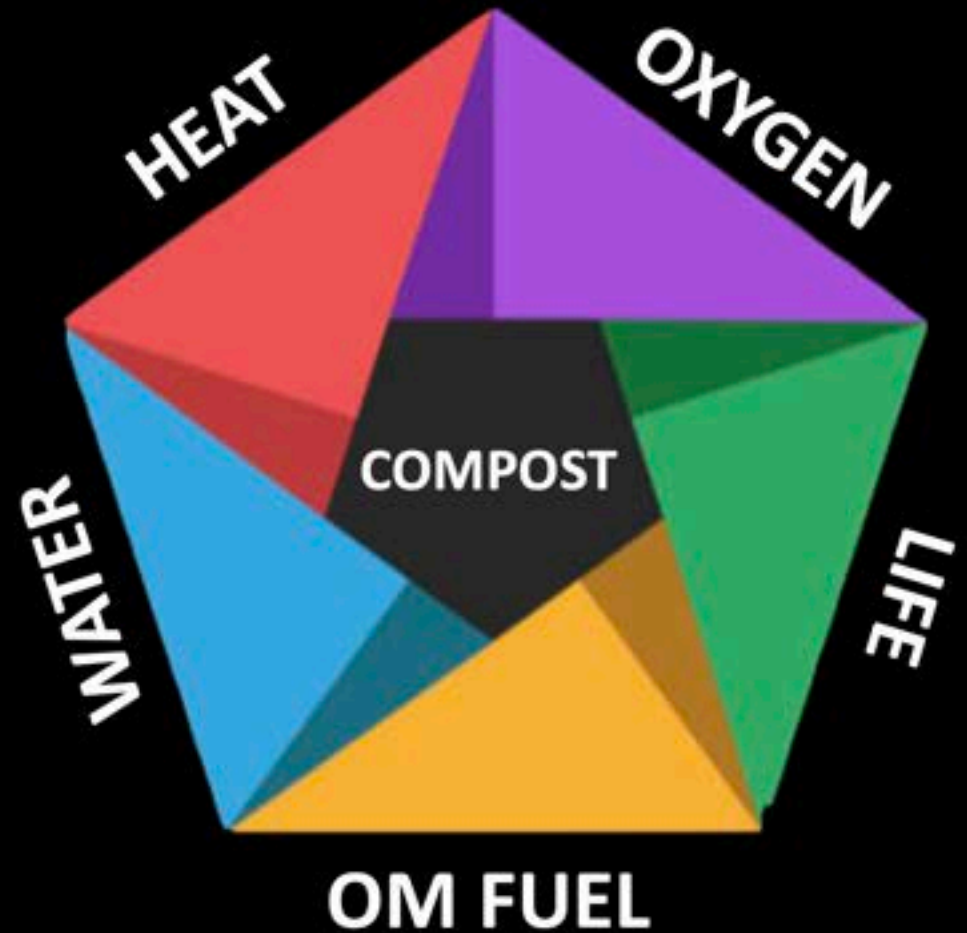
A NATURE-BASED SOLUTION
FOR FIRE & WATER

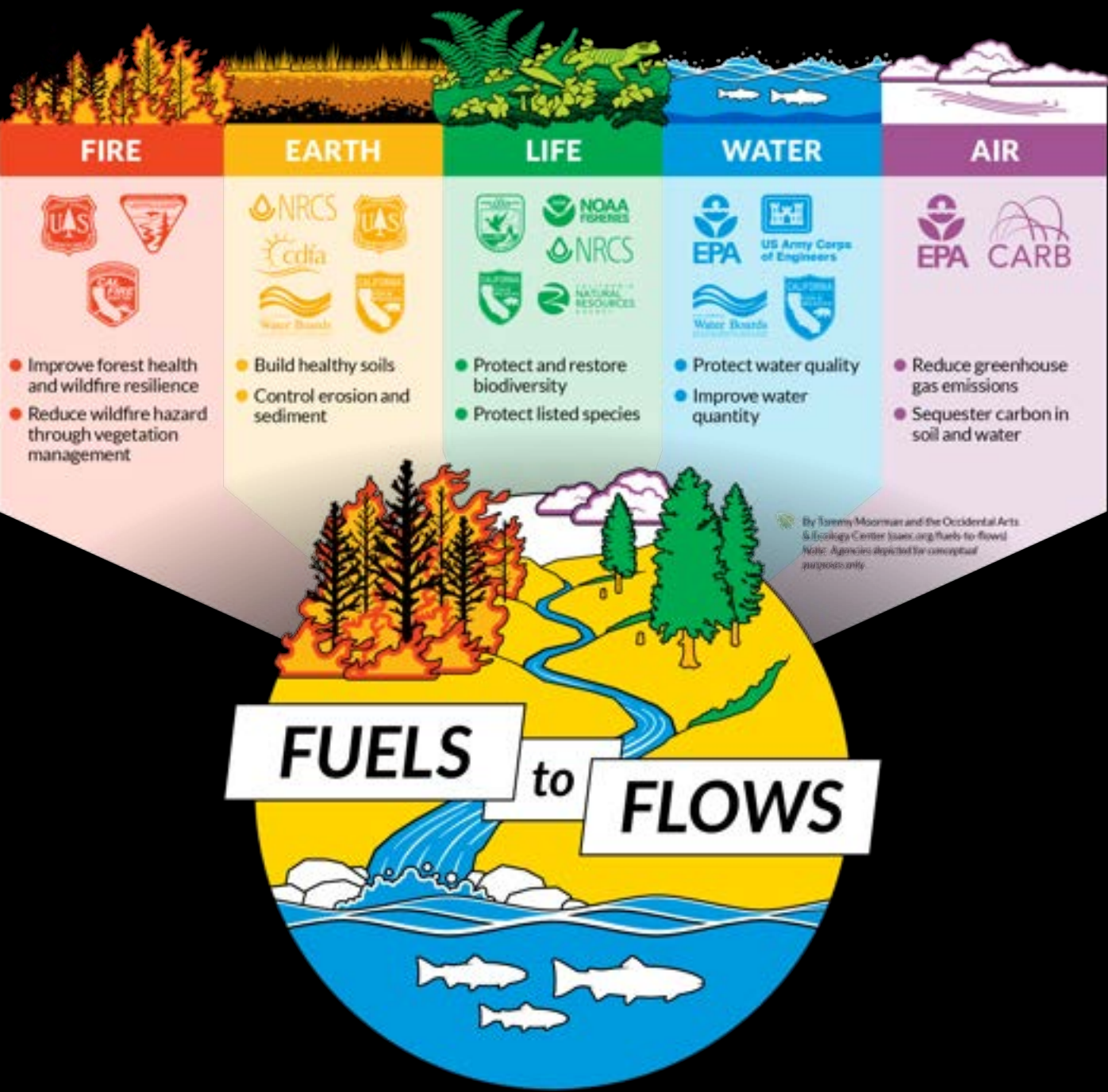
OAEC.ORG/FUELS-TO-FLOWS



**CO₂ & H₂O are equal inputs
but H₂O is the limiting factor
Carbon Follows Water!
Water is Life!**

FATE OF FUELS TO FLOWS: COMBUSTION AND COMPOST





Beneficial Biomass Portfolio

Planning on doing vegetation management for fire resiliency?

Have you considered a broad suite of practices that reutilize slash to achieve multiple restoration goals? Practices closer to the top of the circle tend to retain more carbon on-site, cost less, and produce fewer emissions, benefiting the carbon, water, and life cycles on your land.



*Practices included in this graphic are not comprehensive. Learn more at OAEC.org/fuels-to-flows

To the degree that Change is the only Constant:

Are we acting as Agents of Degenerative or Regenerative Disturbance Regimes?



Touch Too Much
DEGENERATIVE



Goldilocks' Touch
REGENERATIVE



No Touch
DEGENERATIVE

**Disconnecting
Ground Fuel from Crown Fuel**

- Limbing & Thinning
- Lopping & Scattering
- Stuffing of Gullies
- Creating Cavity Nest Habitat

Habitat Snags Created

Fire Ladders Limbed

Gullies Stuffed

Douglas Fir Thinned

Limbs Lopped & Scattered



A photograph of a forest with several trees, some with bare branches and others with green leaves. The ground is covered in dry leaves and twigs. A semi-transparent blue rectangle is overlaid in the center, containing white text.

**While there are
Limits to Growth
we can
Limb It for Growth!**

Permits are needed to 'fill' Waters of the State



North Coast Regional Water Quality Control Board

September 13, 2021

Brock Dolman
Occidental Arts & Ecology Center
15290 Coleman Valley Road
Occidental, CA 95465
brock@oaec.org

Dear Brock Dolman:

Subject: Notice of Applicability (NOA) for Coverage under the *Conditional Waiver of Waste Discharge Requirements for Specific Categories of Low Threat Discharge in the North Coast Region R1-2017-0039*

File: Occidental Arts & Ecology Center Restoration Project,
WDID No. 1B21166WNSO, ECM PIN CW-875439



State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Bay Delta Region
2825 Cordelia Road, Suite 100
Fairfield, CA 94534
(707) 428-2002
www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director



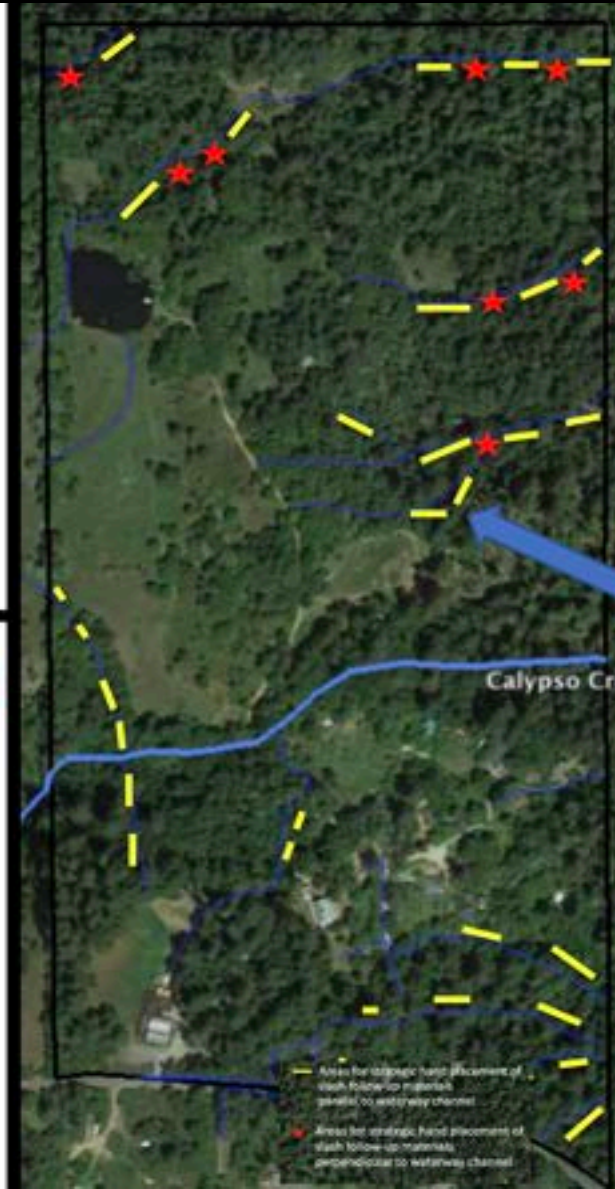
October 5, 2021

Brock Dolman
Occidental Arts & Ecology Center
15290 Coleman Valley Rd
Occidental, CA 95465
Brock@OAEC.org

Dear Mr. Dolman:

Final Lake or Streambed Alteration Agreement, EPIMS Notification No. EPIMS-SON-22045-R3, Upland Watercourse Restoration and Enhancement

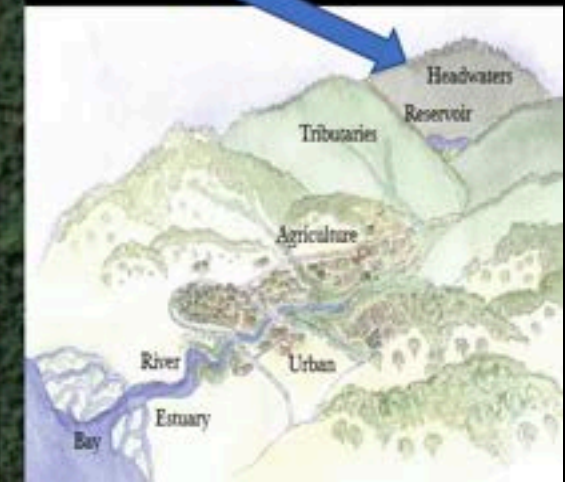
Attached is the final Streambed Alteration Agreement (Agreement) for the Upland Watercourse Restoration and Enhancement (Project). Before the California Department of Fish and Wildlife (CDFW) may issue an Agreement, it must comply with the California Environmental Quality Act (CEQA). In this case, CDFW determined your Project is exempt from CEQA and filed a Notice of Exemption (NOE) on the same date it signed the Agreement.



Order 1 streams are headwater streams where no other streams flows into it.

Forest Practices Act Class 3 upland ephemeral waterways that do not support aquatic life

Headwaters drainages at OAEC selected for Fuels to Flows Treatments



Agents of Regenerative Disturbance Regimes



Marin Conservation Corps at OAEC in 2001



Live
Oaks

Douglas Fir
fuel loads

Fuels to Flows 2001



Live Oaks

Channel Spanning bio-dam

Deeply incised gully

Fuels to Flows 2023



Live Oaks

Channel Spanning bio-dam

Fuel Load Slash in Gully Stuffed with Biomass



OAEC Watercourse Restoration Project Progress and Monitoring Photos

For the period of Oct. 2021 - June 2023



North-West Corner Watercourse



Before (Oct. 2021)



After (Oct. 2021)

A Biomass Boss doing some Prescribed Gully Stuffing

Dino Egg Watercourse



Before (Oct. 2021)



After (May 2023)

Besides dumping dirt in our rivers - headcuts and incised channels desiccate & dehydration hillslope water storage capacity

Below Spillway Watercourse



Before (Sept. 2022)



Rain event (Dec. 2022)

Upland flood terrace connectivity to optimize Slowing – Spreading – Sinking – Storing & Sharing

On-Contour “Carbon Catchers”

We also installed iterative on-contour brush piles upslope to catch soil and carbon, slow, spread & sink water, and serve as wildlife habitat.



Instances of sediment caught and deposited in-place by on-contour brush piles.

Creating Habitat for Leaf Litter Life!



Leaf litter life found at OAEC in moist decomposing brush piles laid on-contour, perpendicular to slope, to catch nutrient and water flows.



"The authors calculate that woodland salamanders at the density in their study would send 179 pounds of carbon per acre of forest down into the soil, rather than up into the atmosphere."

Woodland salamanders as metrics of forest ecosystem recovery: a case study from California's redwoods

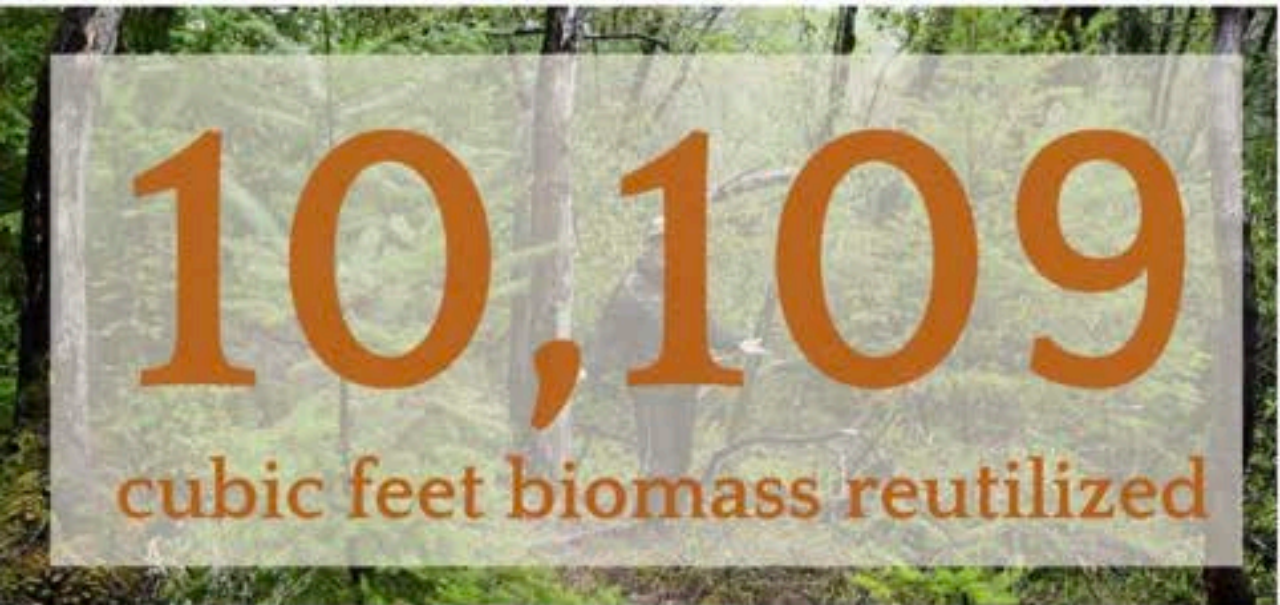
Hartwell H. Welsh Jr. & Garth R. Hodgson

First published: 28 May 2013 | <https://doi.org/10.1890/ES12-00400.1> | Citations: 19



Total Carbon Sequestration Measurements

From OAEC's Fuels to Flows work on only 10 acres



10,109

cubic feet biomass reutilized



to fill

992

feet of channel



sequestering an estimated

75 tons

of carbon*

That's about as much as
Jeff Bezos' 11-minute trip
to space!

Fuels to Flows Workforce Training
North Bay Jobs with Justice and Resilience Works
Hosted by Two Sisters Place - Led by Occidental Arts & Ecology Center
Occidental – December 8th-12th, 2025



OCCIDENTAL ARTS
& ECOLOGY CENTER



RESILIENCEWORKS.BIZ





Fuels to Flows Workflow Sequence

← Sawyers

Sorters & Swampers →



← Stagers

Stuffers →

(Require very different skills & training as this is water work)



**Pre & Post of a lateral headcut treatment
surrounding large mid-channel boulder.**





**Long incised reach fully layered & stuffed up to 3 feet in depth over 75 feet.
Notice that it has been angle pinned in multiple locations with onsite made stakes.**



GULLY STUFFING COLLABORATION WITH GOLDEN GATE NATIONAL RECREATION AREA





**SONOMA COUNTY
REGIONAL PARKS**



Stillwater Cove RP, Stockhoff Creek

SWIFTWATERDESIGN



Monte Rio Redwoods Regional Park



**SONOMA COUNTY
REGIONAL PARKS**





Stuff Incisions before Ignitions!



**Prescribed burn
over a stuffed gully
whose wetted area
resisted being burned.
Monte Rio Regional Park**



Gully stuffing is a very tightly packed layering of green & brown materials with water added when runoff occurs.

Yes it is a compost pile that ultimately provides a nutrient dense & water holding sponge that breaks down to provide a deep root bed to improve biodiversity and forest health for the trees that remain post thinning.

Densely compacted composting matrix is a low oxygen setting.



**Slow & Fast Carbon Cycle
Pool Preferencing:
Soil Pool
Water Pool
Life Pool
Then Air Pool**



North Fork Navarro River - Flynn Creek: Roadside Fuels for Fish Flows

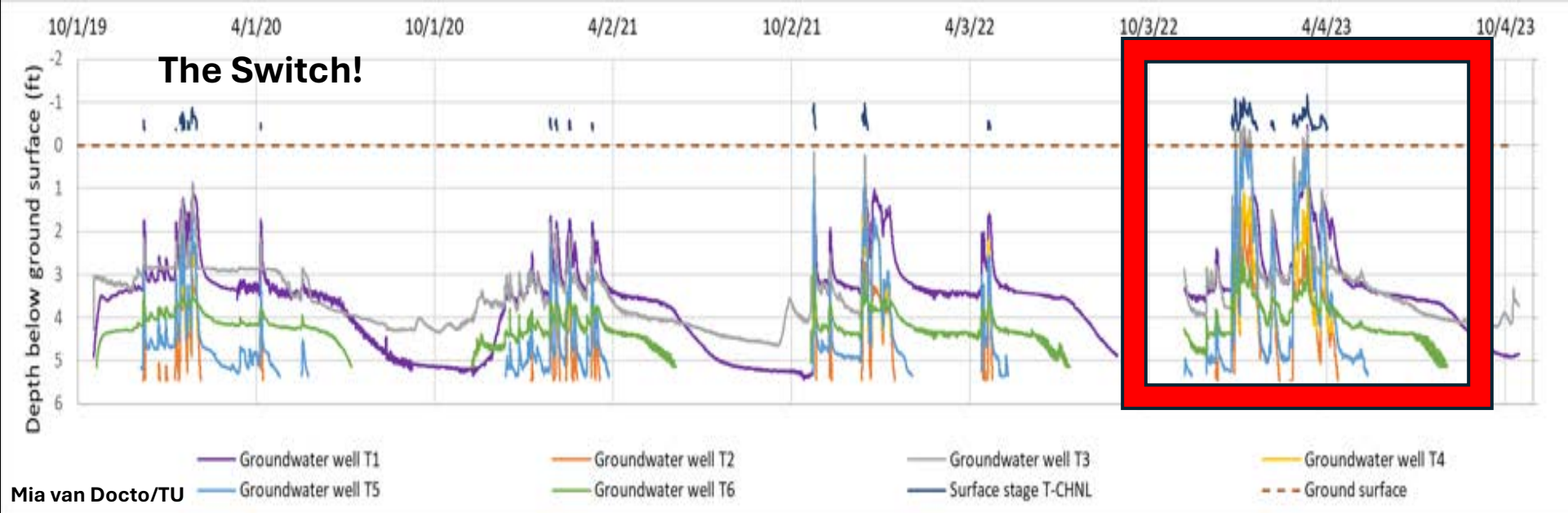


Ryan Shorow - CCC



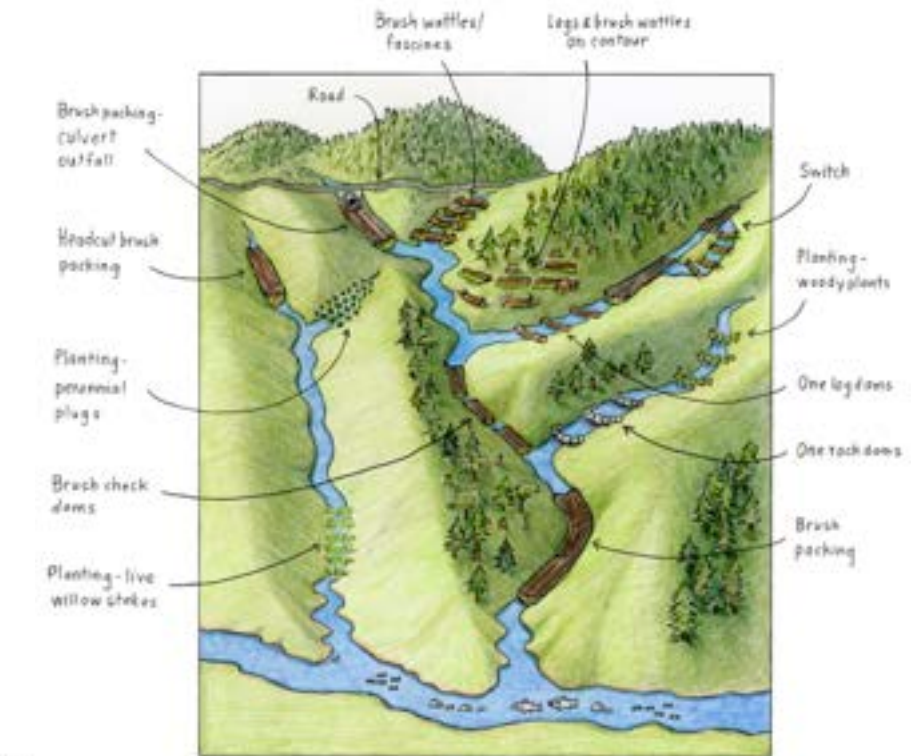
WCB Funded





Photos by Ryan Shorow/CCC's

Low-Tech Process Based Restoration for Upper Watersheds In Draft Review



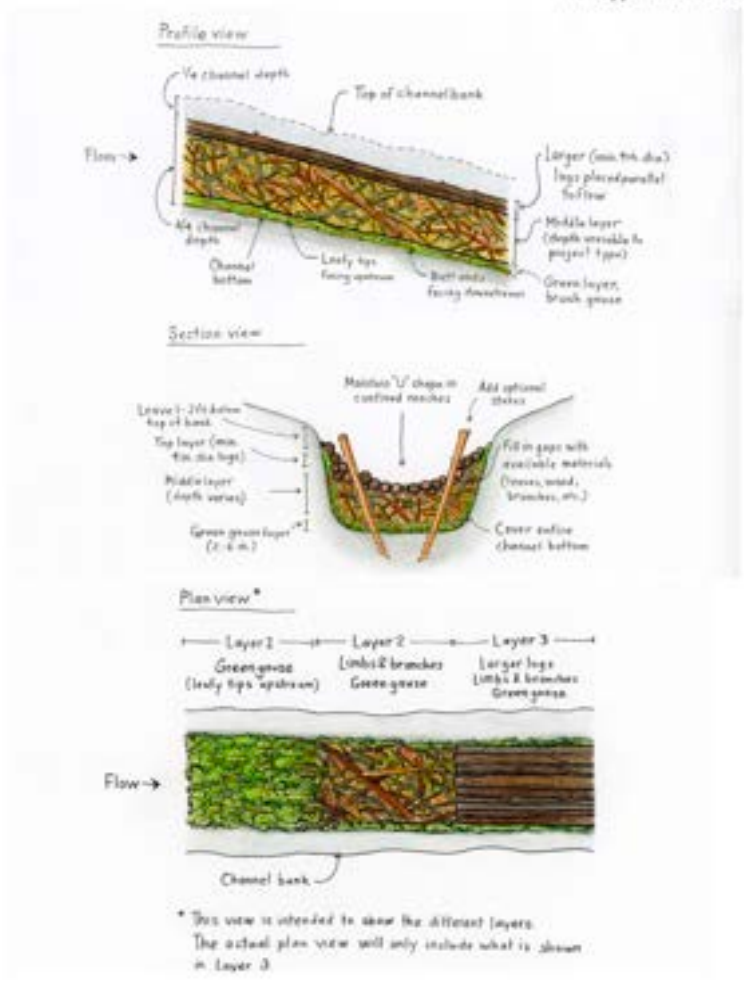
Date
March 2025

Authors
Brock Dolman, Hannah Wilton, Occidental Arts & Ecology Center Water Institute
Minona Heaviland, Sonoma County Regional Parks
Fatima Burhan, Aaron Fairbrook, Jessica Pollitz, P.E., Sonoma Resource Conservation District

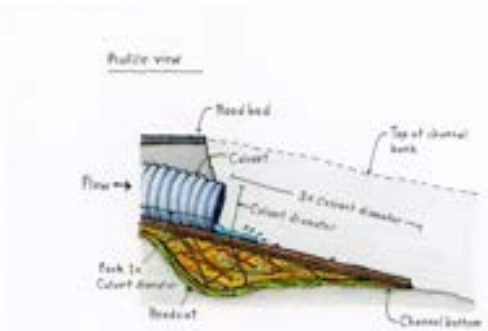
Illustrations
Mary Ann King



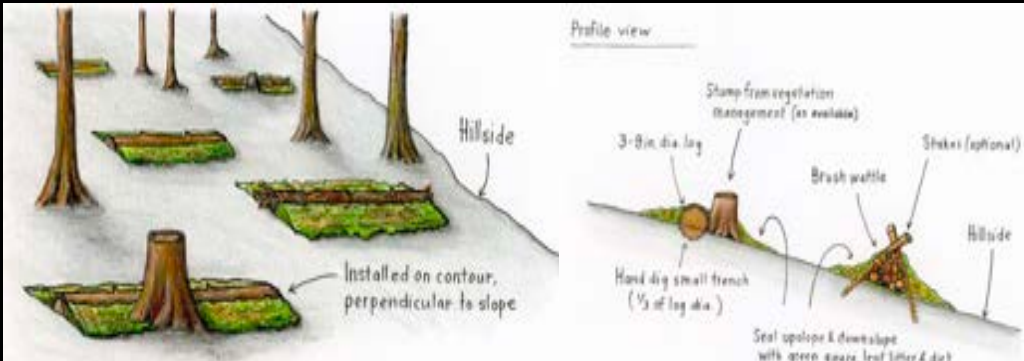
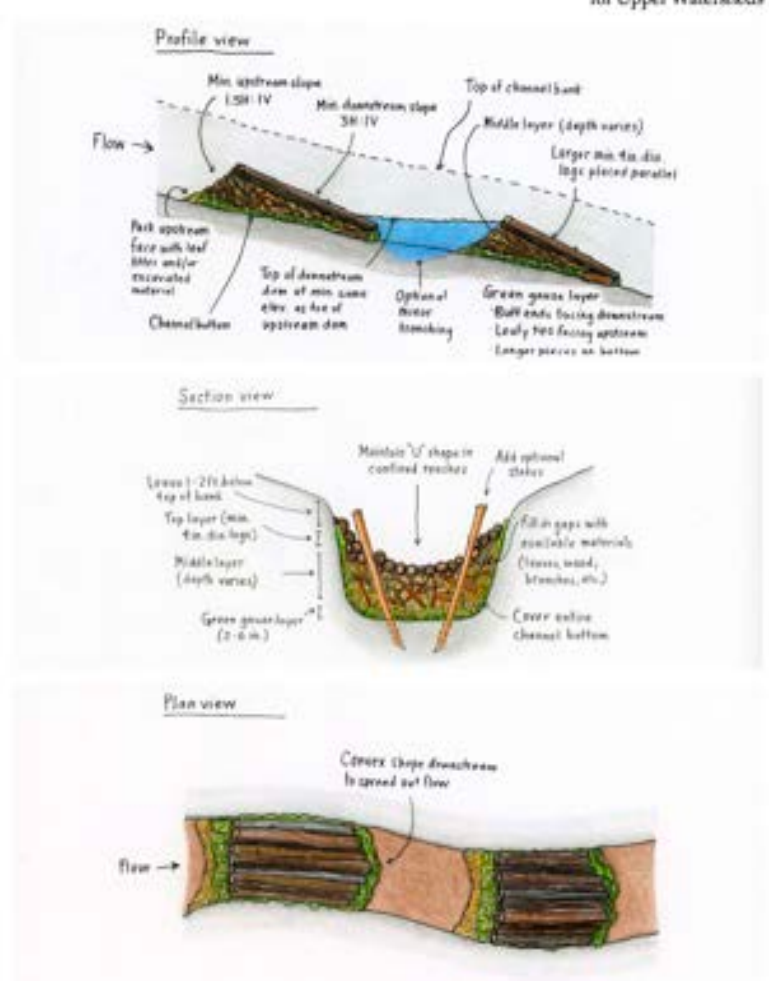
Brush Packing Low-Tech Process Based Restoration for Upper Watersheds



Culvert Outfall



Brush Check Dams Low-Tech Process Based Restoration for Upper Watersheds



Found Gully Model

Base layer

Hidden Visible

- ☒ Basic street map with topography ([from here](#))
- ☐ 2013 aerial photography ([Sonoma GIS, through Esri](#))
- ☐ 2021 aerial photography ([Sonoma GIS, through Esri](#))
- ☐ 2022 hillshade (page 9 of [LIDAR derivatives](#))
 - ☒ — with 10 m contours
 - ☐ 2022 color-enhanced hillshade ([fractional-Laplacian sharpened](#) overlay)

Land ownership

- ☒ Land ownership boundaries ([source](#))

Last clicked in:

Last clicked longitude-latitude:

Fire hazard

- ☐ Hide ladder fuel proxies
- ☐ (material in 1–4 m) / (material in 0–4 m)
- ☒ (material in 1–8 m) / (material in 0–8 m)
(See page 9 of [LIDAR derivatives](#))

Gullies

- ☐ Gully detection probability
- ☐ Gully paths as lines

Erosion

Disclaimer: In all of the following, "erosion" and "deposition" are a simple difference of 2013 and 2022 Digital Terrain Models (DTMs), with "erosion" meaning the elevation is *lower* in 2022. Differences in dense underbrush can mimic changes in elevation, confounding this measure of erosion, so it should be taken as an indication of where erosion may have occurred. Follow up with ground-truth!

- ☒ 2013-2022 elevation difference contours
(☒ erosion, ☐ deposition, contour line every 1/3 meter)
 - ☒ —and fill in the polygons

Volume of erosion

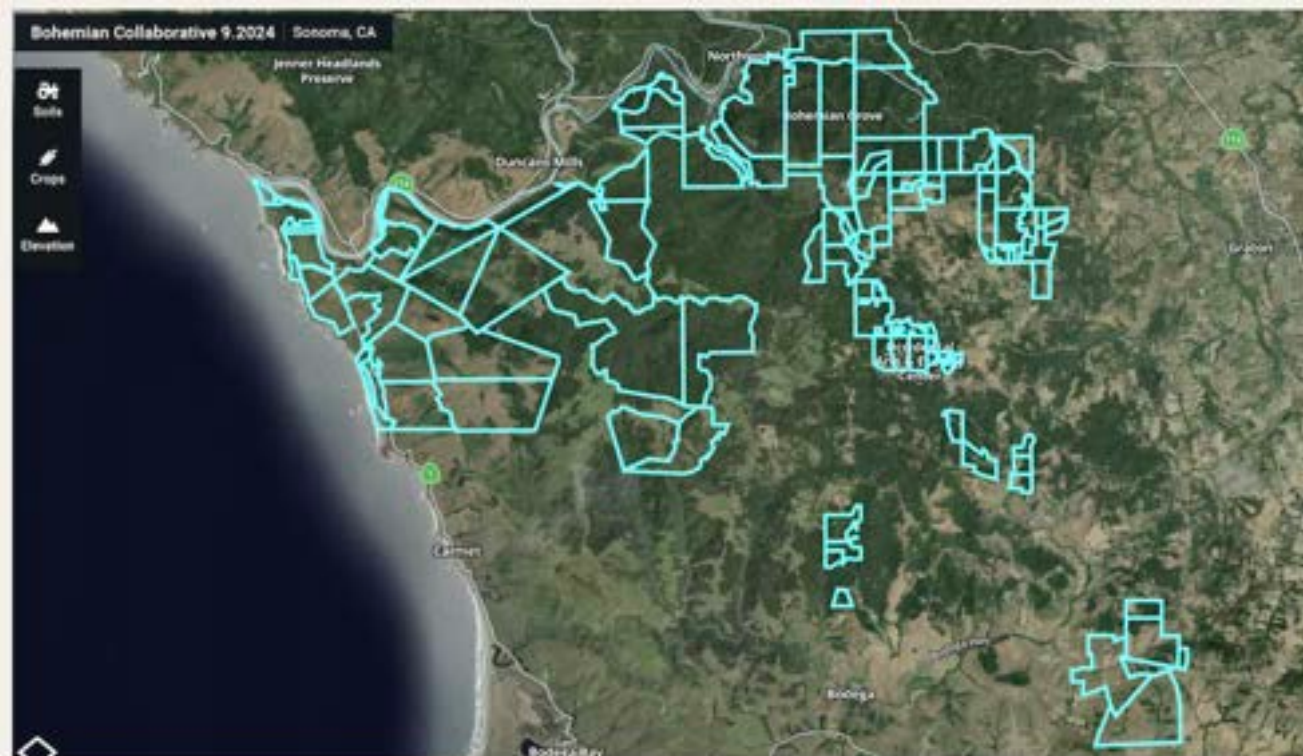
- ☐ Paint region instead of moving map
(holding the **control** or **command** key temporarily enables this paintbrush)

m² in painted area

m³ volume lost from 2013 to 2022

Elevation along line

- ☒ Draw line instead of moving map
(holding the **shift** key temporarily enables this; **two clicks** for a straight line and **drag** for a curve)



Map of the Bohemian Collaborative Membership as of August 2024.
Map created by Wuuii.

Collaborative strives to improve the ecological function and health of our diverse vegetation communities, while increasing the resiliency of the adjoining wildland-urban interface (WUI) communities of Graton, Forestville, Guerneville, Monte Rio, Camp Meeker, Occidental, Freestone, Bodega, and Bodega Bay.

Bohemian Collaborative: a project of:



Members worked with a Fire Chief from Cal Fire to identify top fire risks across the Bohemian Collaborative's nearly 20,000 acres of public and private land ownership/management. Photo by Brock Dolman.

Prop 4 California Climate Bond

Department of Forestry and Fire Protection

Forest Health Program

Grant Guidelines

FY 2025-2026



Concept Proposals Due: 3:00 PM PDT, March 30, 2026

Full Invited Proposals Due: 3:00 PM PDT, June 8, 2026

Based on OAEC, SEC & others publicly submitting Fuels to Flows comments to the new Forest Health Program Grant Guidelines they now include language supporting the on-site use of Beneficial Biomass!

So all you Biomass Bosses take advantage of this new opportunity when you are developing your concept & full invited proposals!

- **Biomass Utilization** – means activities that utilize woody biomass for wood products such as post and pole, firewood, dimensional lumber, plywood, or other products that allow for continued carbon storage; generate energy through combustion or gasification, which displaces carbon-intensive fossil fuel-based energy; or utilize woody biomass to help develop markets for beneficial uses of the material.

The program supports and prioritizes the beneficial use of woody biomass generated through forest health and fuels reduction activities. Eligible activities focus on using woody biomass to support forest health and climate benefits. Projects may produce wood products that store carbon (e.g., dimensional lumber, post and pole, veneer, cross-laminated timber, or artistic/cultural products), generate renewable energy that displaces fossil-fuel use, or develop and expand markets for beneficial uses of biomass (e.g., mulch, animal bedding, oriented strandboard, pulp, or biochar). Transportation of woody biomass is eligible, but costs must not exceed 10% of the total requested grant funds.

The program also supports the on-site use of biomass where appropriate to reduce transportation needs and increase project efficiency. Examples include chipping or masticating material for soil enhancement, erosion control, habitat structures, or other beneficial applications that contribute to site restoration and ecosystem health.



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(707) 874-1557 • oaec@oaec.org
www.oaec.org

February 26, 2026

Tony Andersen, Executive Director
California Board of Forestry and Fire Protection
Via Email: CalVTP@fire.ca.gov

re: Notice of Preparation of a Subsequent Program Environmental Impact Report for the California Vegetation Treatment Program (CalVTP) Update

Dear Executive Director Andersen,

Thank you for the opportunity to comment during the scoping phase of the Re-Issued Notice of Preparation (NOP) of a Subsequent Program Environmental Impact Report for the California Vegetation Treatment Program (CalVTP) Update.

CalVTP Update



RE-ISSUED NOTICE OF PREPARATION

A subset of the public comments submitted by OAEC:

We applaud the Board of Forestry's direction to consider new activities related to the disposition of biomass generated by vegetation treatment. We hope that the agency will consider the following practices in the CalVTP update:

- Restoration of upland gullies and streambed incision in Class III and IV streams using best management practices related to re-use of beneficial biomass;
- Re-use of beneficial biomass using best management practices structured and placed in such a way as to increase slope stability;
- Re-use of beneficial biomass using best management practices structured and placed in such a way as to increase water infiltration;
- Re-use of beneficial biomass using best management practices structured and placed in such a way as to decrease sedimentation and improve filtration of organic and inorganic material to protect water quality and restore spawning and rearing habitat for salmonids;



CALIFORNIA'S STRATEGIC PLAN FOR EXPANDING THE USE OF BENEFICIAL FIRE

MARCH 2022



One
can
dream!



CALIFORNIA'S STRATEGIC PLAN FOR EXPANDING THE USE OF BENEFICIAL BIOMASS

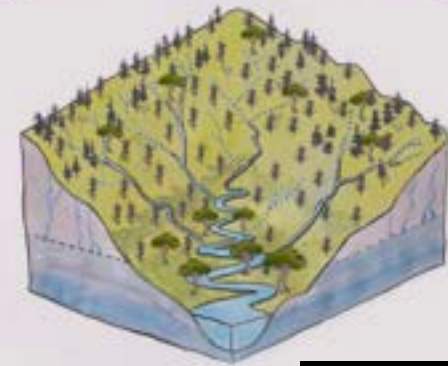
MARCH 2026



Check out our Gully Stuffing Video & Animation!



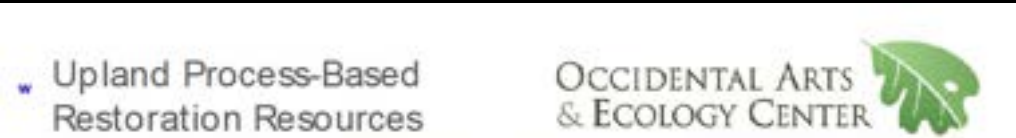
GULLY STUFFING



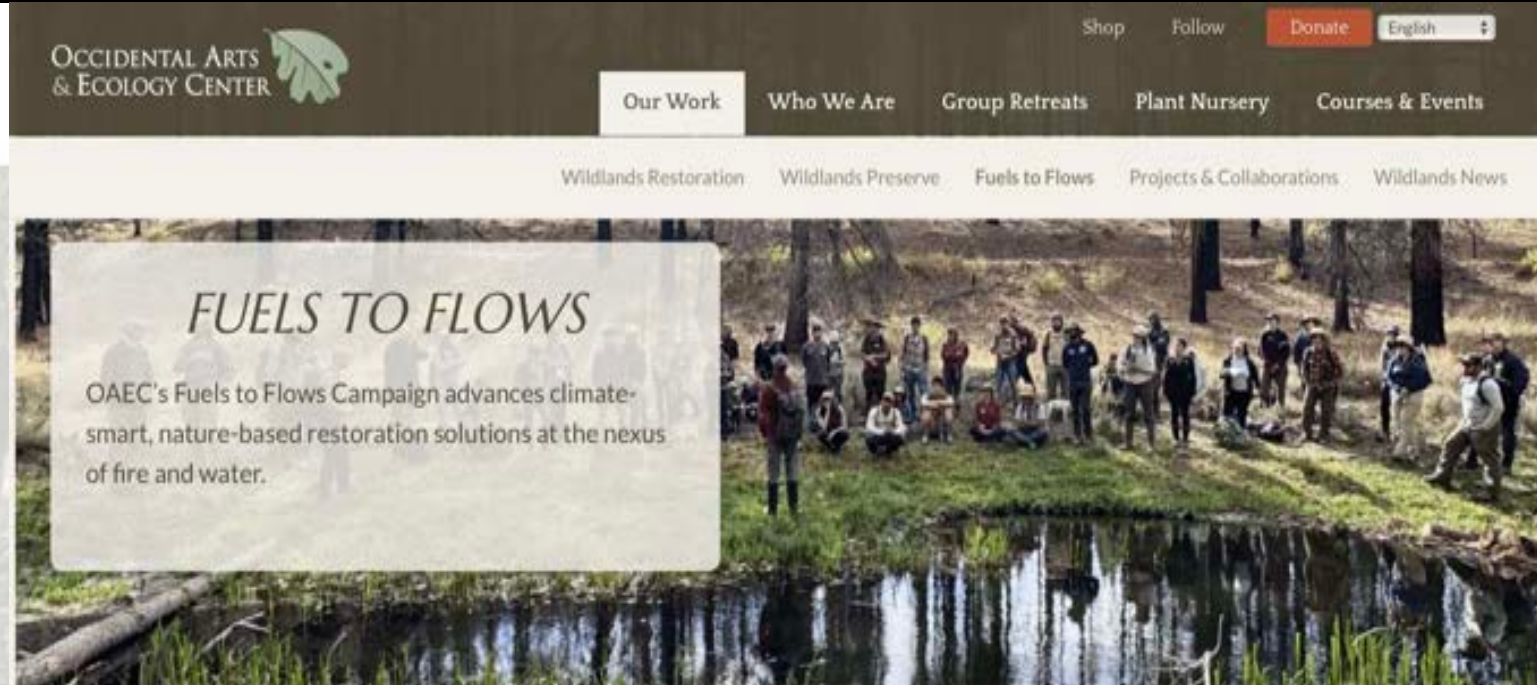
A NATURE-BASED SOLUTION
FOR FIRE & WATER

*Let's Make Haste
with Zero Waste
cuz it's time to connect
our **Fire Fears**
with our **Water Woes**
by turning our
Fish & Fire
Fuels into Flows!*

Scan the QR Code for links to lots of Upland Fuels to Flows PBR Resources from OAEC



1. OAEC Fuels to Flows Campaign web portal: www.oaec.org/fuels-to-flows (launched end of March 2025)
2. OAEC Wildlands Preserve: <https://oaec.org/our-work/projects-and-partnerships/wildlands/>
3. OAEC Stewardship Plan: <https://oaec.org/projects/wildlands-preserve-stewardship-plan/>
4. Tending The Land website (multi-partner Sonoma County collaboration): <https://tendingtheland.org/>
5. NBC Bay Area TV news story on OAEC's fir & water nexus projects: <https://oaec.org/nbc-news/intersection-of-fir-water-at-oaec/>
6. Fire Safe Sonoma May 2023 Speaker Series - Brock Dolman of the Occidental Arts & Ecology Center talk: <https://www.youtube.com/watch?v=xkduW8LG7mI>
7. OAEC's upland PBR "Slash Ain't Trash It's Beneficial Biomass" projects: <https://oaec.org/forest-thinning-and-gully-repair/>
8. Ecological Restoration based Worker Training via our collaboration with North Bay Jobs w/ Justice: <https://oaec.org/why-we-cant-build-a-fir-resilient-future-without-worker-justice/>
9. YESM magazine highlights Climate Justice in Sonoma County: <https://oaec.org/yes-magazine-highlights-climate-justice-in-sonoma-county/>
10. Strategically using Prescribed Fire at OAEC as an upland PBR tool: <https://oaec.org/oaec-conducts-winter-prescribed-burn/>
11. Collaboratively using planned grazing at OAEC as an upland PBR tool: <https://oaec.org/community-grazing-project-at-oaec-two-sisters-place-mighty-arrow-ranch/>
12. Long term Coastal Prairie & Geophyte regeneration efforts: <https://oaec.org/oaec-featured-fremontia-journal/>
<https://oaec.org/wp-content/uploads/2017/04/Geophytes.pdf>
13. OAEC's Rewilding California efforts PBR powerpoint show - "Elemental Rewilding with Keystone Processes": <https://oaec.org/oaec-organizes-rewilding-california-convening/>
<https://www.youtube.com/watch?v=whn3Br-Xc8>
14. Link to CA's new Process-based Restoration (CaPBR) Network: <https://www.calpbr.org/>
15. Blog on CA PBR Network Workshops: <https://oaec.org/cal-pbr-workshops/>
16. OAEC's Upland rural Stormwater PBR efforts with "Slow It Spread It Sink It Store It Share It": <https://oaec.org/publications/integrated-stormwater-retention-system/>
<https://sonomarcop.org/wp-content/uploads/2017/06/Slow-It-Spread-It-Sink-It-Store-It-Share-It.pdf>
17. Biodiversity observations at OAEC via iNaturalist: <https://oaec.org/join-oaec-on-inaturalist/>



Thank You!!



Temporal Habitat Changes and Fish Response Following Catastrophic Fires

Accounting for Impacts when
Prioritizing Restoration Need and
Fish Population Estimates

Presented by Tricia Bratcher, USFWS
Red Bluff Fish and Wildlife Office

On behalf of co-authors:
(FWS) RJ Bottaro, Sam Provins, and (CDFW)
Patrick Jarrett
April 2026

Presentation Goals

- ID why we prepared a white paper on catastrophic fire impacts on fish
- Discuss Potential Fire Impacts
- Share Case Studies
- Share trajectory for impacts on the landscape
- Discuss implications for future restoration; also tied to restoration “programs” (e.g. NTRS, AFRP, CDFW programs, Recovery Plans, etc.

(PS. Any references in the presentation are associated with a white paper; please just ask me for a copy!)



Park Fire Photo: UC San Diego

Major Central Valley Project Structures

Shasta Dam and reservoir on the Sacramento River,

Trinity Dam and reservoir (formerly called Clair Engle Lake) on the Trinity River

Folsom Dam and reservoir on the American River

Friant Dam and reservoir on the San Joaquin River

New Melones Dam and reservoir on the Stanislaus River (which helped galvanize the river-preservation movement in California)

San Luis Reservoir, a joint federal-state storage offstream facility.



CVPIA

The Central Valley Project Improvement Act of 1992 (CVPIA) started the Central Valley Project (CVP) in a new direction.

The CVPIA provisions dealt with water contracts, improved water management, **restoration of anadromous fish populations**, water supplies for State and Federal refuges, and mitigation for other fish and wildlife impacted by the CVP.



The Fish Species CVPIA Primarily Addresses in the Northern Central Valley

- Winter-run Chinook Salmon, dually listed as Endangered
- Spring-run Chinook Salmon, dually listed as Threatened
- Central Valley Steelhead (*O. mykiss*), federally listed as Threatened
- Sacramento River Fall-run Chinook Salmon and Late Fall-run Chinook Salmon, State Species of Special Concern
- Southern DPS, Green Sturgeon, federally listed as Threatened
- Other anadromous species, such as Pacific Lamprey



Current Management and Direction of CVPIA Restoration

Science Integration
Team (SIT) established
in 2012

Structured Decision-
Making Framework

Diverse backgrounds of
members

Products

Near-term Restoration
Strategy (NTRS)

Annual Adaptive
Management Update

Decision Support
Models

So, what does that have to do with fire impacts, as it relates to anadromous fish population dynamics, restoration priorities, and overall recovery?



Answer

Stochastic events, such as largescale fire, could alter key assumptions and/or data used in the Decision Support models → In the case of CVPIA, the models inform recommendations of the next iteration of the next Near Term Restoration Strategy (2026 to 2031)



How we
assess fish
“response”
may depend
on numerous
factors:

- The time scale of the observations (Gresswell, 1999),
- Fire severity,
- Geology/topography,
- Pre- and post-fire land management activities,
- Climate,
- The ecology of where the fire occurs.

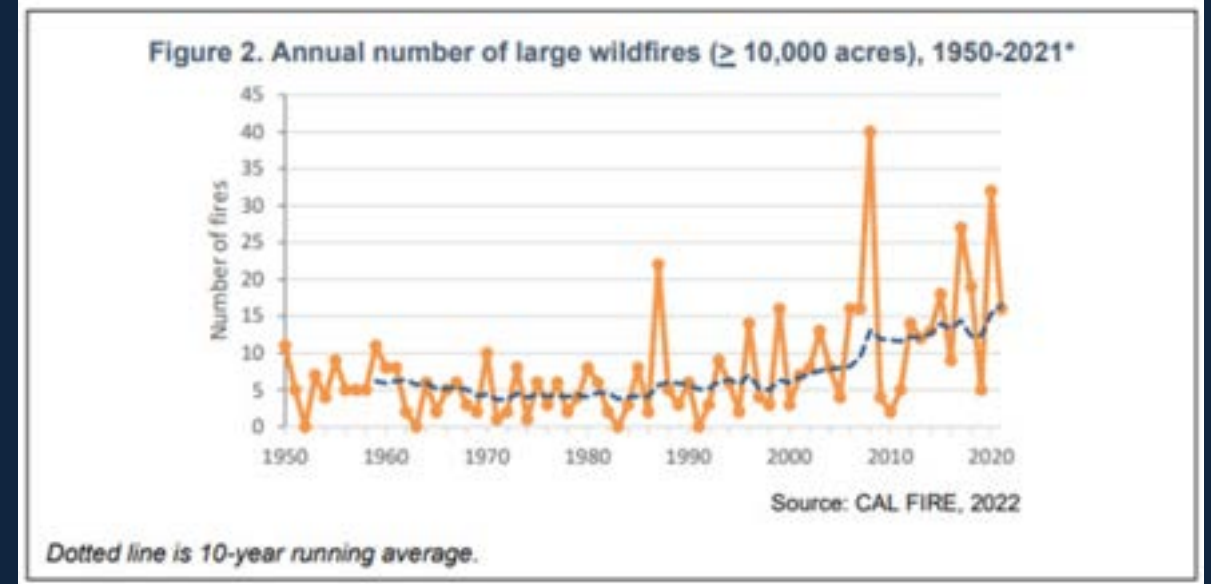
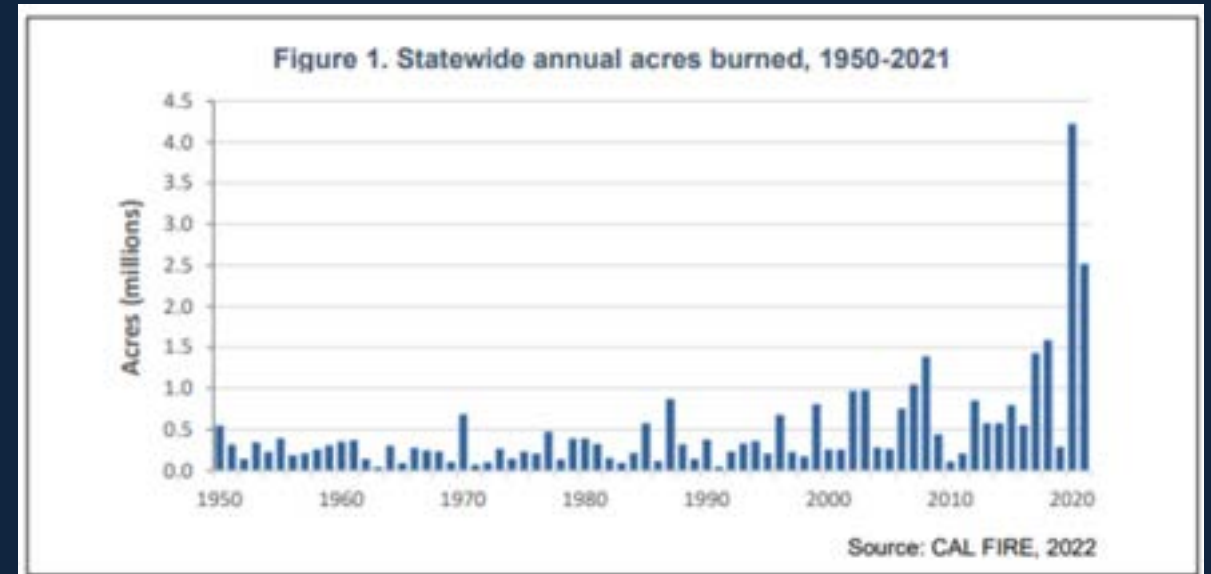
Both short- and long-term fire impacts and fish responses vary significantly (Bixby et al., 2015; Isaza et al., 2022; Jager et al., 2021). ‘

Different fish species also respond differently to fire (LeMoine et al., 2020).

What has been going on in California lately?

Wildfires in 2020 burned an unprecedented 4 million acres across California, the highest annual acreage in California of record. In 2021, about 2.6 million acres burned, which made it the second highest year. 2018 ranked third, with 1.5 million acres burned.

The area burned by wildfires and the number of large fires (10,000 acres or more) across the state of California have increased markedly in the last 20 years (California Office of Health and Human Services, 2022).

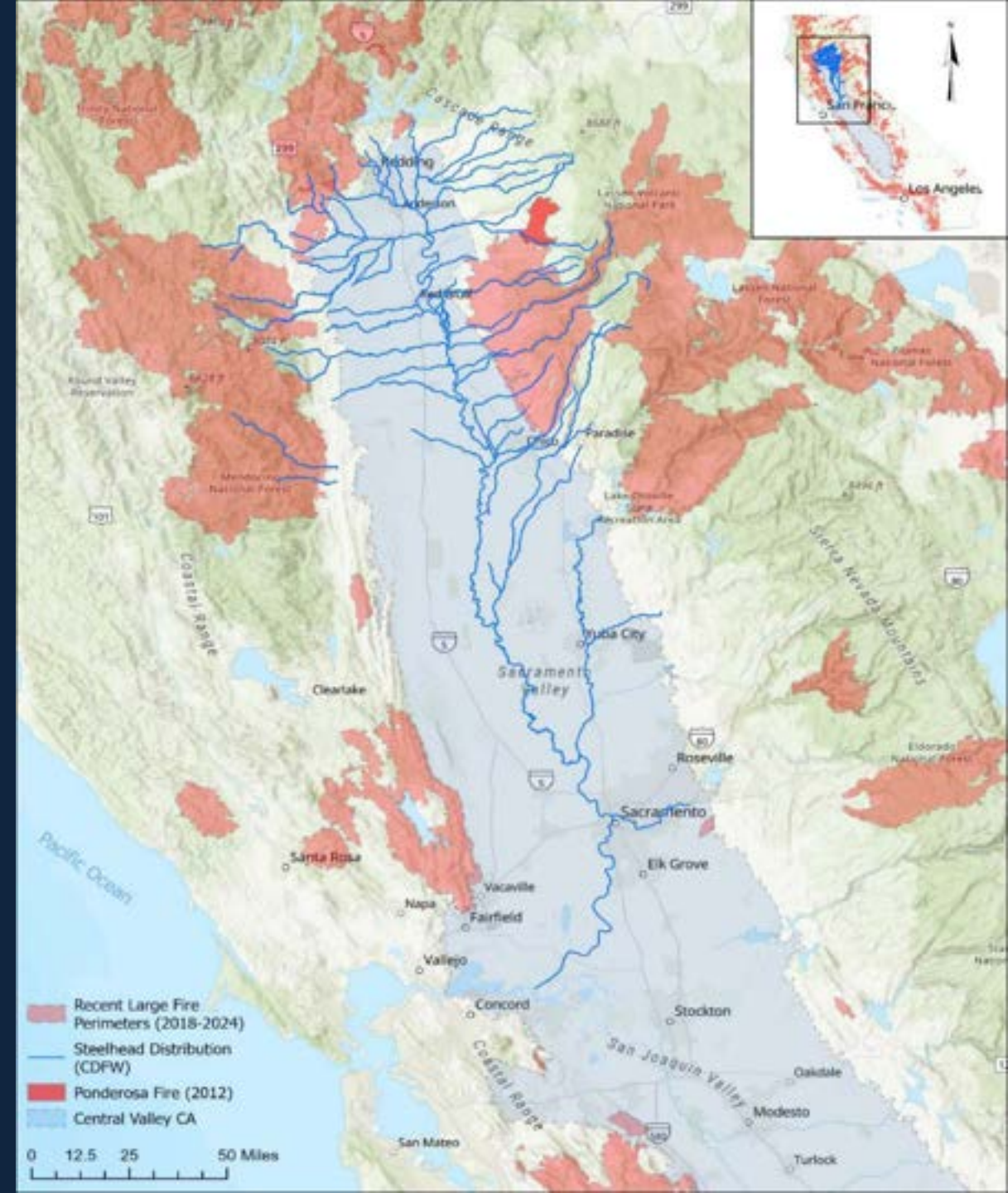


Copied figures from the State of California, CALFIRE website, reflecting annual acres burned in California between 1950 and 2021 (Figure 1) and number of large fires (over 10,000 acres) burned in California between 1950 and 2021 (Figure 2).

Recent Fire Magnitude and Frequency

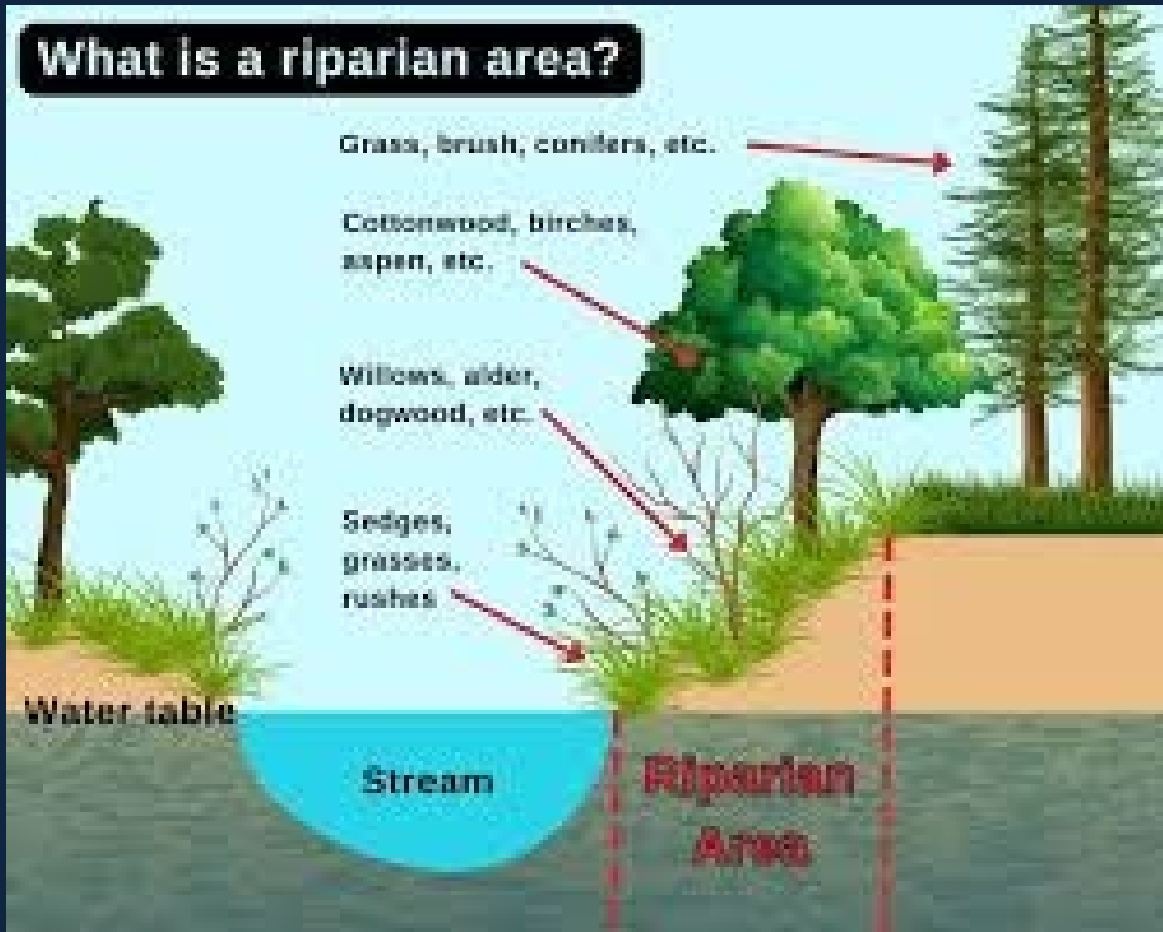
Most vegetation types have seen increases in area burned since 2000, with conifer forests showing the greatest increase including headwater areas in watersheds, many of which support anadromous fish in the Central Valley.

Large wildfires (>5,000 acres) from 2018 to 2024 in anadromous stream reaches of the Central Valley, CA. Sources: California Department of Forestry and Fire Protection (fire perimeters); California Department of Fish and Wildlife (steelhead distribution) websites.



Fire Effects on Habitat

Impacts to Riverine Habitat and Streamside Vegetation



Graphic source: Rogue Riverkeeper

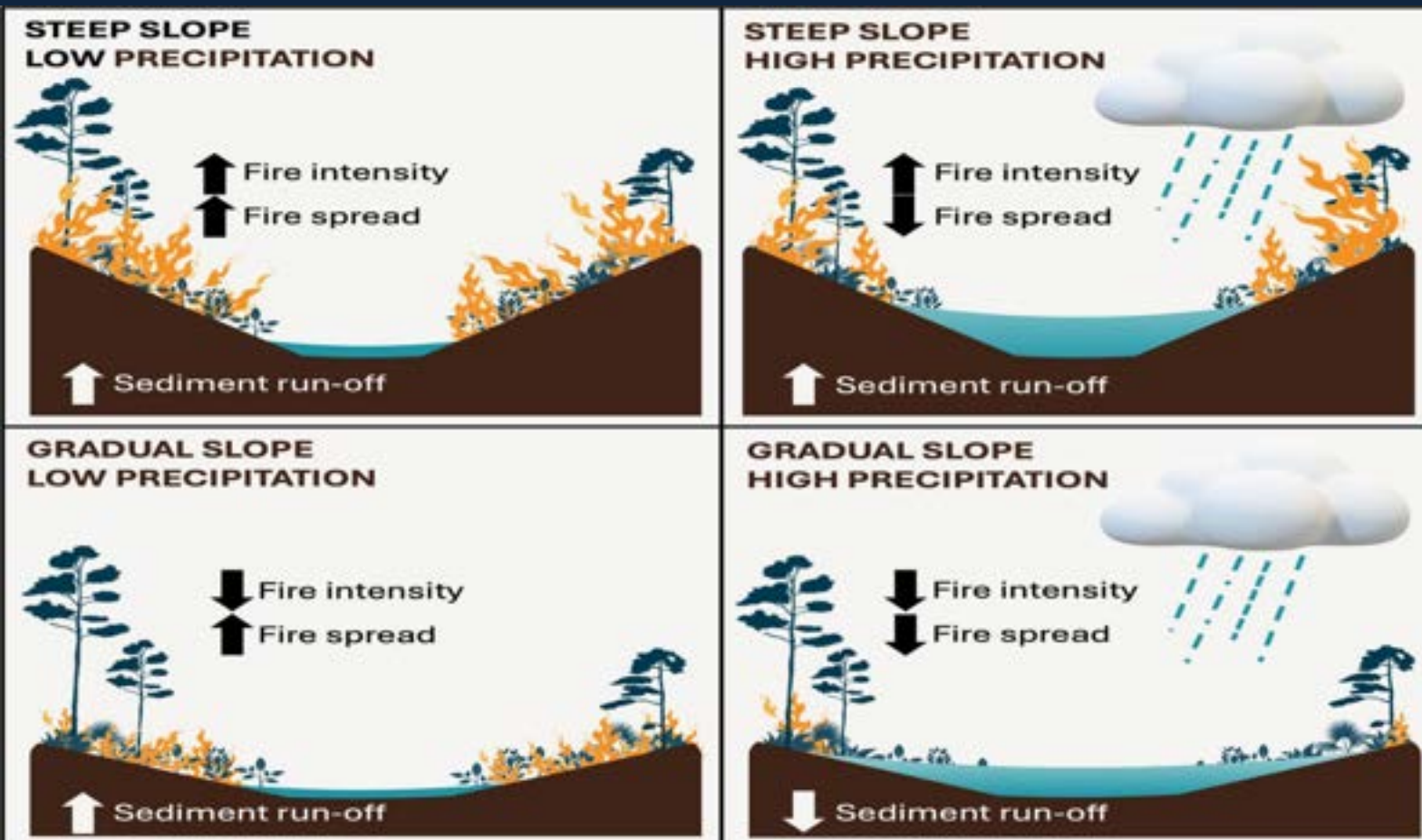


2020 Wallbridge Fire, Photo source: Sea Grant California

Fire Effects on Habitat

Sedimentation and Sediment Routing

Fire facilitates erosion through changes in vegetation and soil, with major postfire erosion



Whiskey Creek bridge loss, 2018 Carr Fire



2021 Dixie Fire runoff, NF Feather River into L. Almanor (CA GS photo)

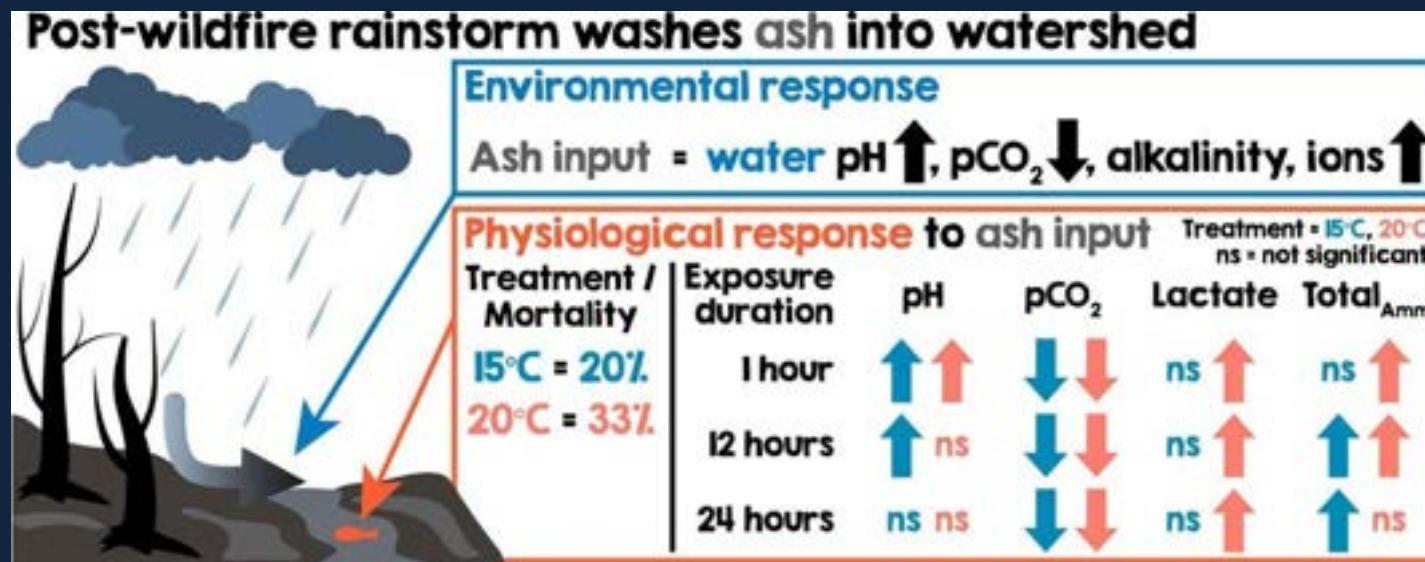
Fire Effects on Habitat – Sediment cont'd

Impact Type	Low Turbidity (<25 NTUs)	Moderate Turbidity (25-100 NTUs)	High Turbidity (>100 NTUs)
Overall Observed Behavior	Minimal	More evident	Significantly different than normal
Migration	May be slow slightly at higher end of this range	May be delayed or altered	Significant disruption; may halt migration entirely, seek refuge, or re-route
Spawning Activity	Largely unaffected	Fish may avoid spawning; may lead to pre-spawn mortality if turbidity event is long	Suppressed or avoided, leading to pre-spawn mortality; energetic costs increase due to delays and searching behavior
Impacts to Redd	No obvious observed impact	Eggs may suffer reduced oxygen due to siltation	Eggs more likely to perish due to reduced oxygen
Physiological Impacts	No real measurable physiological stress	Extended exposure leads to elevated stress hormones (e.g. cortisol)	Can weaken immune function over prolonged periods; can lead to sub-lethal stress, impairing reproductive readiness
Other	--	Adults may hold in place or avoid turbid sections Adults remain physiological resilient compared to juveniles	Visual cues are impaired—may interfere with mate selection and redd site identification.

Fire Effects on Habitat

Water Chemistry and Water Quality

- Substantial increase in nutrients, ions, organic chemicals, and metals in burned watersheds
- Burned infrastructure (buildings, vehicles) impacts -> more severe water quality impacts)
- Increases in turbidity and conductivity
- Decreased pH and dissolved oxygen.
- Impacts from fire retardant: See Delta Science Tracker online (UC Davis studies)
- Kwan et. al. 2024: Despite pH and RBC pH recovery and non-lethal nitrogenous waste levels, they observed 20 % and 33 % mortality in 15 and 20 °C treatments within 12 h of exposure, respectively.



From Kwan et al. 2024:

<https://doi.org/10.1016/j.scitotenv.2024.176040>

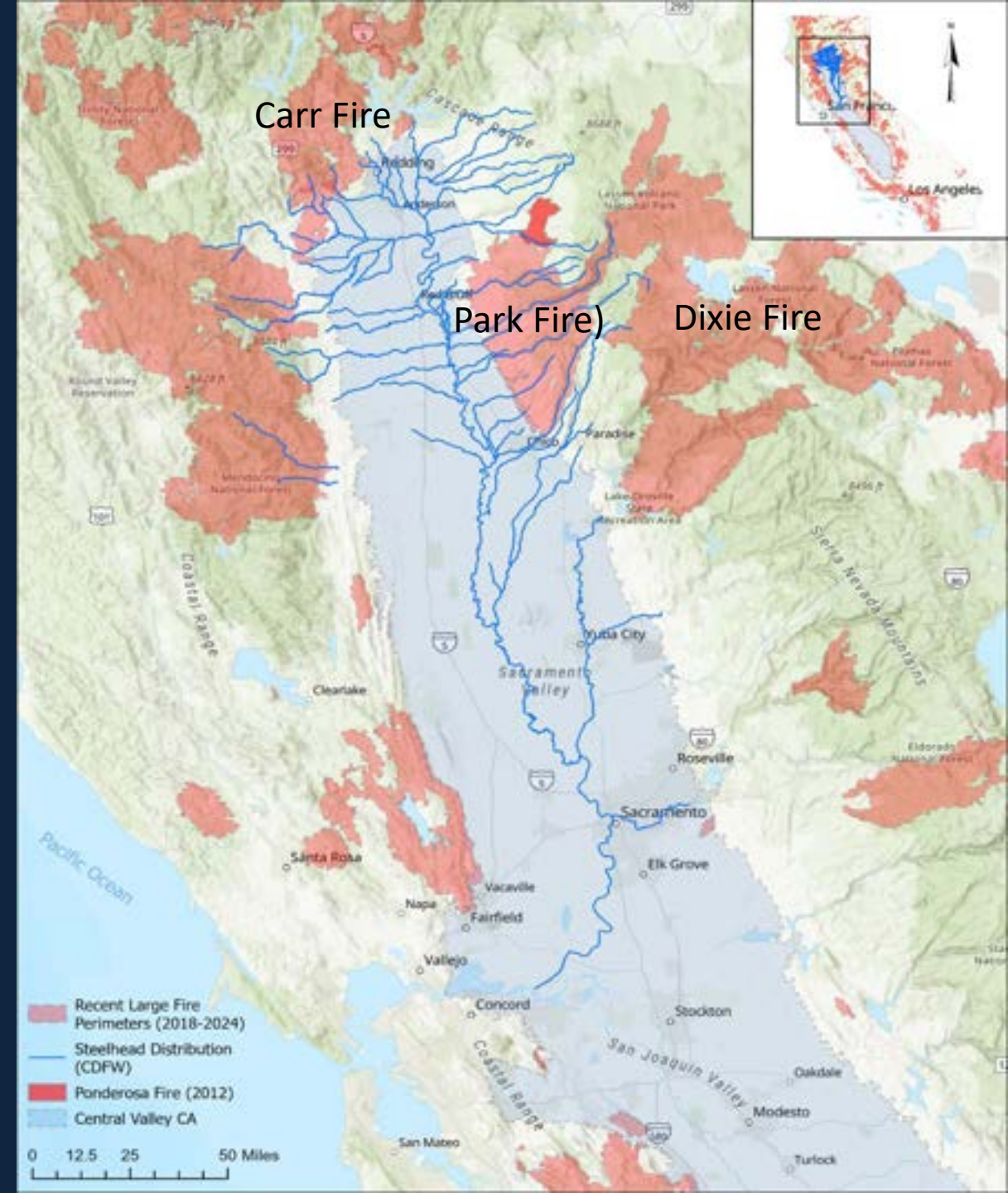
Case Histories

2012 Ponderosa Fire (dark red polygon),
east of Anderson

2018 Carr Fire, west of Redding

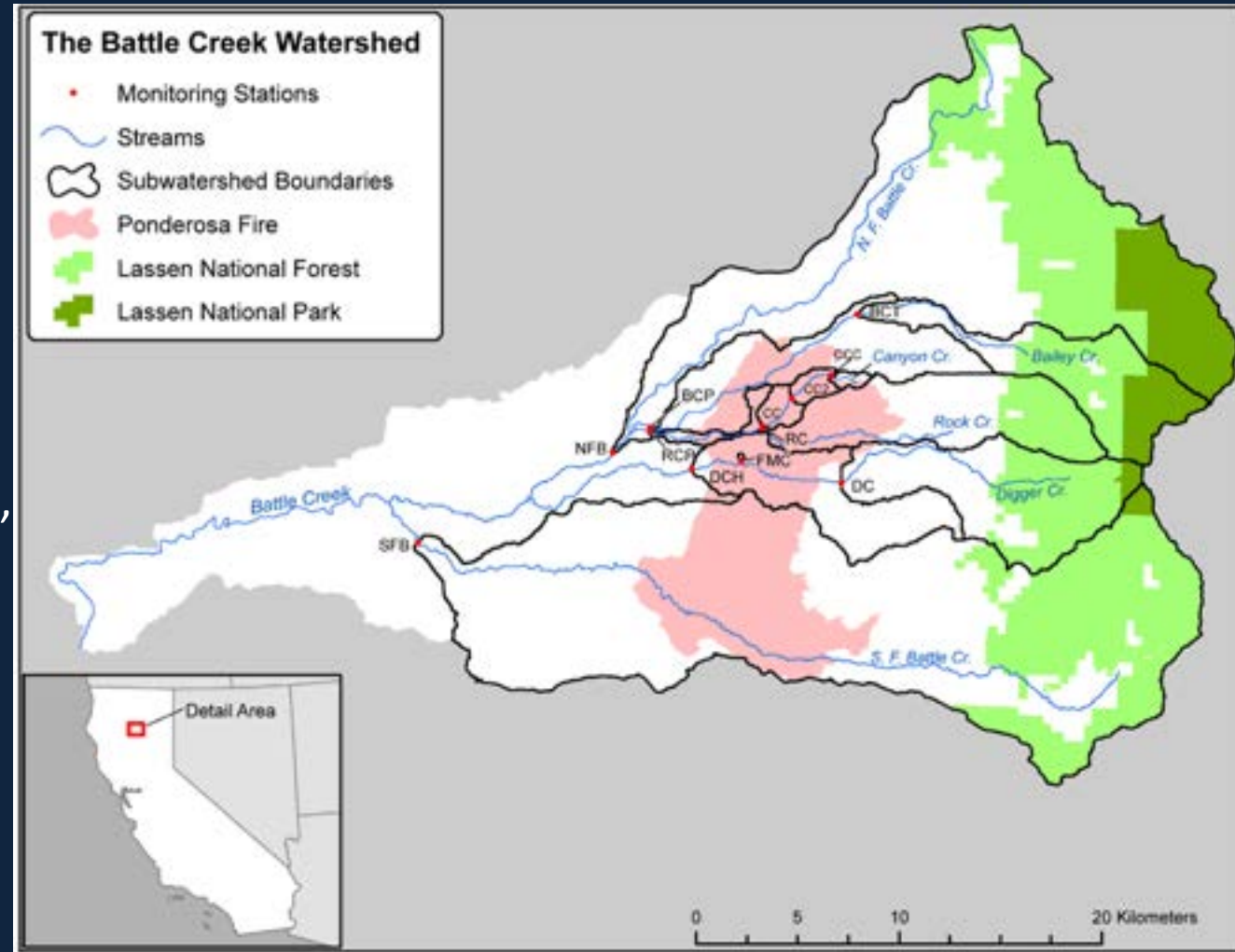
2021 Dixie Fire, east of Red Bluff and Chico

2024 Park Fire, east of Red Bluff and Chico



2012 Ponderosa Fire

- Started August 18, contained on August 31, 2012
- Located in the Battle Creek watershed, Shasta and Tehama Counties
- Acres burned: 27,676
- Structures destroyed: 133 (towns of Shingletown and Manton)
- Cause: Lightning strike
- Lives Lost: 0
- Anadromous fish species/runs affected: Winter-run, Spring-run, Fall-run, Late Fall-run Chinook Salmon, Central Valley Steelhead, Pacific Lamprey
- Monitoring conducted by US Fish and Wildlife Service (USFWS) in 2015 included observations of metric tons of sediment entering the South Fork of Battle Creek and its tributaries
- Extensive fire salvage after the fire
- Multiple instances of road failure in the upper watershed



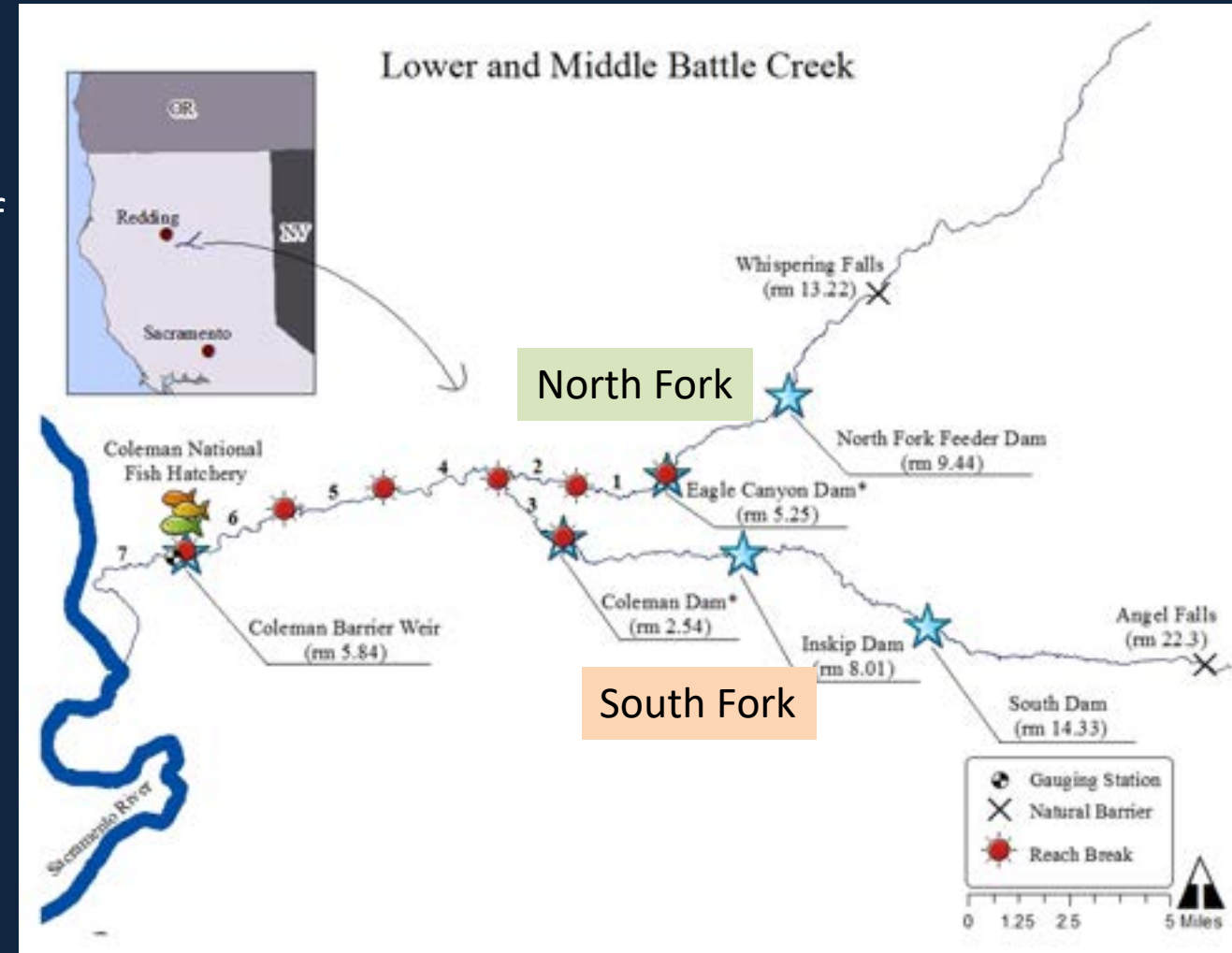
Map provided by Battle Creek Restoration Program, Bureau of Reclamation.

Ponderosa Fire Impacts

Spawning adults/redd condition:

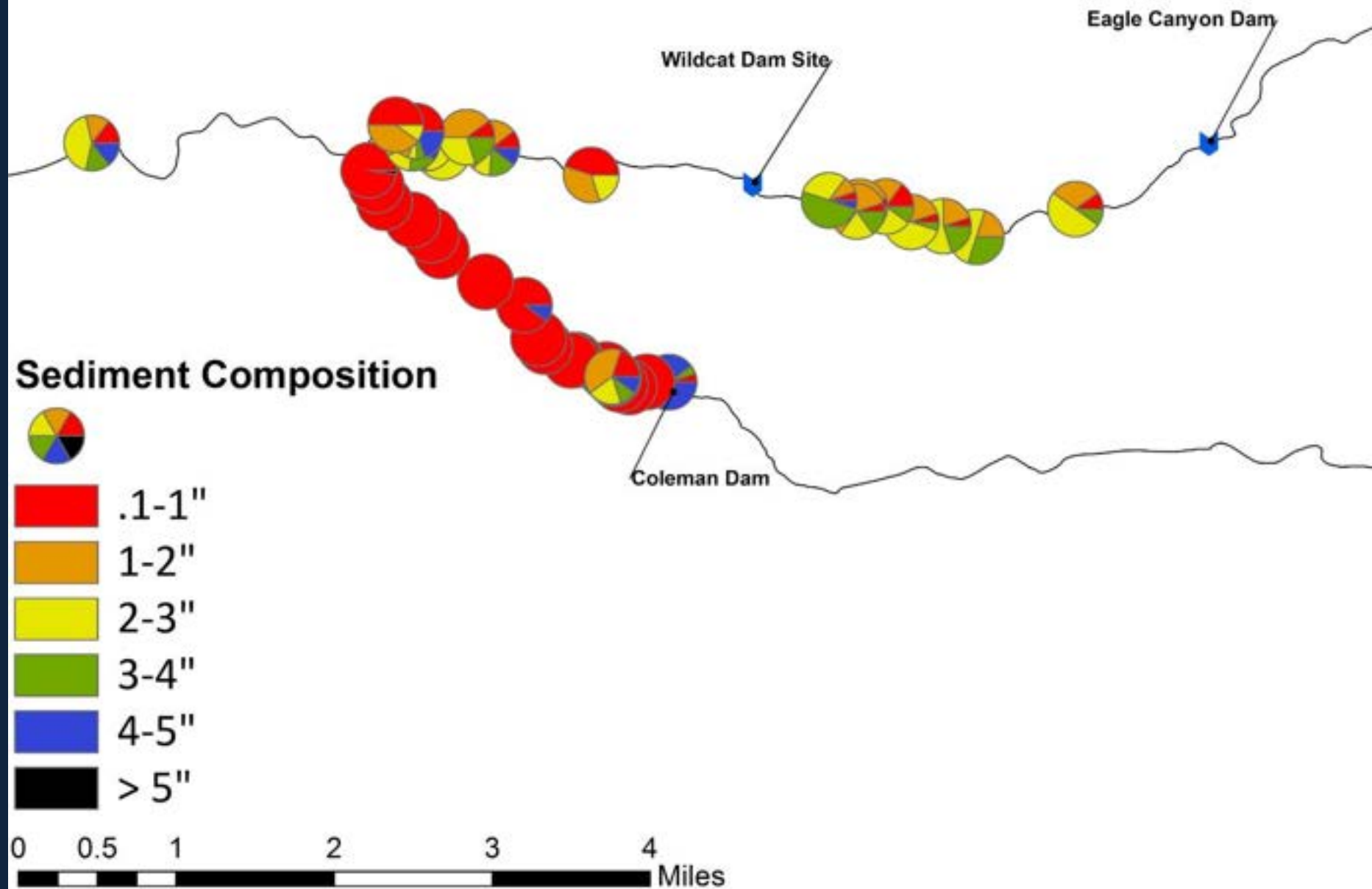
Spring 2015:

- Initial observations identified bank to bank filling of sediment throughout the South Fork of Battle Creek. This sediment was first observed upstream of South Dam (RM14) and was persistent for approximately 16 miles downstream to the confluence of the North and South forks of Battle Creek
- Possible cause due to land management, road failures, large weather events (e.g. December 2014).
- No pool or riffle habitat was found,
- All areas were blanketed in sand.
- Void of observations of aquatic invertebrates and other small native fishes.

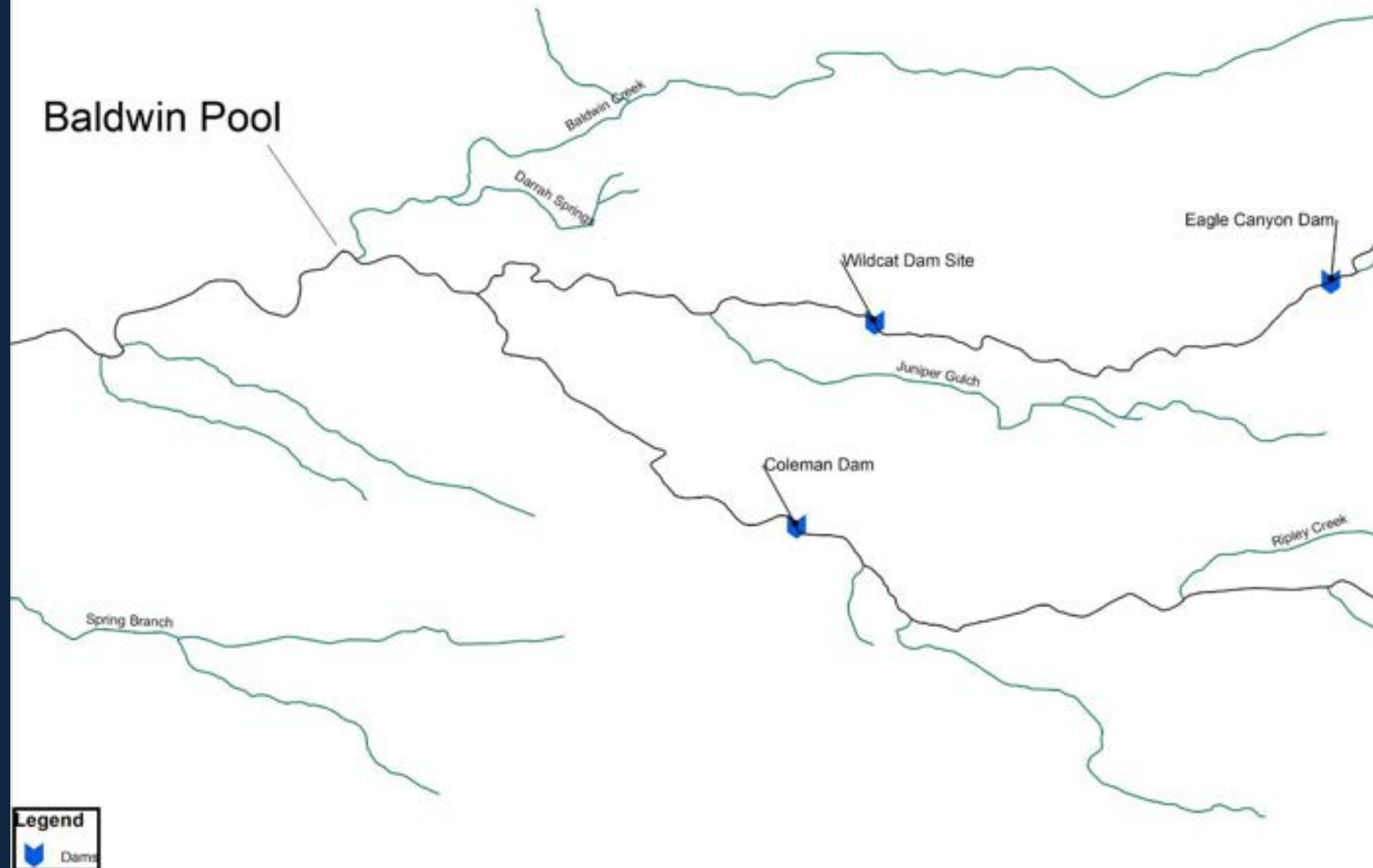


Battle Creek Restoration Program Map

Sediment Composition During Snorkel Survey:
7/13/15 - 7/16/15



South Fork Battle Creek Watershed



Baldwin Pool

July 25, 2012





Baldwin Pool

July 16, 2015

2015/07/16

Source: USFWS



Baldwin Pool

October 7, 2015

Source: USFWS

2018 Carr Fire

- Dates: Started July 23, contained August 30, 2018
- Located in the Clear Creek, Trinity River, Sacramento River watersheds (and tribs above and below Shasta Reservoir)
- Acres burned: 229,651 (97% of the Clear Creek watershed, 50% of the anadromous portion of the watershed)
- Structures destroyed: 1,604
- Cause: Accidental; sparks from tire failure on Hwy 299
- Lives lost: 8 (3 firefighters, 5 civilians)
- Anadromous species/runs affected: Winter-run, Spring-run, Fall-run, Late Fall-run Chinook Salmon, Central Valley Steelhead, Pacific Lamprey, green sturgeon*



Picture Source: Penitentes, public domain



Examples of extent of impact instream and on fish populations, Clear Creek, October 2018.

Examples of extent of impact instream and on fish populations. Paige Boulder Creek—main tributary to Lower Clear Creek



Paige Boulder Creek confluence, looking downstream, Jan 2019

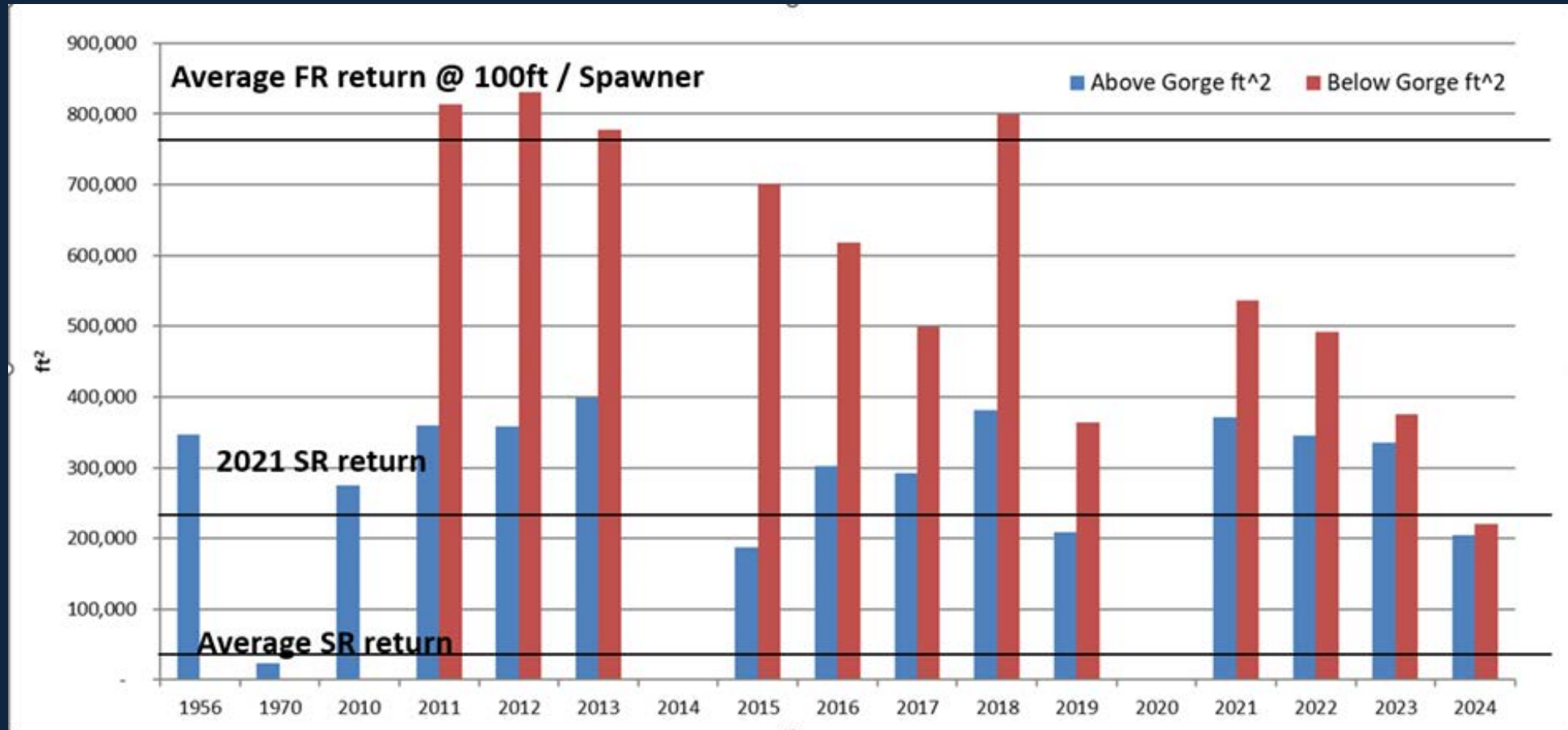


Paige Boulder Creek confluence, looking upstream, Jan 2019

Paige Boulder, Feb 2019, Need Camp Bridge (below Paige Boulder), excessive sand deposition



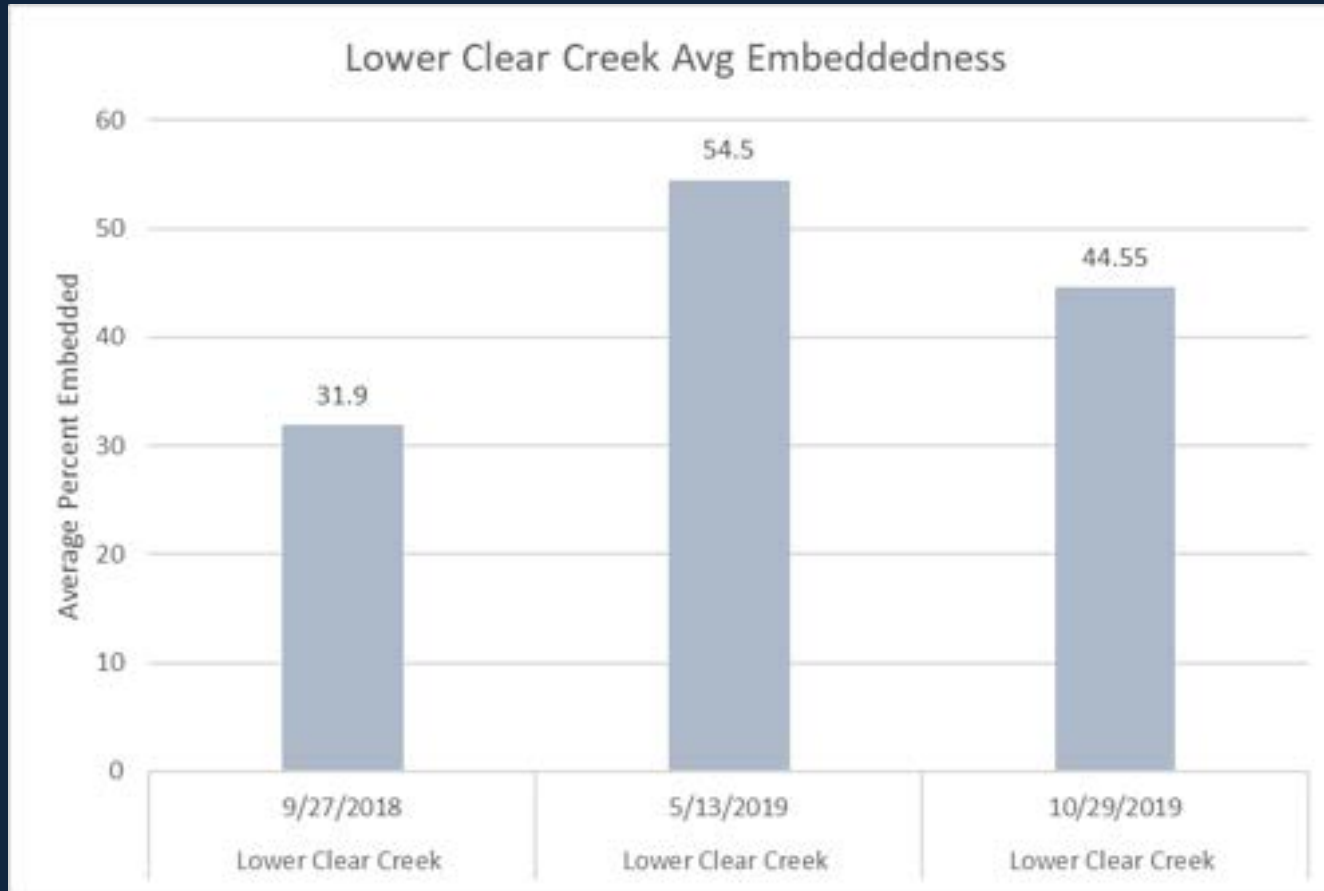
Carr Fire—Effects on Potential Spawning Habitat



USFWS measurement of potential spawning habitat measured in July of each year. Blue bars represent the spawning area measured above the Gorge cascade; area primarily used for spring-run Chinook Salmon spawning (habitat above ~RM 6.6). Red bars represent the roughly 6 miles of stream measured below the Gorge cascade; area primarily used for fall-run Chinook spawning. Horizontal bars represent the spawning habitat requirements for an average return of each species based on literature values.

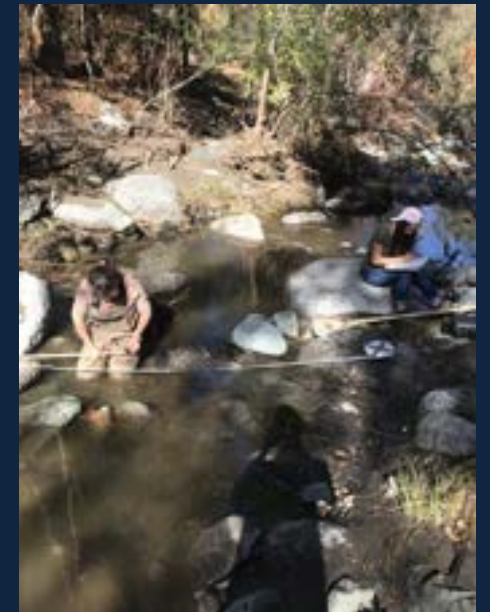
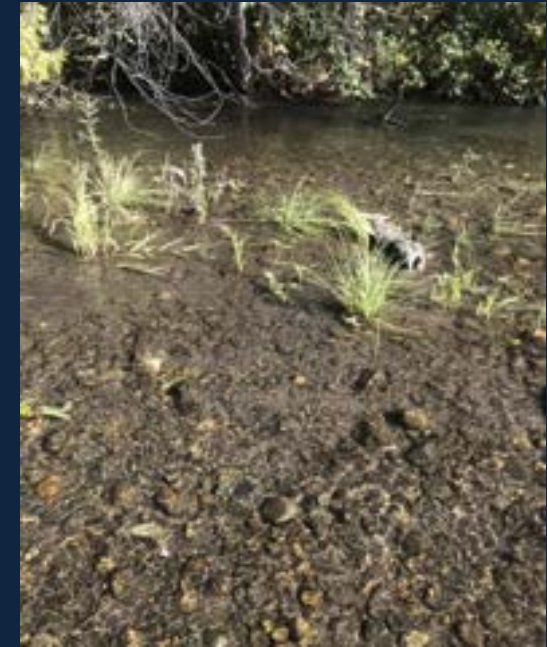
Carr Fire Effects

Egg Incubation and Habitat



Source: USFWS

Change in average embeddedness, Lower Clear Creek study site, Carr Fire, but below the largest tributary input (SF Clear and Paige Boulder)

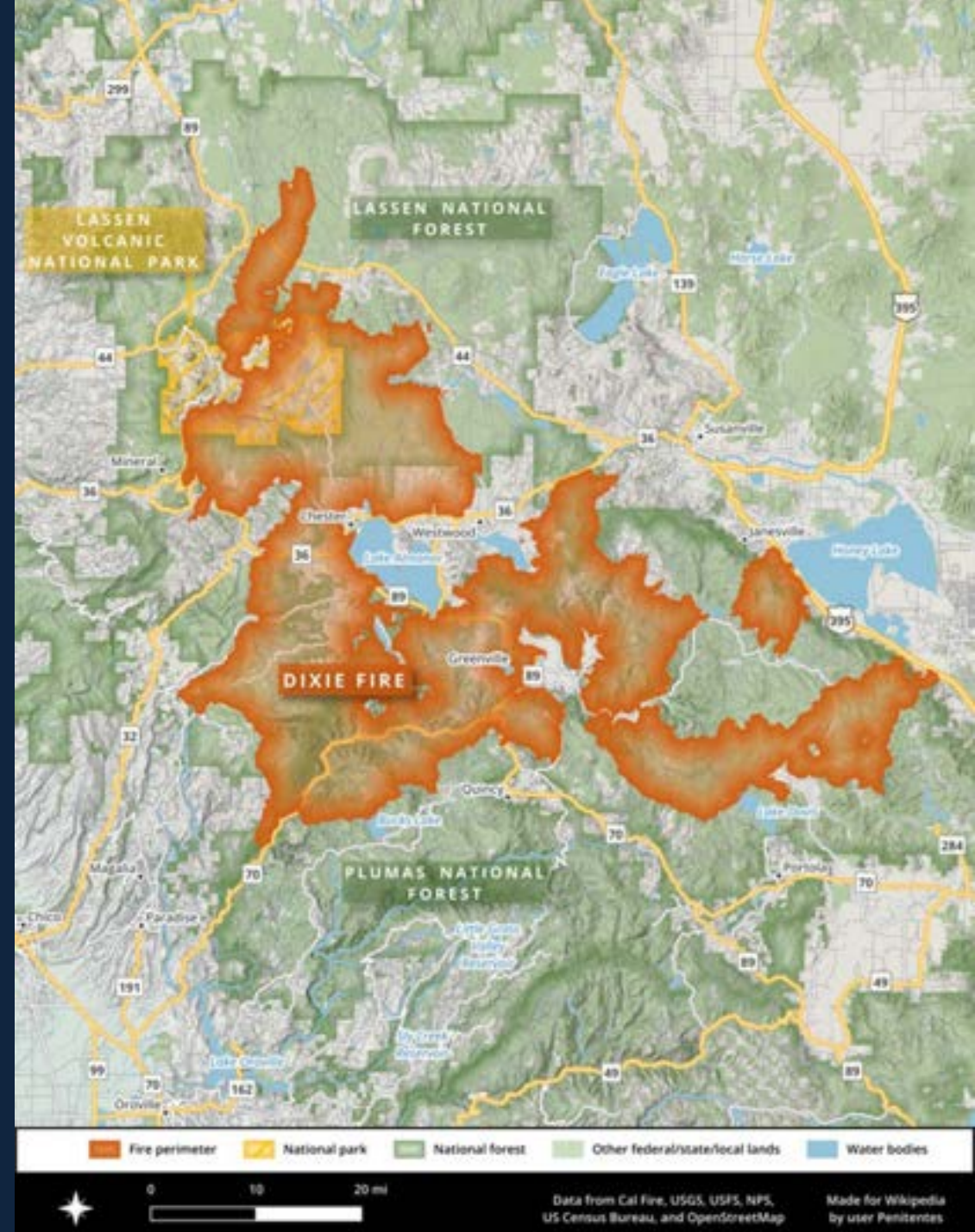


Source: CDFW

2021 Dixie Fire

- Dates: Started July 13, contained October 25, 2021 (105 days)
- Located in Hat Creek, Feather River, Mill Creek, Deer Creek, and Butte Creek watersheds, numerous smaller tributaries (Butte, Plumas, Shasta, Tehama and Lassen Counties)
- Acres burned: 963,309 acres
- Structures destroyed: 1,329, including the town of Greenville, Canyon Dam, and Indian Falls
- Cause: Tree falling on PG&E power line, exacerbated by later acts of arson
- Lives lost: 1 (firefighter)
- Anadromous species/runs affected: Spring-run ("direct"), Fall-run, Late Fall-run Chinook Salmon, Central Valley Steelhead ("direct"), Pacific Lamprey

Source: Penitentes, public domain



Dixie Fire

The most expensive wildfire suppression effort in United States history, in part due to a reliance on contracted and higher-paid local and private firefighters. \$637.4 million, split between multiple agencies such as CAL FIRE and the U.S. Forest Service.

Acres burned in Mill Creek Watershed: 11,145 (13% of total watershed acreage); majority of the headwaters acreage (portion of which within anadromy)

Acres burned in Deer Creek watershed: 16,398 acres (12% of watershed); roughly half of the headwaters area (above anadromy).

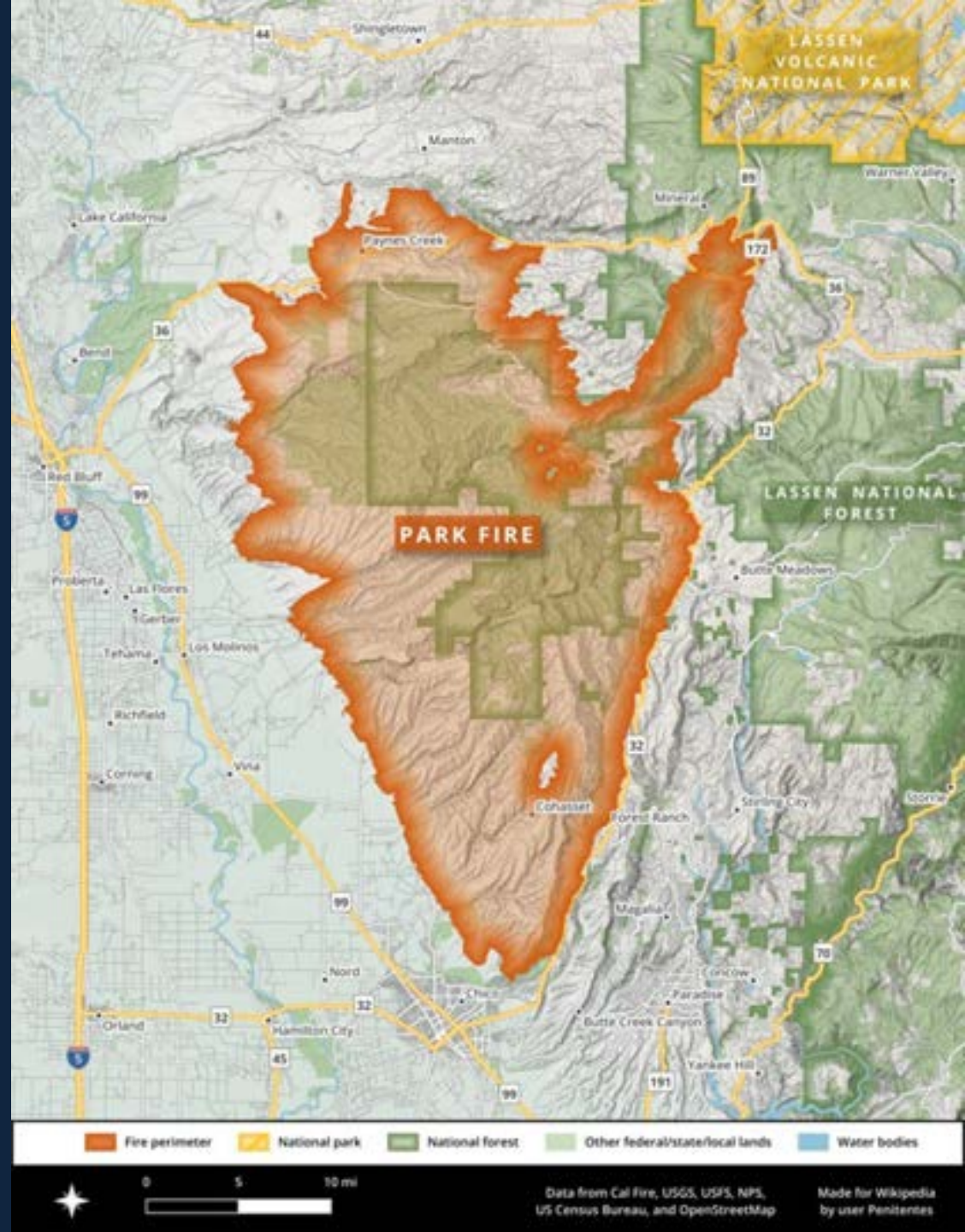
Source: USFS BAER report

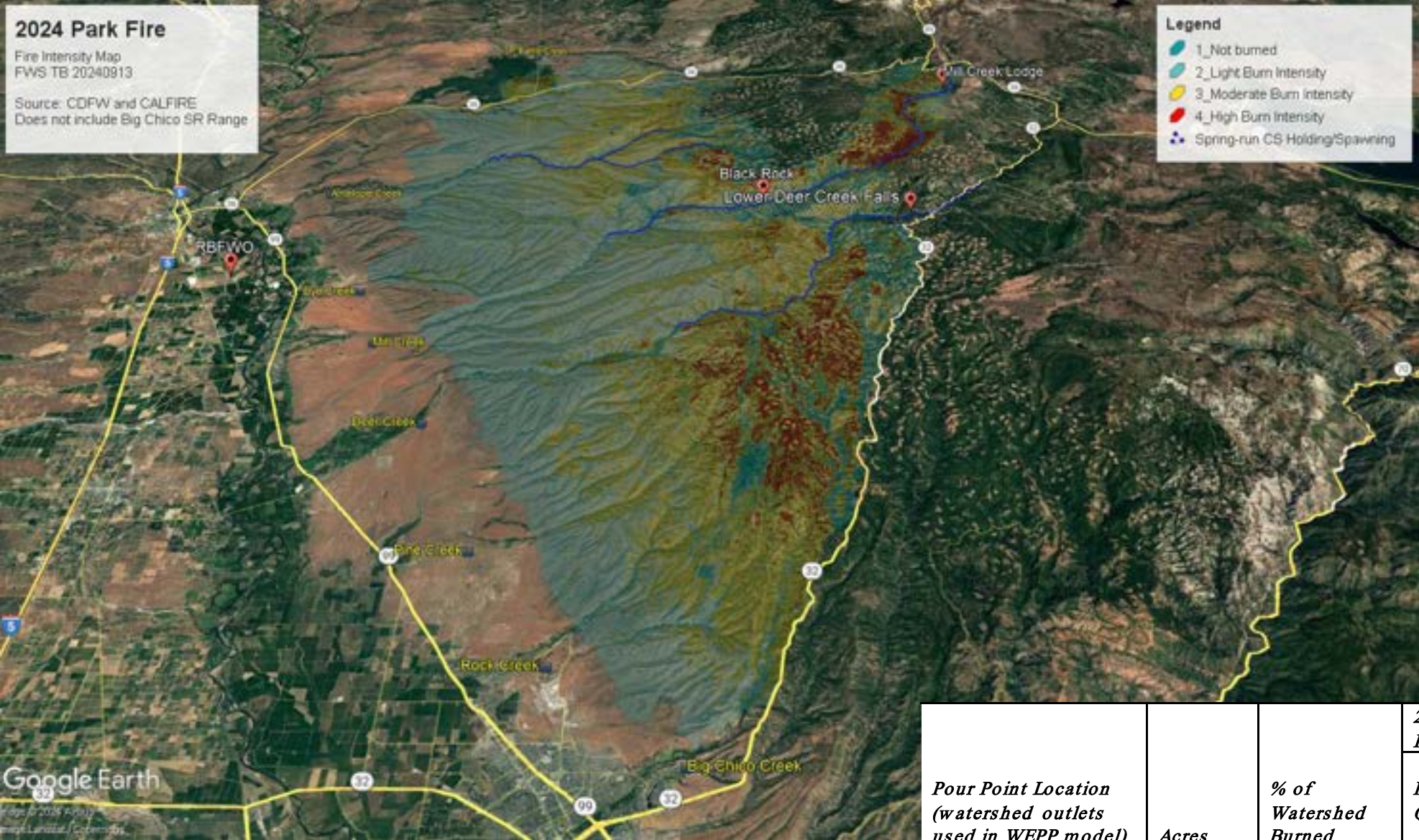


2024 Park Fire

- Dates: Started July 24, contained September 26, 2024 (64 days)
- Located primarily in the Big Chico, Deer, Mill, Antelope and Paynes Creek watersheds (Butte, Tehama counties)
- Acres burned: 429,603 acres
- Structures destroyed: 709
- Cause: Arson
- Lives lost: 0
- Anadromous fish species/runs affected: Winter-run, Spring-run, Fall-run, Late Fall-run Chinook Salmon, Central Valley Steelhead, Pacific Lamprey, Green sturgeon*

Source: Penitentes Public Domain





Pour Point Location (watershed outlets used in WEPP model)	Acres	% of Watershed Burned	2-year Peak Return Interval		Average Annual	
			Pre-Fire Q (cfs)	Post-Fire Q (cfs)	Pre-Fire Hillslope Sediment (tons)	Post-Fire Hillslope Sediment (tons)
Below CG - Mill Creek	22,000	11%	2,700	3,600	700	4,000
Canyon outlet – Lower Mill Creek	77,000	78%	4,800	10,270	3,400	78,000
Canyon outlet – Lower Deer Creek	130,000	42%	6,000	13,200	5,300	82,000
Canyon outlet - Lower Antelope Creek	75,000	60%	15,000*	27,000*	3,200	48,000

Water Erosion Prediction Project (WEPP) predicted 2-yr return interval peak streamflow discharges and average annual hillslope sediment production for Mill, Deer and Antelope Creeks

Antelope Creek Watershed Sept 2024



Mill Creek Watershed



Deer Creek Watershed 2015



Deer Creek Watershed 2024



Park Fire – Mill Creek Focus

Spawning adults and redd condition:

- An estimated 18 adult spring-run Chinook Salmon and 100 fall-run Chinook Salmon were counted on Mill Creek based on redd counts during the 2024 season. All observed redds were within the Park Fire footprint.
- Large peak flows of 15,000 cfs (~10 year event) occurred during the fall and winter of 2024-25 likely inducing streambed scour and significant increases in sediment transport.

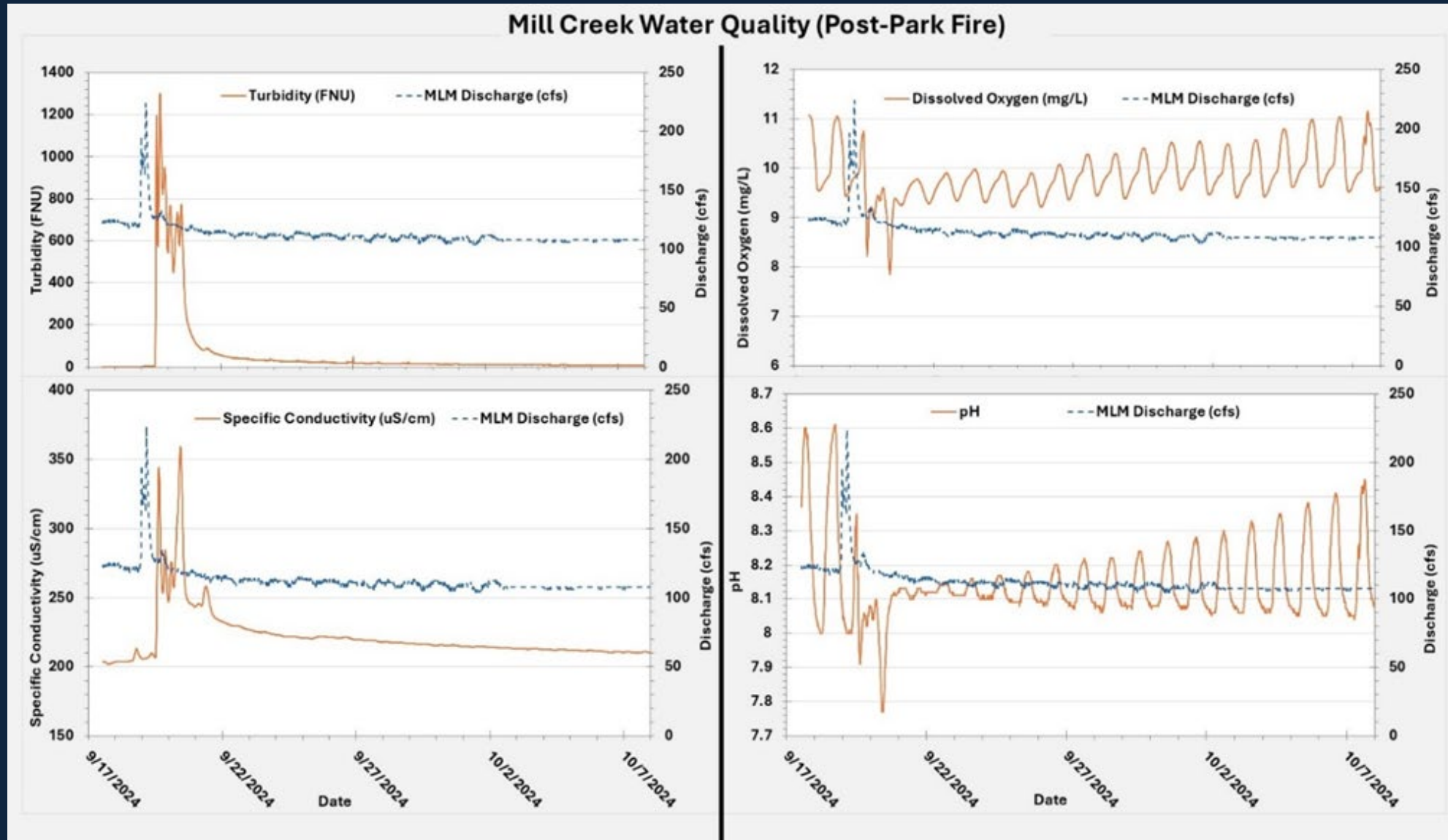
Park Fire Effects

Smolts and Outmigration: Some spring-run leave Mill and Deer creeks as yearlings. Expected to be impacted by lack of shade/higher water temperatures (oversummering).



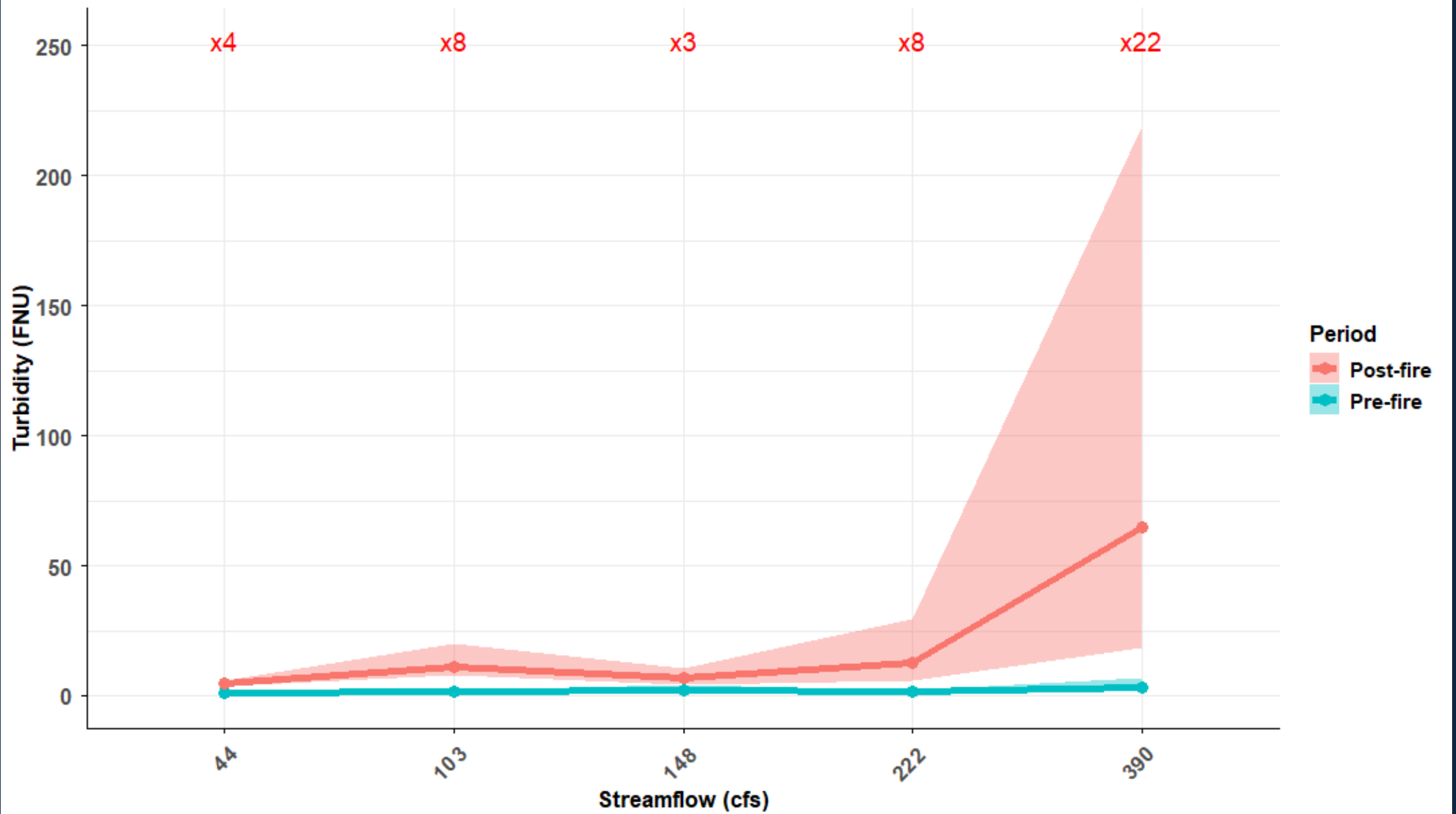
The Big Bend to Canyon Camp reach of Mill Creek with high burn severity along riparian area. Fall 2024. Photo by California Department of Fish and Wildlife.

Park Fire – Sonde Data

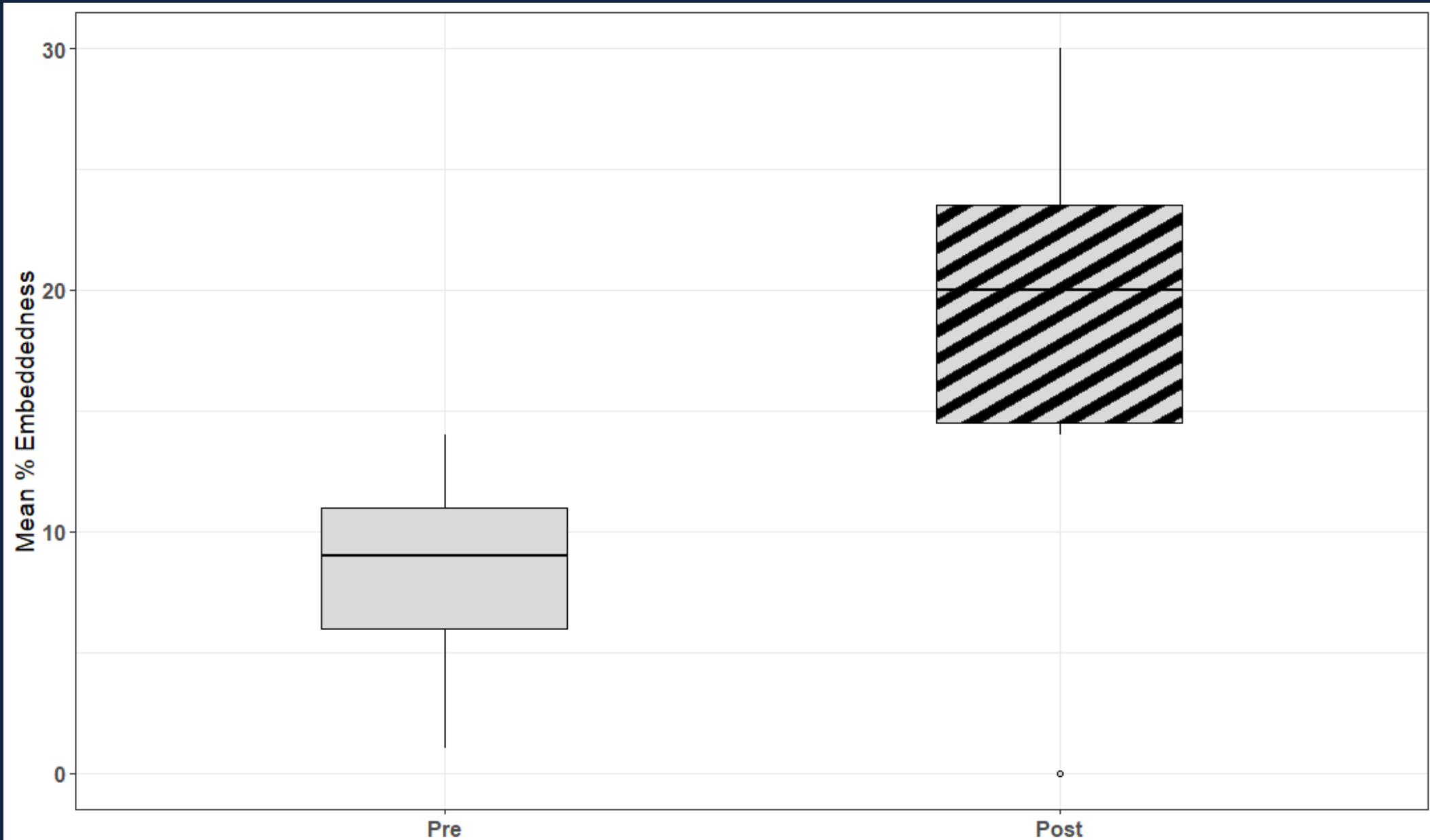


Turbidity and conductivity increased following peak discharge, while dissolved oxygen and pH decreased. Discharge from USGS stream gage “MLM”, located on Mill Creek above the upper diversion dam in the valley floor. Source: CDFW and DWR

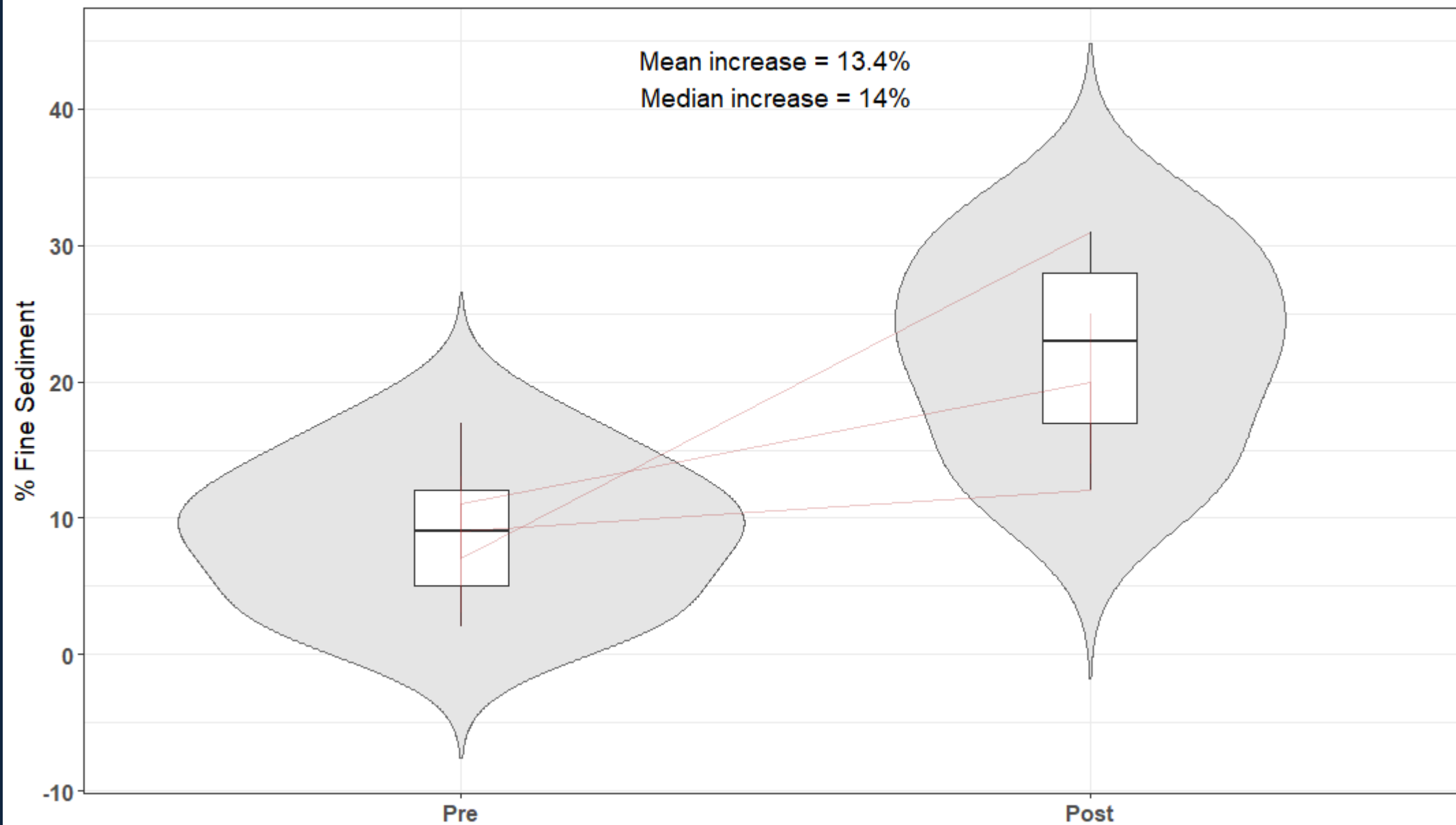
Mill Creek Pre- vs Post-Park Fire Turbidity by Flow Bin, 2025 results



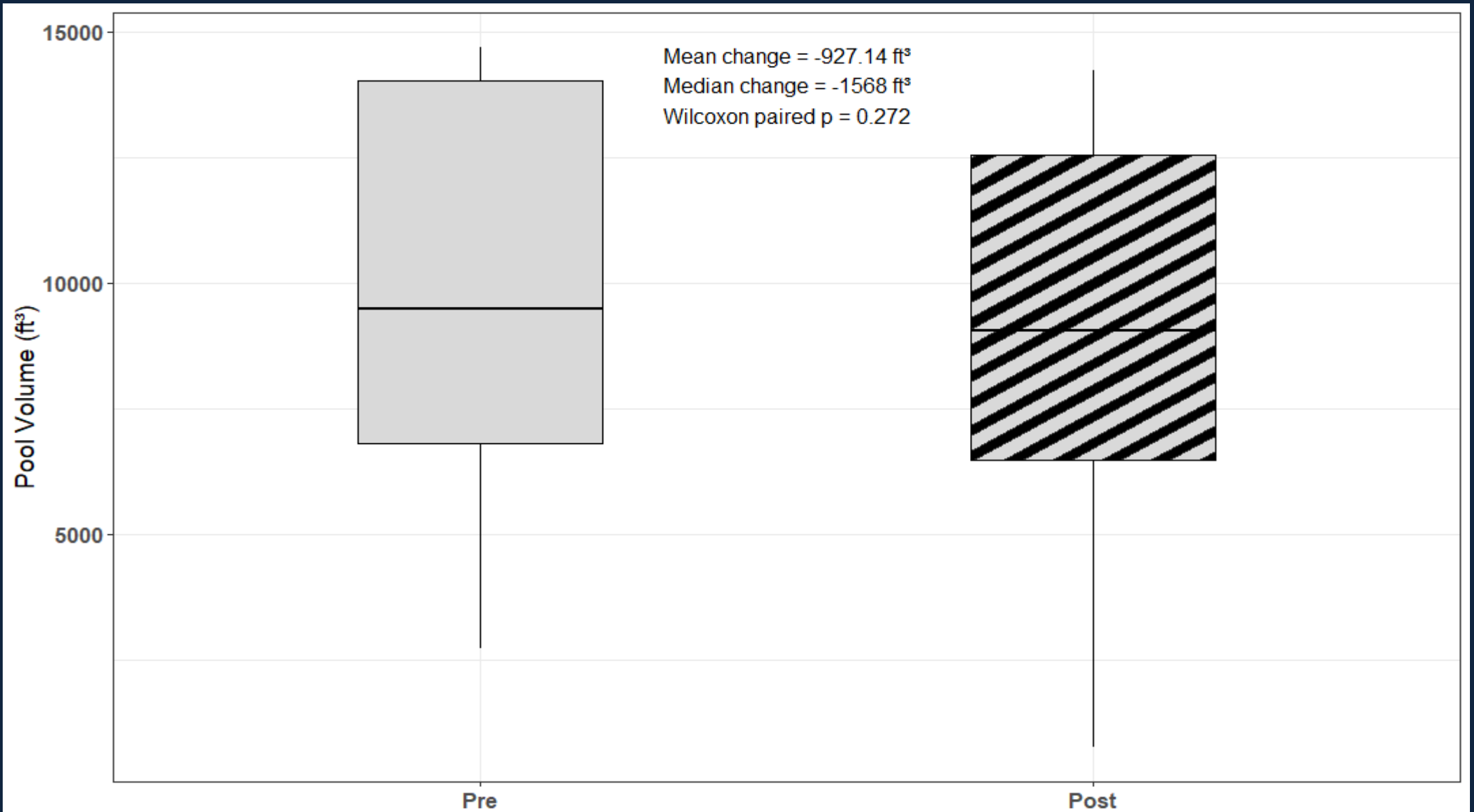
Park Fire Monitored Tailout Data, Embeddedness, Mill Creek, 2025 Results



Park Fire Monitored Tailout Data, Fine Sediment, Mill Creek, 2025 Results



Park Fire Monitored Tailout Data, Pool Volume, Mill Creek, 2025 Results

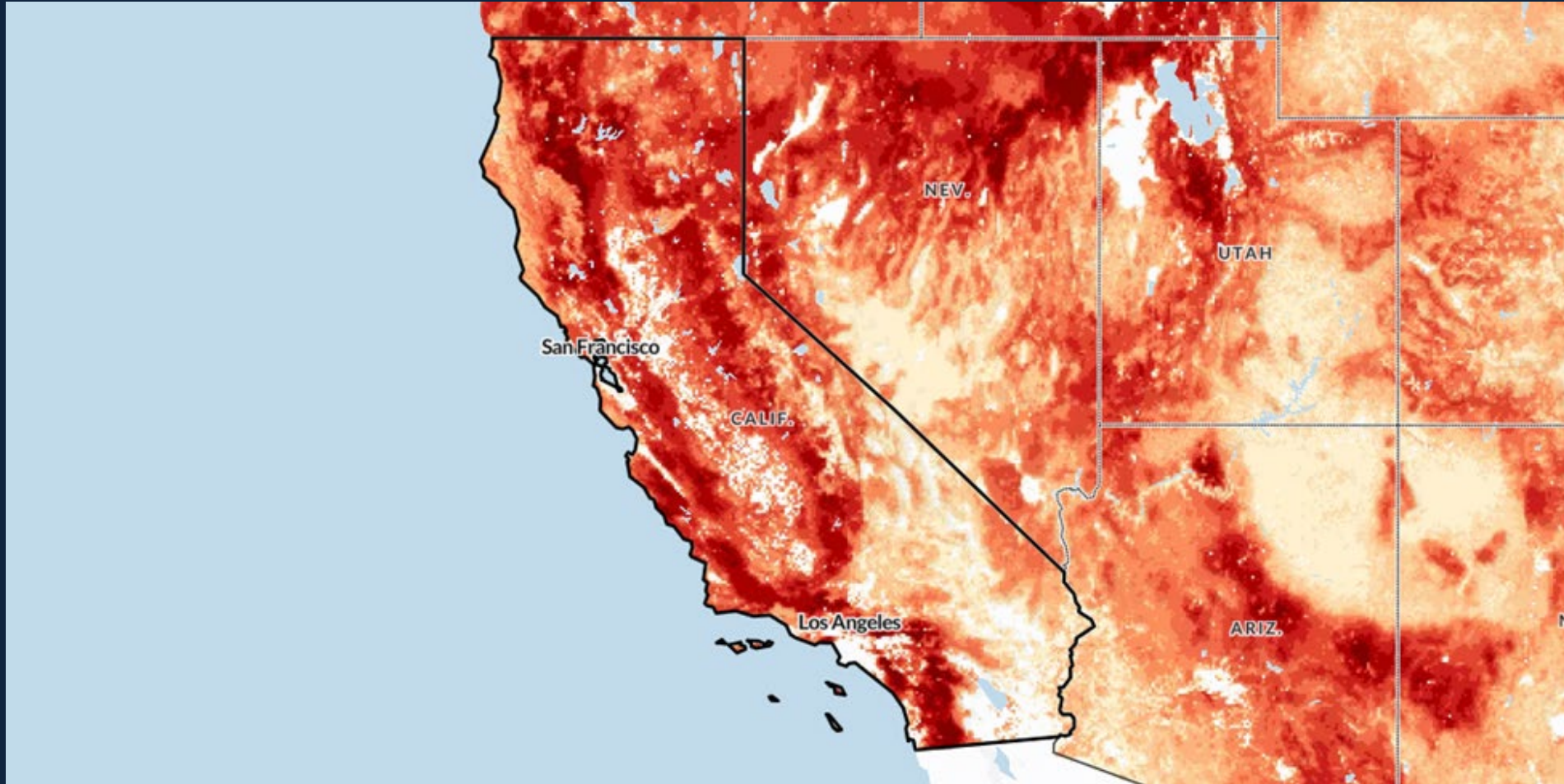


Other Impacts from the Park Fire



Source: CDFW graphics

Projection of Future Fires



USFS wildfire prediction model website page. Light colors (pale orange) show a low likelihood, dark red/burgundy is highest likelihood. Source: <https://wildfirerisk.org/explore/wildfire-likelihood/06/> and https://lao.ca.gov/Publications/Report/4952#How_does_wildfire_risk_vary_across_the_state.3F

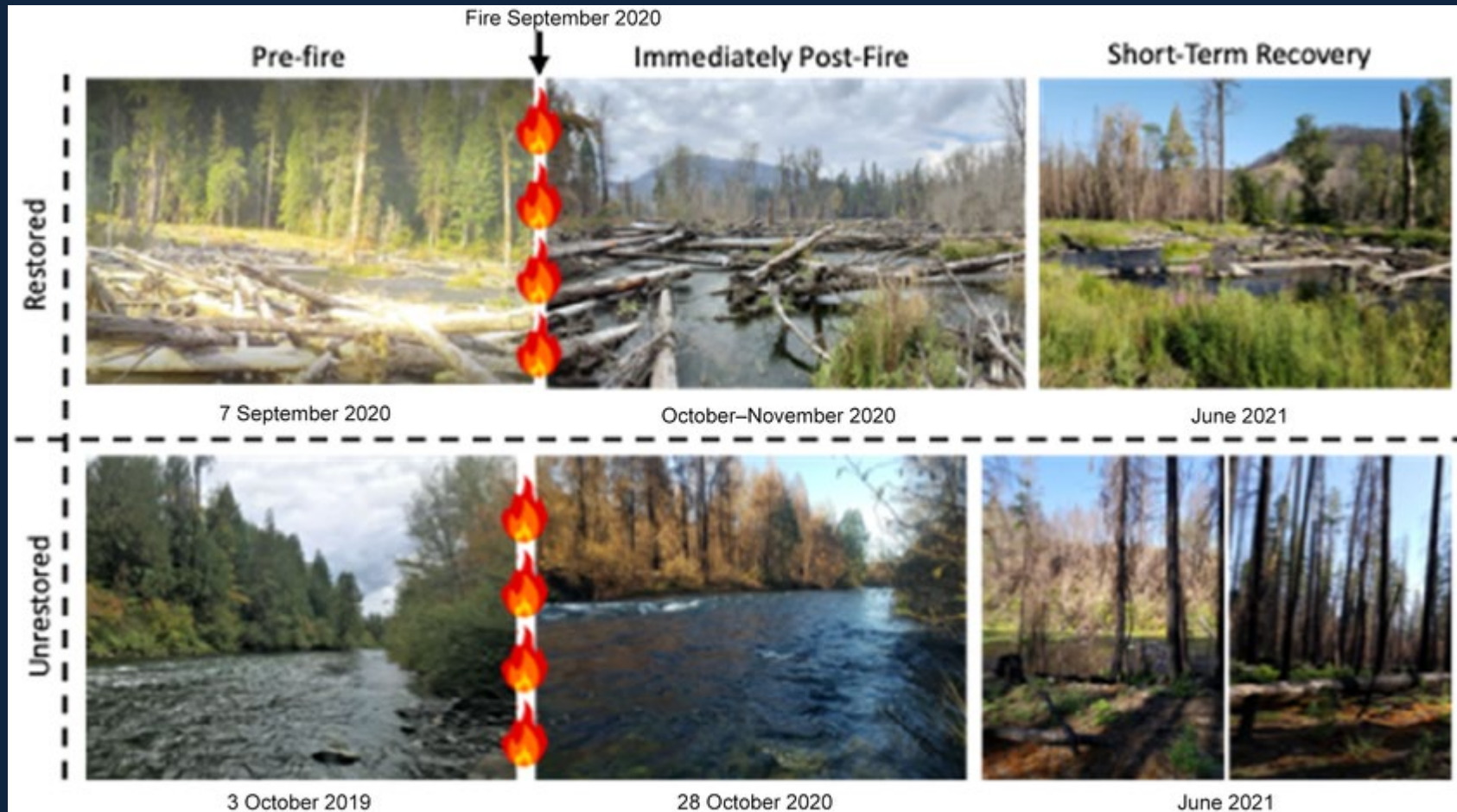
Decadal Wildfire Projections. See: <https://v2.cal-adapt.org/tools/wildfire>

What can we do?

Tools to consider for future use and assessment:

- Use the “Potential Solution/Evaluation” method: <https://iwaponline.com/wqri/article-abstract/50/2/123/21602/Evaluation-of-effect-of-sediment-on-aquatic?redirectedFrom=fulltext>
- Explore the CALFIRE “Fire Across Time” mapper:
https://experience.arcgis.com/experience/b72eede32897423683a94c61bf9d3027/page/Fire-Across-Time#data_s=id%3Aadd-data-widget_109-1-1754091098626%3A838
and
<https://experience.arcgis.com/experience/aff840a6cd8d4e49958f2b61982b5b11>
- The USDA Forest Service created *Wildfire Risk to Communities* under the direction of Congress. It was first published in 2020 and uses nationally consistent data grounded in the best available science. See: <https://wildfirerisk.org/explore/overview/06/> and <https://research.fs.usda.gov/firelab>
- To explore wildfire scenario projections for area burned and estimated decadal wildfire probabilities for California, CAL-Adapt developed a “Fire Severity Simulator” as part of a recent climate change assessment. See: <https://v2.cal-adapt.org/tools/wildfire/>
- Explore the Resist Accept Direct (RAD) framework in the context of adaptation to change caused by increased fire on the landscape, as well as in the context of further evaluating climate change in the SIT Climate Change subgroup. Lynch et al. (2025) recently illustrated RAD concepts using case studies on walleye (*Sander vitreus*) stocking decisions in Wisconsin, wildfire response in the Greater Yellowstone Ecosystem, and bull trout (*Salvelinus confluentus*) management in Oregon.

Synopsis



Comparison of restored and unrestored reaches of the South Fork McKenzie River, Oregon, USA, before (autumn 2019 and summer 2020), immediately after (October–November 2020) and during the initial post-burn recovery period (June 2021) for the “Holiday Farm” wildfire, which occurred in September 2020.

Note that burn was generally more heterogeneous and habitat recovery faster in the restored reach.

Photograph/reporting credits: Robert Ashworth, Colin Thorne, Lisa Renan, Mickey Means-Brous, Dan Scott and Kate Meyer.



Thank you!

*Mill Creek Headwaters 2013
Personal Photo*

Tricia Bratcher, USFWS, Red Bluff Fish and Wildlife Office
Patricia_Bratcher@fws.gov 530-789-1991

Habitat Resilience in the Face of Wildfire along Whychus Creek Central Oregon



Mathias Perle – Restoration Program Manager
Lauren Mork – Monitoring Program Manager

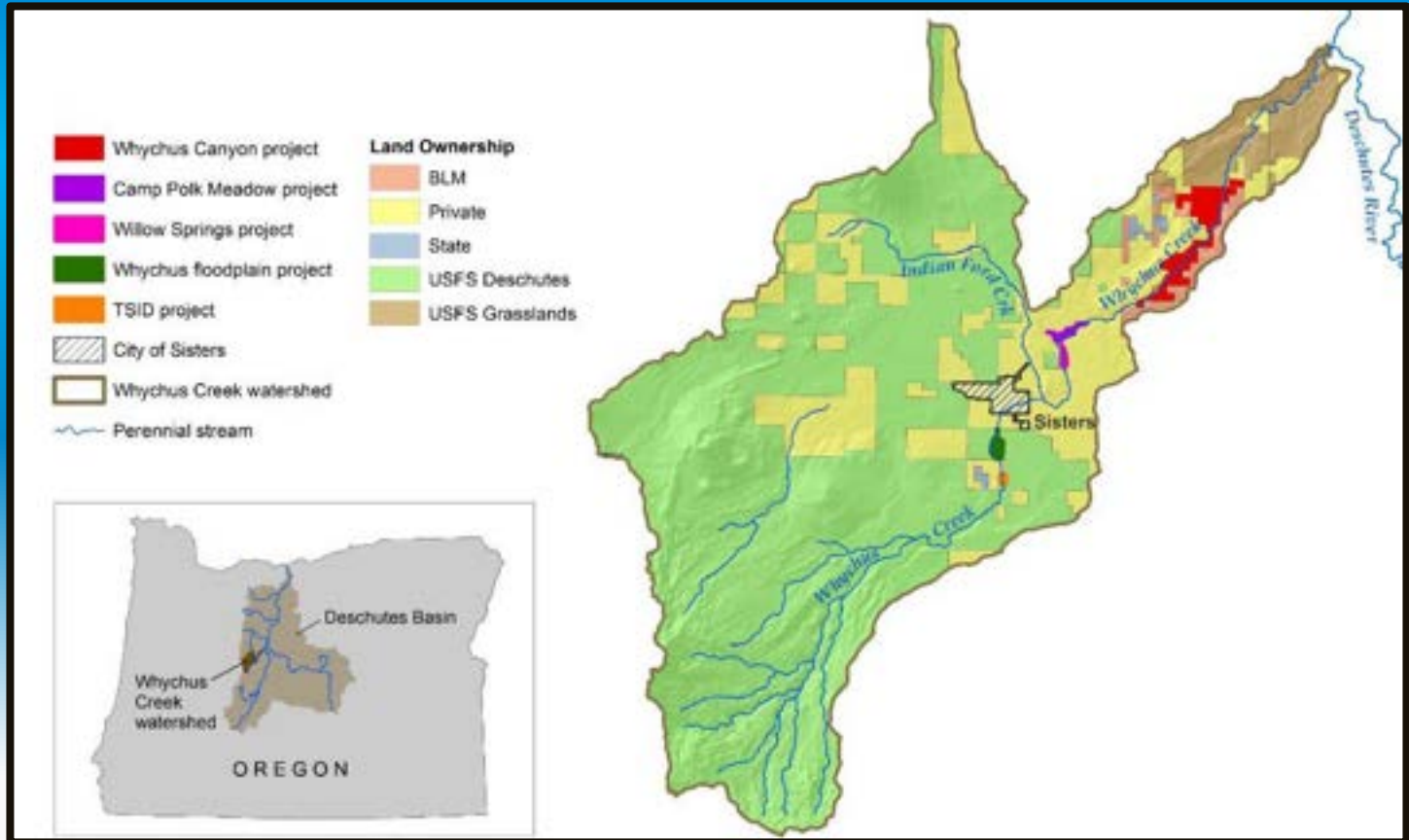


UPPER DESCHUTES
WATERSHED COUNCIL

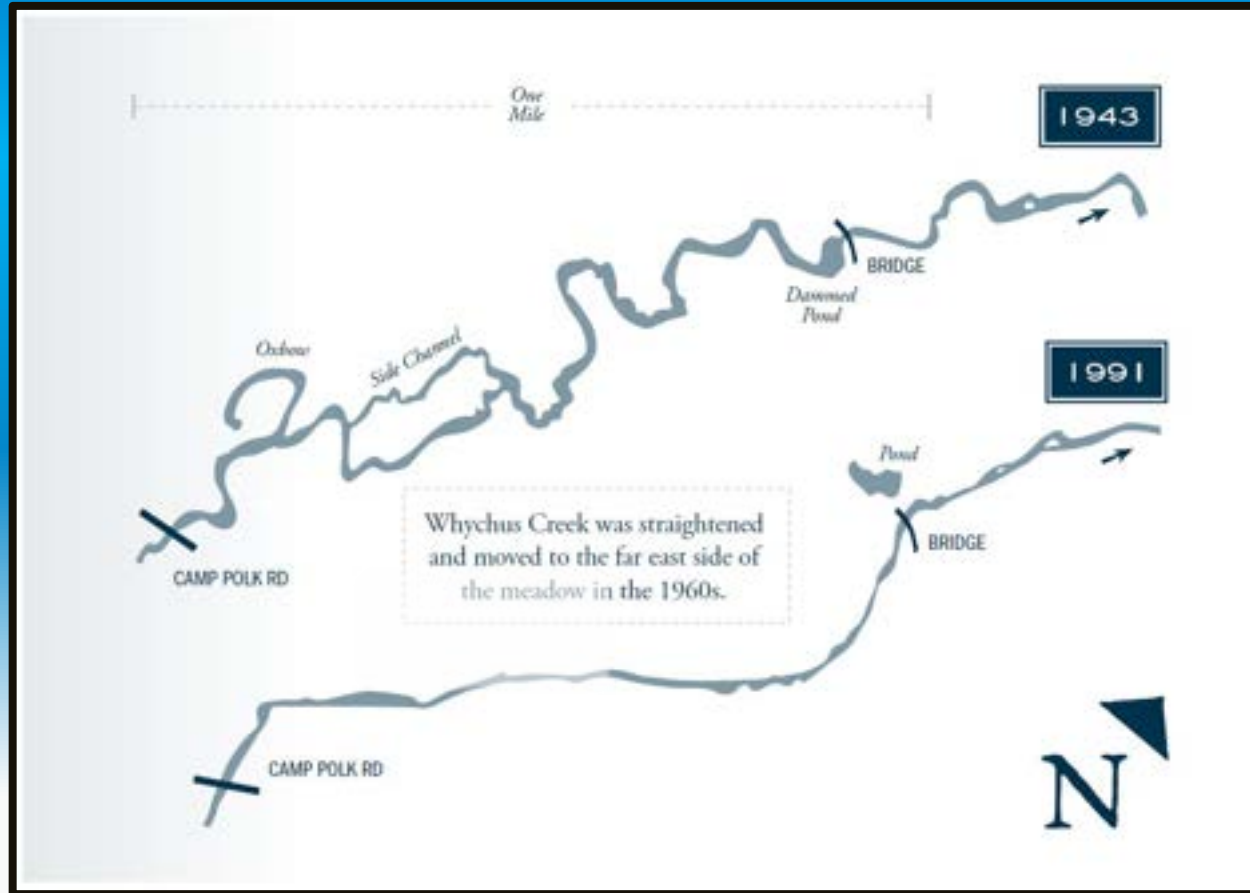




Whychus Creek Watershed

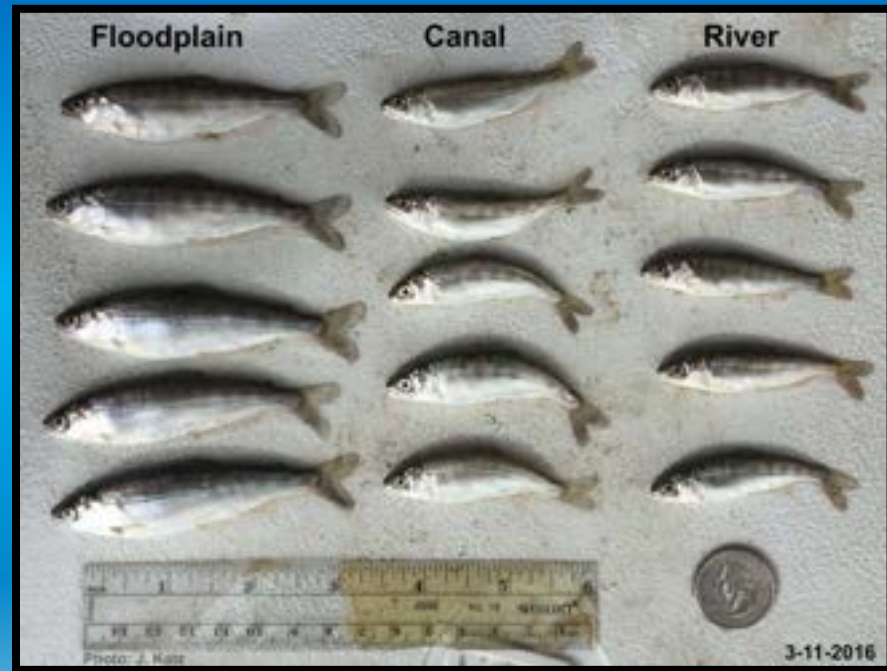


Habitat Restoration



Why does this matter?





Productive habitat

Restoration Approaches





Whychus Canyon Preserve



Whychus Canyon Preserve



Pre-restoration (July 2016)



Post-restoration (October 2016)

Jay Mather – Deschutes Land Trust



Three years post-restoration (July 2019)



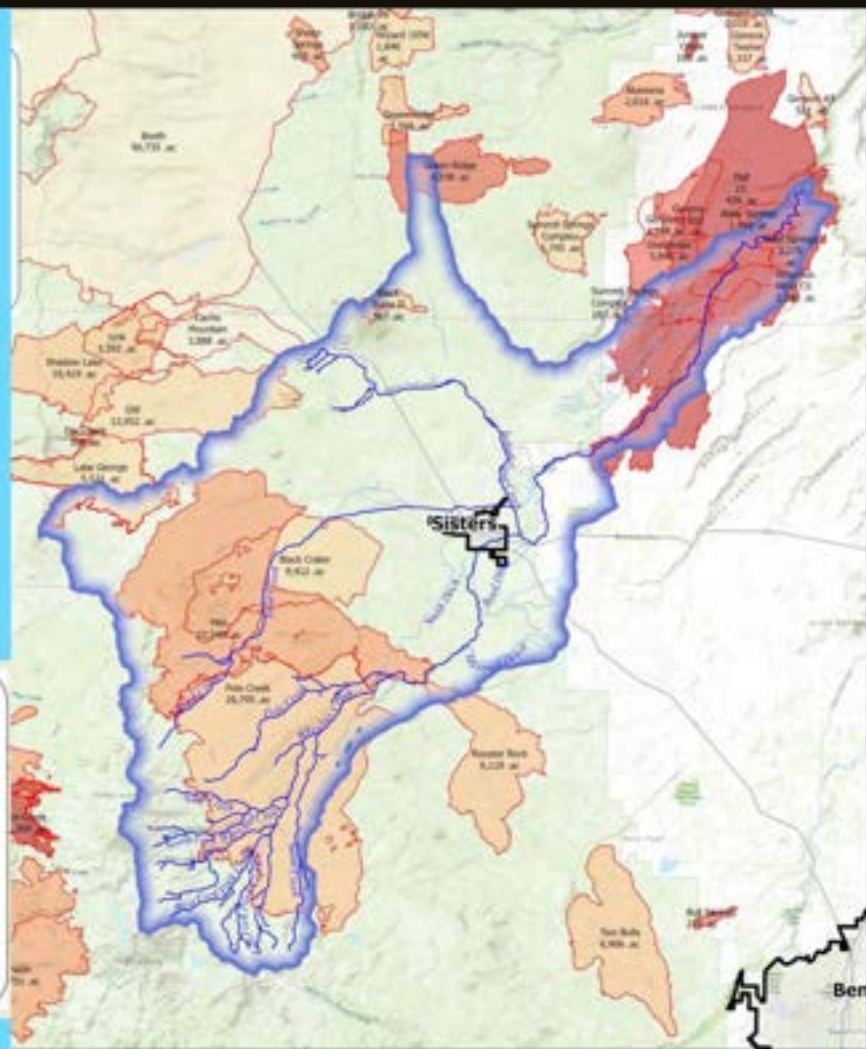
Photo Credit: Joe Wheaton

Whychus Watershed Fire History since 2000

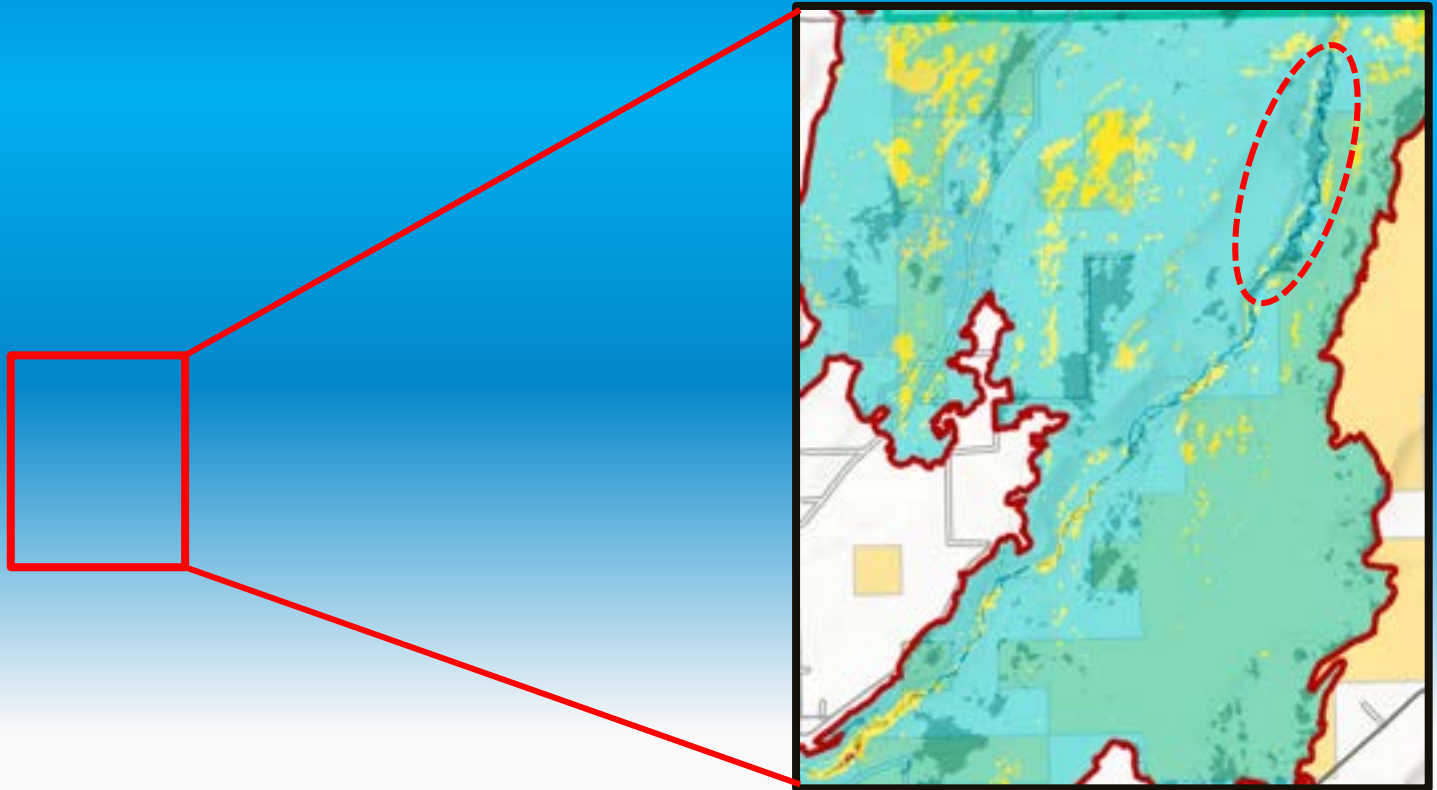
- 15 Wildfires
- 81,215 acres
- 49.28% burned

NWCC Fire History 2000-2025

FIRE_YEAR



2025 Flat Fire





Deschutes Land Trust– Rimrock Ranch



Deschutes Land Trust Whychus Canyon Preserve



Upper Deschutes Watershed Council - Deschutes Land Trust Whychus Canyon Preserve



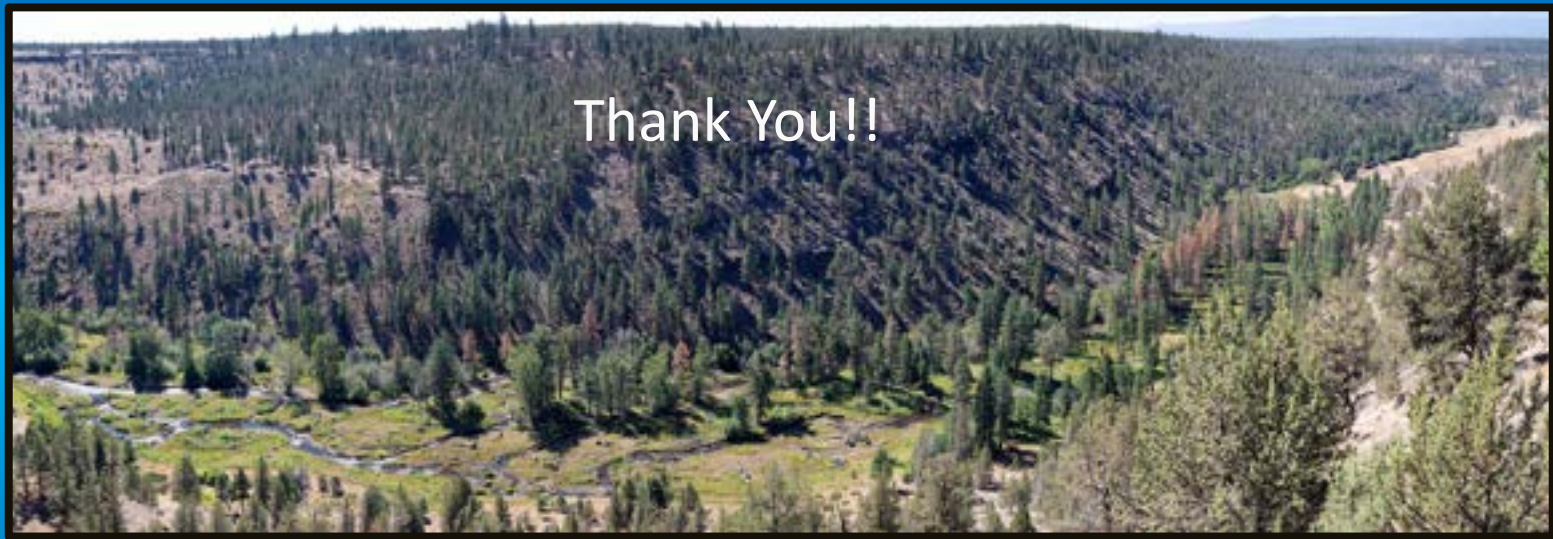




Deschutes Land Trust– Whychus Canyon Preserve

December 19th 2025 Flood





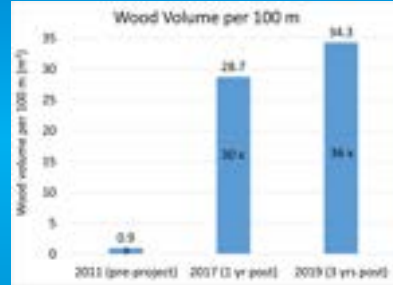
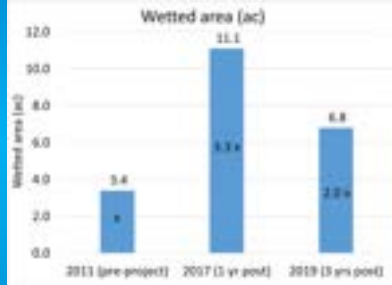
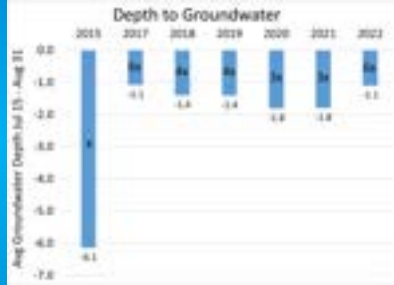
Thank You!!



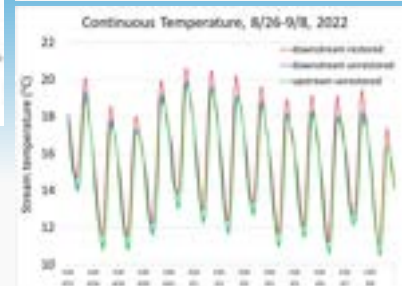
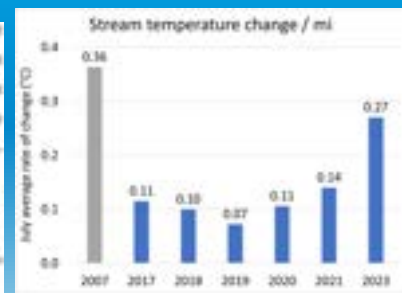
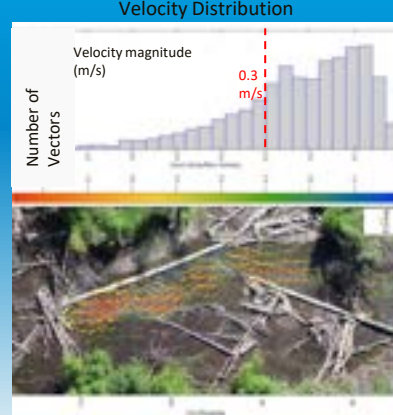
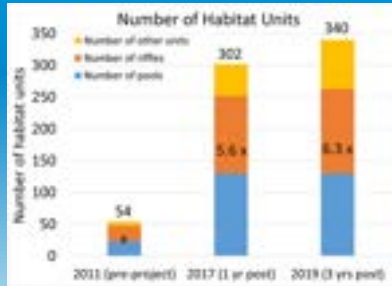
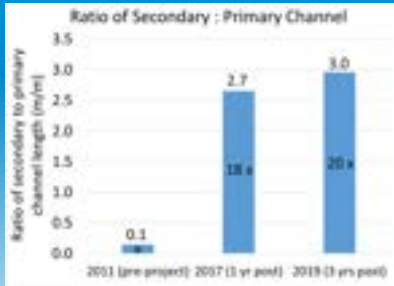
Stage 0 Stream Restoration Outcomes

Whychus Creek, Oregon

Connectivity: Storing; increasing amount of resources



Complexity: Increasing heterogeneity of resources



Biological response: *increased richness & productivity*

