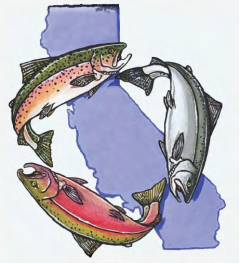
Fish & Fire 2025:
Where There are Fish, There is Fire

A Workshop at the 42nd Annual Salmonid Restoration Conference
Santa Cruz, California, April 29 - May 2, 2025

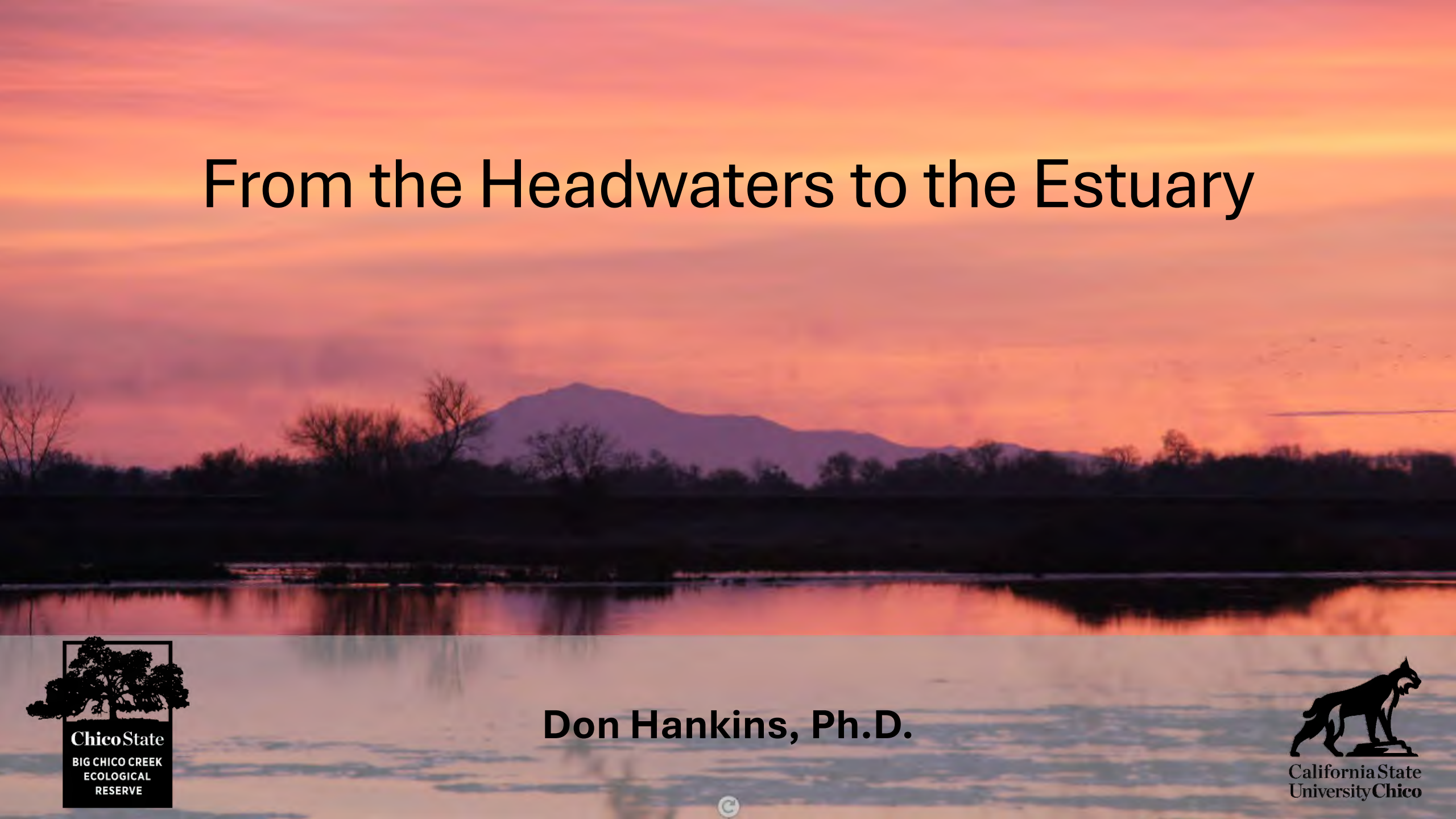
Session Coordinators: Lenya Quinn-Davidson, *University of California Agriculture and Natural Resource* and Josh Smith, *Watershed Research and Training Center*

2024 brought another major fire season to California, and more reminders of the interconnectedness across fire, water, and fish. Like so many fires before it, the Park Fire has daylighted several interesting intersections: the potential for high-severity fire in critical watersheds like Mill Creek (one of the last Central Valley strongholds for wild spring-run Chinook), the need for suppression activities and retardant drops to carefully consider fish habitat and infrastructure (like the fish hatchery in lower Battle Creek), and the reality that the same fire can be both damaging and restorative across the larger landscape, especially in a place that evolved with frequent fire. This workshop will continue the Fish & Fire conversation started over the last two years of SRF conferences, highlighting recent examples like the Park Fire and digging further into the ecology of fish and fire, the impacts of fire exclusion and fire suppression on aquatic habitats, and the potential for restoration practitioners to more meaningfully bring fire into the way they envision and implement their work. The first part of the workshop will focus on relevant research and management examples, and part two will be more hands-on, including dialogue and training on the use of beneficial fire. By the end of the day, participants will have a better understanding of the many connections between fish and fire, more contacts and networks to bridge the two disciplines, and new skills and inspiration that they can bring to their restoration work.

Presentations



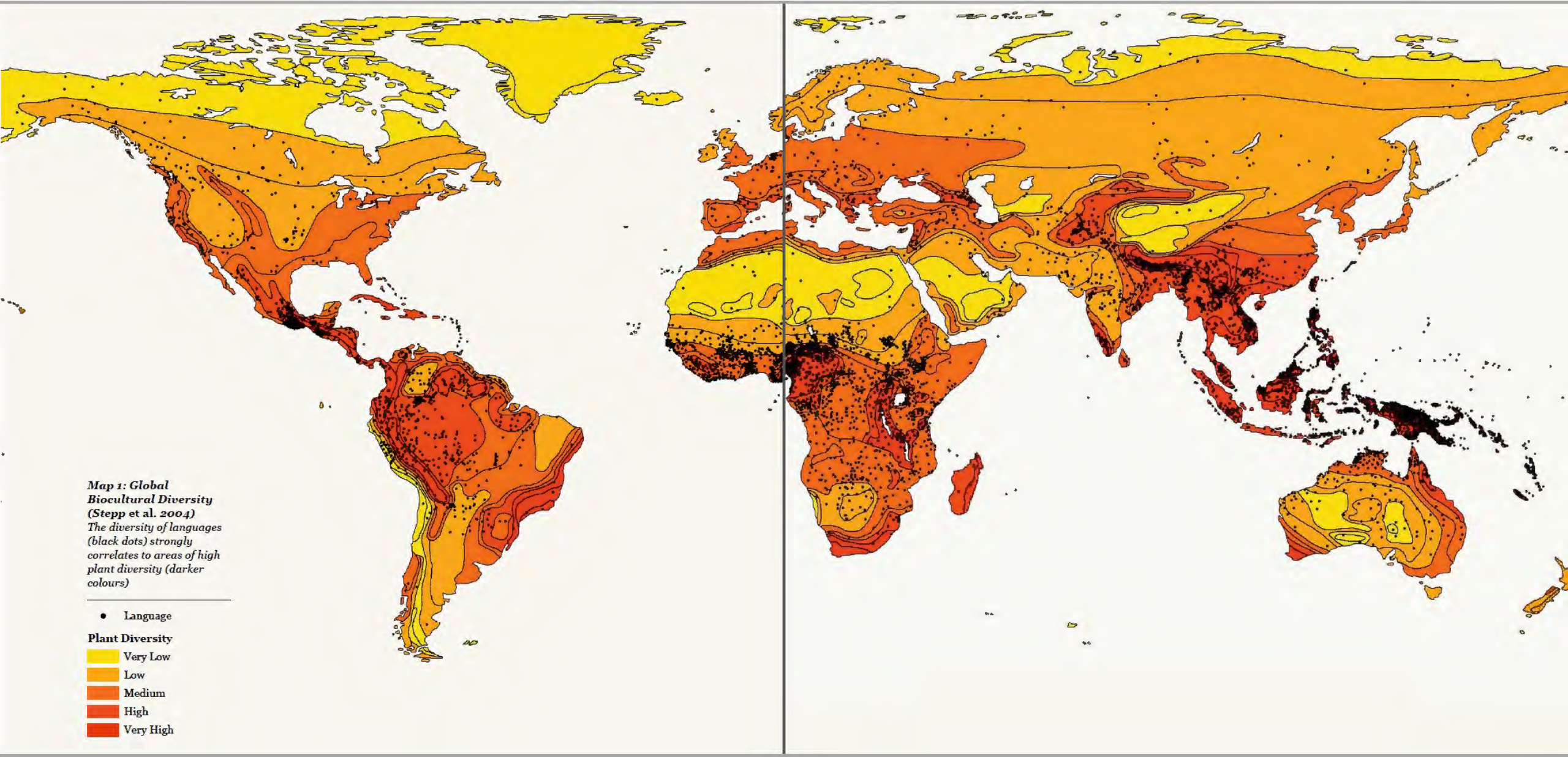
From the Headwaters to the Estuary



Don Hankins, Ph.D.

Chico State
BIG CHICO CREEK ECOLOGICAL RESERVE

California State University Chico



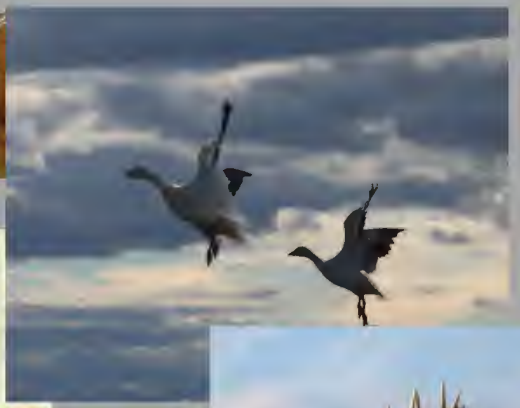
Loh and Harman 2014

The diversity of life has resulted from the diversification of species and the interactions that occur among them... (Thompson 1996)


?Ompin
?Annissumne?
Musupum
Cukumne?
Kinemsla?
Jacikumne?
Jlamne?
?Ocehamne?
Tiwajcumne?
Siakumne?
Walakumne?
Tulejumne?
?Olonapatme?
Hulpumne?
Pusunlumne?
Mokelumne?
Sakumne?
Kosomne?
Cillamne?
Lelamne?









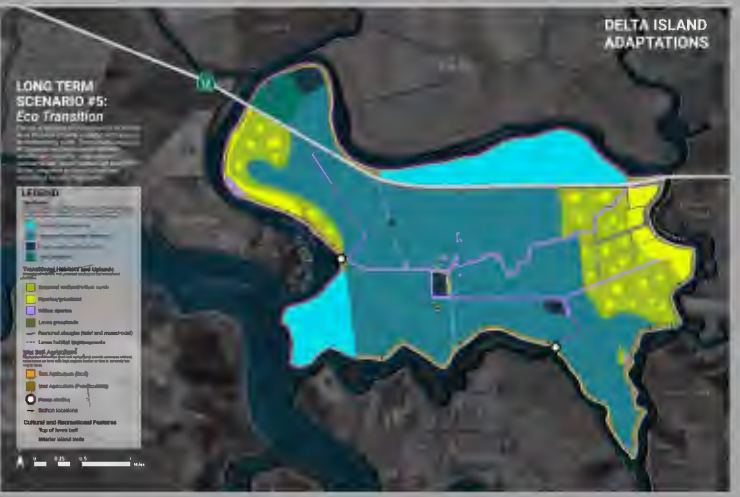




?Eleltek Wyke?


Deer Creek Highway
Deer Creek Highway
Deer Creek Highway

?Eleltek Kiik



Webb Tract Ecocultural

Historic landscape with ecocultural systems.

Legend

- Sandy loam
- Slough
- Transitional Dune
- Wetland & River Channel

Google Earth

Image © IABA

Image © SF Estuary Institute/Contra Costa County/USGS

N

mi


IST


Mercator Projection
WGS84
UTM Zone 10S
CALTOPO
0.5
1.0
1.5 km
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9 mi
Scale 1:10598
1 inch = 883 feet
MN
12.7°

Hankins *PNAS 2024*

Food webs of 10 lakes before and after a mega-wildfire

Christine A. Parisek [1,2]
Steve Sadro [3]
Andrew L. Rypel [1,2,4]

[1] UC Davis, Center for Watershed Sciences
[2] UC Davis, Wildlife, Fish, & Conservation Biology
[3] UC Davis, Environmental Science & Policy
[4] Auburn University, School of Fisheries, Aquaculture and Aquatic Sciences

caparisek.github.io
caparisek@ucdavis.edu

Food webs of 10 lakes before and after a mega-wildfire

Christine A. Parisek [1,2]
Steve Sadro [3]
Andrew L. Rypel [1,2,4]

[1] UC Davis, Center for Watershed Sciences
[2] UC Davis, Wildlife, Fish, & Conservation Biology
[3] UC Davis, Environmental Science & Policy
[4] Auburn University, School of Fisheries, Aquaculture and Aquatic Sciences

caparisek.github.io
caparisek@ucdavis.edu

Fire & Freshwater Ecosystems

- Fire is a natural, healthy, & necessary feature on many landscapes.
- Due to landscape mismanagement, unprecedented mega-wildfires are becoming increasingly common worldwide. (2019-20 Australian brushfire, 2019 & 2021 taiga forests in Siberia, 2022 France, 2022 Spain, 2022 Portugal, 2023 Chile)
- Direct effects of fire on streams is reasonably well-documented.
- How does **mega-fire disturbance** impact lakes, their ecology, and food web energy transfer?

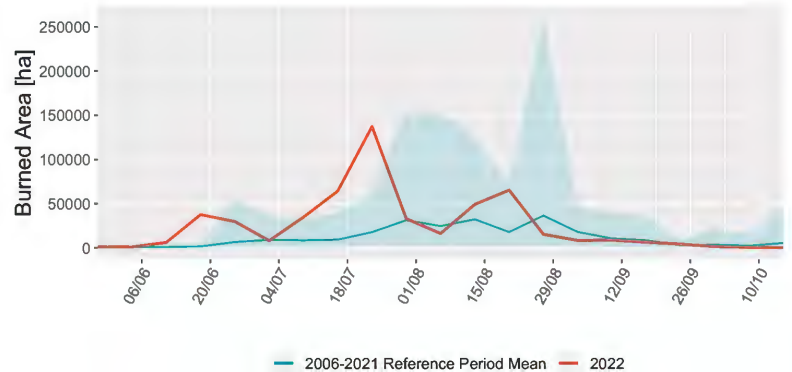
Lake Almanor, CA / Jaime Menendez 2022

In July and August 2022 significant fire events took place across Europe, especially in France, Portugal and Spain.

Published on
14 December 2022

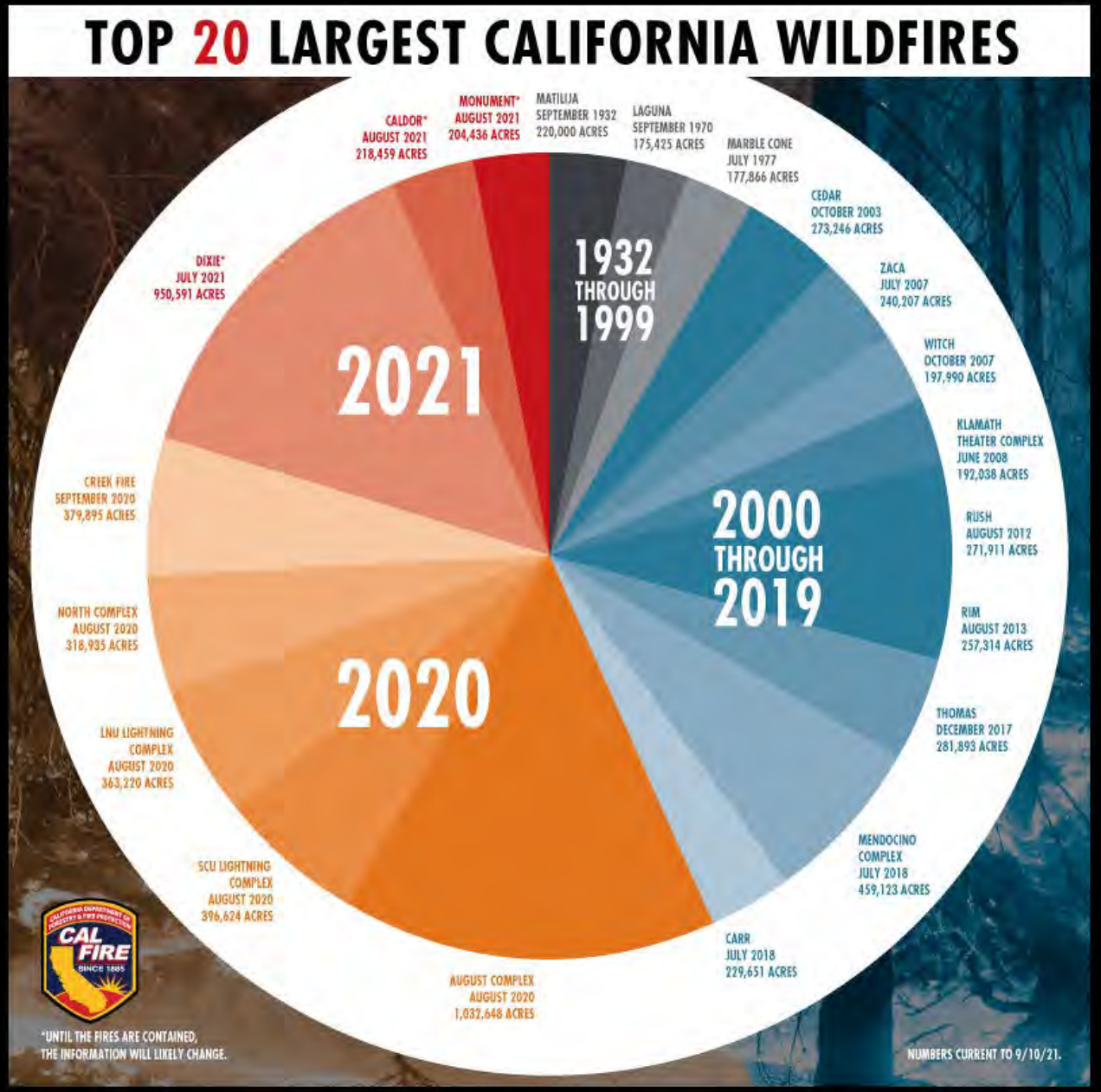
By Anu-Maija Sundström (FMI), Sabrina Szeto, Julia Wagemann and Federico Fierli

Wildfire season in Europe typically spans from early June to late September. Wildfires occur more frequently, and are more extensively, in southern parts of Europe, than in the north. The wildfire season in Summer 2022 was exceptional, in terms of number of fires observed, extent of burned area (Figure 1), as well as high fire-related atmospheric emissions. According to The European Forest Fire Information System (EFFIS), from early June to mid August 2022 the number of detected fires in Europe was higher than the long term average of 2006-2021 and higher than the earlier maximum values since the start of the EFFIS data record in 2006.

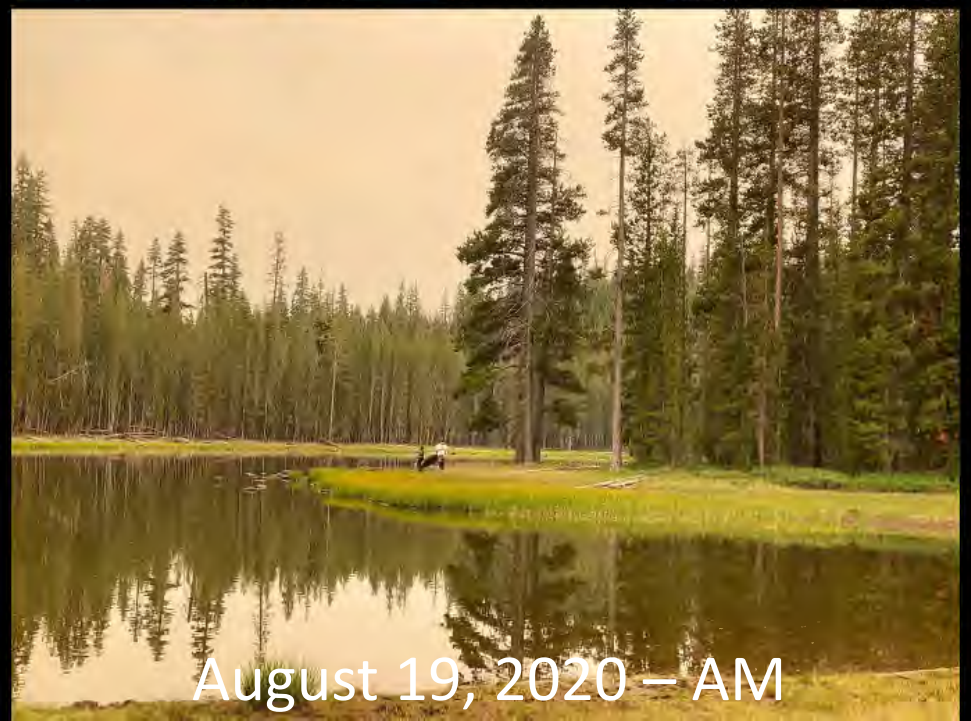


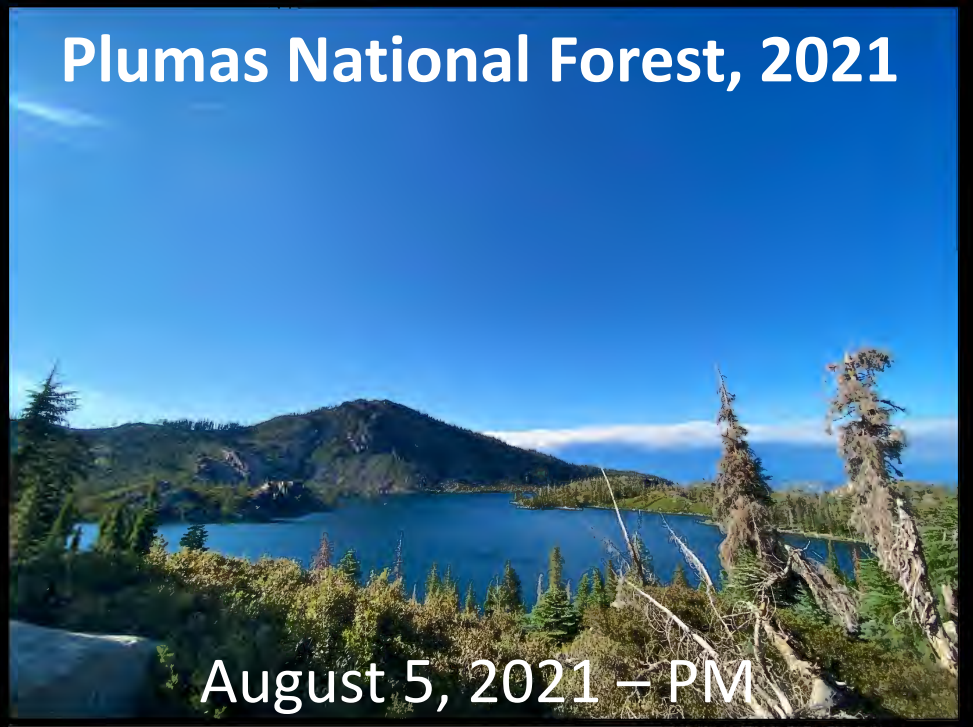
Recent surges in wildfire

- Surge in climate-driven wildfires across Pacific West of North America.
- 7 largest wildfires in CA occurred within the last 6 years.
- Mega-fires cause unprecedented disturbance effects to ecosystems.




Lassen National Forest, 2020
August 18, 2020 – PM


August 19, 2020 – AM


Plumas National Forest, 2021
August 5, 2021 – PM


August 6, 2021 – AM

Do lakes feel the burn?

Received: 26 September 2018 | Revised: 3 April 2019 | Accepted: 27 April 2019

DOI: 10.1111/gcb.14732

RESEARCH REVIEW

Global Change Biology WILEY

Do lakes feel the burn? Ecological consequences of increasing exposure of lakes to fire in the continental United States

Ian M. McCullough[1] | Kendra Spence Cheruvelil[1,2] | Jean-François Lapierre[3] | Noah R. Lottig[4] | Max A. Moritz[5,6] | Jemma Stachelek[1] | Patricia A. Soranno[1]

[1]Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan

[2]Lyman Briggs College, Michigan State University, East Lansing, Michigan

[3]Département de Sciences Biologiques, Université de Montréal, Montréal, QC, Canada

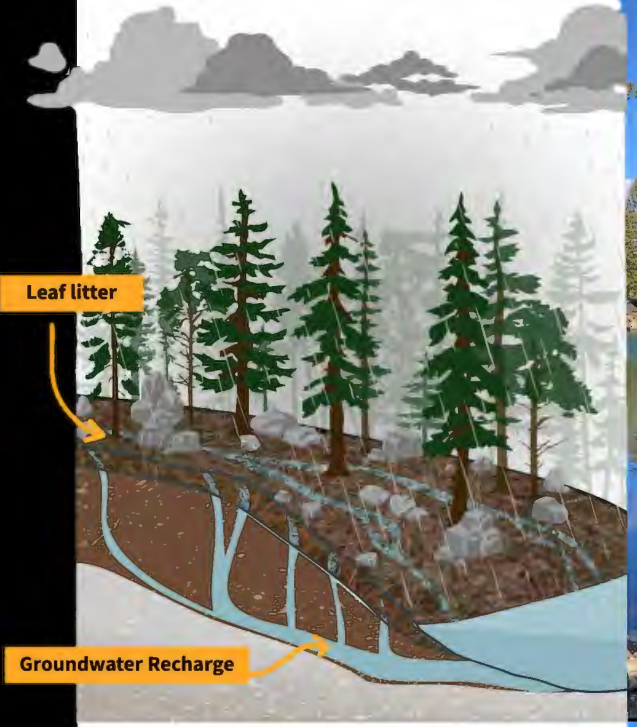
[4]Trout Lake Station, University of Wisconsin–Madison, Boulder Junction, Wisconsin

[5]Bren School of Environmental Science & Management, University of California Santa Barbara, Santa Barbara, California

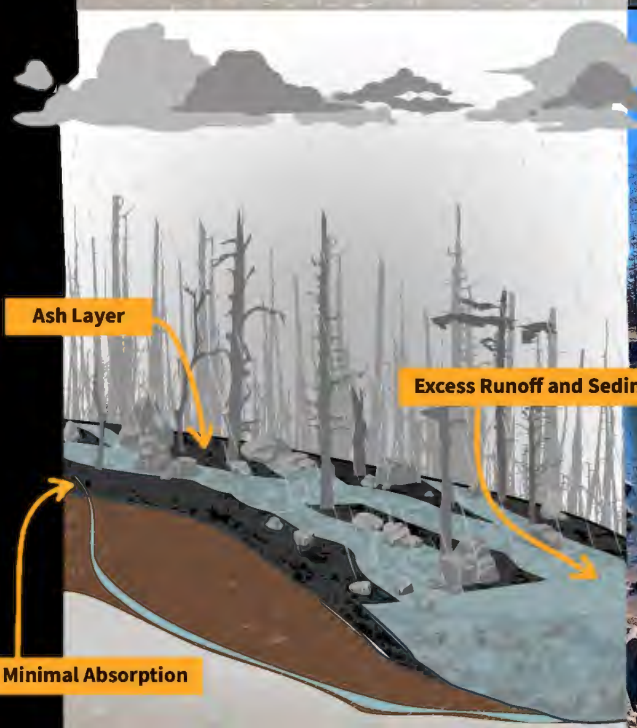
[6]University of California Cooperative

Abstract

Wildfires are becoming larger and more frequent across much of the United States due to anthropogenic climate change. No studies, however, have assessed fire prevalence in lake watersheds at broad spatial and temporal scales, and thus it is unknown whether wildfires threaten lakes and reservoirs (hereafter, lakes) of the United States. We show that fire activity has increased in lake watersheds across the continental United States from 1984 to 2015, particularly since 2005. Lakes have experienced the greatest fire activity in the western United States, Southern Great Plains, and Florida. Despite over 30 years of increasing fire exposure, fire effects on fresh waters have not been well studied; previous research has generally focused on streams, and most of the limited lake-fire research has been conducted in boreal landscapes. We


Leaf litter
Groundwater Recharge

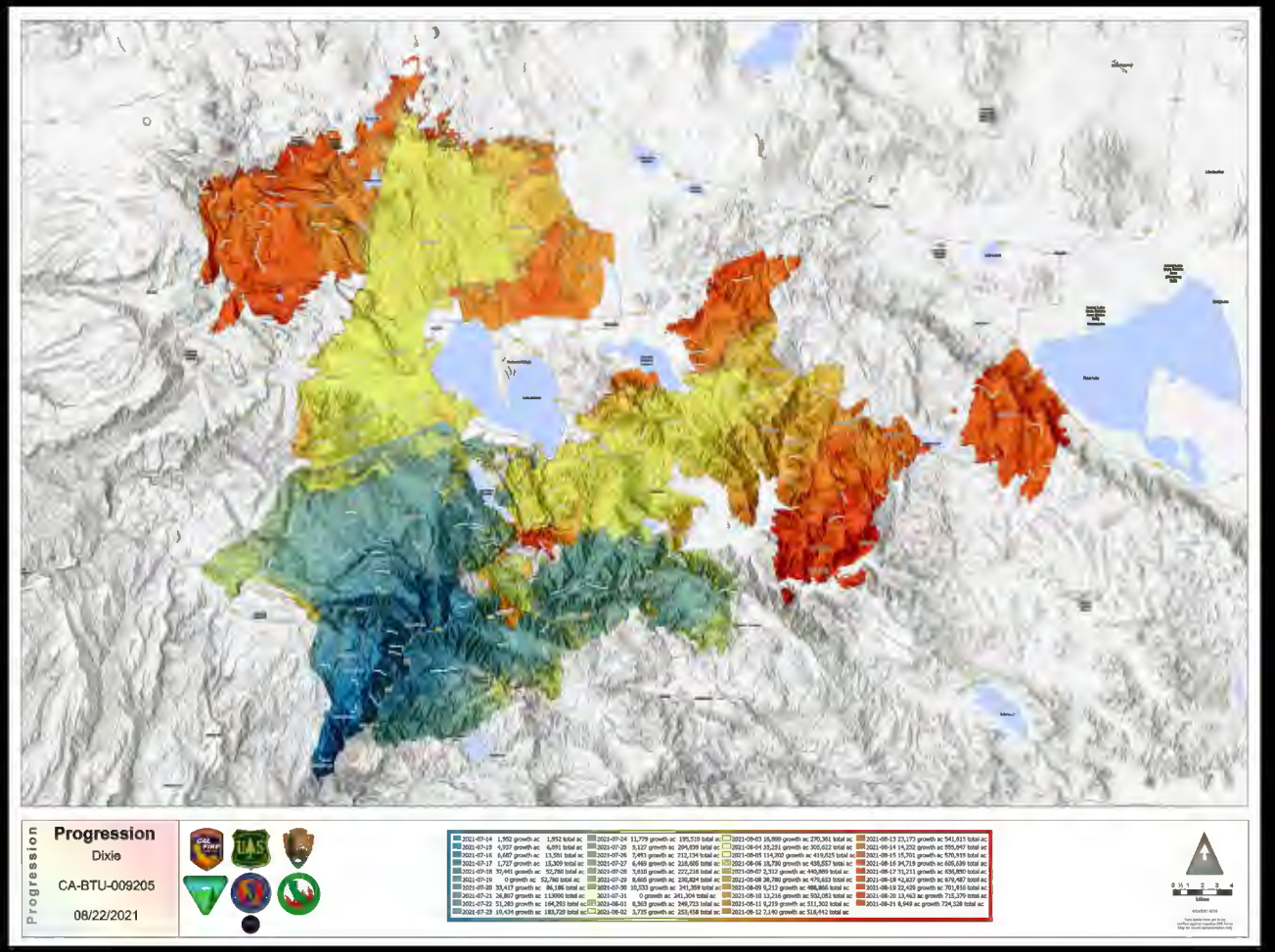

Pre-Fire Emerald Lake


Ash Layer
Excess Runoff and Sediment
Minimal Absorption


Post-Fire Emerald Lake

Dixie Fire, California (2021)

- Largest single-source wildfire in CA on historic record.
- Burned ~1M acres in Northern California (July–October)
- Burned ~70% of Lassen National Park
- Rare autumn storm put out the fire (7–42 cm rain <48 hr)

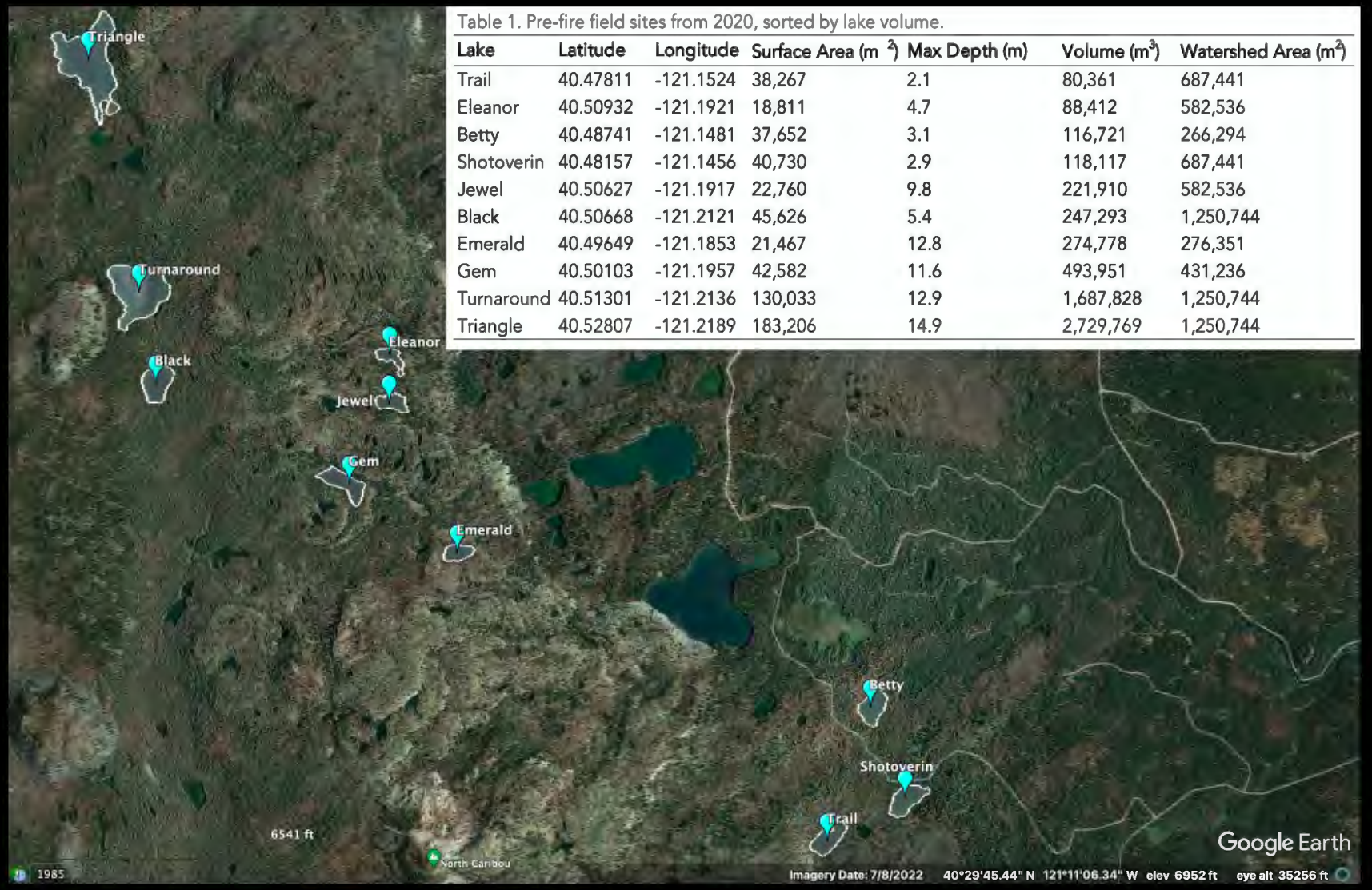


Caribou Wilderness, Lassen National Forest

- Pre-fire food webs
- 10 lakes
- Various lake sizes, watershed sizes, & burn severity

Table 1. Pre-fire field sites from 2020, sorted by lake volume.

Lake	Latitude	Longitude	Surface Area (m^2)	Max Depth (m)	Volume (m^3)	Watershed Area (m^2)
Trail	40.47811	-121.1524	38,267	2.1	80,361	687,441
Eleanor	40.50932	-121.1921	18,811	4.7	88,412	582,536
Betty	40.48741	-121.1481	37,652	3.1	116,721	266,294
Shotoverin	40.48157	-121.1456	40,730	2.9	118,117	687,441
Jewel	40.50627	-121.1917	22,760	9.8	221,910	582,536
Black	40.50668	-121.2121	45,626	5.4	247,293	1,250,744
Emerald	40.49649	-121.1853	21,467	12.8	274,778	276,351
Gem	40.50103	-121.1957	42,582	11.6	493,951	431,236
Turnaround	40.51301	-121.2136	130,033	12.9	1,687,828	1,250,744
Triangle	40.52807	-121.2189	183,206	14.9	2,729,769	1,250,744



Trophic cascades can have long-term effects

Freshwater Biology

Freshwater Biology (2011) **56**, 828–838 doi:10.1111/j.1365-2427.2010.02529.x

Indirect effects of introduced trout on Cascades frogs (*Rana cascadae*) via shared aquatic prey

MAXWELL B. JOSEPH*, JONAH PIOVIA-SCOTT†, SHARON P. LAWLER* AND KAREN L. POPE‡

*Department of Entomology, University of California, Davis, CA, U.S.A.
†Center for Population Biology, University of California, Davis, CA, U.S.A.
‡USDA Forest Service, Pacific Southwest Research Station, Arcata, CA, U.S.A.

Ecosystems (2001) 4: 275–278
DOI: 10.1007/s10021-001-0009-0

ECOSYSTEMS

FISH STOCKING IMPACTS TO MOUNTAIN LAKE ECOSYSTEMS

The Introduction of Nonnative Fish into Wilderness Lakes: Good Intentions, Conflicting Mandates, and Unintended Consequences

Roland A. Knapp,*[1] Paul Stephen Corn,[2] and Daniel E. Schindler[3]

[1]Sierra Nevada Aquatic Research Laboratory, University of California, Star Route 1, Box 198, Mammoth Lakes, California 93546, USA; [2]US Geological Survey, Northern Rocky Mountain Science Center, Aldo Leopold Wilderness Research Institute, P.O. Box 8089, Missoula, Montana 59807, USA; and [3]Department of Zoology, University of Washington, Box 351800, Seattle, Washington 98195-1800, USA

Indirect effects of fish on macrophytes in Bays Mountain Lake: evidence for a littoral trophic cascade

T.H. Martin[1,*], L.B. Crowder[1], C.F. Dumas[1], and J.M. Burkholder[2]

[1] Department of Zoology, [2] Department of Botany, North Carolina State University, Raleigh, NC 27695, USA

Ecology, 91(8), 2010, pp. 2406–2415

Nonnative trout impact an alpine-nesting bird by altering aquatic-insect subsidies

PETER N. EPANCHIN,[1,3] ROLAND A. KNAPP,[2] AND SHARON P. LAWLER[1]

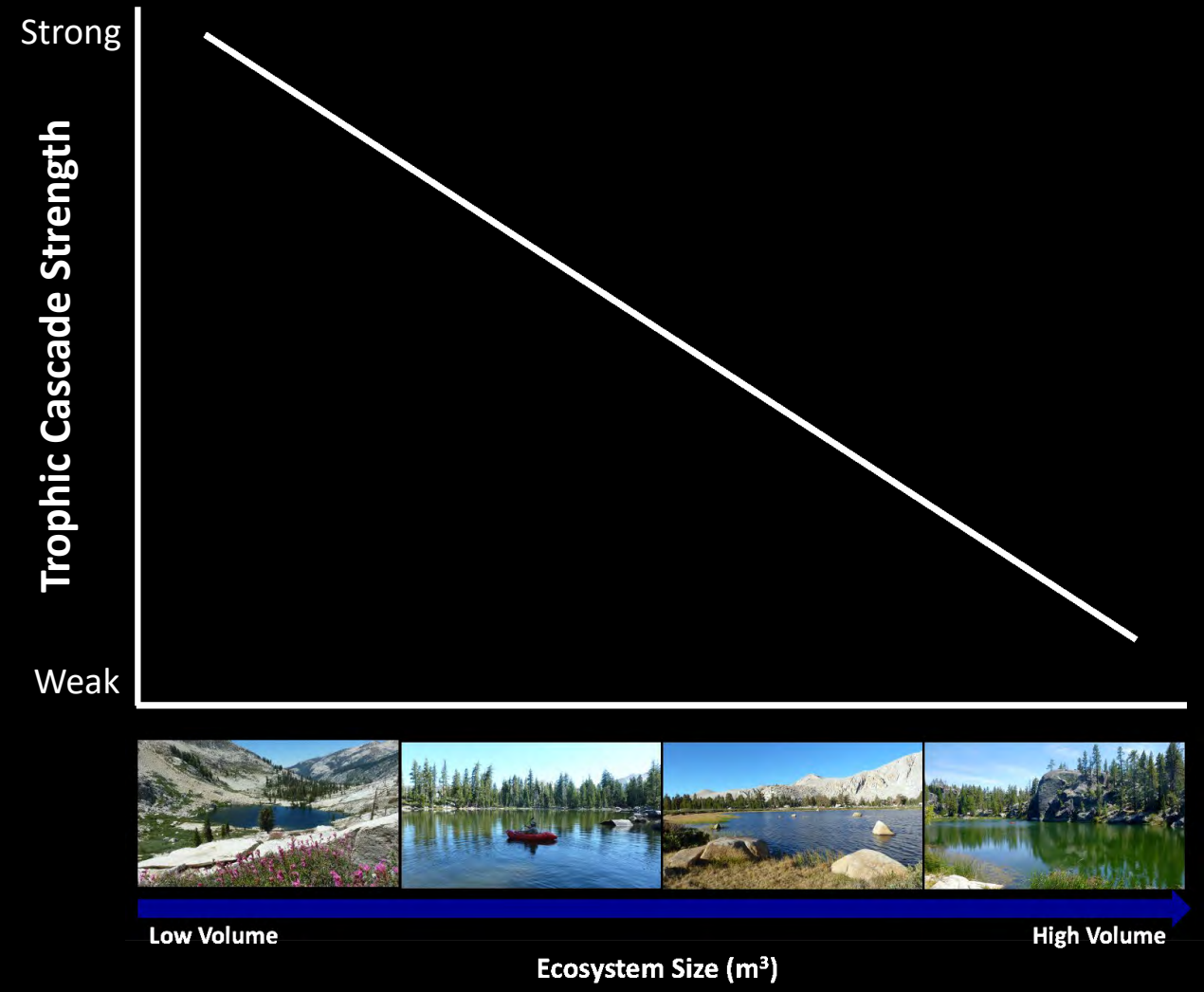
[1]*Graduate Group in Ecology, Department of Entomology, University of California, Davis, One Shields Avenue, Davis, California 95616 USA*
[2]*Sierra Nevada Aquatic Research Laboratory, University of California, HCR 79, Box 198, Mammoth Lakes, California 93546 USA*

Question 1:
Are fishes eradicated in lakes following mega-wildfires?

- Hypothesis: Fish will be eradicated in small lakes, but not in larger lakes where they will be reduced in abundance but persist overall. Likely due to runoff and oxygen depletion.

Question 2: Does trophic cascade strength vary with ecosystem size?

- Hypothesis: Fish reductions will generate trophic cascades, the strength of which will vary by intensity of fish reduction.



Question 3: How does lake food web structure and function shift following intense watershed burning?

- Hypothesis: Fire-driven loss of fishes will truncate & contract food webs, leading to fundamental change in populations & communities.

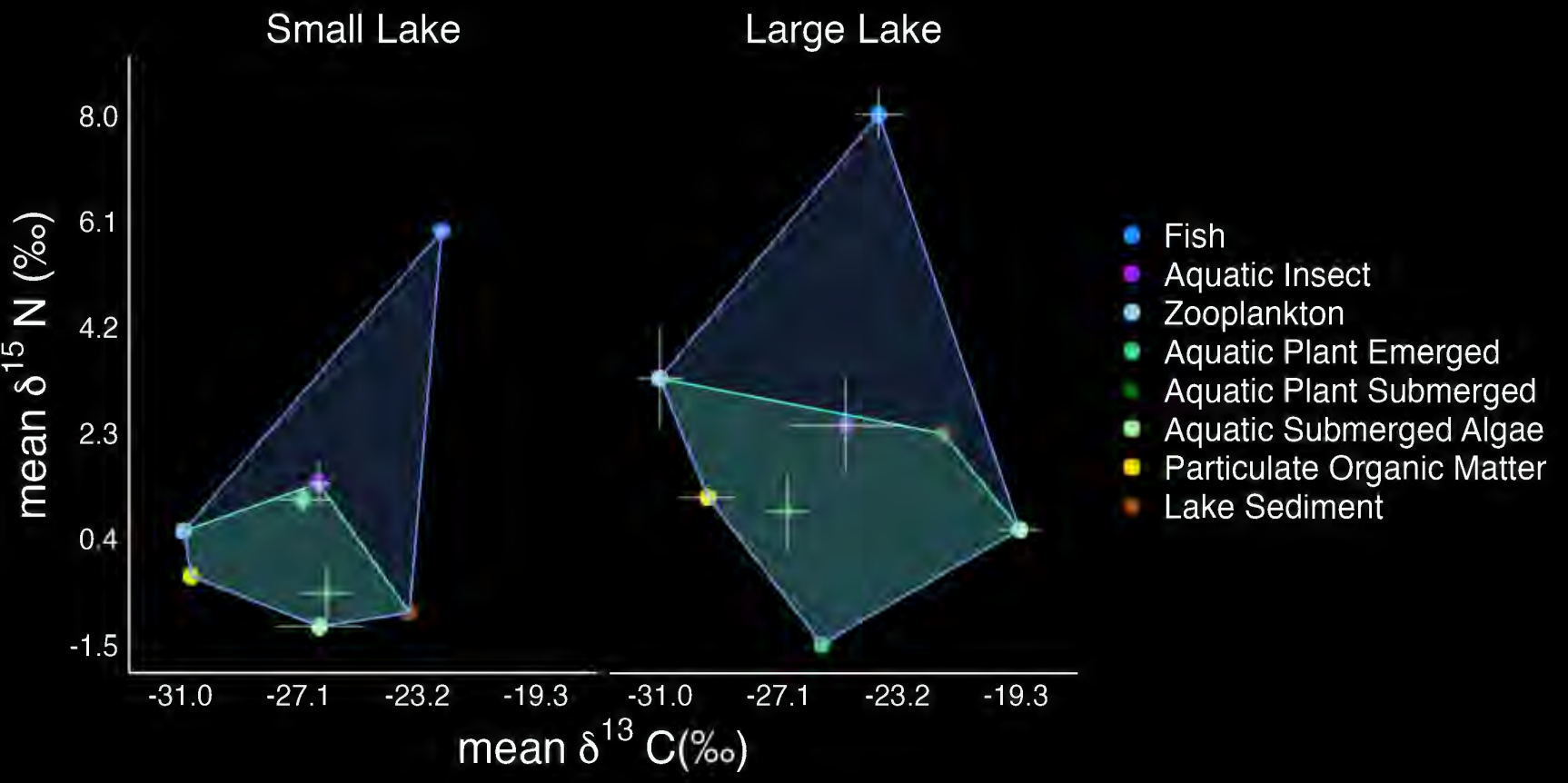


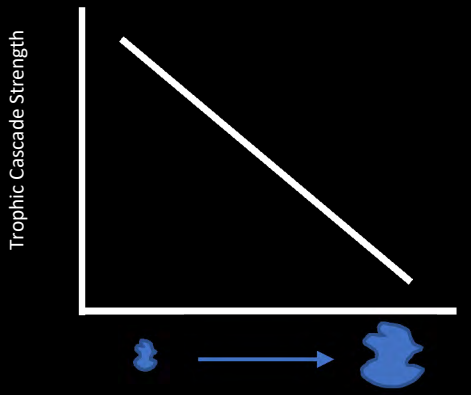
Figure 1. Mean d13C–d15N +/- 1 SE biplot for a representative large and small lake, illustrating pre-fire food web structure (with fish) in a blue polygon and hypothesized post-fire changes to food web structure (without fish, assuming no other changes) in a teal polygon.

Field Data Collection

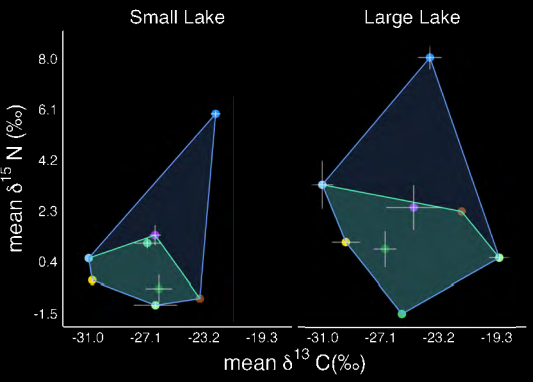
Methods & Analyses

- Q1 – Are fishes eradicated in lakes following mega-wildfires?
  - Quantify impact of overwinter anoxia & changes to fisheries abundance using experimental gill nets to compare **catch per unit effort (CPUE)**

- Q2 – Does trophic cascade strength vary with ecosystem size?
  - Evaluate **response ratios** to quantify trophic cascade effect size
  - Mixed effect Bayesian models and GAMs to statistically test ratios

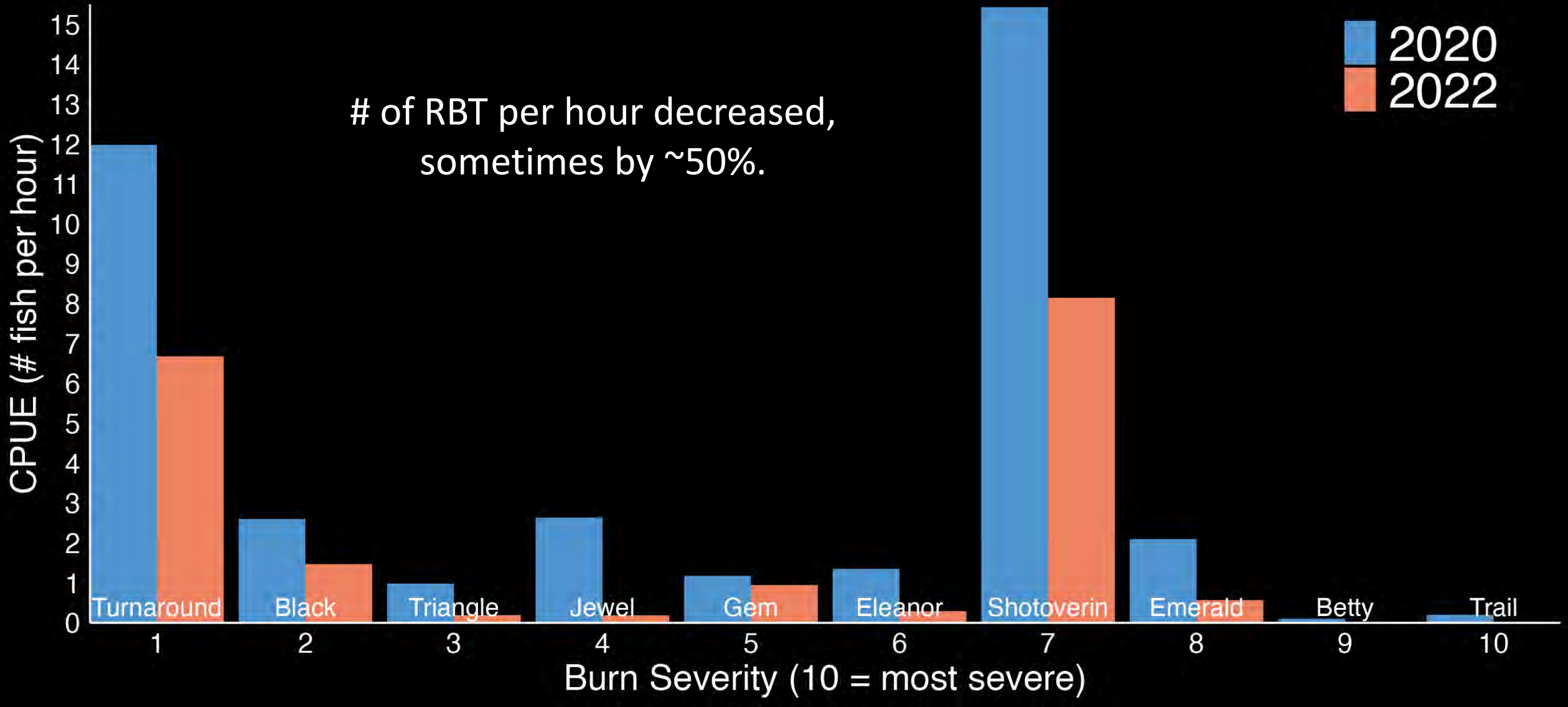


- Q3 – How do food webs shift after intense watershed burning?
  - Food web sampling for nitrogen ($\delta^{15}N$) & carbon ($\delta^{13}C$) **isotopes**
  - Deploy temperature & oxygen moorings; vertical profiles



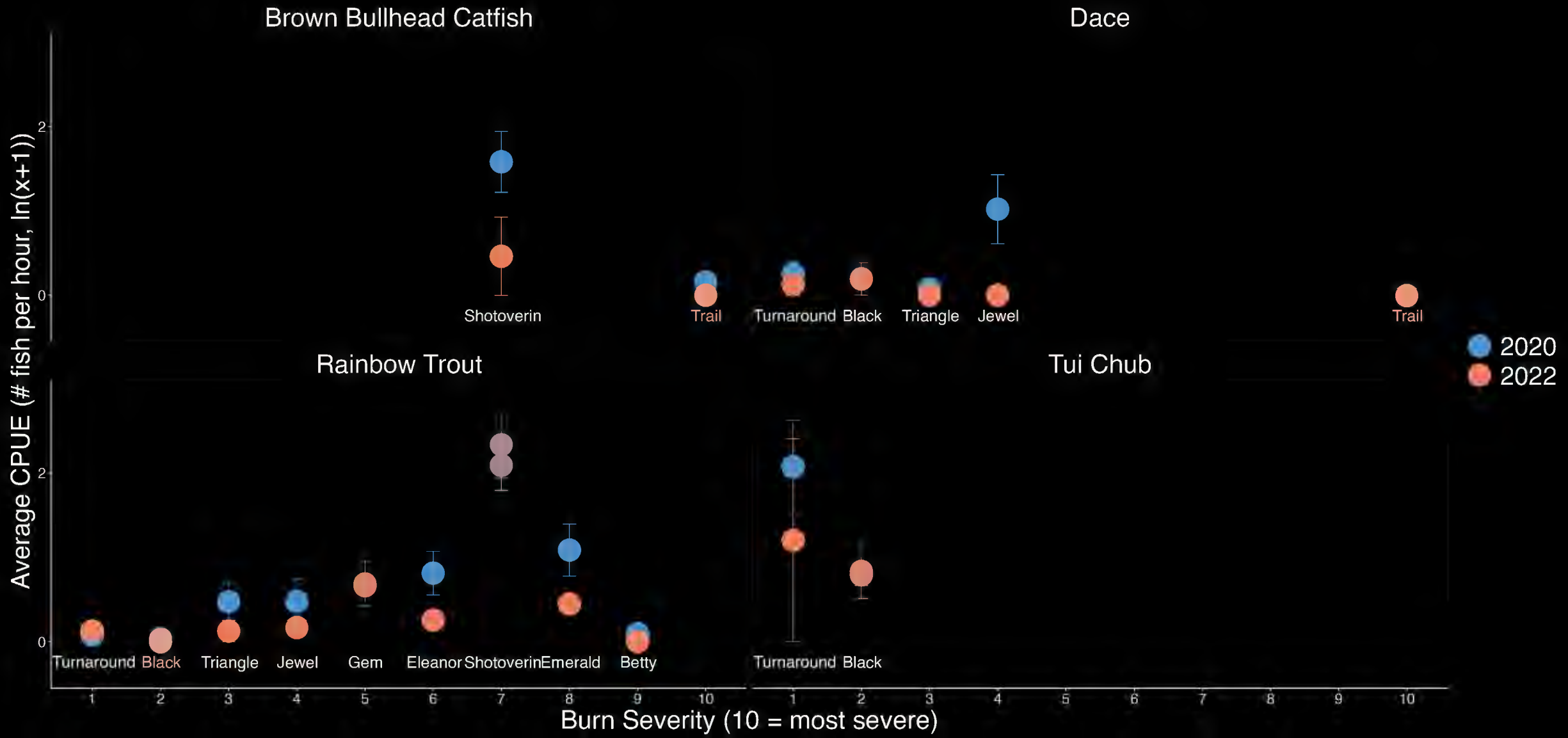
Preliminary Results

Q1 – Are fishes eradicated in lakes following mega-wildfires?



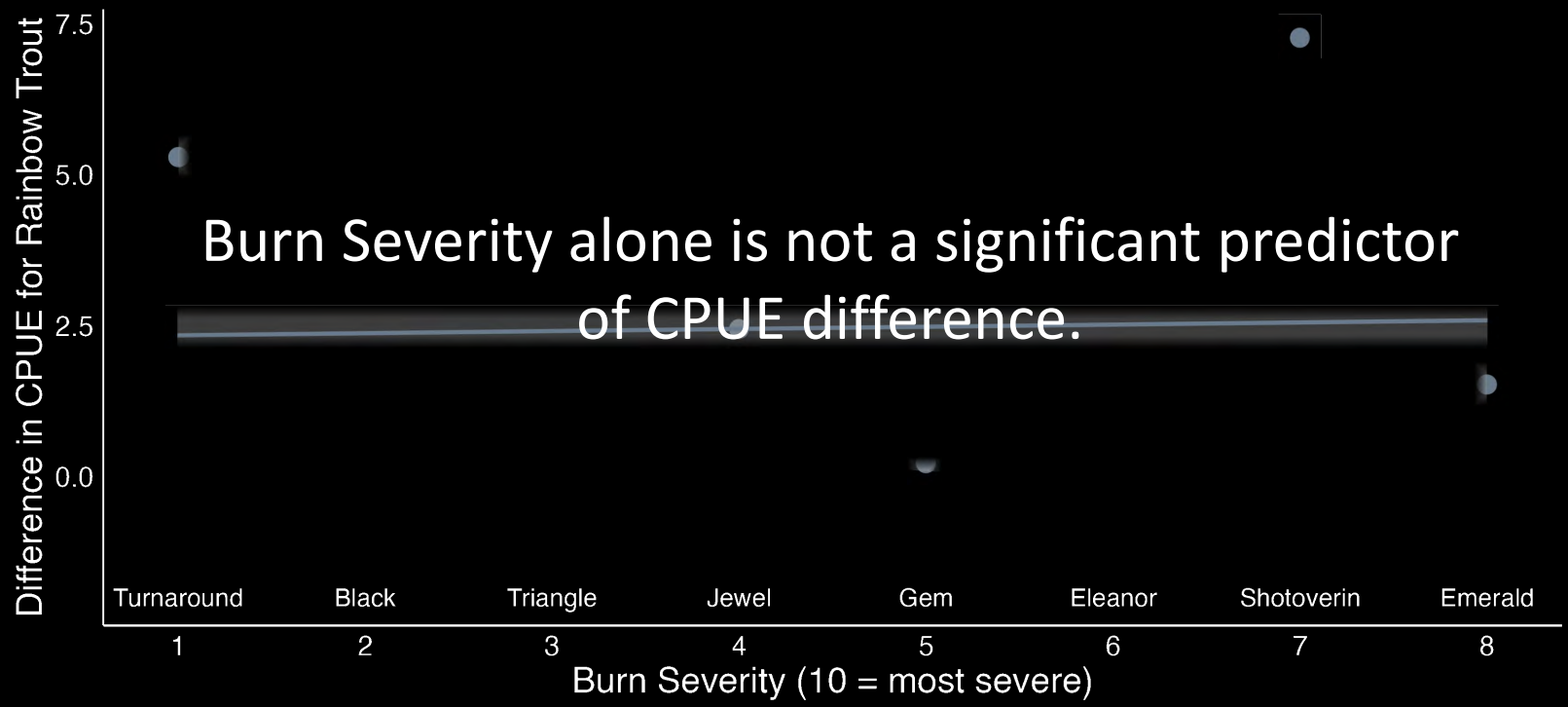
Preliminary Results

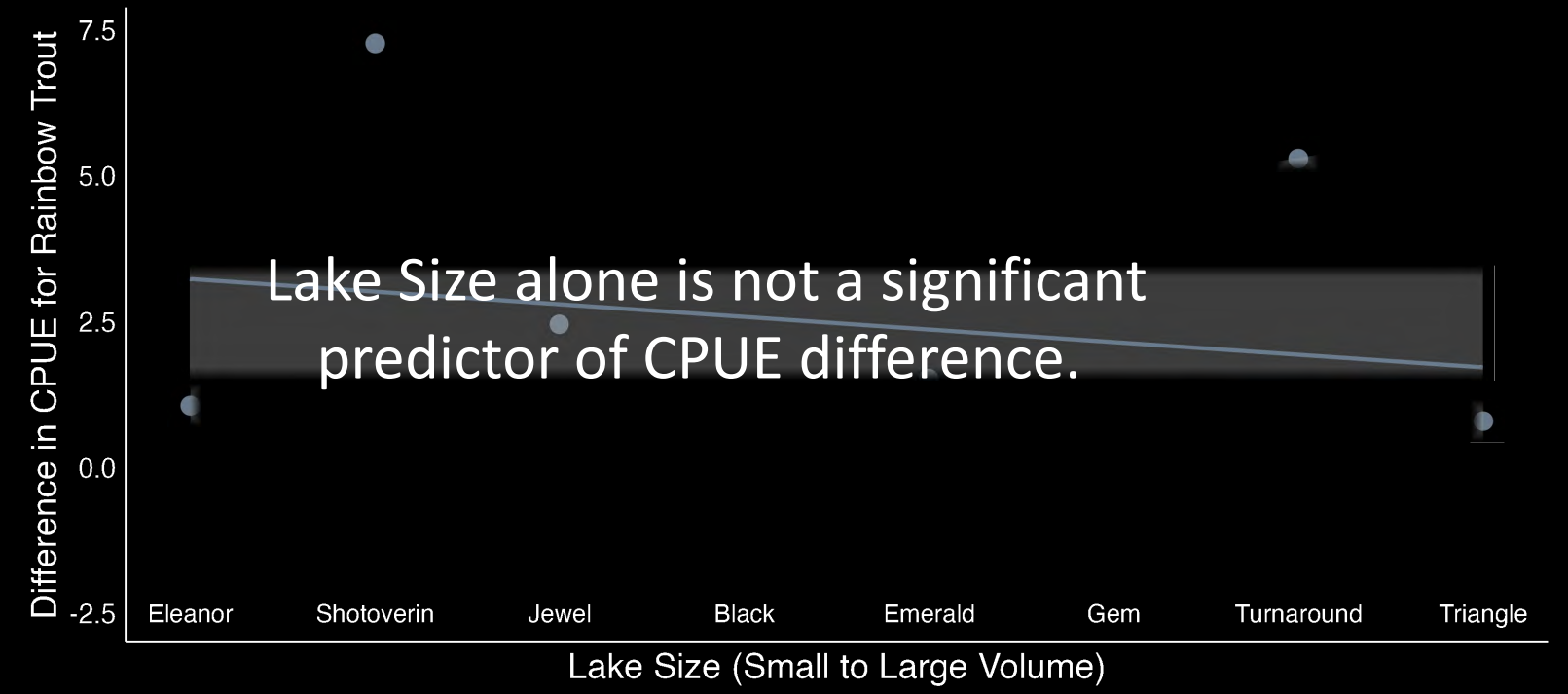
Q1 – Are fishes eradicated in lakes following mega-wildfires?



Preliminary Results

Q1 – Are fishes eradicated in lakes following mega-wildfires?

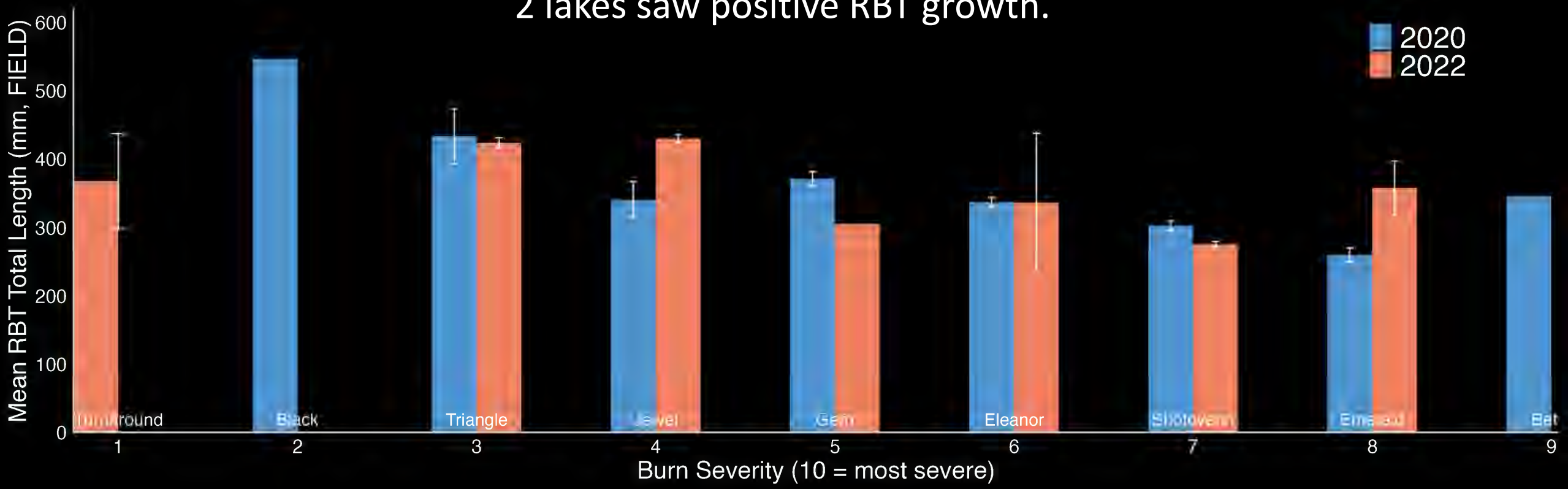




Preliminary Results

Q1 – Are fishes eradicated in lakes following mega-wildfires?

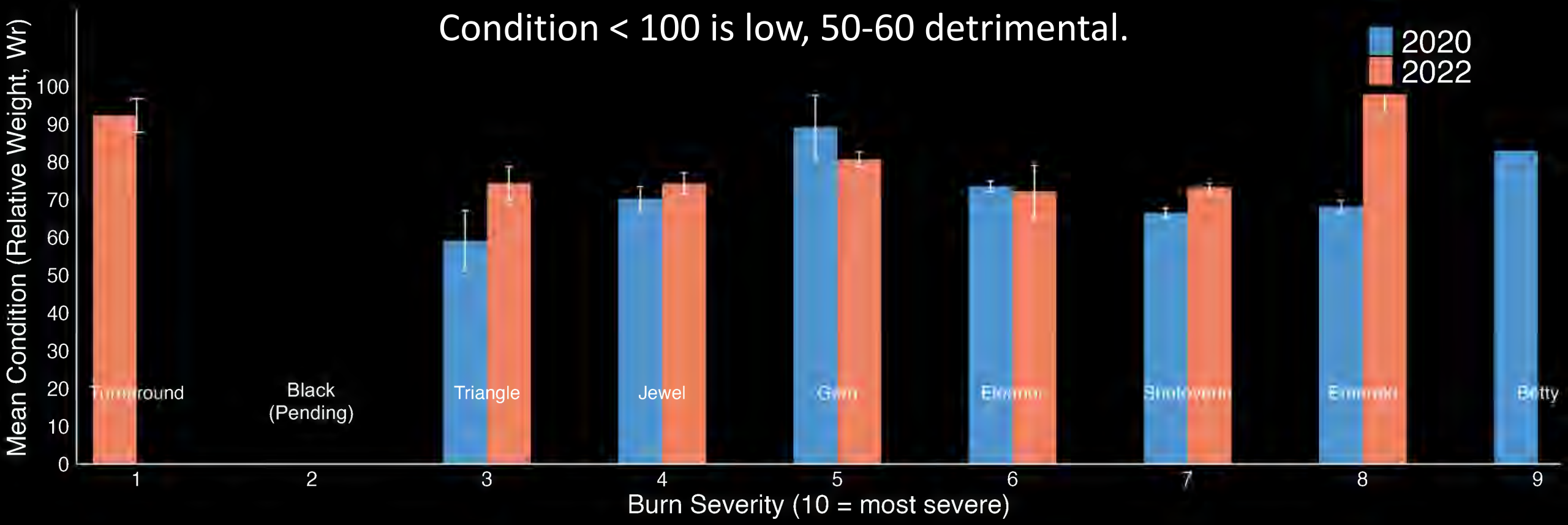
4 lakes saw RBT *Total Length* decline or remain consistent.
2 lakes saw positive RBT growth.



Preliminary Results

Q1 – Are fishes eradicated in lakes following mega-wildfires?

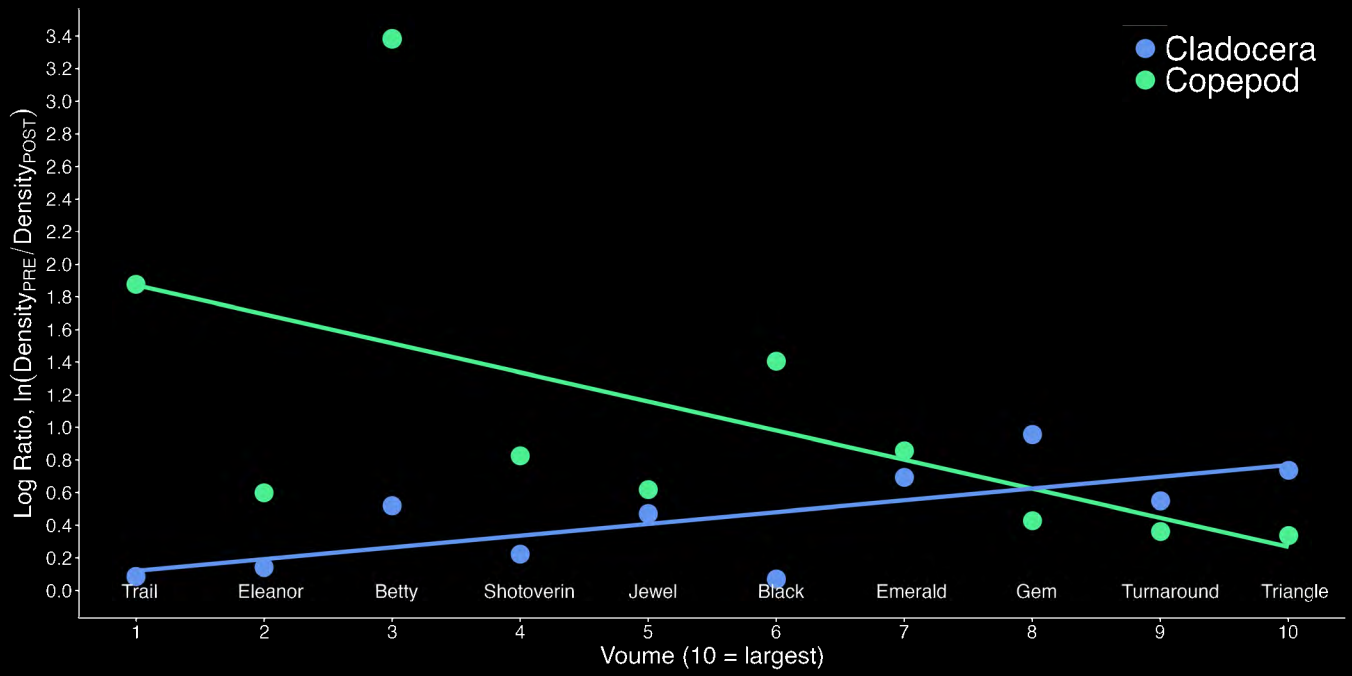
RBT condition is overall poor in the lakes.
Condition < 100 is low, 50-60 detrimental.

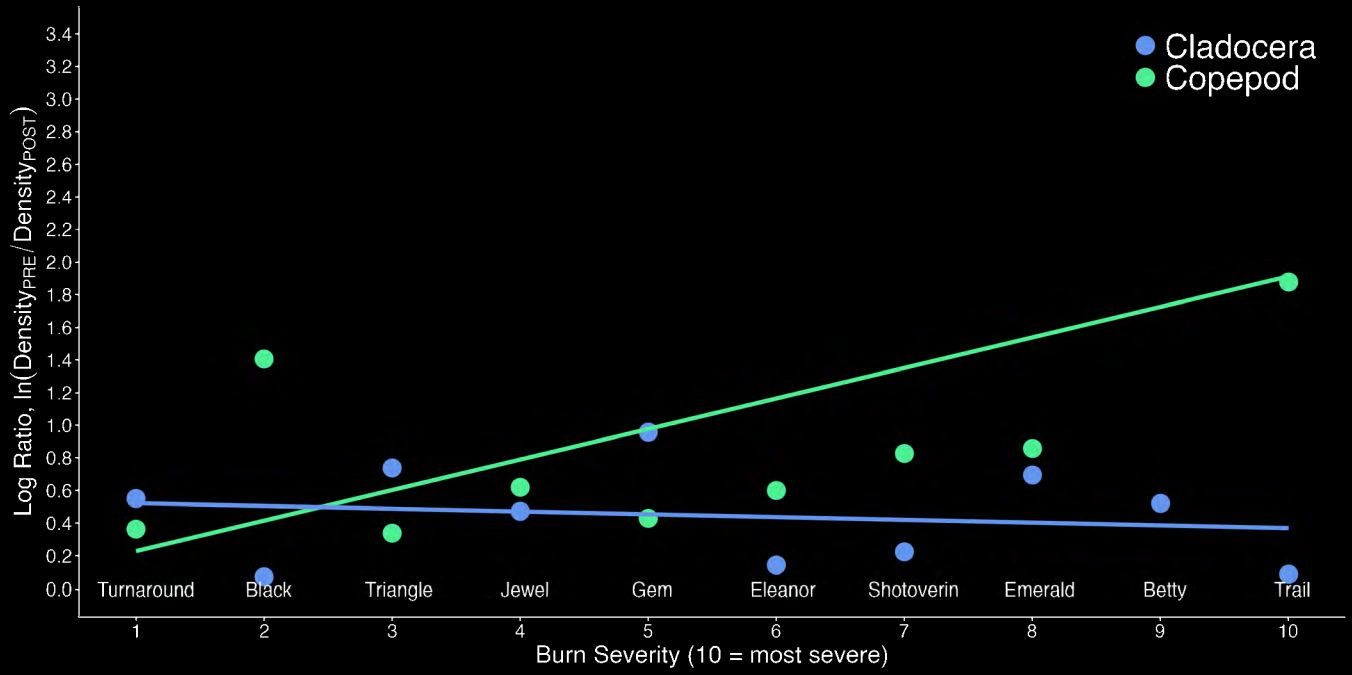


Preliminary Results

Q2 – Does trophic cascade strength vary with ecosystem size?

Answer – TBD!

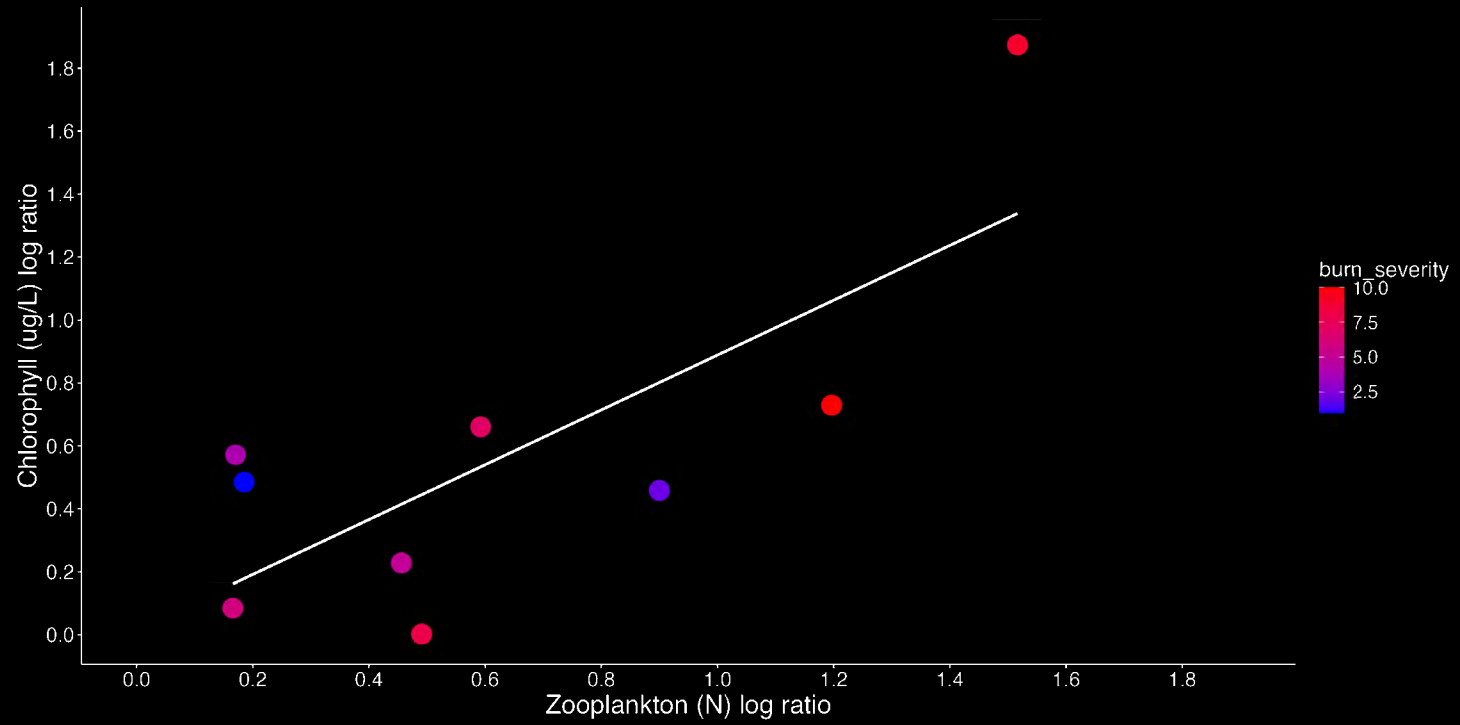


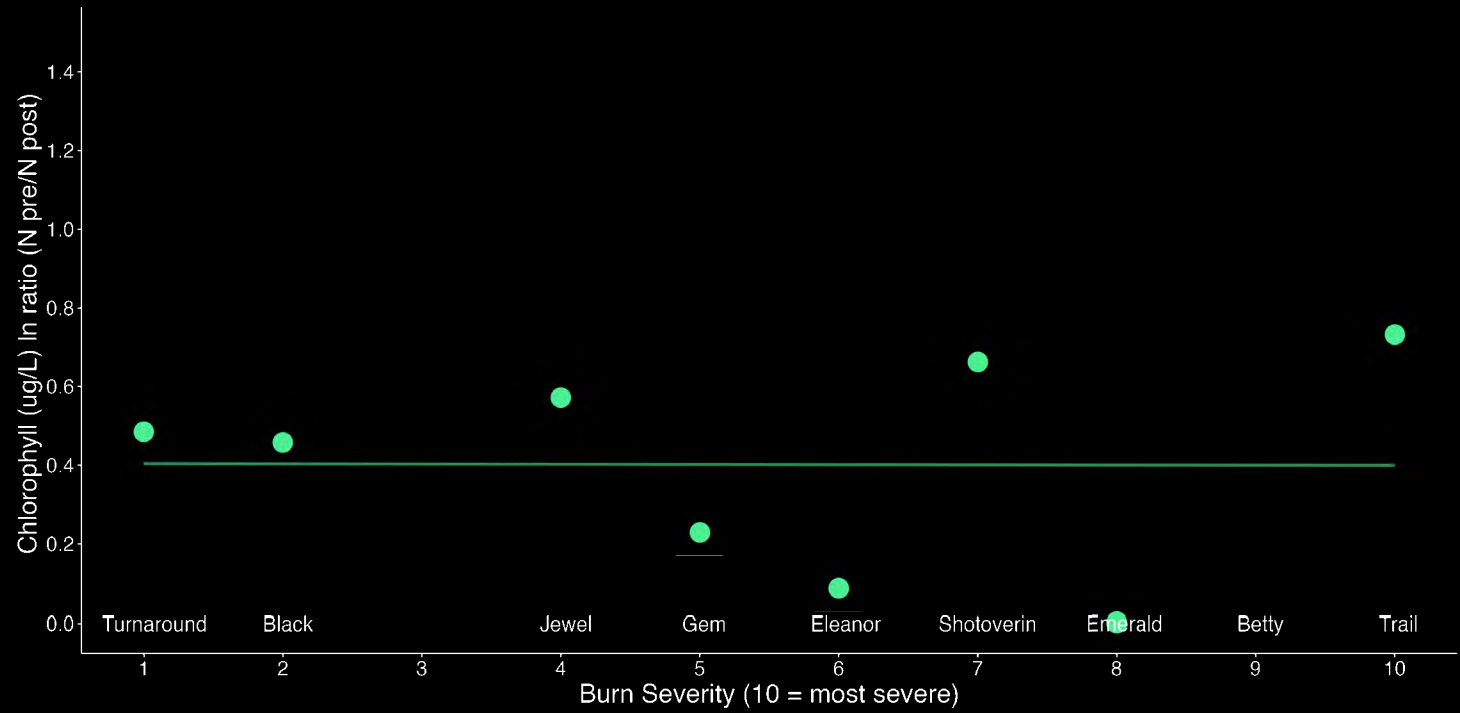


Preliminary Results

Q2 – Does trophic cascade strength vary with ecosystem size?

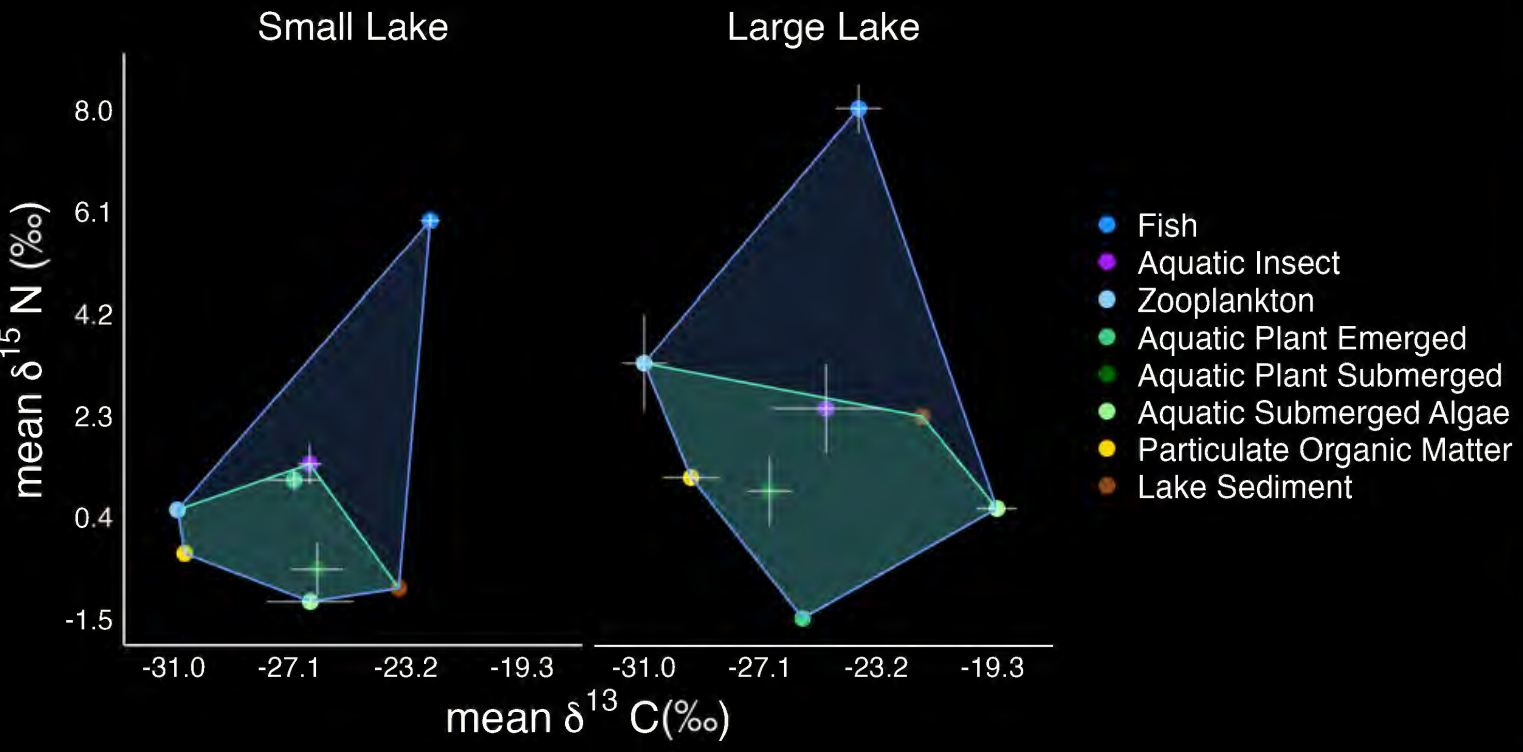
Answer – TBD!

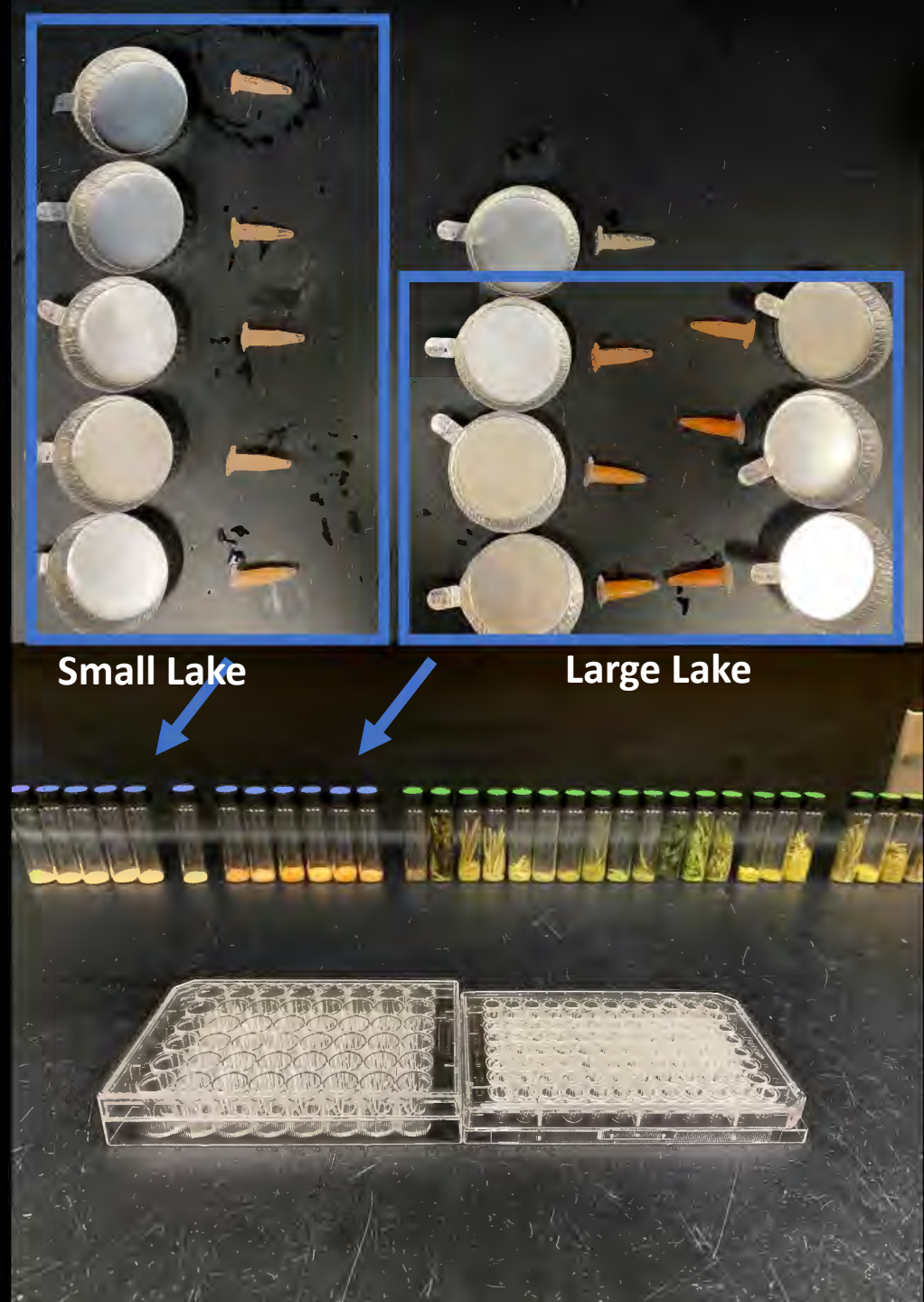




Preliminary Results

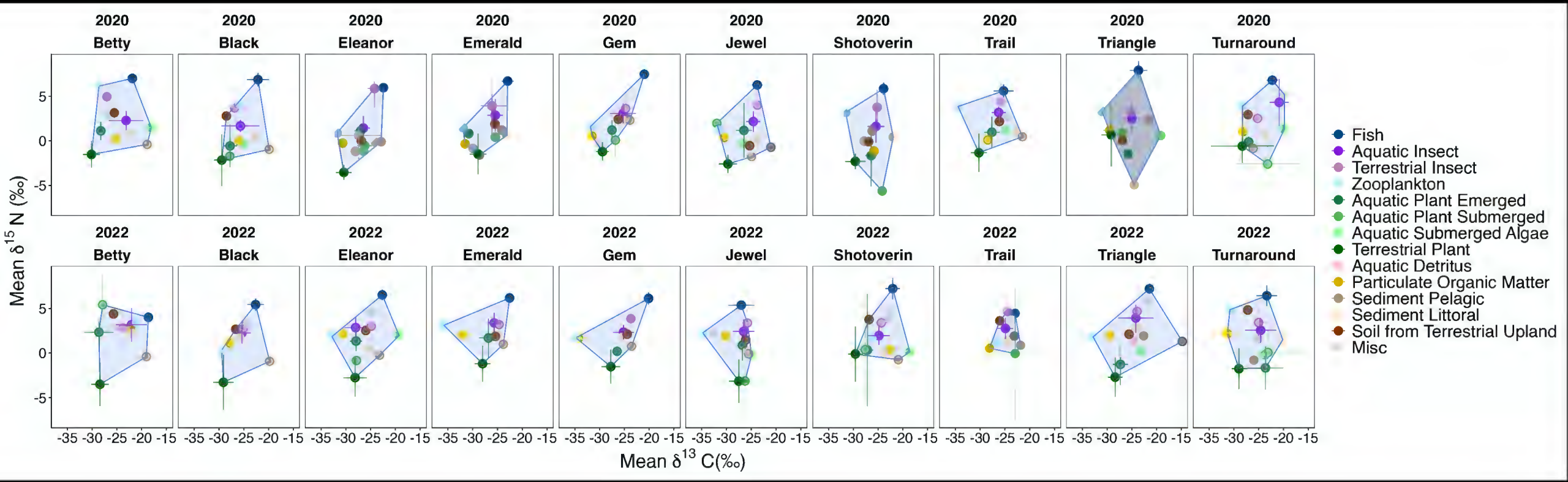
Q3 – How does lake food web structure and function shift following intense watershed burning? Answer – TBD!





Preliminary Results

Q3 – How does lake food web structure and function shift following intense watershed burning? Answer – TBD!



So What?

- Ecological patterns are often scale-dependent.
- Trophic cascade strength likely hinges on ecosystem size, but this is a unique angle in the ecological literature.
- Wide applicability towards understanding what is happening in lake ecosystems post-fire, both regionally and beyond.
- What data are available to address these, and other, questions? How can we acquire those data we are missing?

Thank You!

- National Science Foundation, RAPID DEB-2225284
- California Trout & Peter B. Moyle Endowment for Coldwater Fish Conservation
- UC Davis WFCB, Lloyd Swift Endowment for Undergraduate Experiential Learning Opportunities
- Paul Divine, California Department of Fish & Wildlife
- Isaac Chellman, Lassen National Forest Fisheries Biologist
- Field Crews: Riley Hacker, Sophia Sanchez, Katherine Fierro, Jaime Menendez, Kaylee Pebelier, MJ Farruggia, Mackenzie Miner, Jordan Colby, Wilson Xiong, Dave Ayers

Thank You!

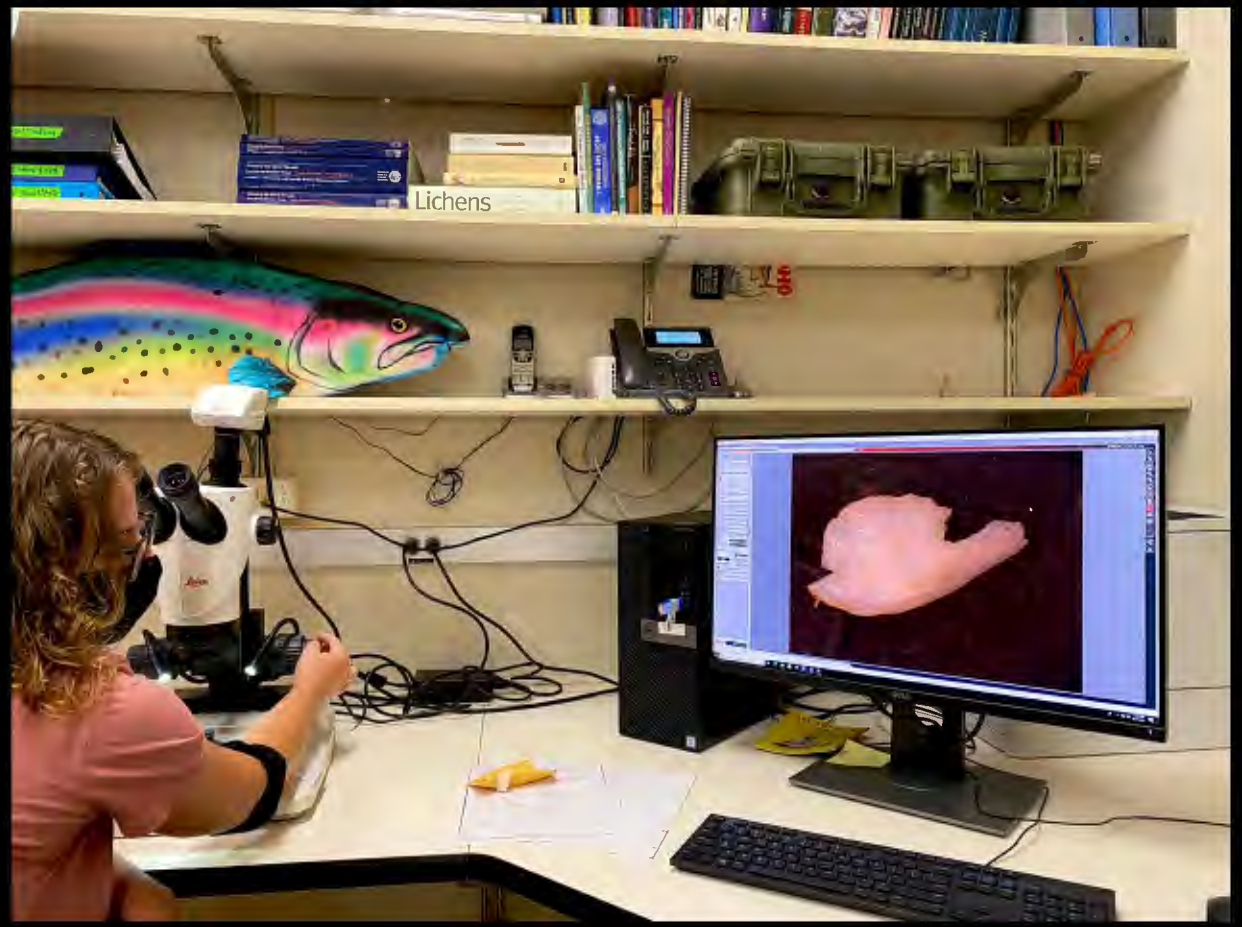
caparisek.github.io

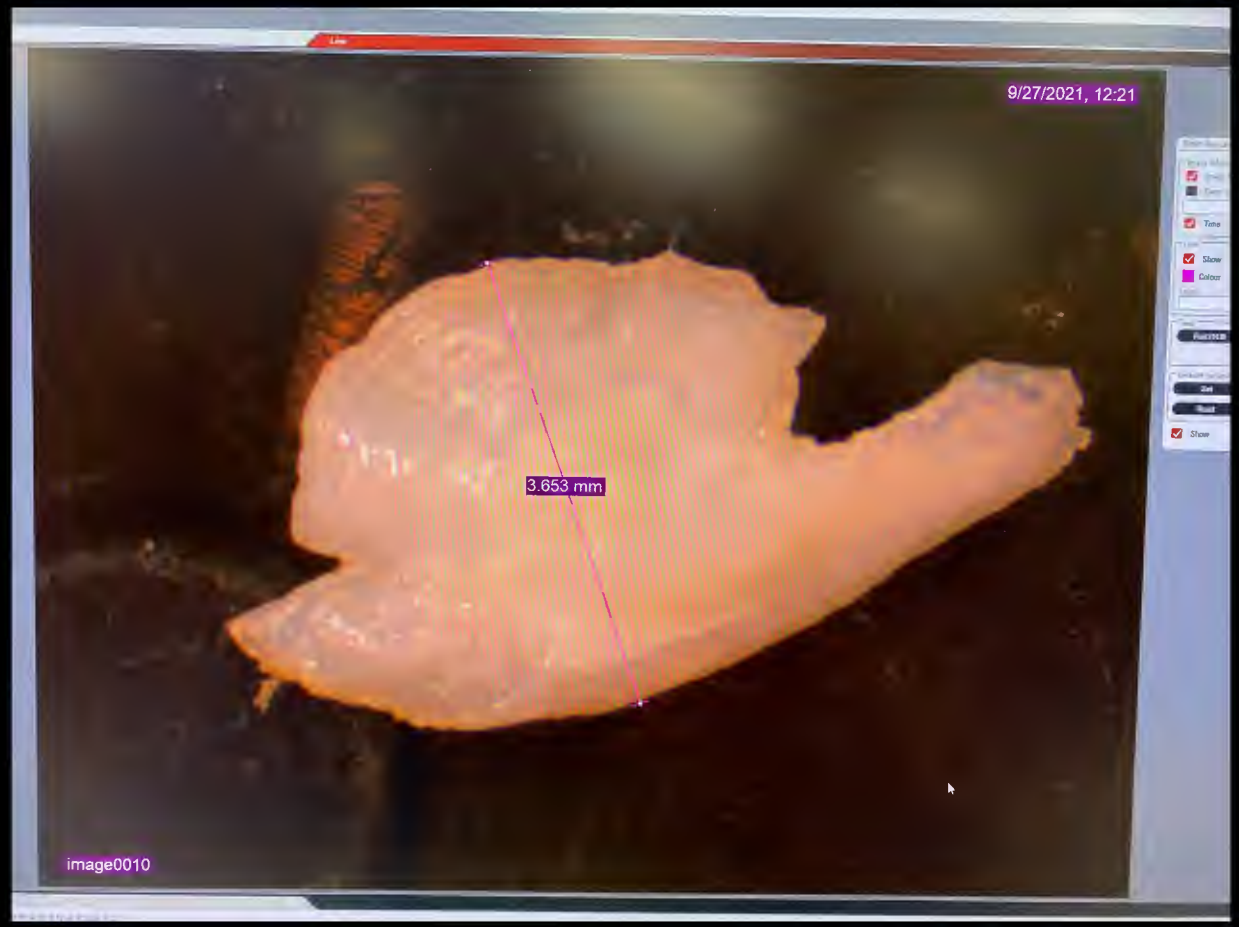
caparisek@ucdavis.edu

Table 2. Suite of food web complexity metrics that can be employed whether or not baseline carbon shifts pre- versus post-fire.

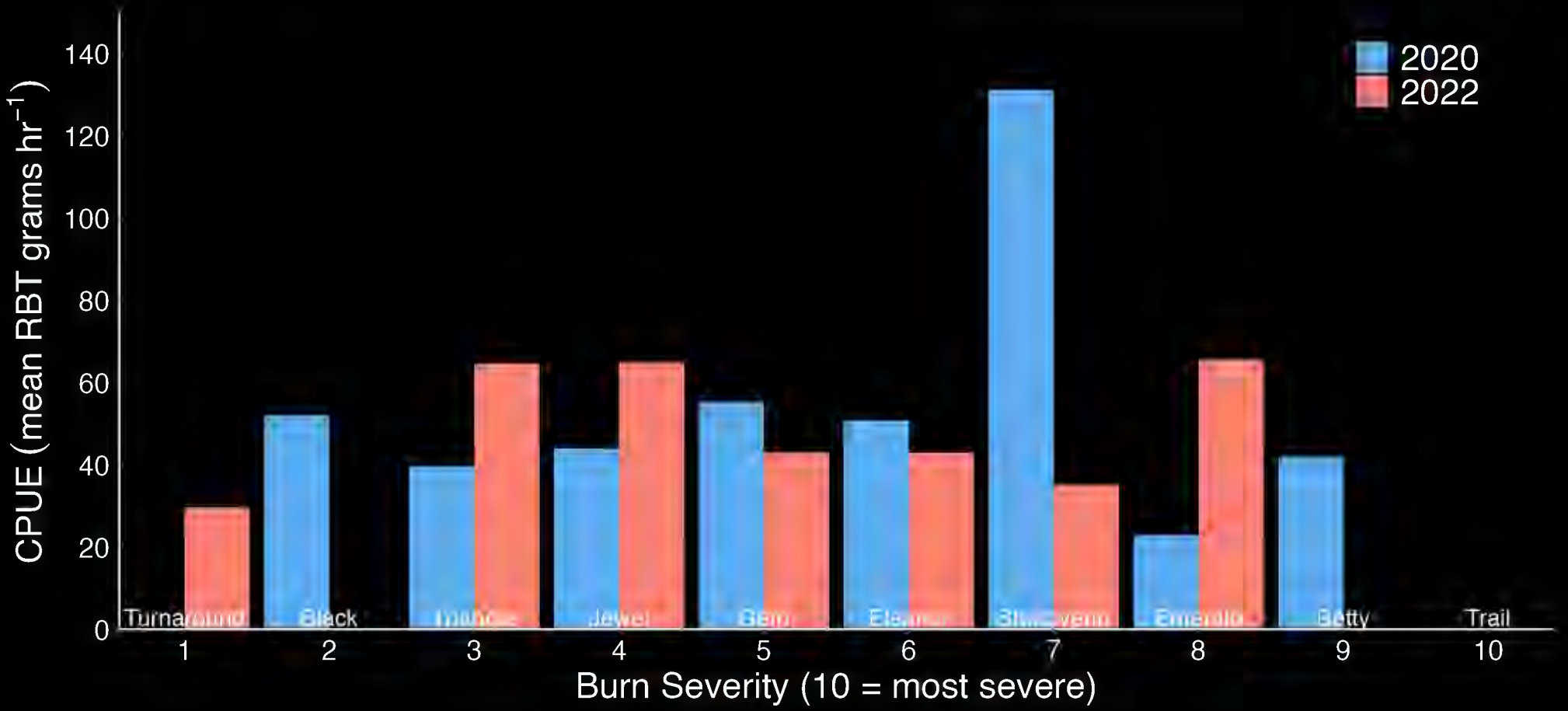
If baseline $\delta^{13}C$ did not shift		If baseline $\delta^{13}C$ did shift	
Metric	**Description**	**Metric**	**Description**
Community metrics of trophic structure (Layman et al. 2007)	Six metrics to quantify trophic diversity and redundancy, i.e., δ15N and δ13C Range, Total Convex Area, Mean Distance to Centroid, Mean Nearest Neighbor Distance (NND), and Standard Deviation of NND.	Standardizing multidimensional space (Cucherousset and Villéger 2015)	A computational correction formula which addresses potential bias of different δ13C and δ15N ranges among food webs by scaling both axes to a standardized range for each isotope.
Hypothesis-testing framework for Layman metrics (Turner et al. 2010)	A hypothesis-testing framework for Layman's metrics that applies linear models and residual permutation procedure.	Baseline-standardized isotopic vector analysis (BaSIVA) (Black and Armbruster 2021)	BaSIVA handles dual-baseline analysis through a Bayesian framework and then proceeds to quantifying strength and direction of basal resource shifts.
Stable Isotope Baysian Ellipses in R (SIBER) (Jackson et al. 2011)	Extends Layman's metrics into ones which apply Bayesian methodology to compare niche widths; SIBER provides more robust analysis options.	Stable Isotope Trajectory Analysis (SITA) (Sturbois et al. 2021)	SITA is recommended when basal resource differences result in different consumer positions in biplot space.
Bayesian estimation of Trophic Position (TP) (Quezada-Romegialli et al. 2018)	TP calculates population-level trophic position using a Bayesian framework. TP can account for individual variability and can discriminate two distinct C and N sources (e.g., benthic–pelagic, aquatic–terrestrial).		

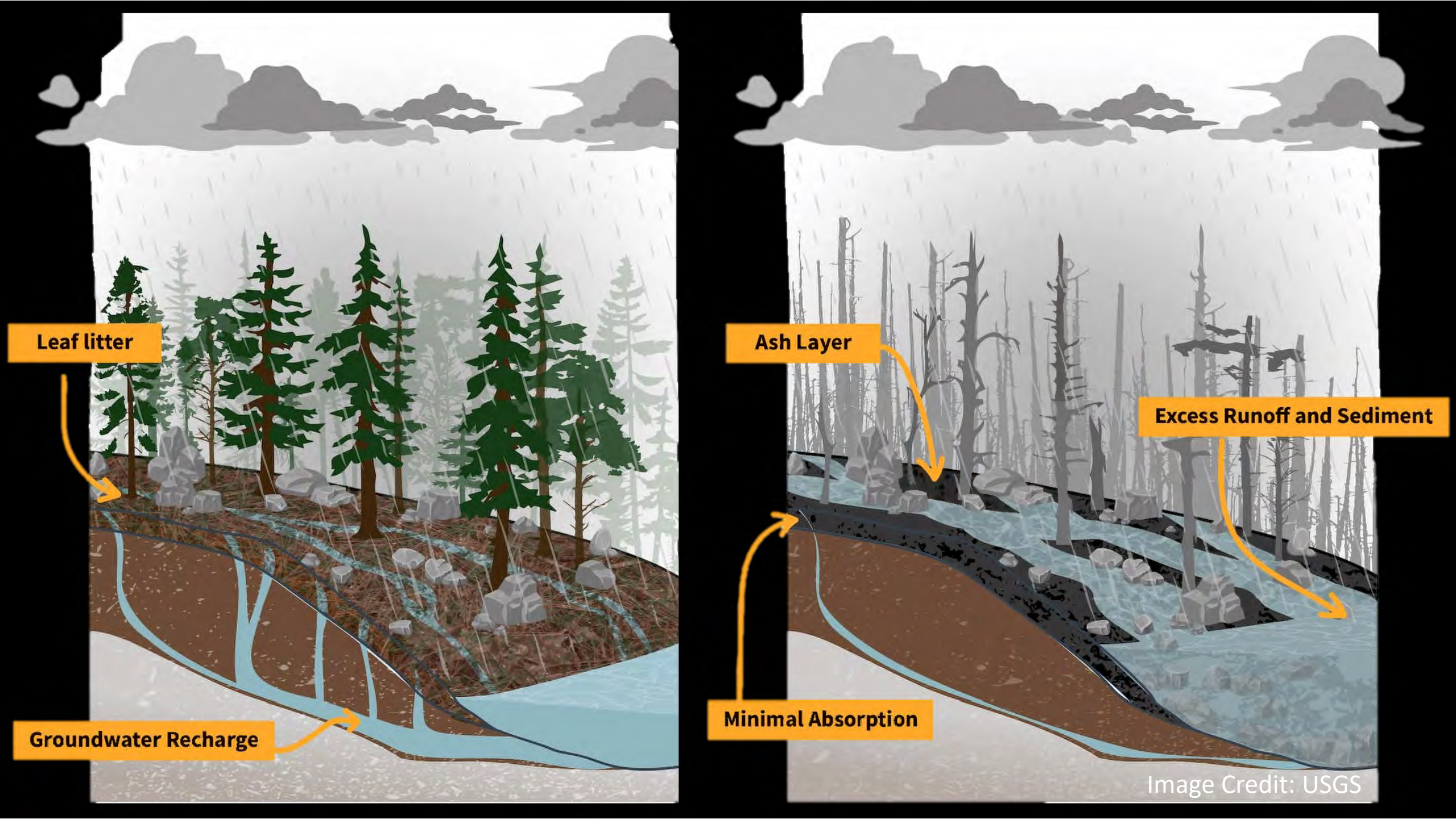
Lake	Surface Area (m^2)	Years Stocked
Eleanor	18,811	2002-2014, 2016, 2018, 2021
Emerald	21,467	2002-2014, 2016, 2018, 2021
Jewel	22,760	2002-2009, 2014, 2016, 2017, 2018, 2021
Betty	37,652	2002-2014, 2016, 2018
Trail	38,267	2002-2009, 2014, 2016, 2018
Shotoverin	40,730	2001-2021
Gem	42,582	2002-2009, 2012-2014, 2016, 2018, 2021
Black	45,626	2002-2014, 2016, 2018, 2021
Turnaround	130,033	2002-2009, 2013, 2014, 2016, 2018, 2021
Triangle	183,206	2002-2009, 2013, 2014, 2018, 2021


Lichens


9/27/2021, 12:21
3.653 mm
image0010

Preliminary Results




Leaf litter
Groundwater Recharge
Ash Layer
Excess Runoff and Sediment
Minimal Absorption
Image Credit: USGS

UCDAVIS

Lethal and Sublethal Effects of Fire Retardants on Salmonid Early Life Stages: Establishing Toxicity Thresholds for Aquatic Health

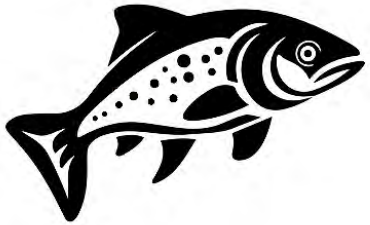
Salmonid Restoration Federation
Workshop 04/30/2025

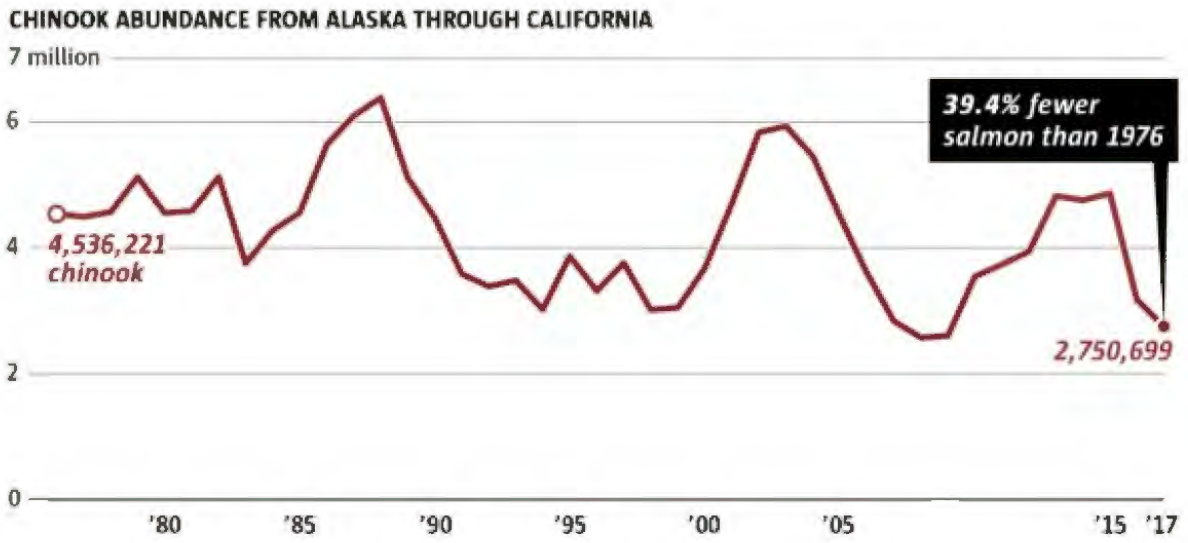
Cominassi, Louise, Quijada Escobar, K., Feddor, E., Lin, D., Reece, P., Raman, R., Blechschmidt, S., Brander, S., Segarra, A.

Background: Salmonids concerning trends in abundance

Pink	Chum	Sockeye	Coho	Chinook	Masu	Steelhead
						

Decline in abundance along the US West coast





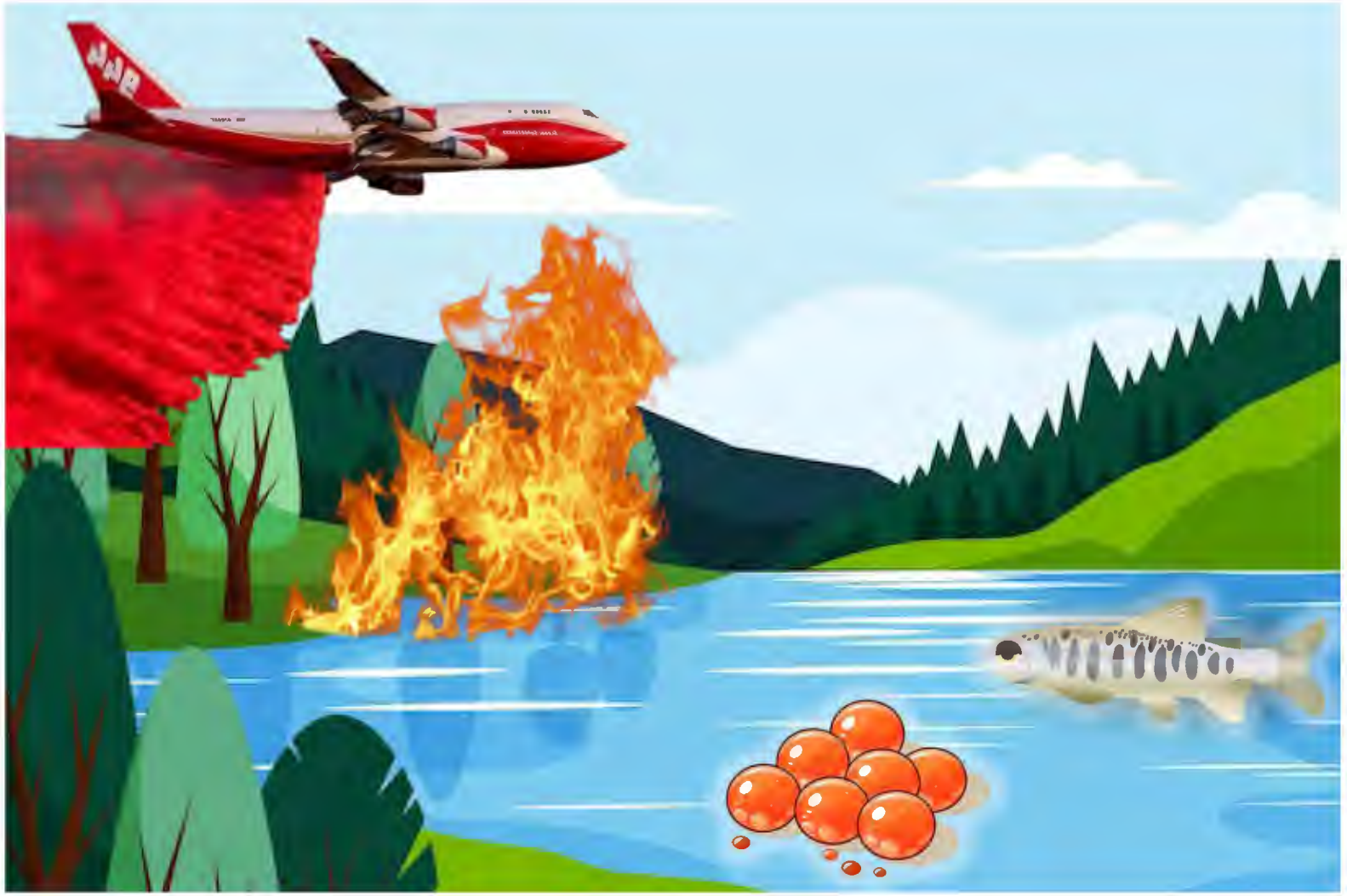
FALL RUN	CONCERN
LATE FALL RUN	CONCERN
WINTER RUN	**ENDANGERED**
SPRING RUN	**THREATENED**

Background: Use of Fire Retardants against Wildfire

@Washington State Recreation and Conservation Office

Background: Use of Fire Retardants against Wildfire

- Wildfires are becoming more frequent due to climate change
- To stop the spread of the fire, fire retardants (**Phos-Chek ®**) are used
- Fire retardants can enter freshwater systems through runoff posing toxic threats to aquatic life



Background: Important Knowledge Gap

- **Toxicity test conducted are usually to test for mortalities: test for LC50** → Limited knowledge on sublethal effects

- **Toxicity of fire retardant often tested on juveniles rainbow trout** → Limited Understanding of Species and Stages-Specific Responses

- **Test the toxicity of the "fresh" product** → Don't account for the impact of the environment on the fire retardant

Project Aim

Understand how fire retardants impact salmonids during their early life stage

Research Question:

- How does fire retardant chemicals affect the lethality on early life stage of salmonid?

Oregon State University

Rainbow Trout

UCDAVIS

Chinook Salmon

- How do fire retardants impact sublethal endpoints such as morphology, behavior and development?

UCDAVIS

Chinook Salmon

Lethal Toxicity

Method

Phos-Chek LC95W
Assessed on juveniles
Rainbow trout
LC50 = 327 µl/L

Weathered

Processed → simulates sunlight exposure

Non - Weathered

Freshly applied

LC50 (Mortalities)

Lethal Toxicity

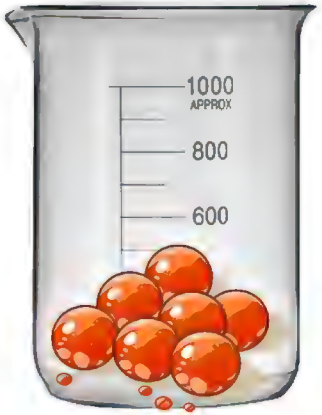
Method

Oregon State University

Rainbow Trout

UCDAVIS

Chinook Salmon



Temp: 10 °C

Lethal Exposure

- Exposed to a range of concentrations
- Exposure of 96h
- Determine the mortality (LC50)

Tested on both weathered and non-weathered

Lethal Toxicity

Results

Oregon State University

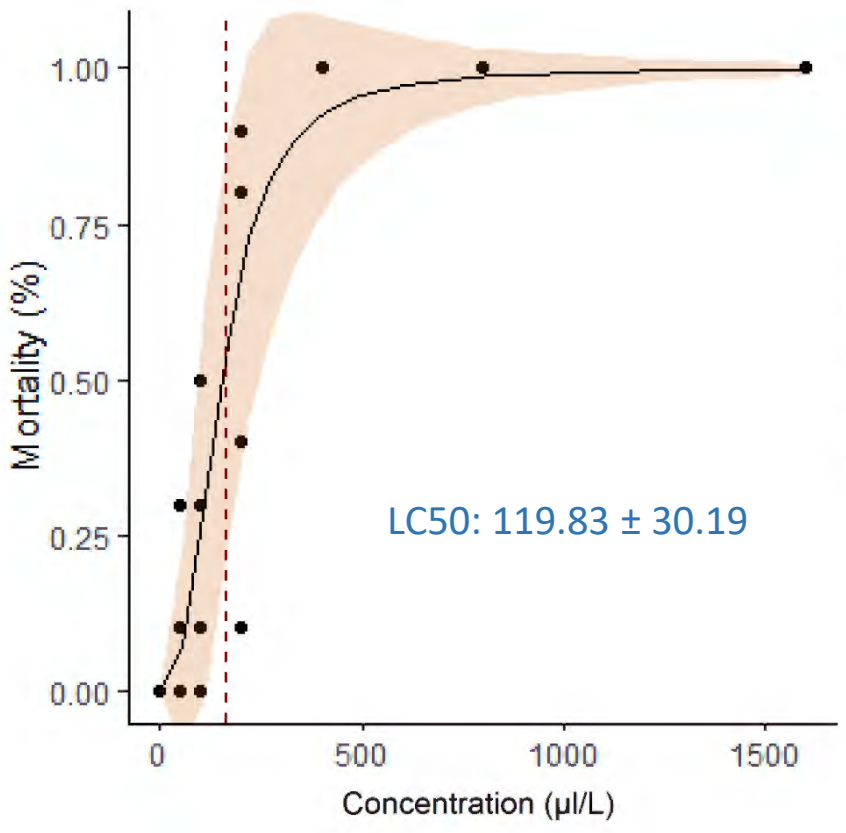
Rainbow Trout

Weathered has a lower LC50, therefore, it is more **toxic** than non-weathered version.

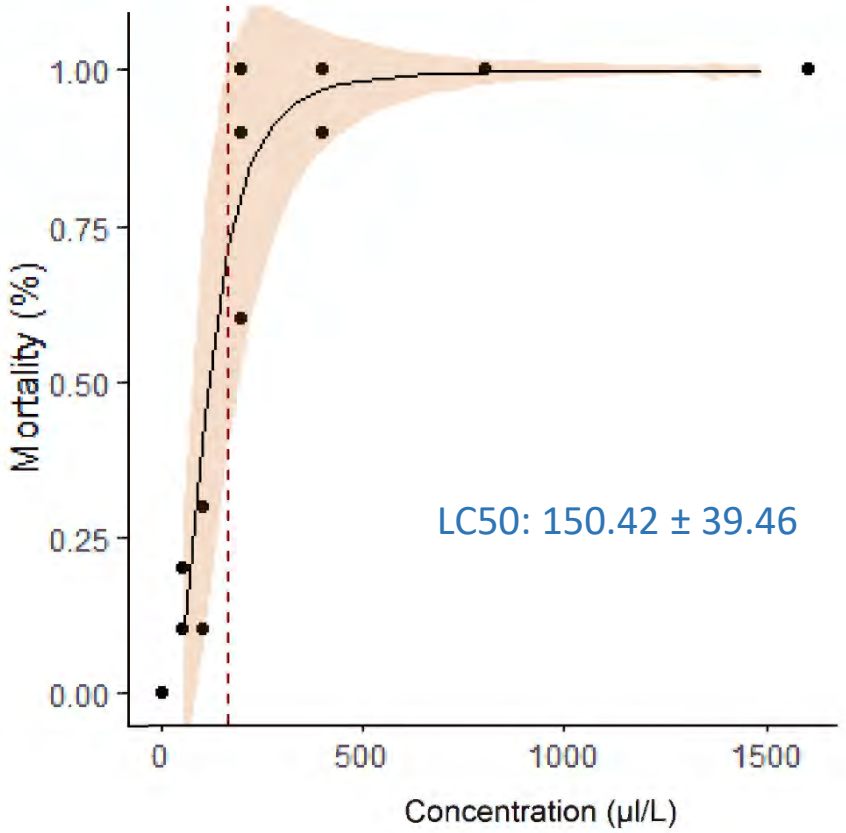
Phos-Chek LC95W
Assessed on juveniles
LC50 = 327 µl/L

Embryos 2x more sensitive

Weathered



Non-weathered



Lethal Toxicity

Results

UCDAVIS

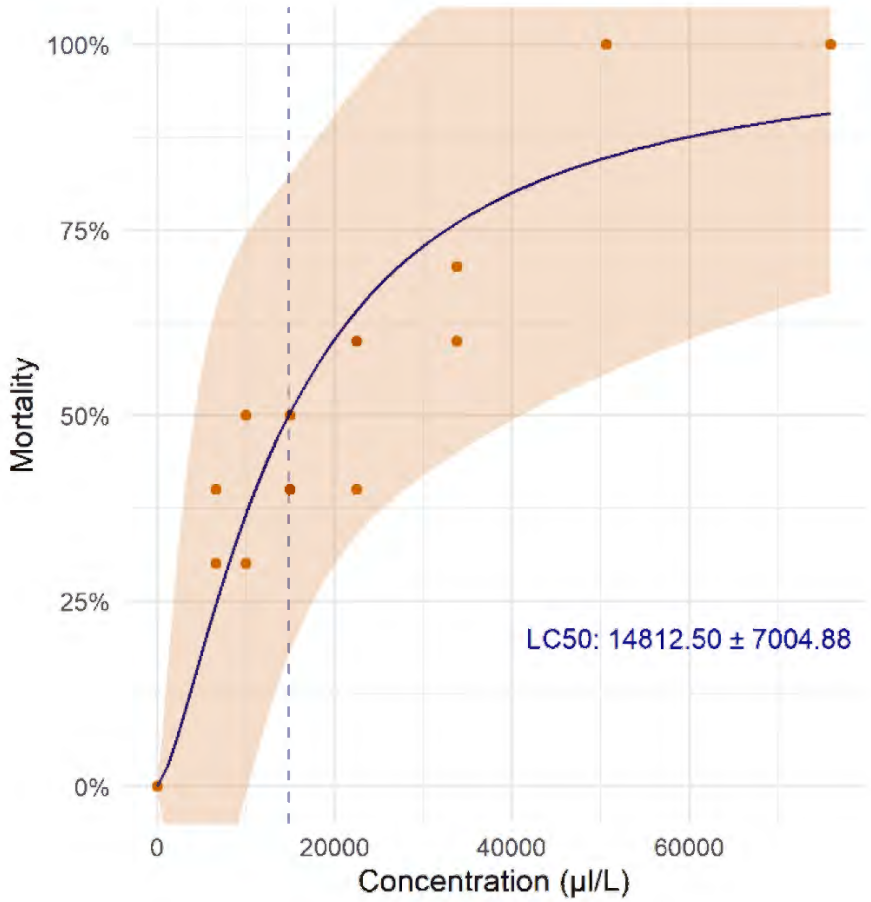
Chinook Salmon

Weathered has a lower LC50, therefore, it is more **toxic** than non-weathered version.

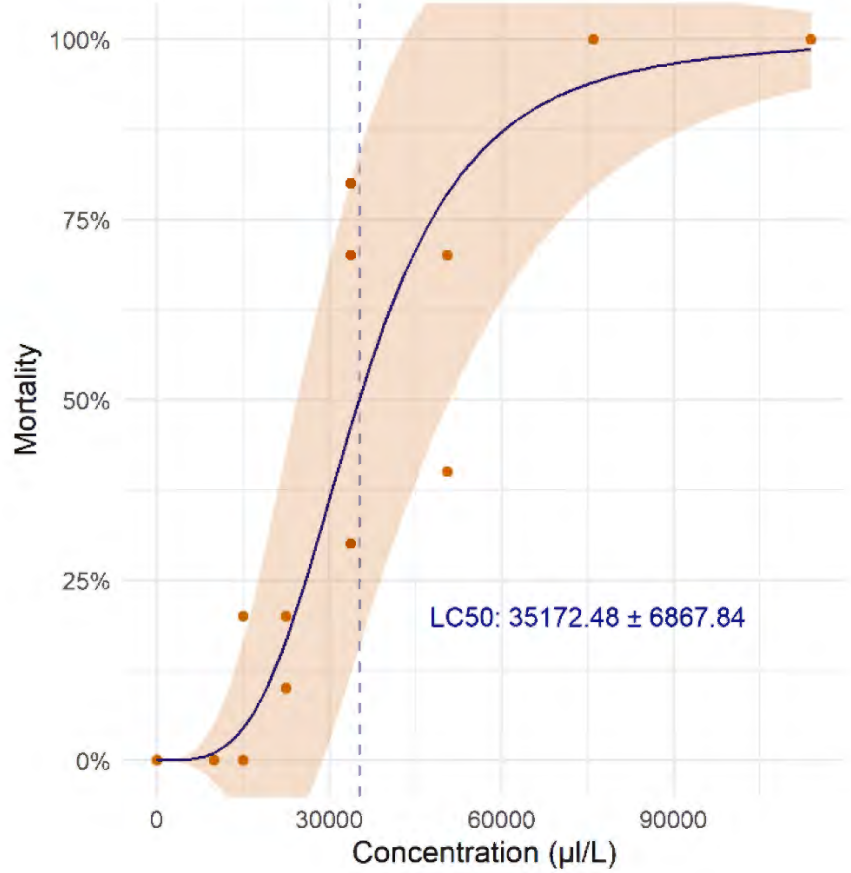
Phos-Chek LC95W
Assessed on juveniles
LC50 = 327 µl/L

Embryos 45x less sensitive

Weathered



Non-weathered



Lethal Toxicity

Discussion

- Toxicity: **weathered** Phos-Chek is more **toxic** than **non-weathered**
- **Rainbow trout embryos are more sensitive** to Phos-Check fire retardant than Chinook Salmon
- Harmful effects of Phos-Check can be **underestimated**→ consider weathering in assessments

Sublethal Toxicity

Method

UCDAVIS

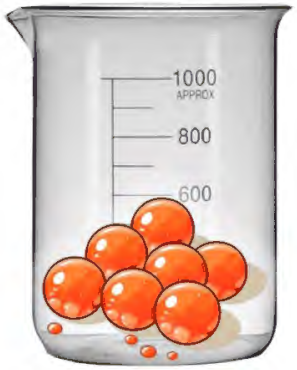
Chinook Salmon

& Weathered / Non-weathered

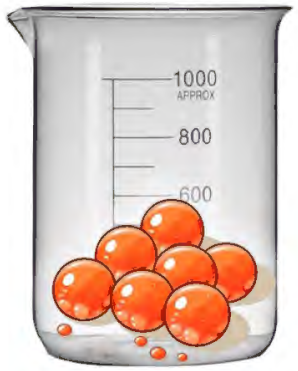
CTL | 50 µl/L | 100 µl/L | 200 µl/L | 400 µl/L | 800 µl/L | 1600 µl/L | 3200 µl/L

24 days

Exposure	Clean Water	Endpoints



96h exposure
Temp: 10 °C



Clean water
Not hatched

Clean water
Hatched

Morphology
Behavior:
- **Locomotion**
- **Photomotor Response**
- **Anxiety-like Behavior**

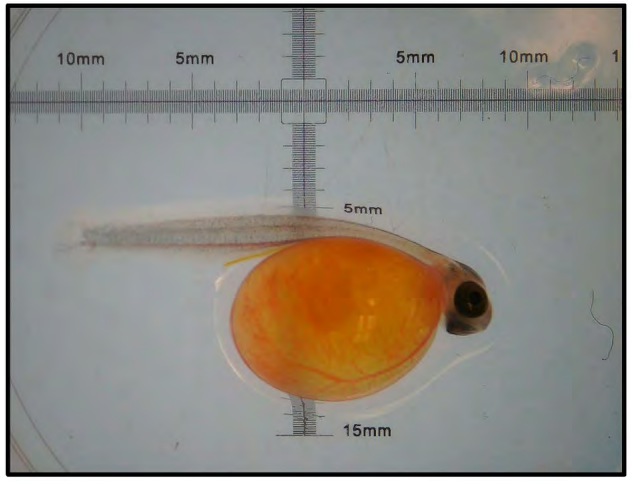
Sublethal Toxicity

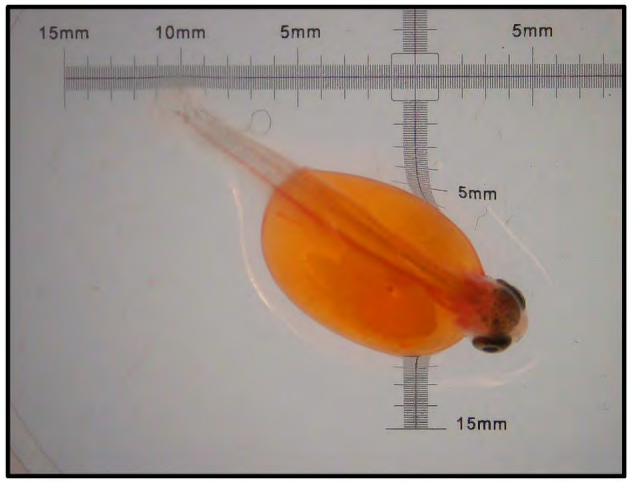
Method

UCDAVIS

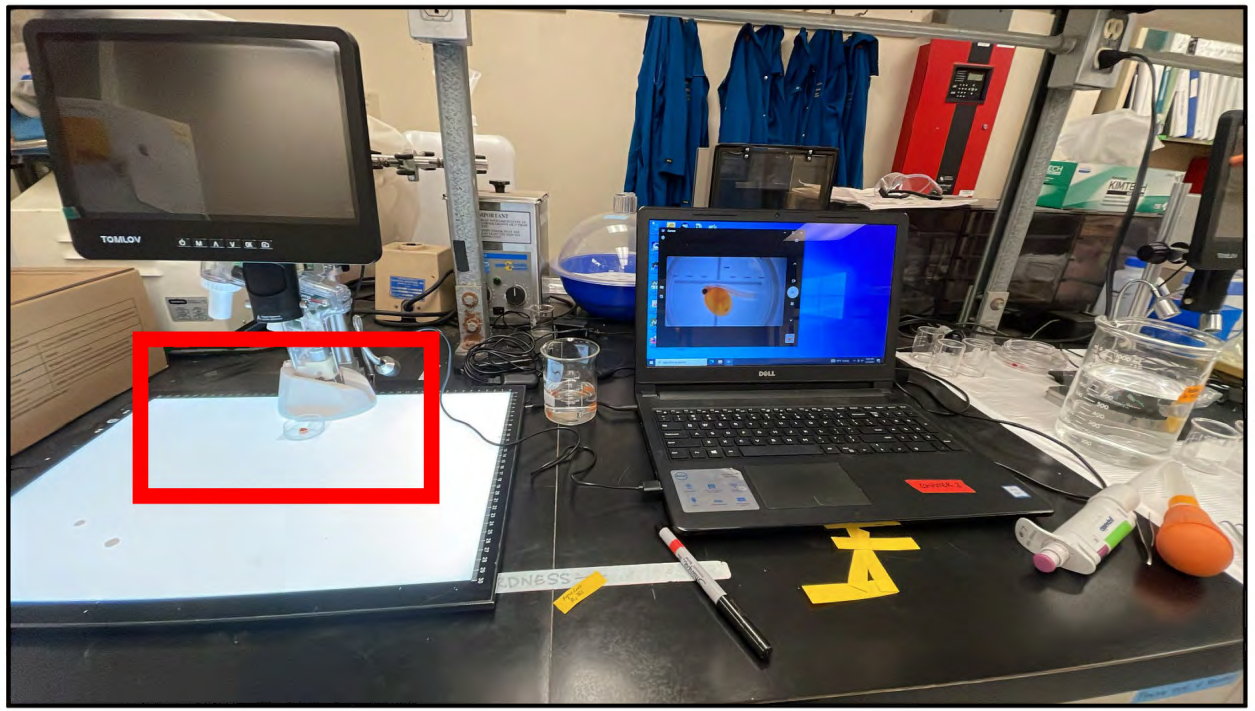
Chinook Salmon

Morphology measurements



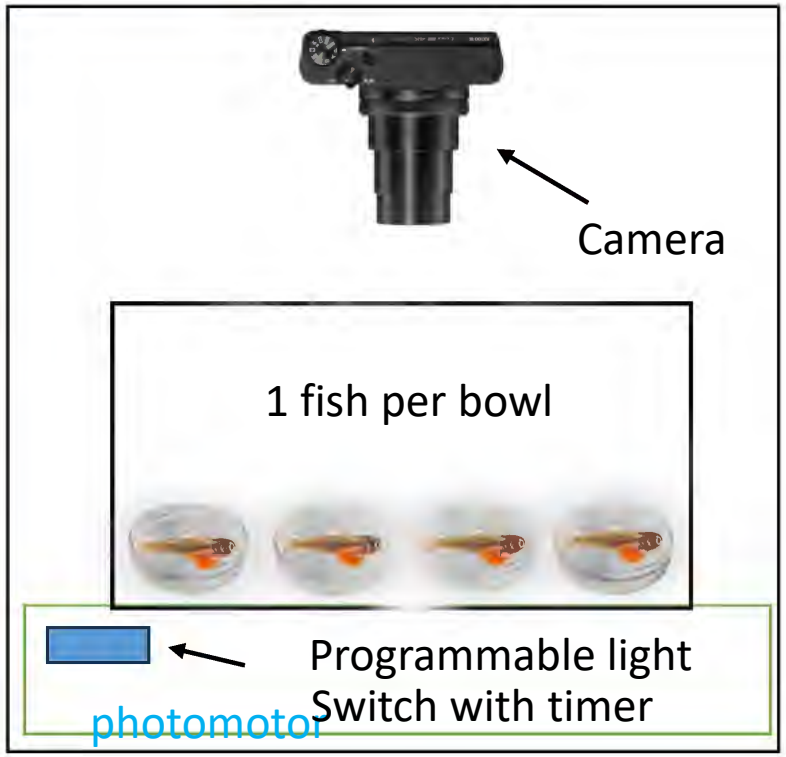


→ Measured just after hatching
→ Standard length and Yolk sac volume



Sublethal Toxicity

Method

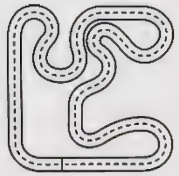


Behavior tests

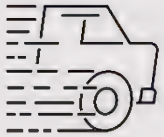
UCDAVIS

Chinook Salmon

Locomotion



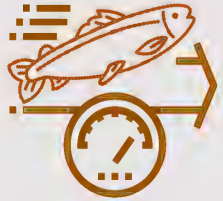
Total distance moved



Velocity

Cruising

Freezing



Bursting

Anxiety-related behavior

Thigmotaxis « wall hugging »

Photomotor Response

Light Trigger response

Sublethal Toxicity

Results

Mortality after 96h Sublethal Exposure

UCDAVIS

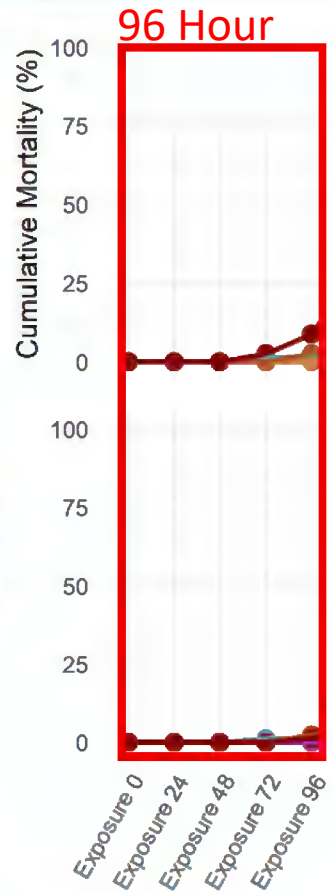
Chinook Salmon

Weathered

LC50: ~14800 µl/L

Non-weathered

LC50: ~35170 µl/L



No significant mortalities during the exposure.

Noticed an increase in mortality after exposure ended.

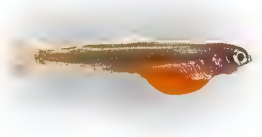
Morphology

Hatching

Swimming

Behavior

Timeline



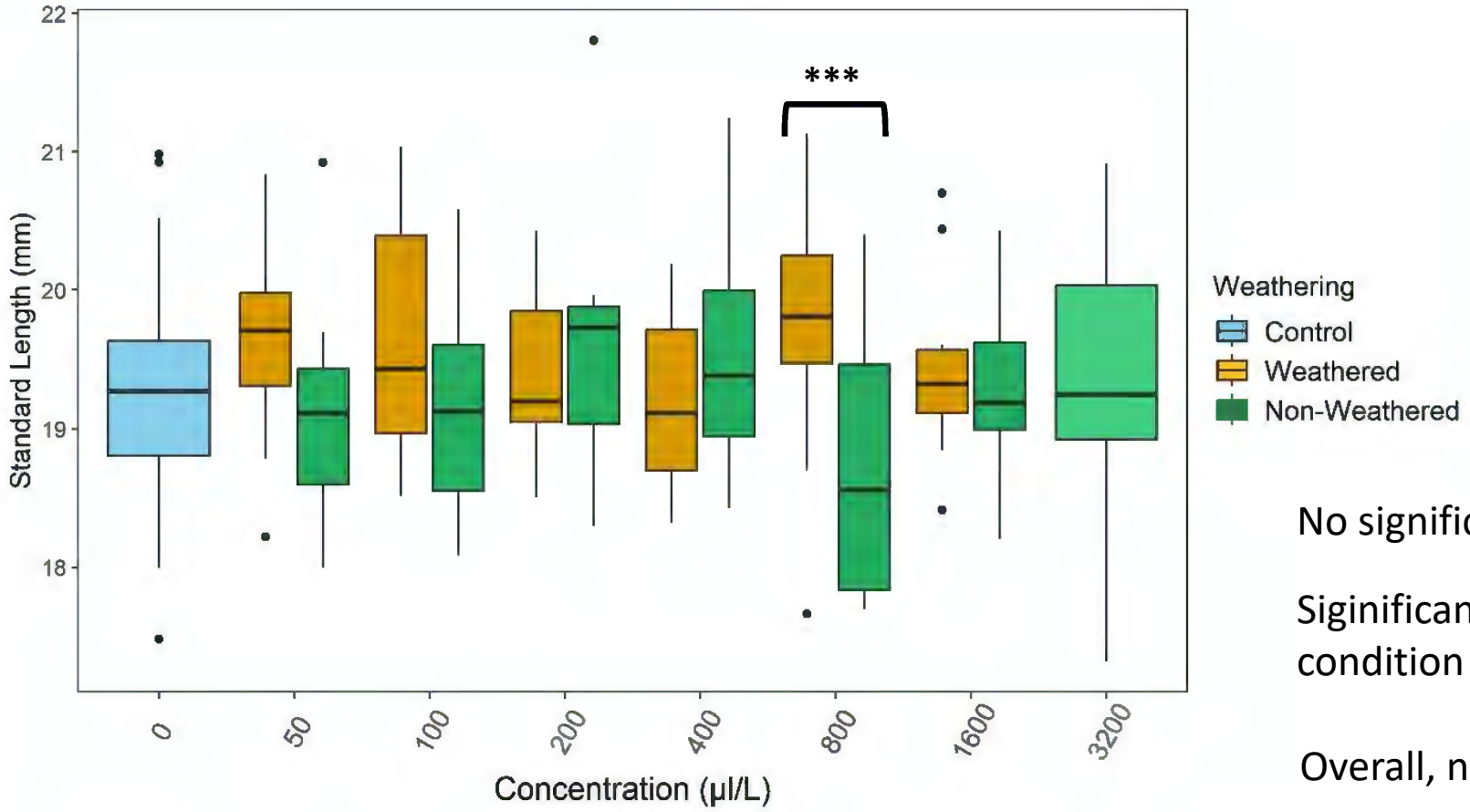
Sublethal Toxicity

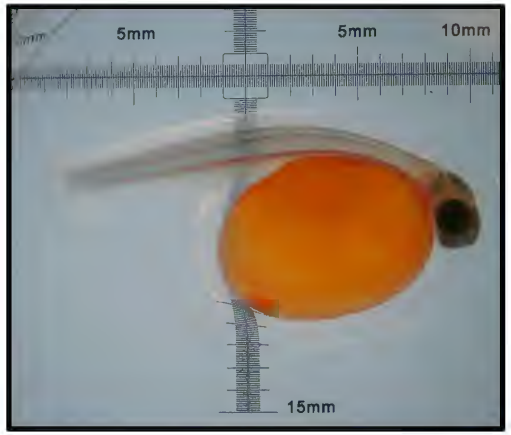
Results

Morphology – Standard Length

UCDAVIS

Chinook Salmon





No significant differences compared to control.

Siginificant difference between weathering condition only at 800 µl/L.

Overall, no effect of Phos-Check on length at hatch

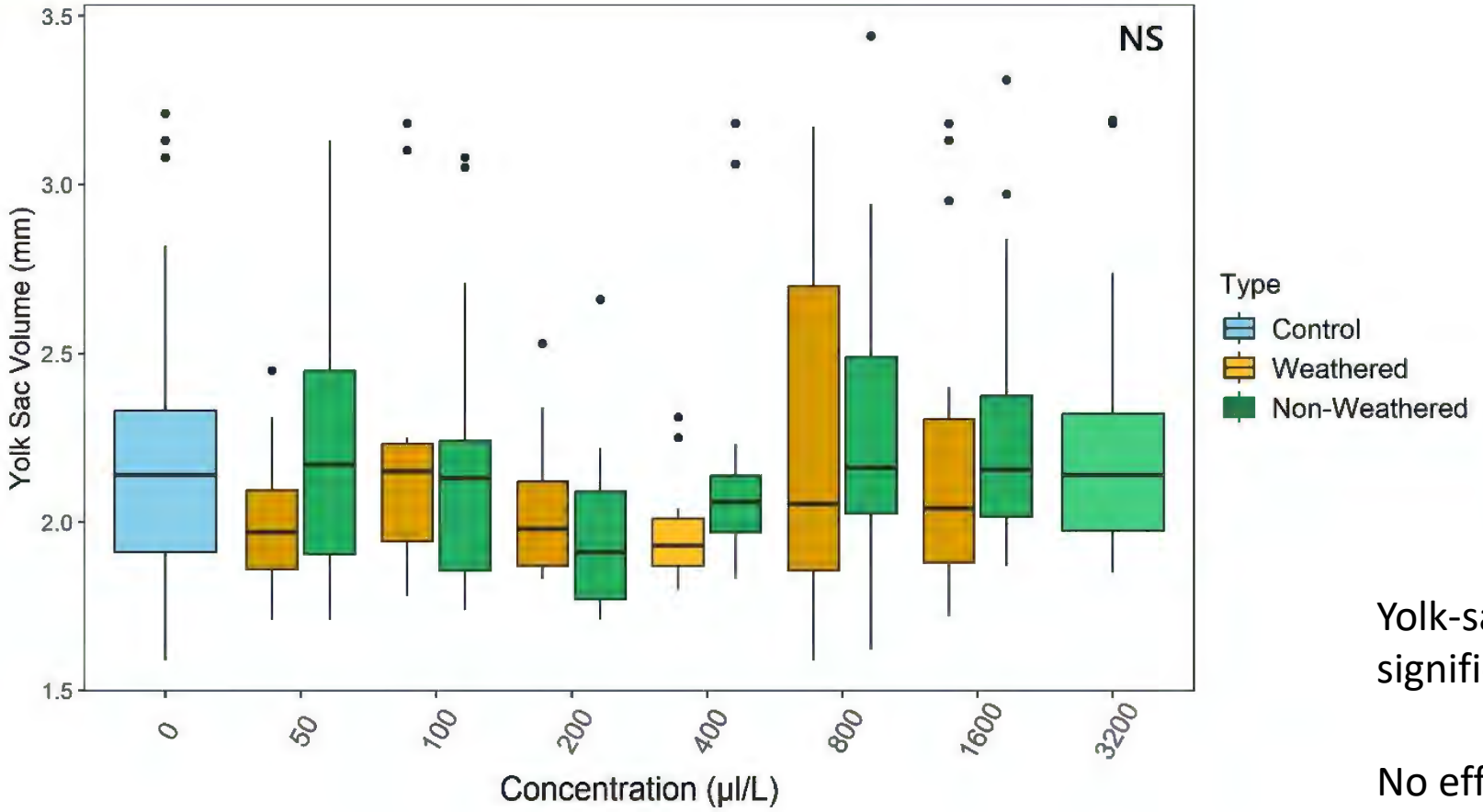
Sublethal Toxicity

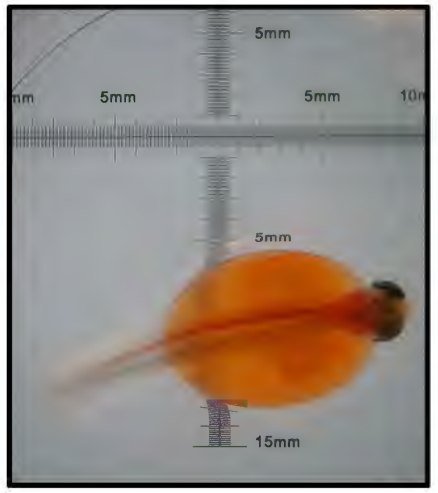
Results

Morphology – Yolk Sac Volume

UCDAVIS

Chinook Salmon





Yolk-sac volume in exposed fish was not significantly different compared to control.

No effect of Phos-Check on yolk sac volume at hatch.

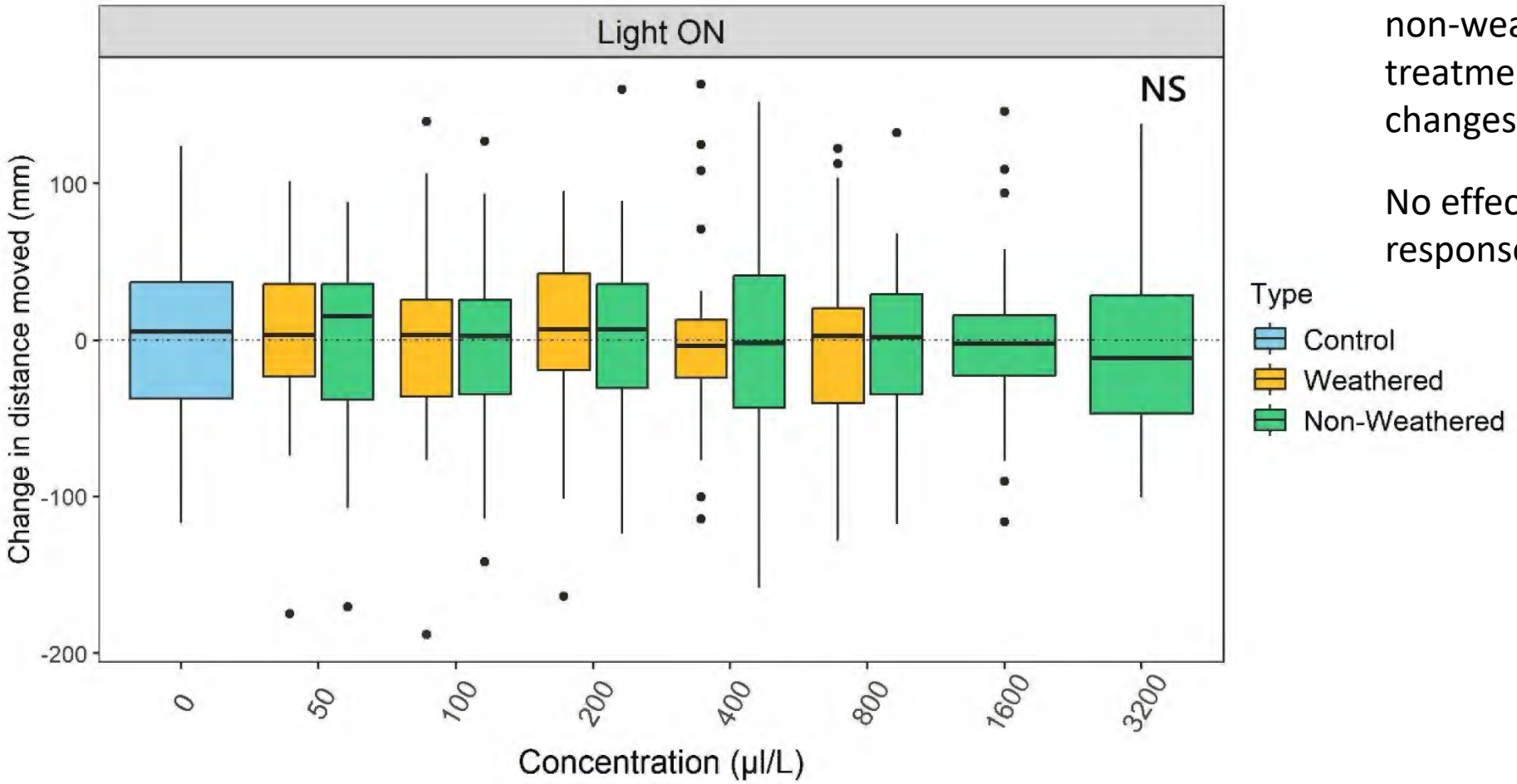
Sublethal Toxicity

Results

Behavior – Photomotor Response

UCDAVIS

Chinook Salmon



No significant difference between non-weathered and weathered treatments with how they respond to changes in light conditions.

No effect of Phos-Check on photomotor response

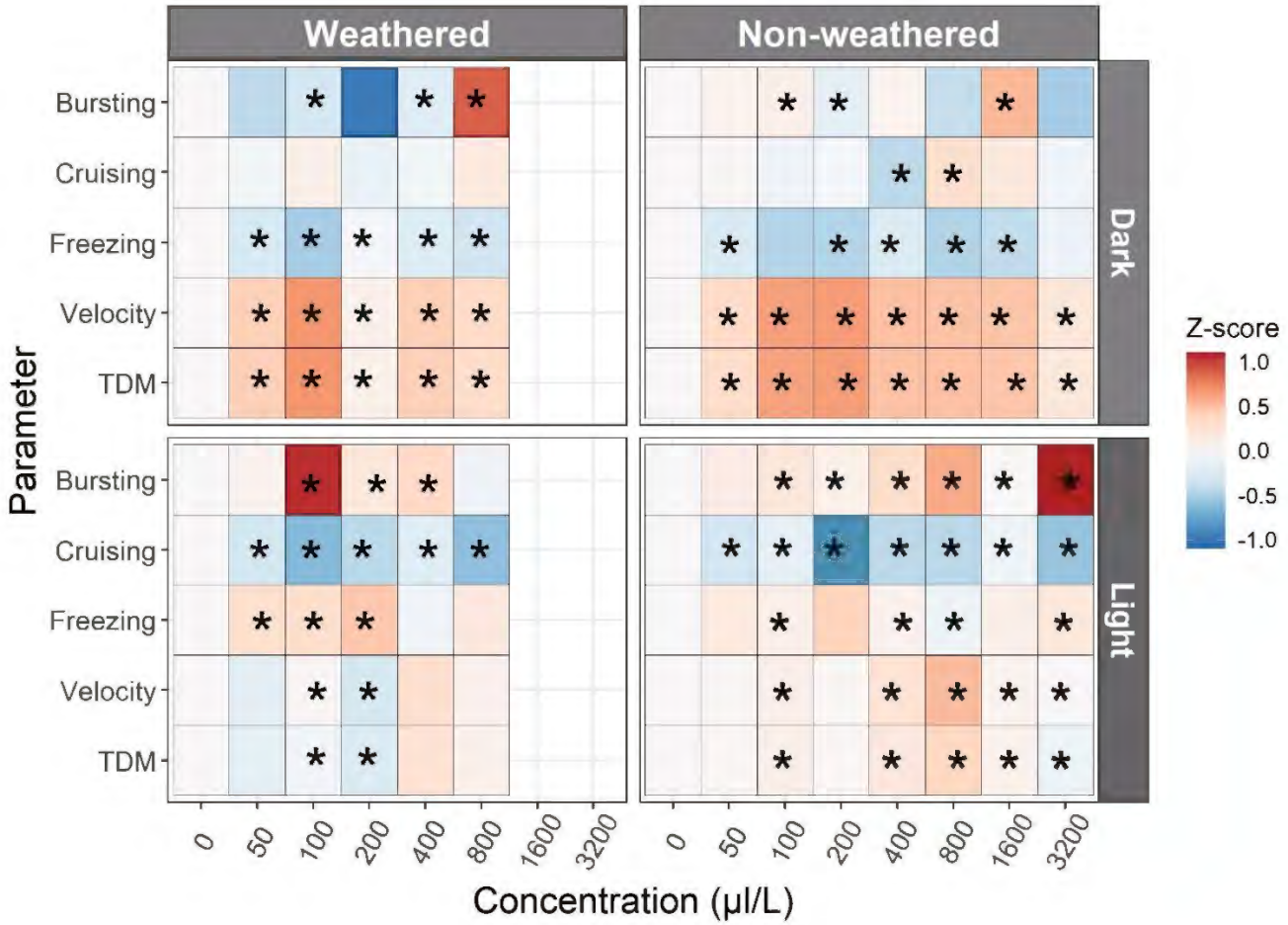
Sublethal Toxicity

Results

Behavior – Locomotion

UCDAVIS

Chinook Salmon



Fish exposed to weathered and non-weathered treatments showed significant alteration in behavioral responses.

↳ Hyperactive/Erratic behavior compared to control

Exposure to Phos-Check at embryos stage affect locomotion of larvae

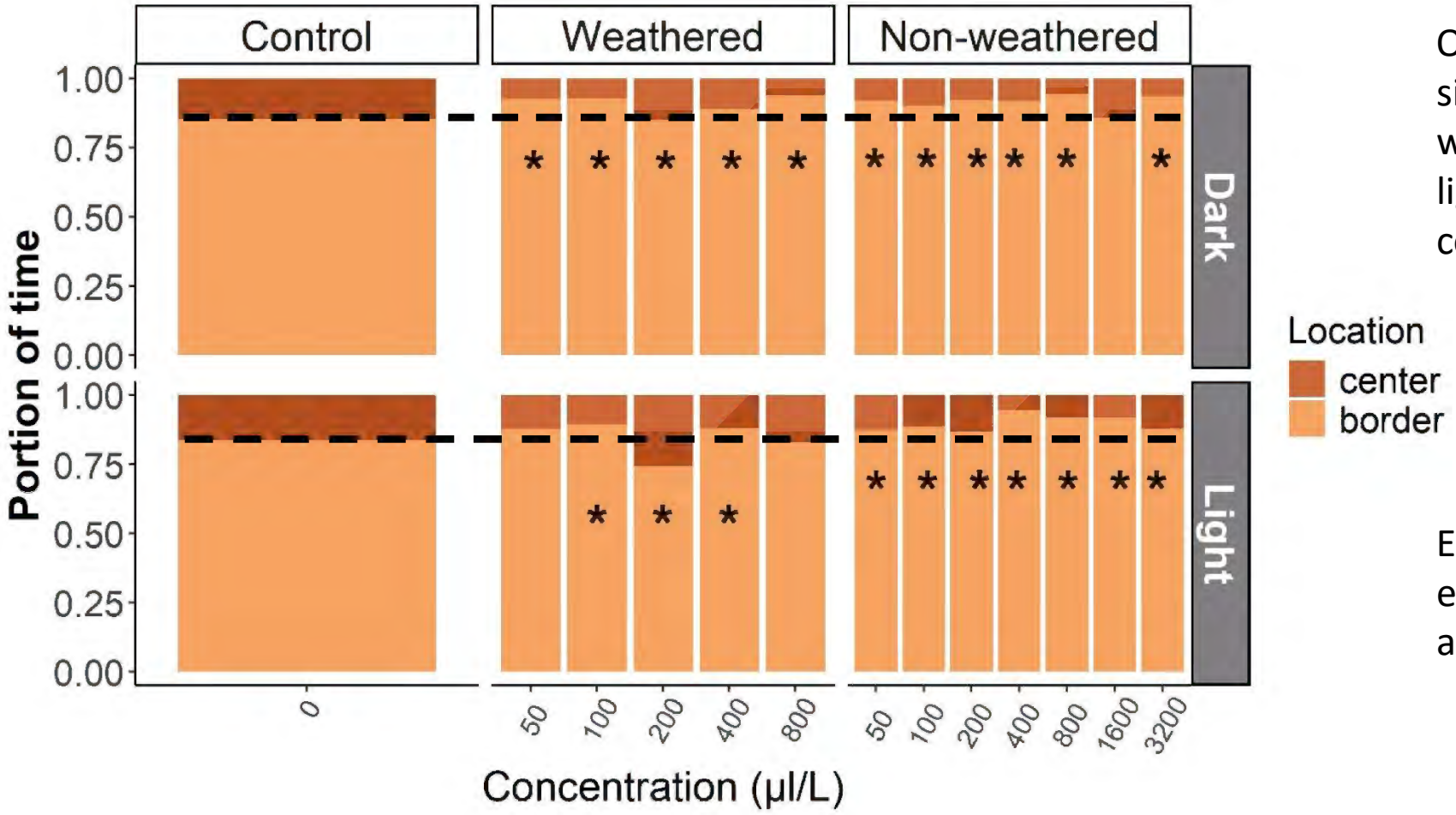
Sublethal Toxicity

Results

Behavior – Anxiety-like behavior

UCDAVIS

Chinook Salmon



Overall, anxiety-like behavior significant increase for both weathered and non-weathered in light and dark conditions compared to control

Exposure to Phos-Check at embryos stage increase larvae anxiety-like behavior

Sublethal Toxicity

Discussion

UCDAVIS

Chinook Salmon

- mortalities after 96h sublethal exposure in concentrations that were 10x lower than concentration used for LC50.
  - The 96 h-LC50 might underestimate mortality.

- morphology: no effect on yolk-sac volume
  - Suggest no energetic cost on development

- anxiety-like behavior and alteration in locomotion
  - Might affect foraging for food and avoiding predators
  - Might add to the existing stressors in the wild

General Discussion

- Toxicity of Phos-Check is **species specific**
- Importance of looking into **sublethal effect**: **Behavioral** effect were observed at concentration 200x lower than their LC50
- Active ingredient = **ammonia phosphate**
- Changes in water parameters: pH
- Recent research highlight **presence of metal**

Future Directions

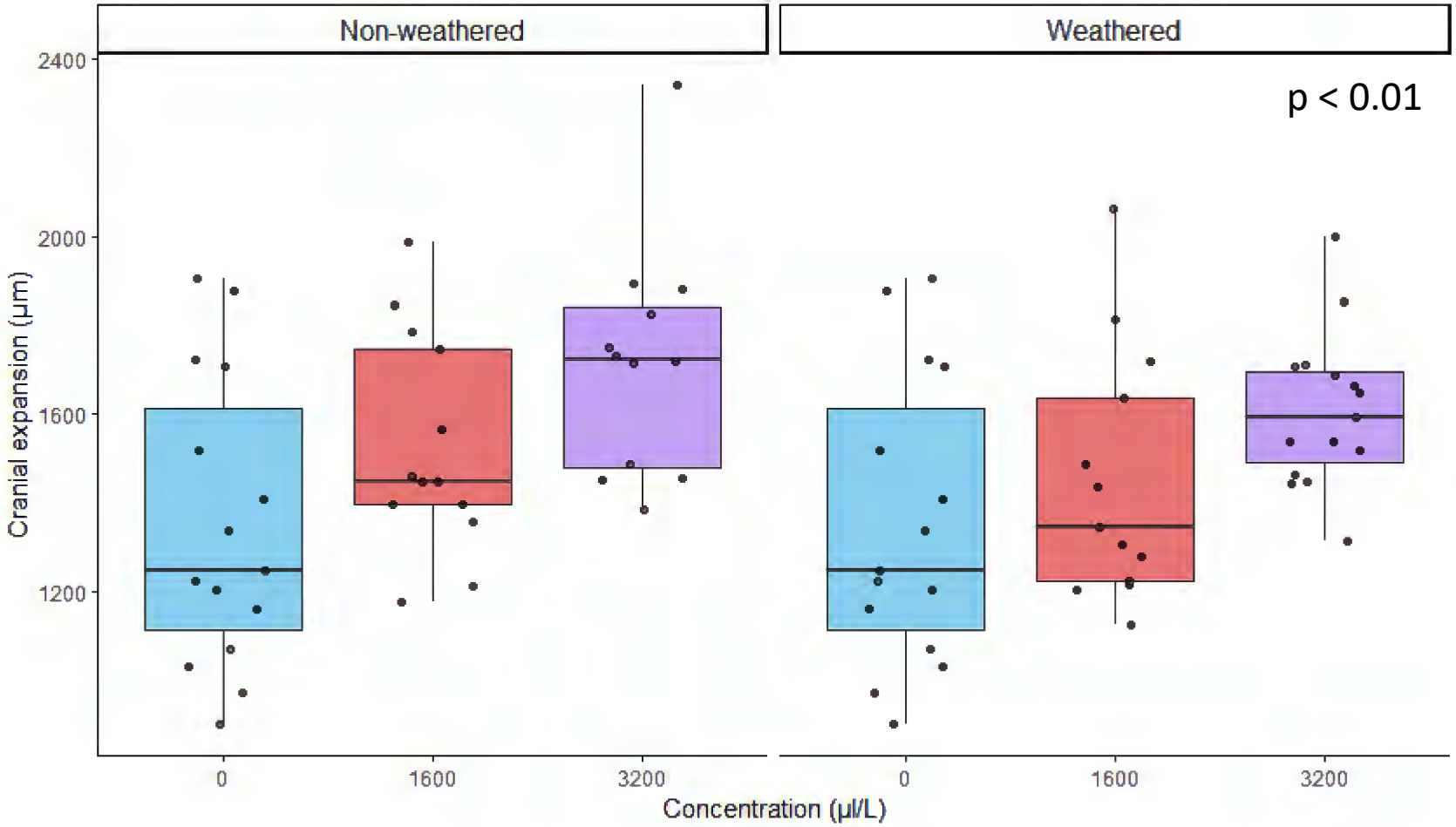
- Assess Chinook Salmon **hatching success**
- Test the difference in response between weathered and non-weathered in locomotion and anxiety at each concentration
- **Non targeted analysis**
- Assess the toxicity on **Chinook Salmon alevins.**

Sublethal Toxicity on Fry Rainbow Trout

Oregon State University

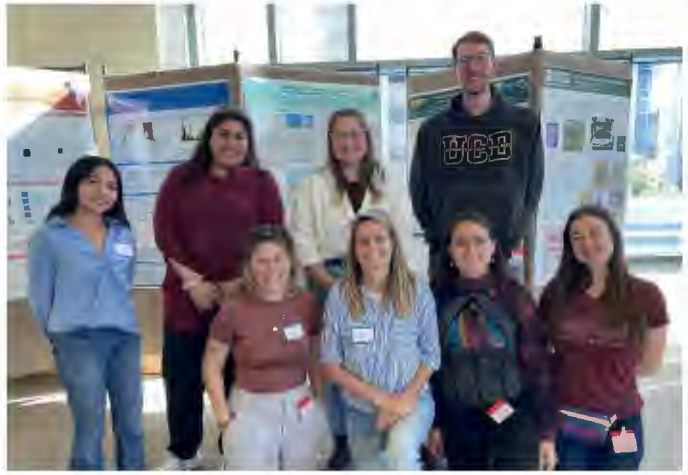
Rainbow Trout - Morphology

Cranial expansion in Rainbow trout increased with higher concentrations (ANOVA, $p<0.01$) but was not impacted by the weathering status of Phos-Check



Acknowledgements

Dr. Amelie Segarra



UCDAVIS

Segarra lab: Environmental Toxicology & Aquatic Animal Diseases

Oregon State University

Brander lab: Ecotox and Environmental Stress Lab

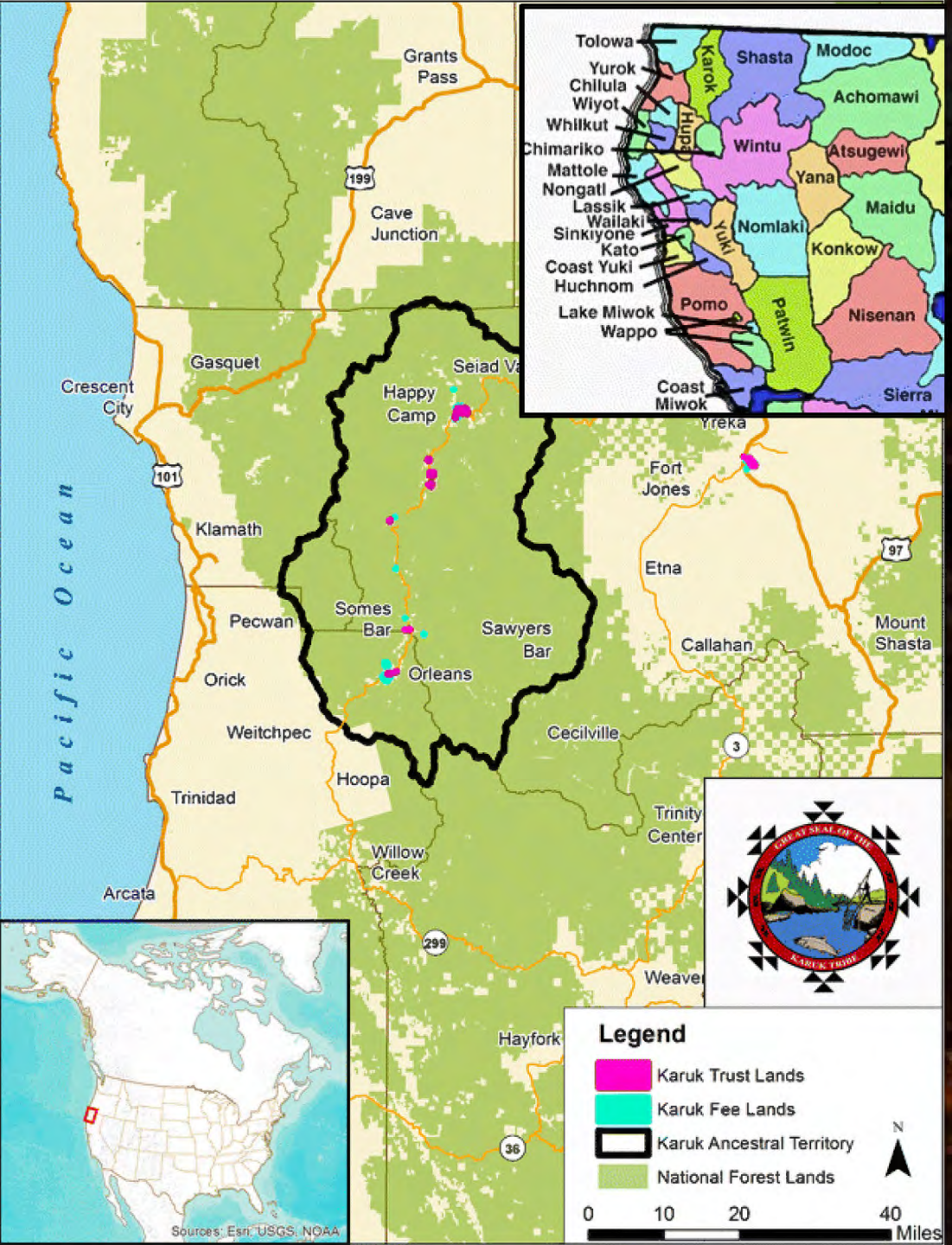
Delta Stewardship Council

Award #DSC22083 to AS

#DSC22082 to SB

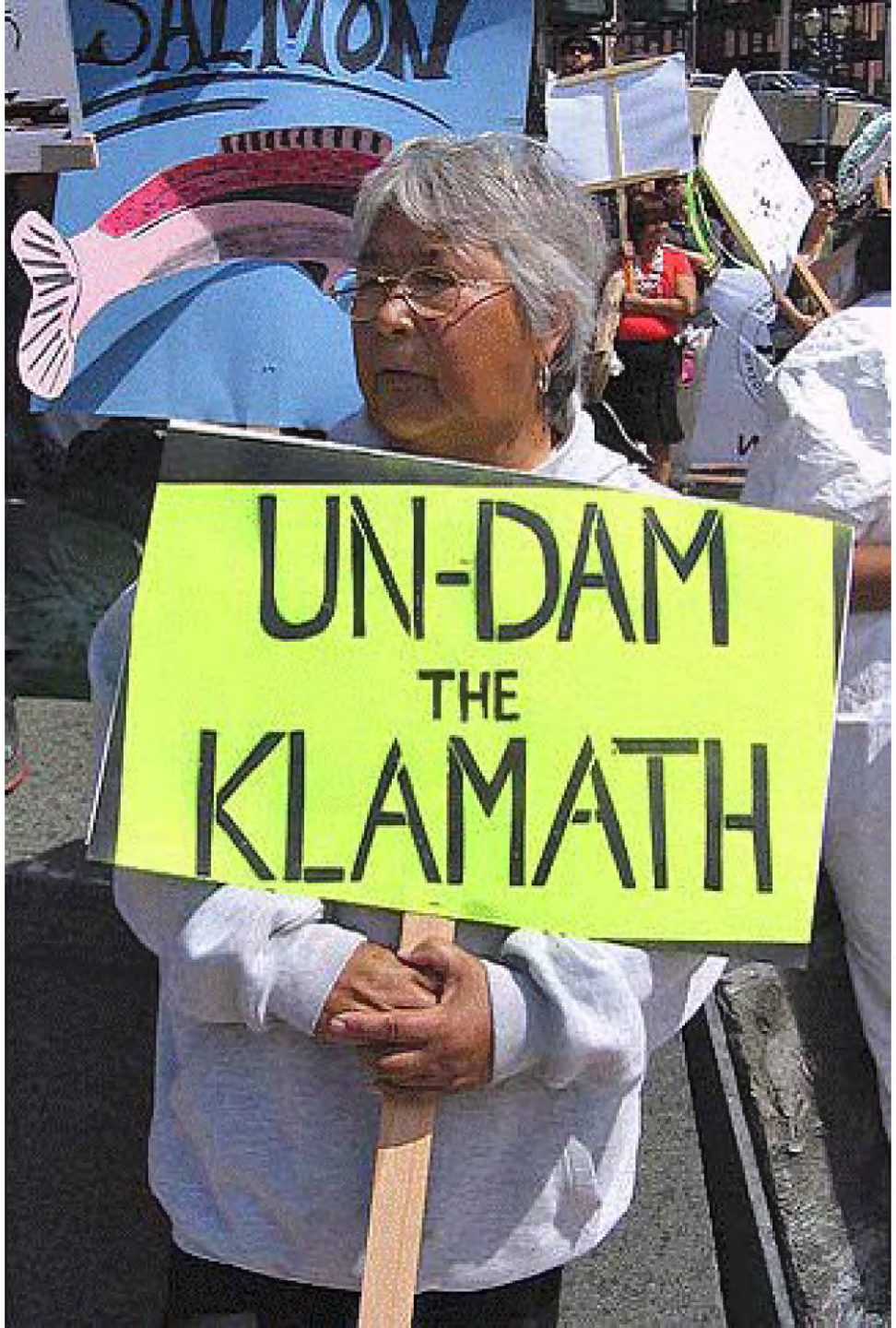
The Klamath Dams Fell, Now Let's Get to Work Restoring Fire for the Fish!

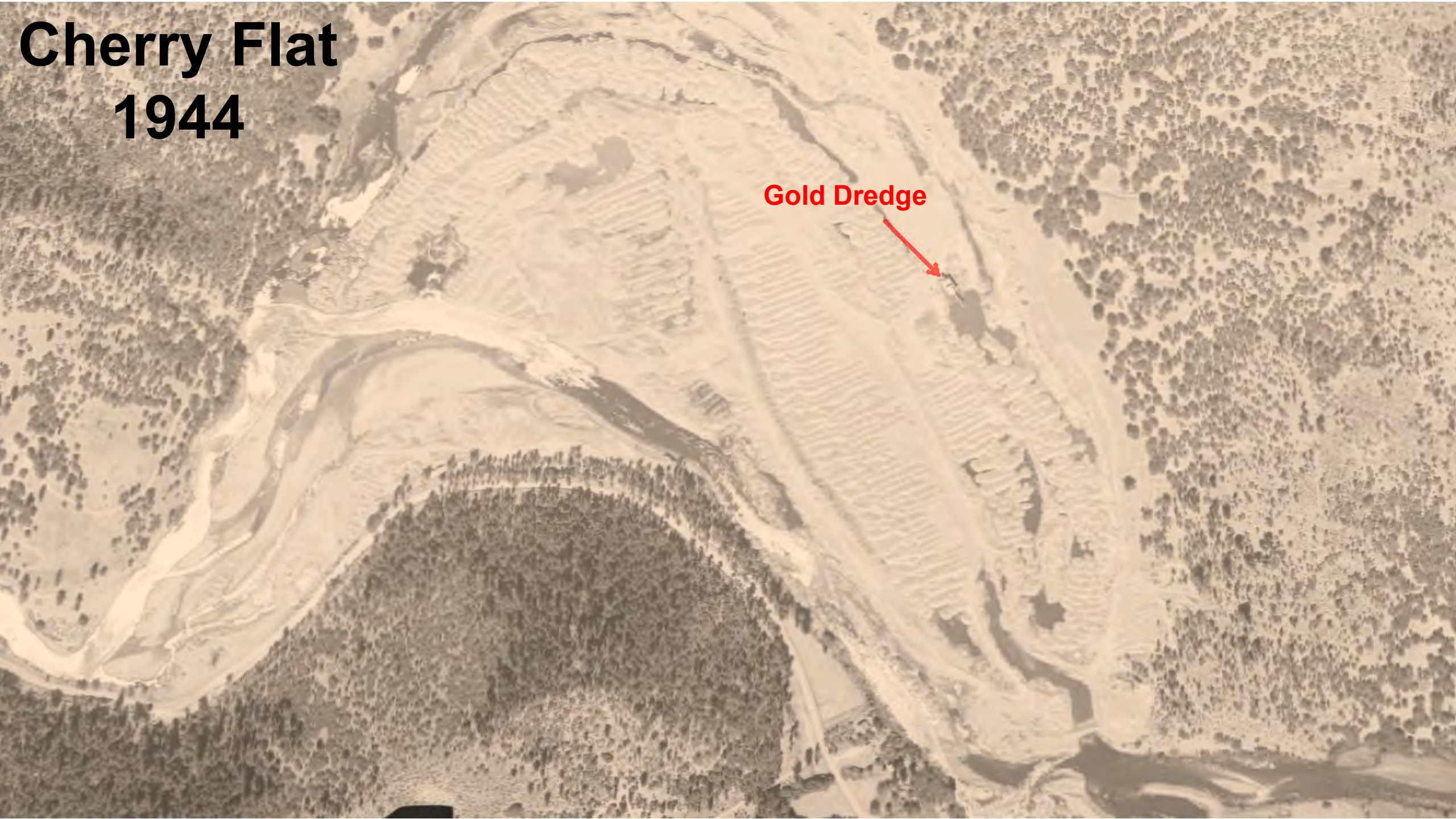
Will Harling – Restoration Director
Mid Klamath Watershed Council


Grants Pass
199
Cave Junction
Gasquet
Crescent City
Happy Camp
Seiad Va
101
Klamath
Pecwan
Somes Bar
Sawyers Bar
Orleans
Orick
Weitchpec
Hoopa
Trinidad
Arcata
Willow Creek
299
Hayfork
36
Yreka
Fort Jones
Etna
97
Callahan
Mount Shasta
Cecilville
3
Trinity Center
Weaver
Pacific Ocean
Tolowa
Yurok
Chilula
Wiyot
Whilkut
Chimariko
Mattole
Nongatl
Lassik
Wailaki
Sinkiyone
Kato
Coast Yuki
Huchnom
Lake Miwok
Wappo
Coast Miwok
Karok
Shasta
Modoc
Achomawi
Hupa
Wintu
Atsugewi
Yana
Maidu
Nomlaki
Yuki
Konkow
Pomo
Patwin
Nisenan
Sierra
Legend
Karuk Trust Lands
Karuk Fee Lands
Karuk Ancestral Territory
National Forest Lands
N
0 10 20 40
Miles
Sources: Esri, USGS, NOAA


CASIO

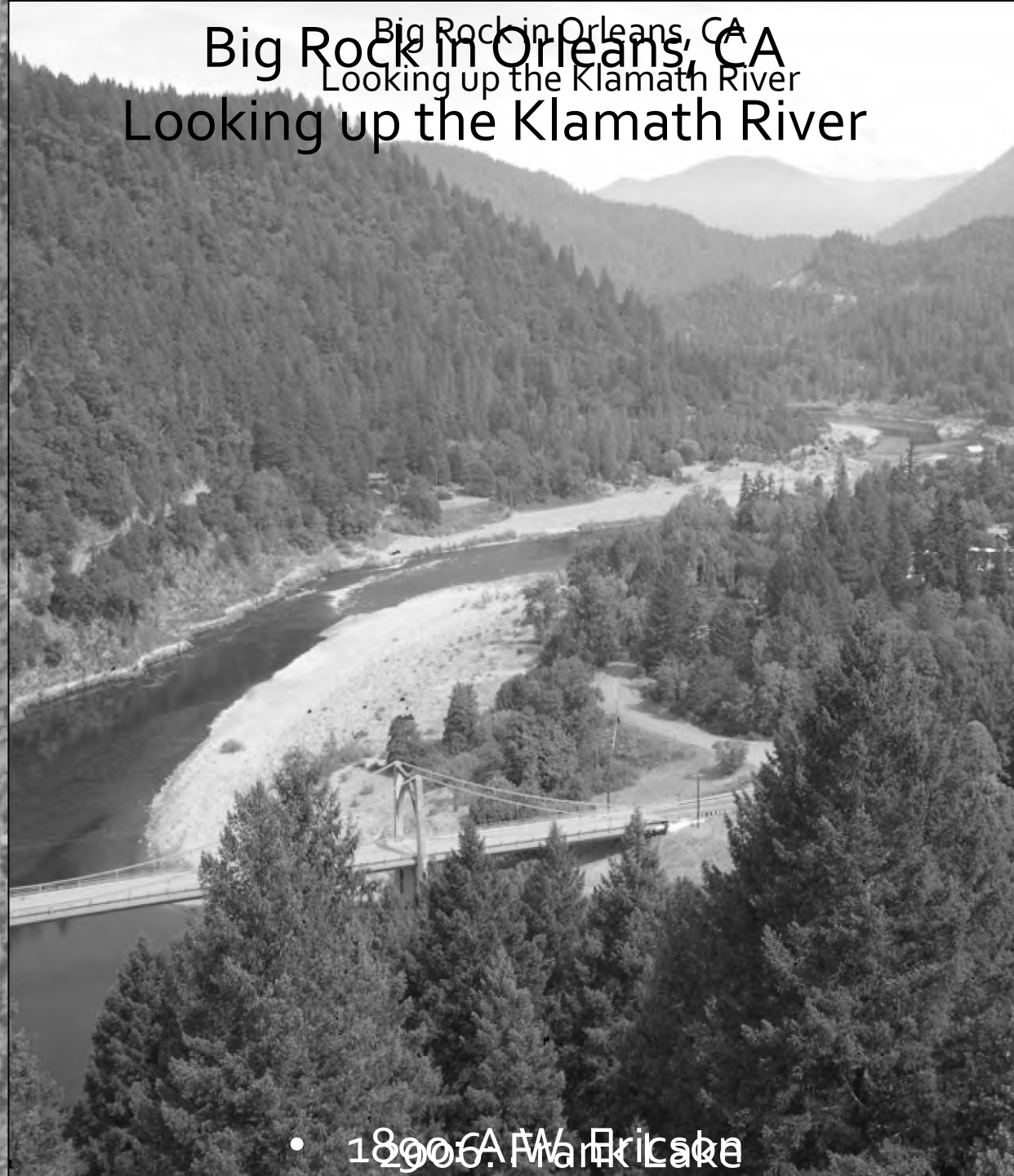

DAMS:
WEAPONS
OF MASS
OBSTRUCTION
SCOTTISH
POWER—
DO THE
RIGHT
THING
ScottishPowe
FIRST THE
BUFFALO
NOW THE
SALMON


SALMON
UN-DAM
THE
KLAMATH


Cherry Flat
1944
Gold Dredge

Ikxariatuyiiship – Offield Mountain – 1890's

Red Cap Glade - 2005

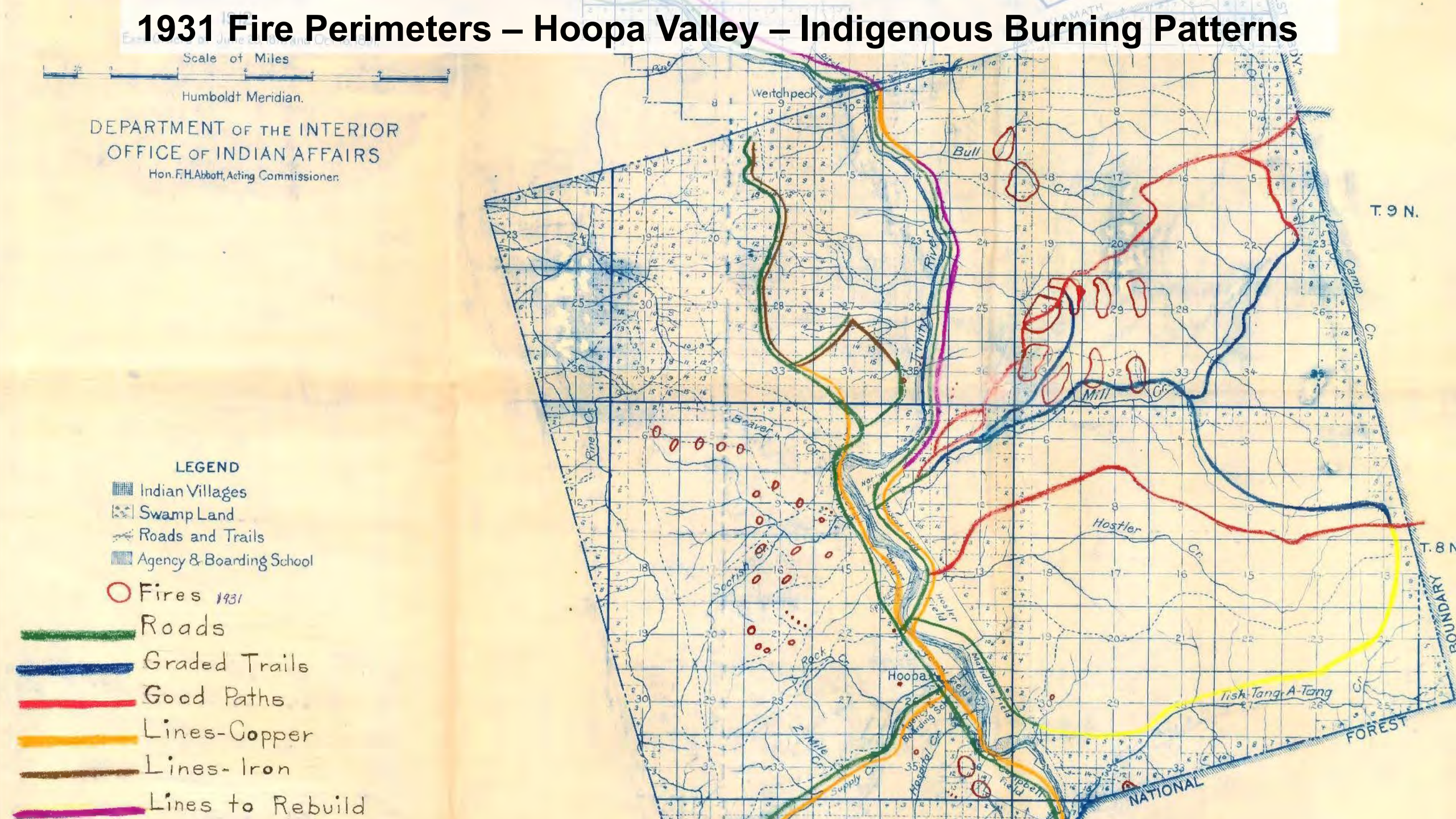


Big Rock in Orleans, CA

Looking up the Klamath River

- 1906: Frank Lake

1931 Fire Perimeters – Hoopa Valley – Indigenous Burning Patterns



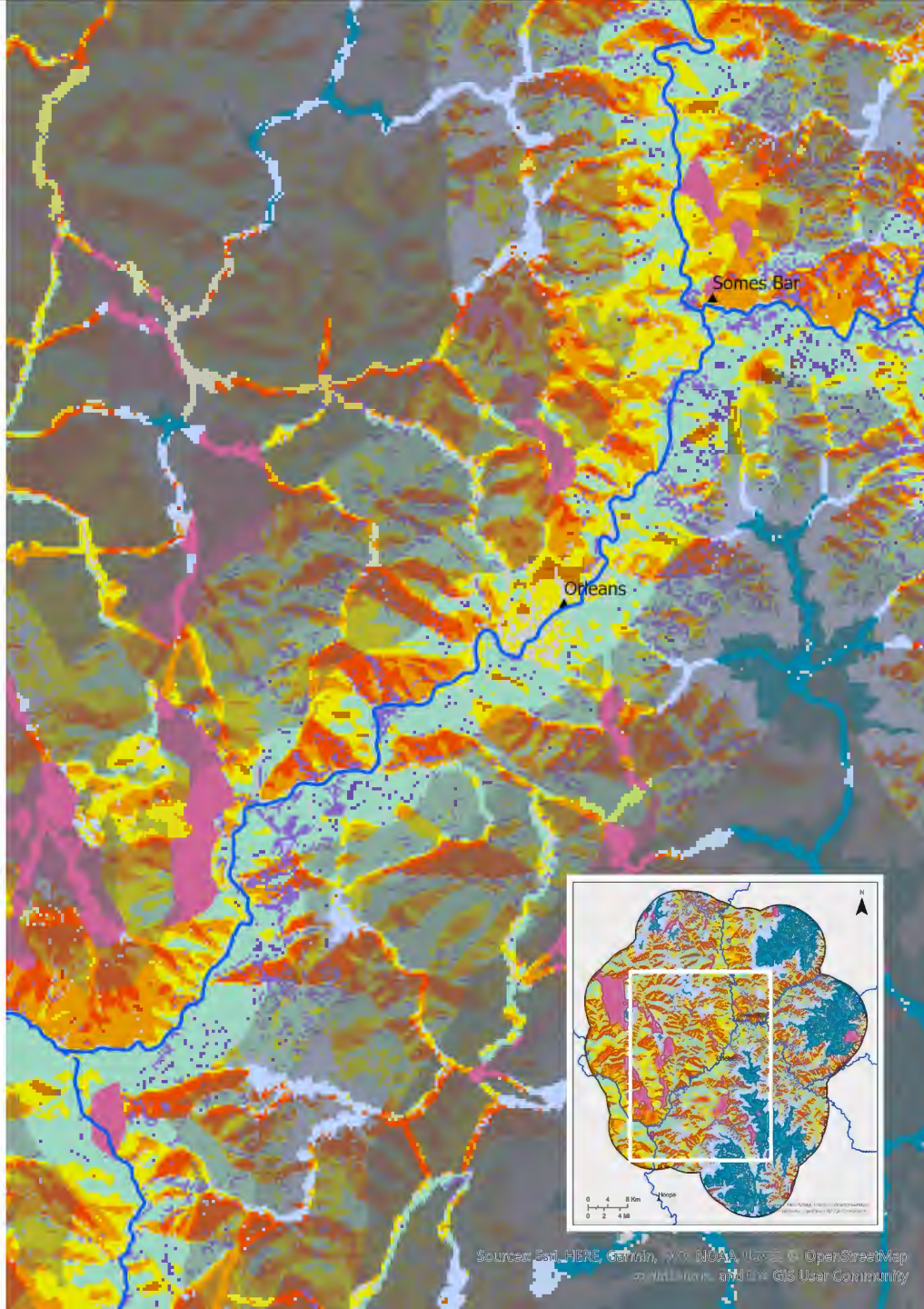
2023 – Greenler et al. Simulating Cultural Ignition Patterns in the Western Klamath Mountains

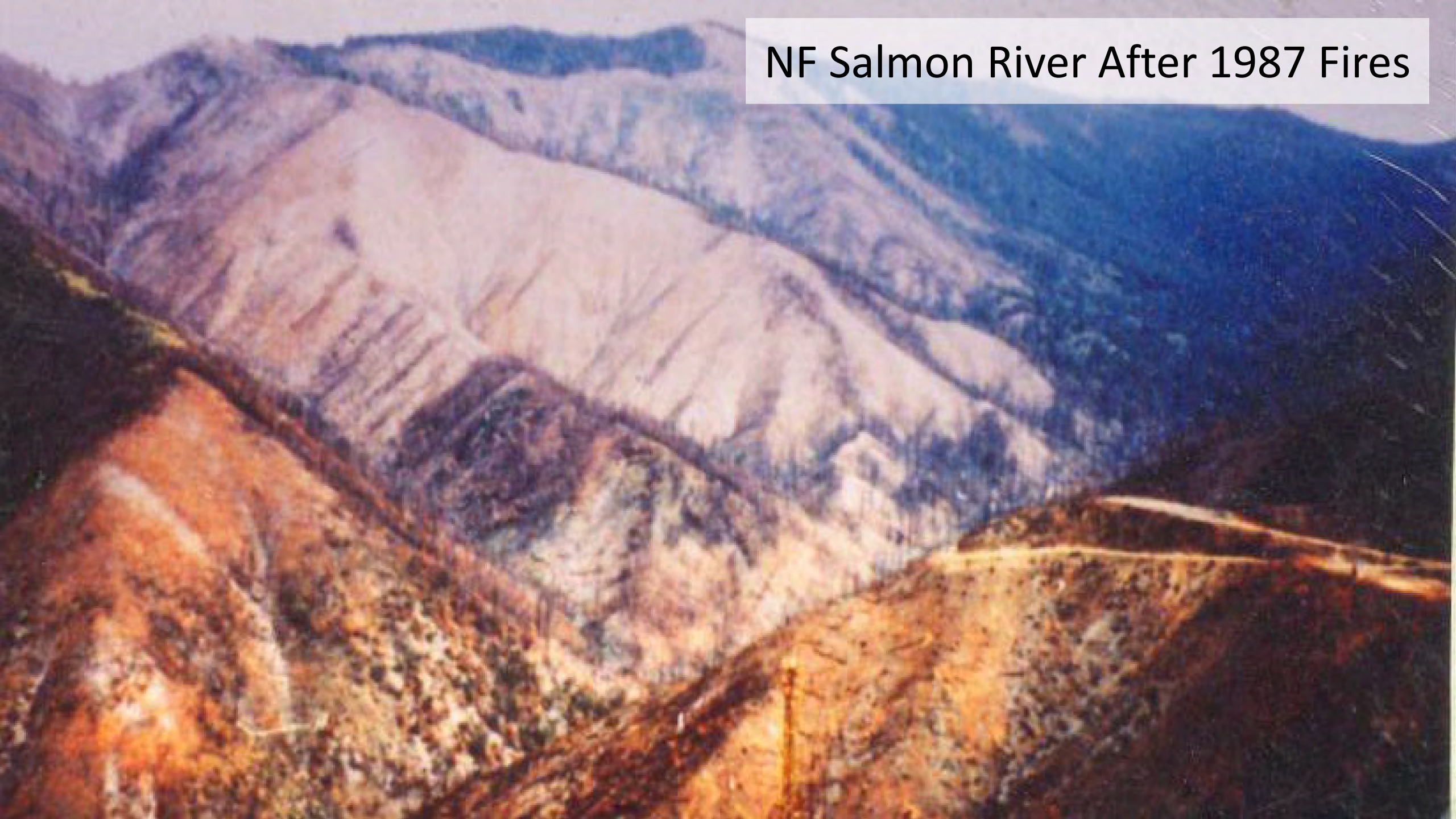
Map areas with estimated high levels of Indigenous fire stewardship

- Villages
- Trails and traversable ridges
- ~ 7,000 cultural ignitions annually on a 600,000 acre landscape.

[My father] said the fir trees were just startin' to grow around here [in the 1870s]. because ***the Indians kept the villages and the sides of the hills so well burned****. They were mostly just oak trees and they burned underneath them all the time. There was no brush.* ***You could see half a mile underneath the trees****.... **They just burned all the time, all their village sites and around up on the hillsides behind them.** So that there was no danger of fire... and the elk and the deer would have something to eat.*

– Mavis McCovey (born 1933)

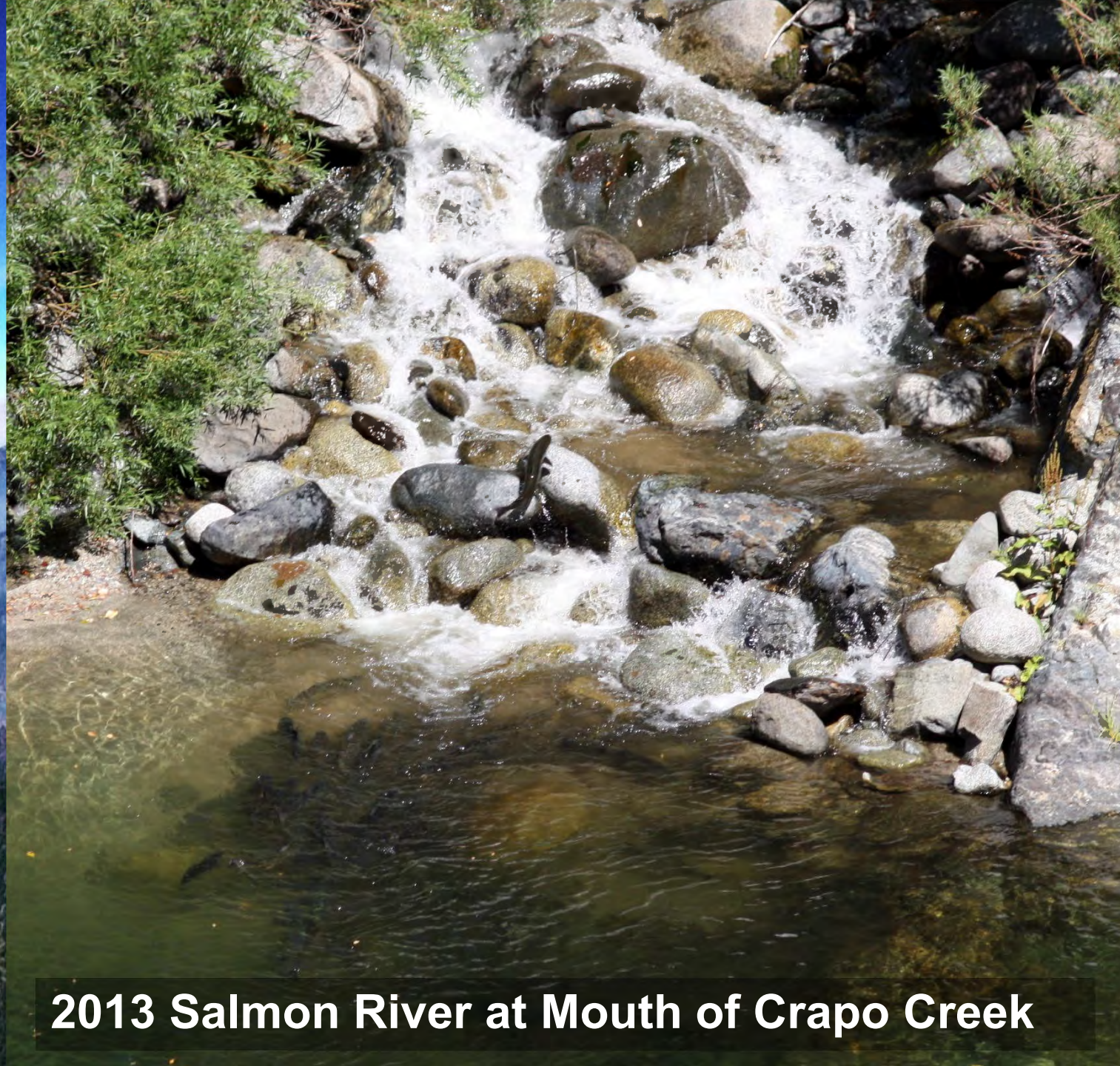


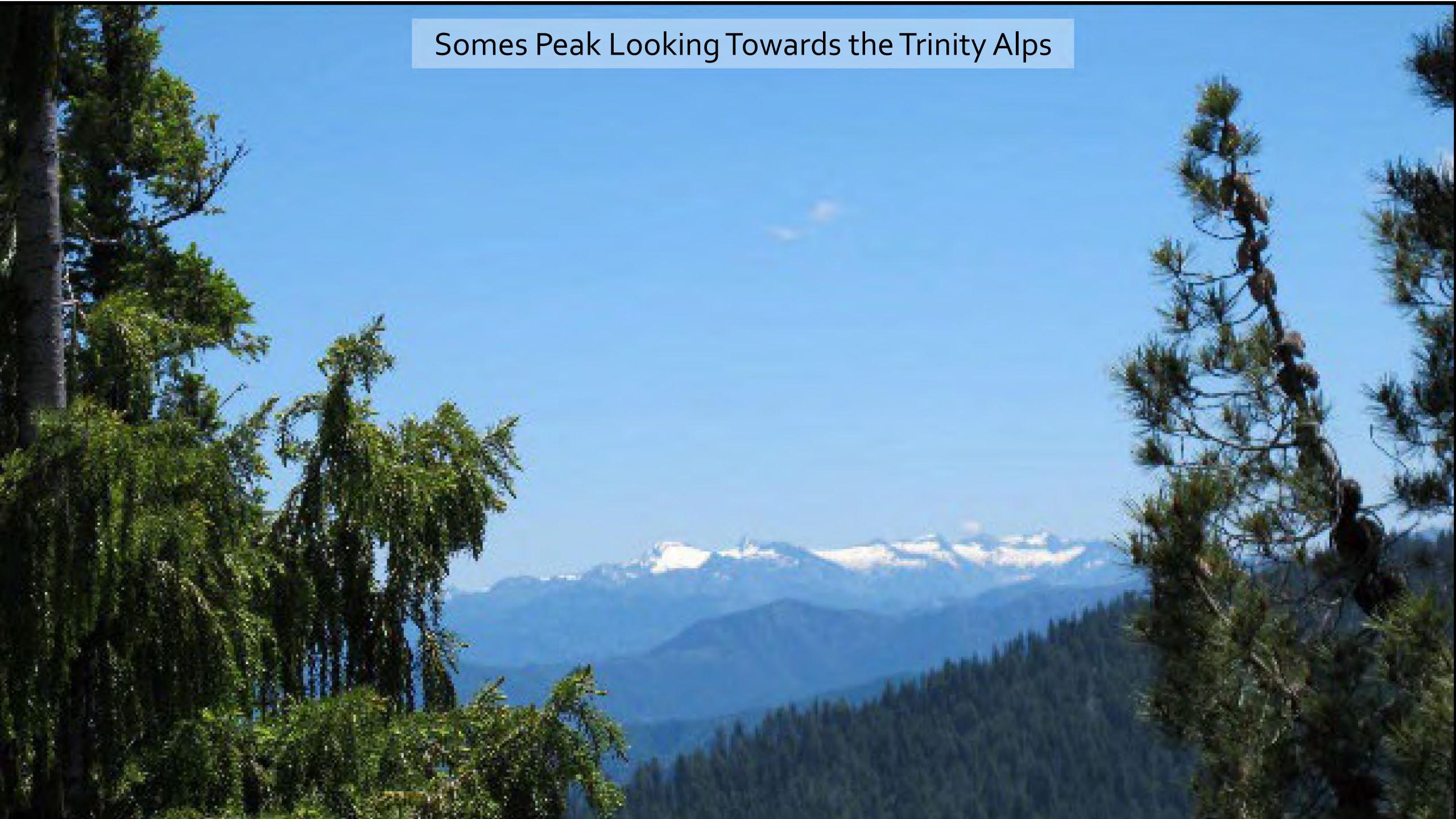

NF Salmon River After 1987 Fires


Sept 8, 2020
Slater Fire – Happy Camp
2018 Natchez Fire
Happy Camp
2017 Oak Fire
- 50 mph East wind with 3% humidity
- Burned 120,000 acres in 24hrs (30 mi. x 9 mi.)
- Over 230 homes burned
- Three Deaths
- Indian Creek flows increase over 40%


Grider Creek at Pacific Crest Trailhead
Feb 2015
July 2015
Photos: Mark Motyka


2015 Steinacher Fire in
Wooley Creek
Photo: Aja Conrad


2013 Salmon River at Mouth of Crapo Creek


Somes Peak Looking Towards the Trinity Alps


AQUALUNG
seaquest
AQUALUNG

Mid Klamath Watershed Council

MKWC plays a major role in building a restoration-based economy in the Western Klamath Mountains. We are results oriented and work through developed partnerships to plan and implement projects based on traditional cultural knowledge and the best available western science.

Community Liaison Program

Firewise Program

Engaging with fire management agencies during wildfire events through the Community Liaison Program

Fire Adapted Communities/ Fire Learning Network

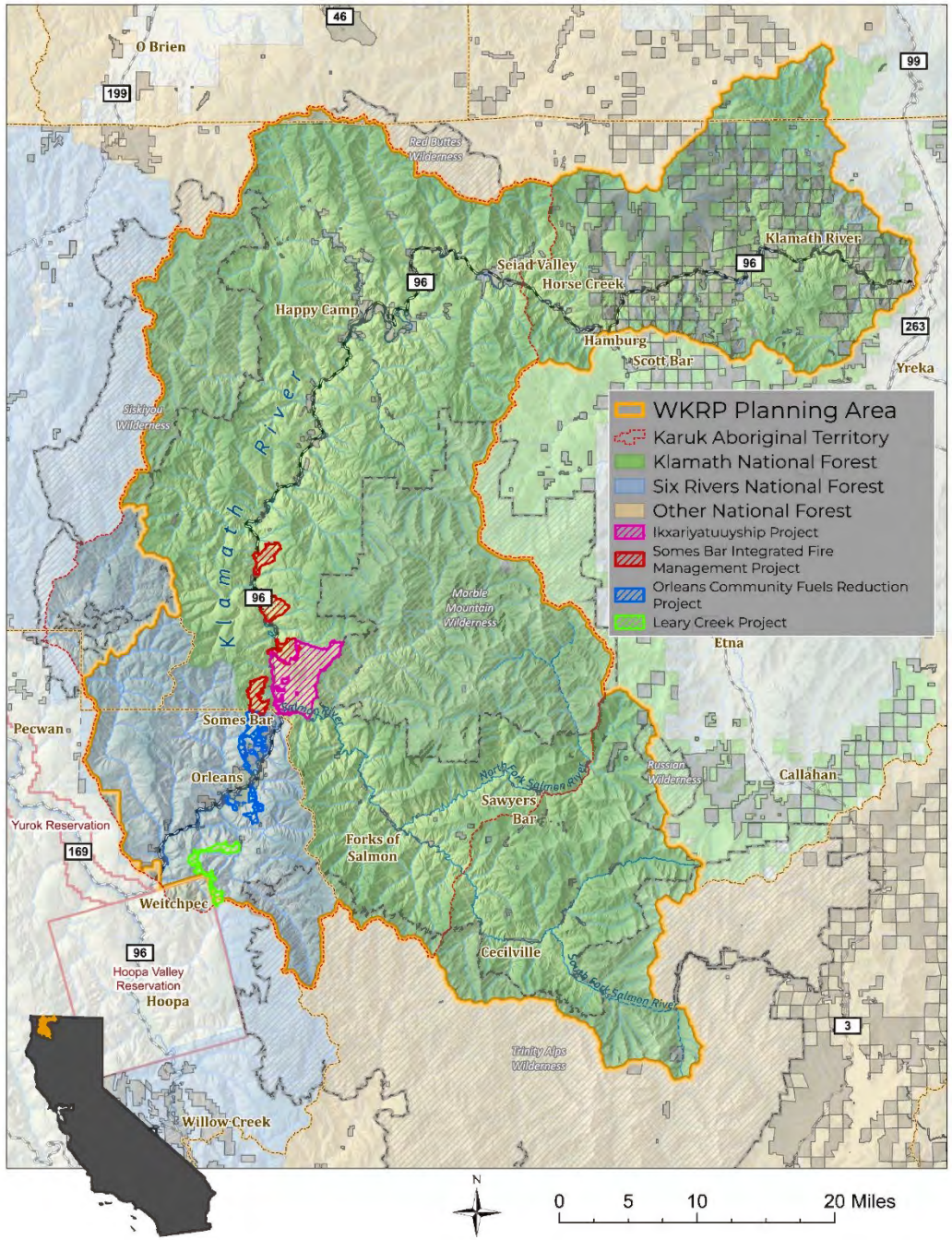
Fire Safe Councils


Brush
100 ft
From Your
Home
READY
?
100 ft


I Love Butter


wrk
it
out!

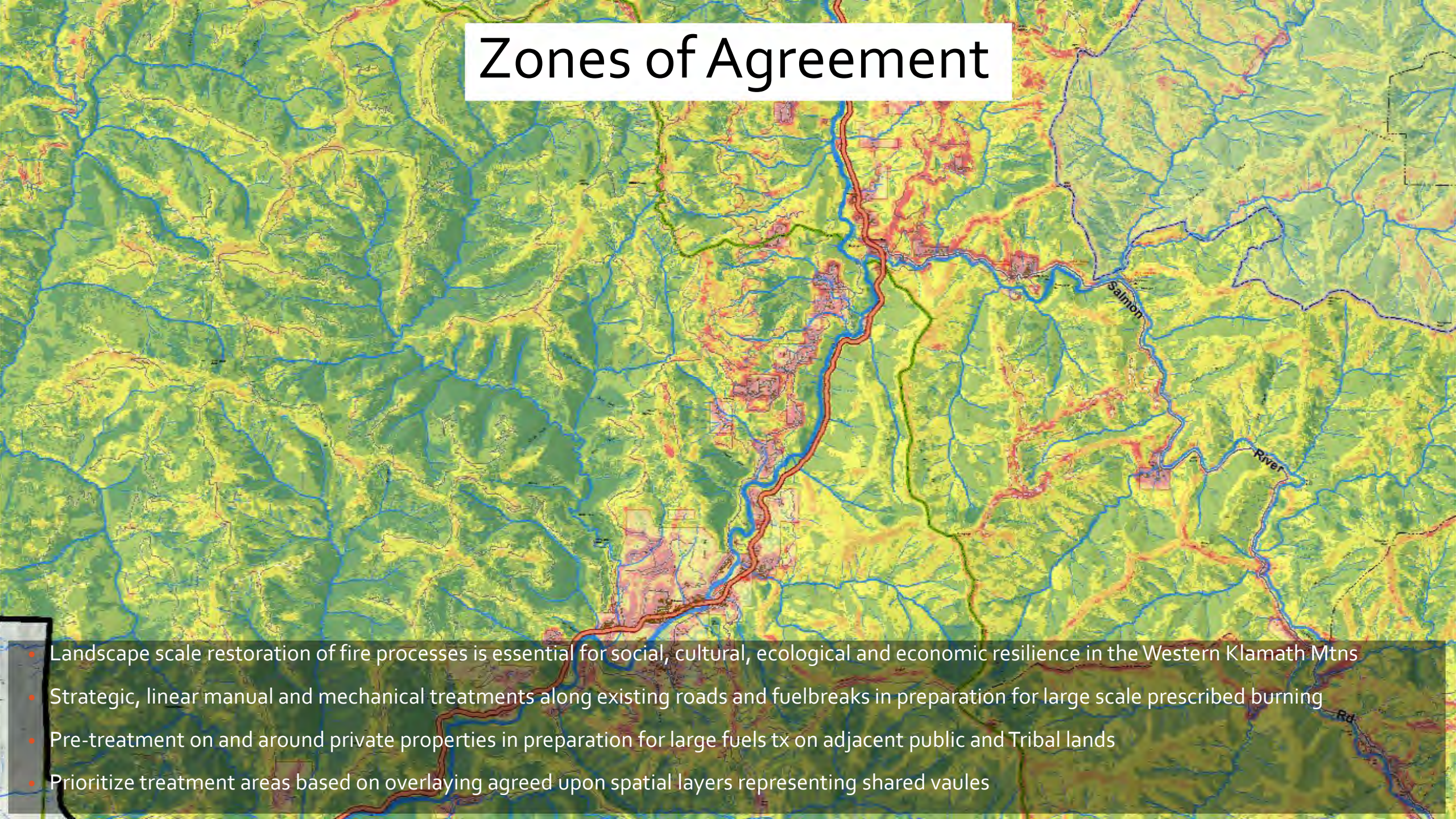
WKRP Geographic Scope and Planning Area



WESTERN KLAMATH RESTORATION PARTNERSHIP

- Began facilitated workshops w US Fire Learning Network in Spring 2013.
- Federal, State, Tribal, NGO, and local participants.
- Collaboratively identified planning area (1.6 million acres)
- Goal: Restore “historic” (natural w people) fire regimes in the Western Klamath Mtns.
- Plan big while implementing smaller projects together to build trust.
- ~ 70,000 project acres w NEPA/CEQA for RX Fire

Zones of Agreement



- Landscape scale restoration of fire processes is essential for social, cultural, ecological and economic resilience in the Western Klamath Mtns
- Strategic, linear manual and mechanical treatments along existing roads and fuelbreaks in preparation for large scale prescribed burning
- Pre-treatment on and around private properties in preparation for large fuels tx on adjacent public and Tribal lands
- Prioritize treatment areas based on overlaying agreed upon spatial layers representing shared vaules

Klamath Prescribed Fire Training Exchange (TREX) and All Hands All Lands (AHAL) Burn Programs

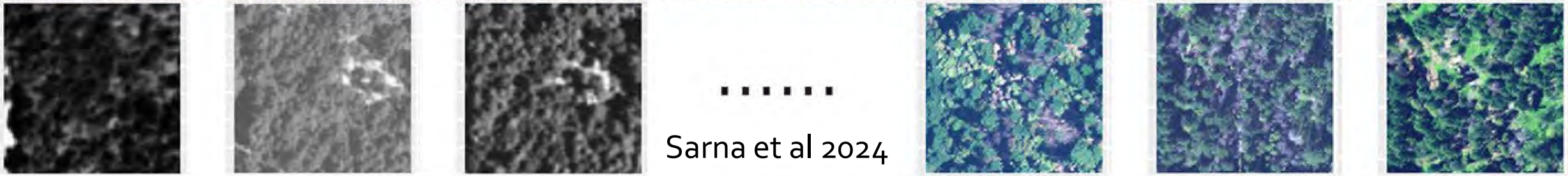
TREX and AHAL: Building Local Resources

Photo: Frank Lake

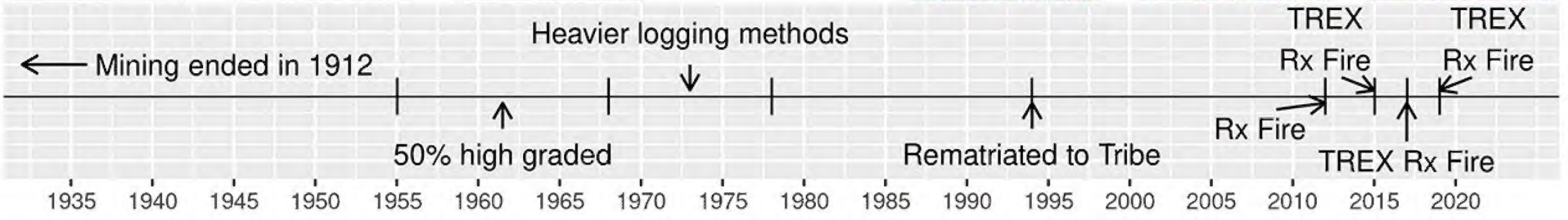
Photo: Stormy Staats


NATURAL


Track 1
7.52 mi | 04:49:19
snags
line
ainsaw work
Road
Hand
line
Possibl
arch si



Sarna et al 2024

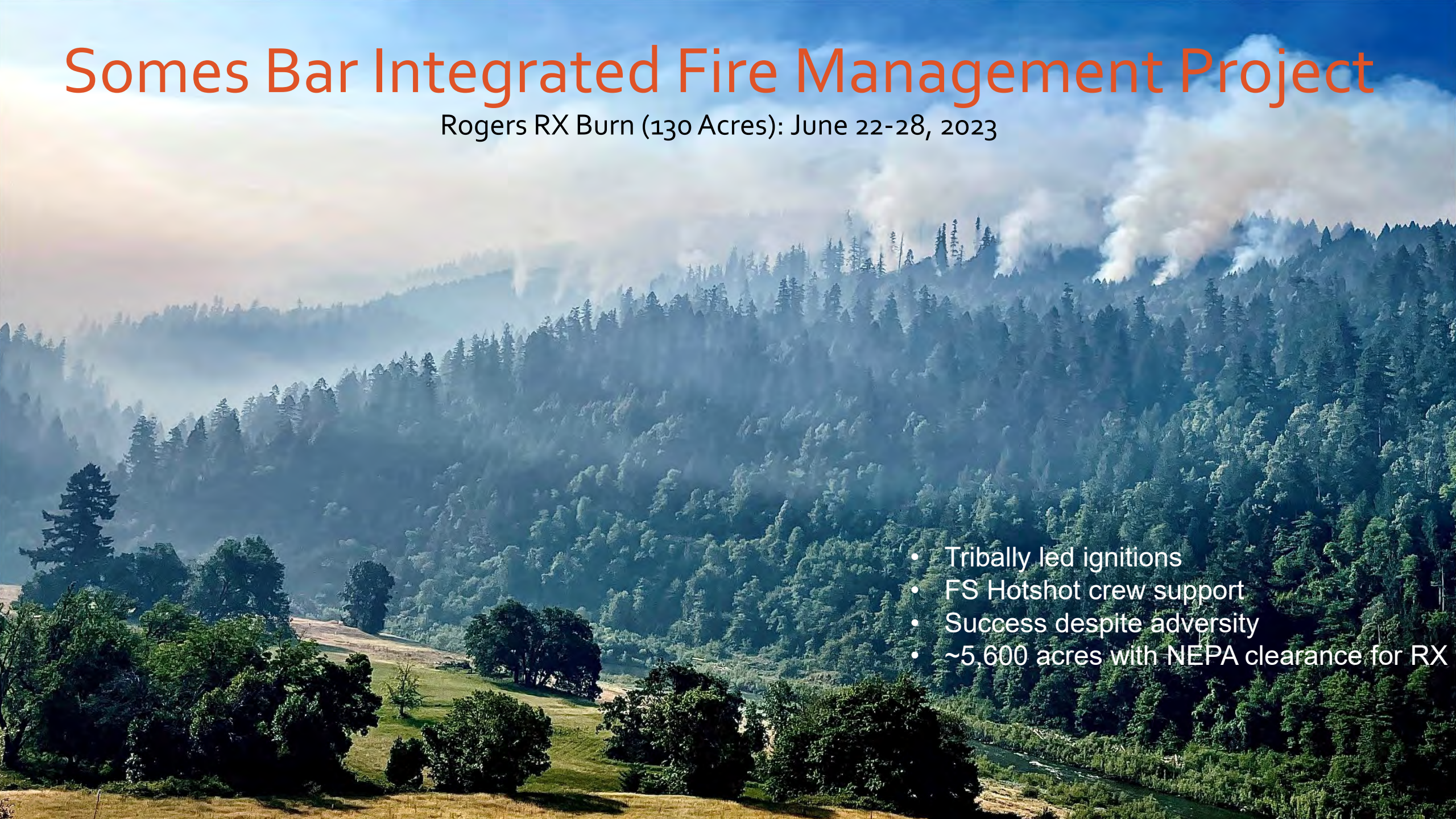


2014-2024 Klamath Prescribed Fire Training Exchange (TREX) Accomplishments

- 4,000+ acres burned on 220+ properties in the WUI of eight communities
- 800+ participants from 70+ local, tribal, state, national and international organizations
- No escaped fires, no serious injuries, no litigation

Somes Bar Integrated Fire Management Project

Rogers RX Burn (130 Acres): June 22-28, 2023

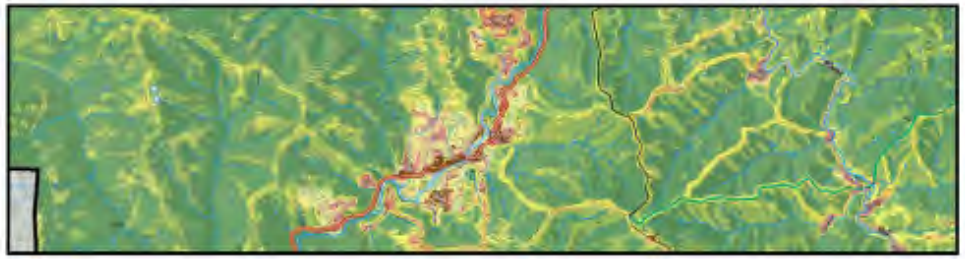


- Tribally led ignitions
- FS Hotshot crew support
- Success despite adversity
- ~5,600 acres with NEPA clearance for RX

Secure | https://www.wkrp.network

Western Klamath Restoration Partnership

A Plan for Restoring Fire Adapted Landscapes



Including Descriptions of the:

Somes Bar Integrated Fire Management Project

Submitted to:
Patricia Grantham, Forest Supervisor, Klamath National Forest

Principle Authors:
Will Harling - Mid Klamath Watershed Council
Bill Tripp - Karuk Tribe

June 30, 2014

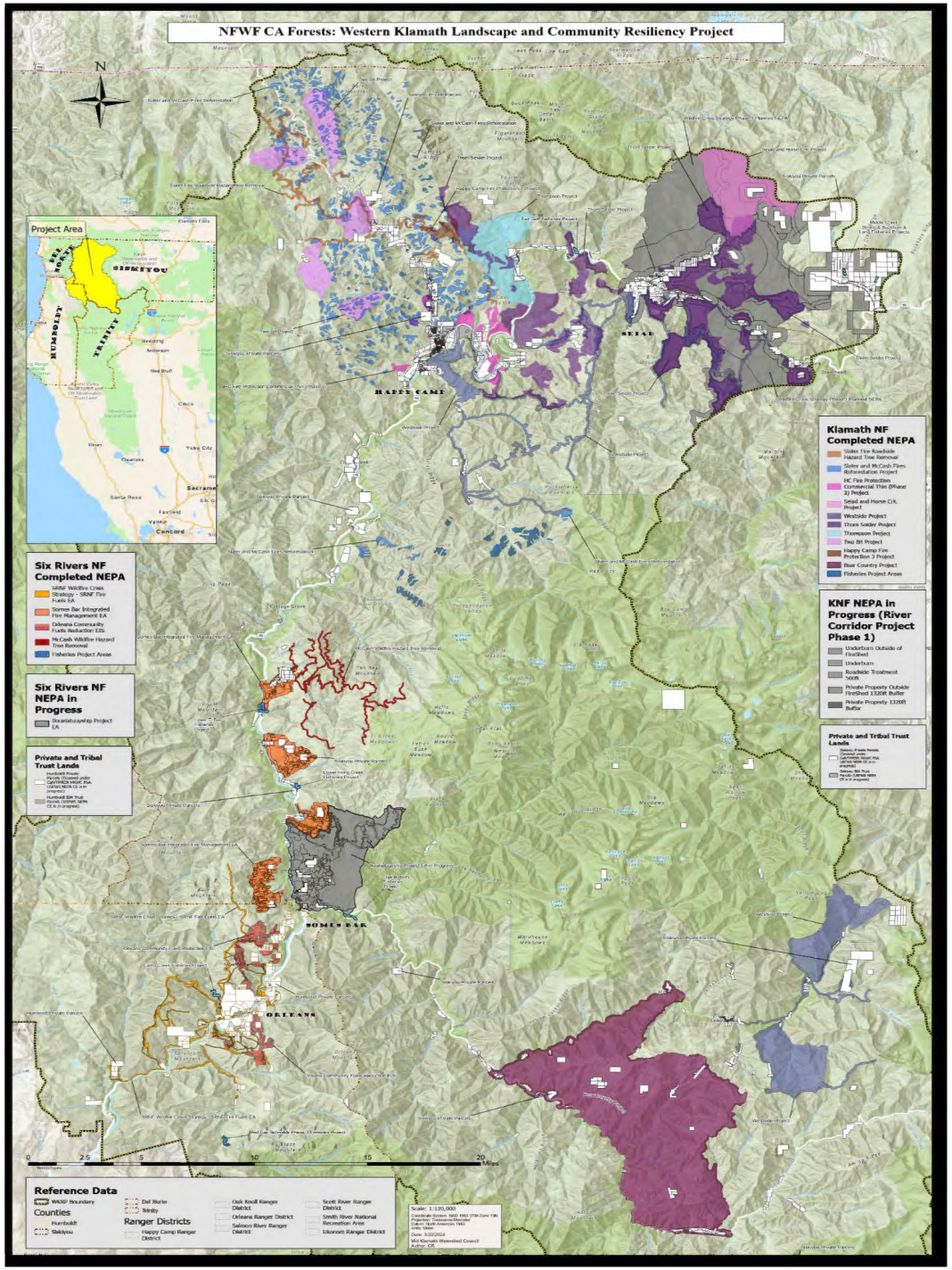
Special Thanks to:
Lynn Decker and Mary Huffman, US Fire Learning Network
Frank K. Lake, USFS Pacific Southwest Research Station
Jill Beckmann, Karuk Tribe Department of Emergency Services
Zeke Lunder and Paul Lackovic, Deer Creek GIS
Max Creasy, Ecologist

WESTERN KLAMATH RESTORATION PARTNERSHIP

The Slater Fire, September 8, 2020, encroaches on the town of Happy Camp, CA. Nearly 200 homes were lost as the fire burned over 90,000 acres on this day alone. Photo: Will Harling.

Post-Fire Management Recommendations

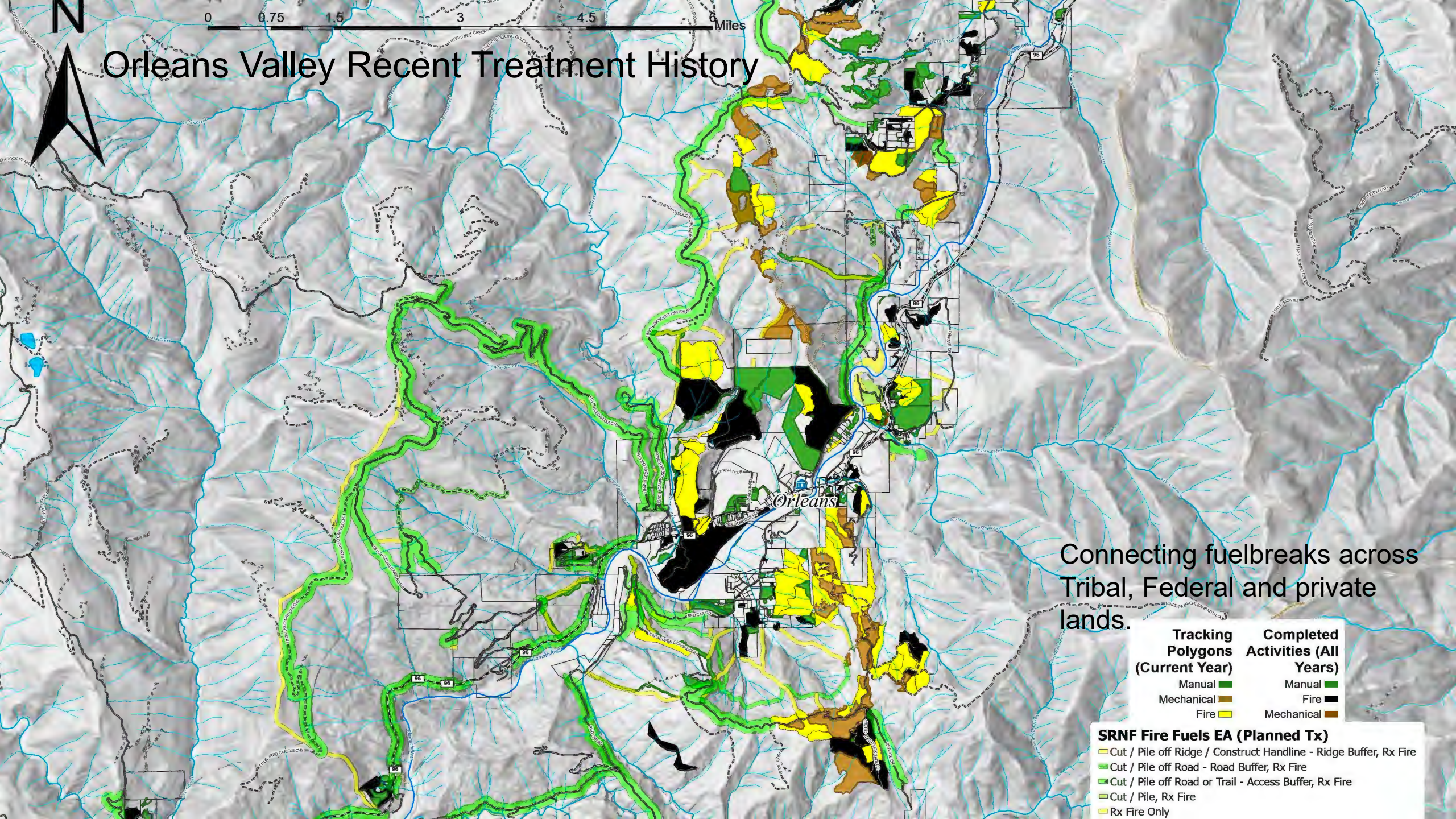
April 2021



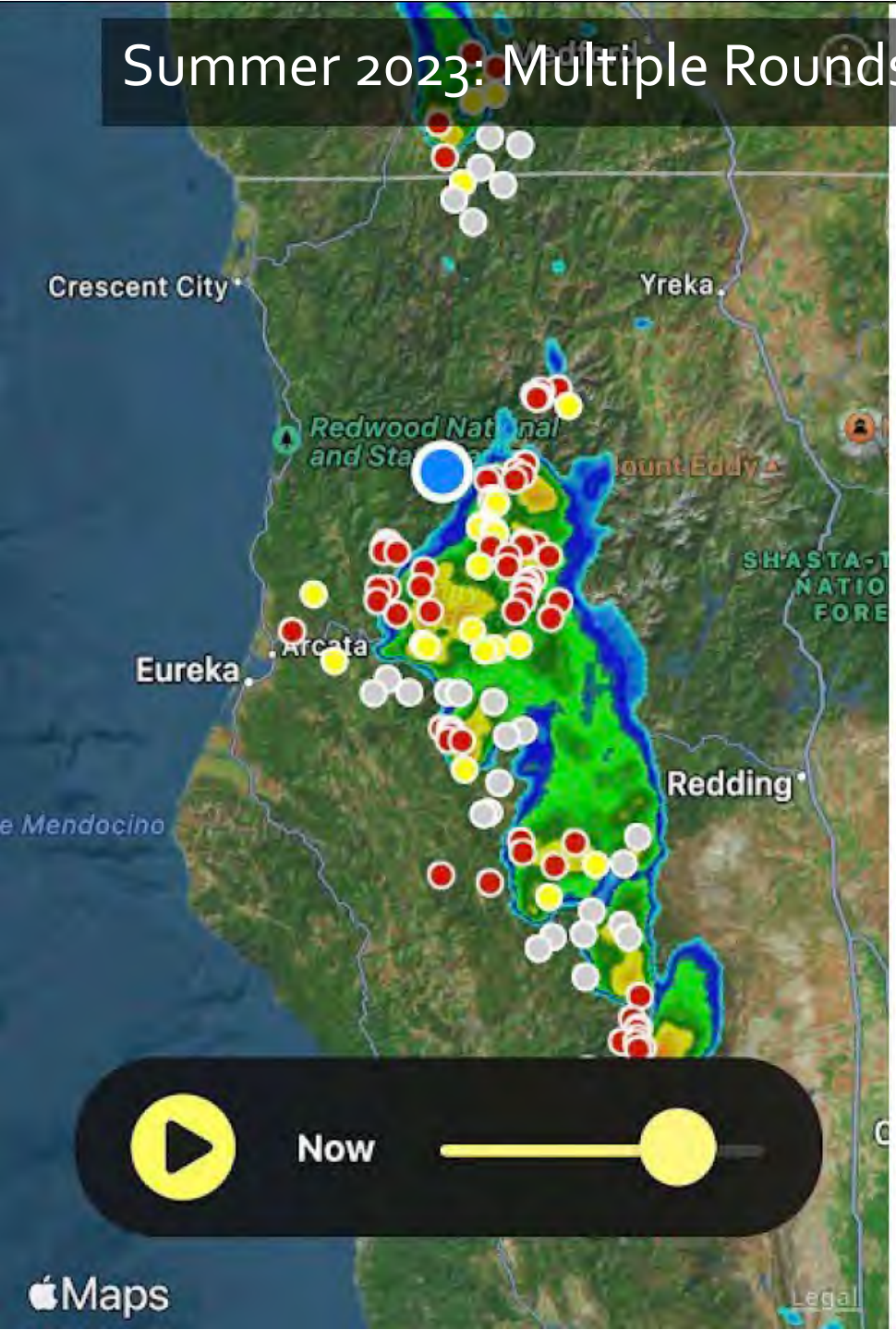
WESTERN KLAMATH RESTORATION PARTNERSHIP

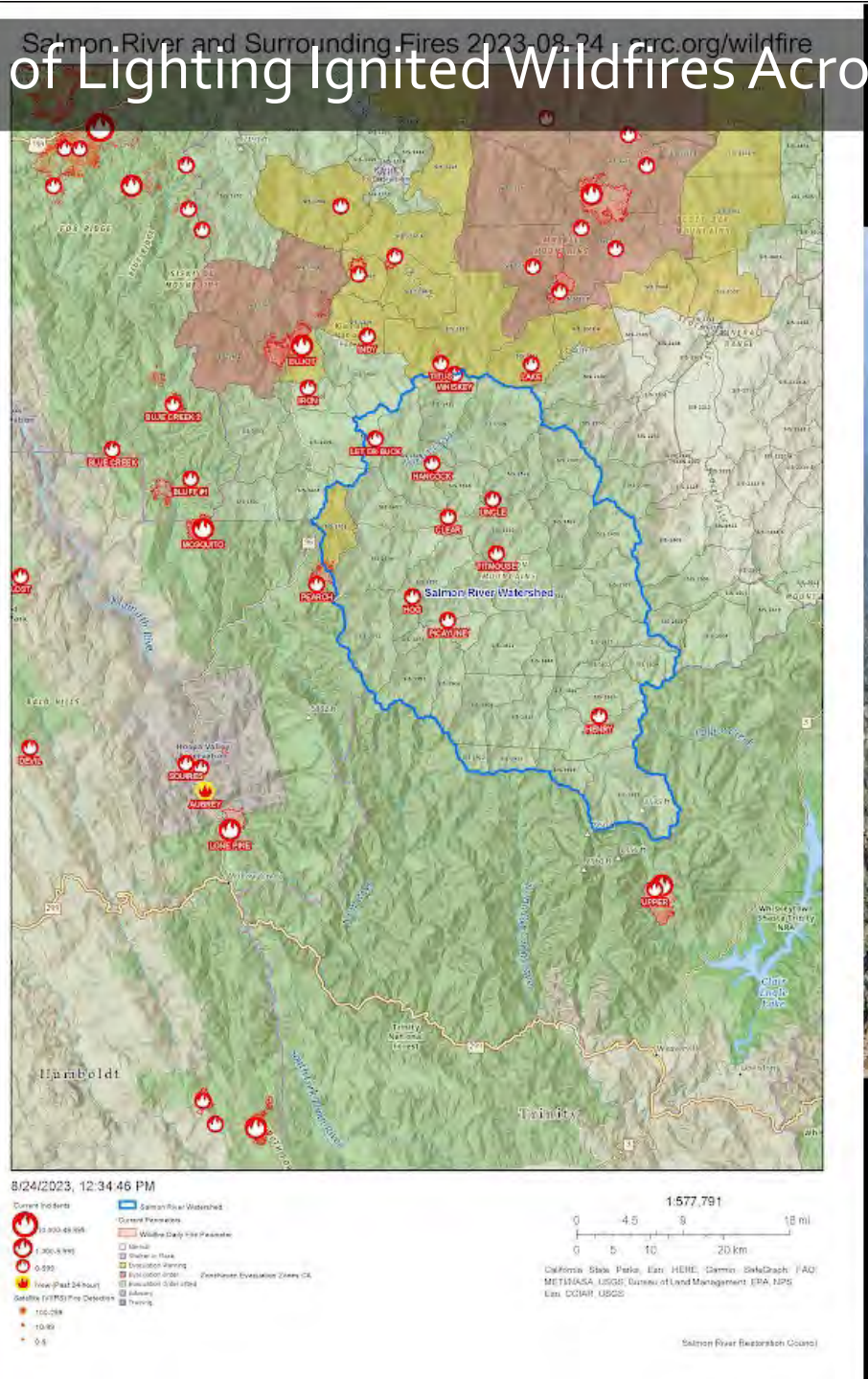
2018-2030 Funding: $69 million

- Collaborative Forest Landscape Restoration Program (CFLRP): $30 million over 10 years to restore fire process on 1.2 million acres.
  - Includes fire and fuels, invasive species, fish habitat, and meadow restoration treatments.
- $12 million in FY2023 between the KNF, SRNF and Tribe in BIL/IRA funding.
- $17 million from CAL FIRE FH to implement cultural and rx fire, and manual and mech thin.
- ~ $10 million from NFWF CA Forests for addressing bottlenecks in getting to scale.


N
0
0.75
1.5
3
4.5
6
Miles
Orleans Valley Recent Treatment History
Orleans
Connecting fuelbreaks across Tribal, Federal and private lands.
Tracking Polygons (Current Year)
Manual
Mechanical
Fire
Completed Activities (All Years)
Manual
Fire
Mechanical
SRNF Fire Fuels EA (Planned Tx)
Cut / Pile off Ridge / Construct Handline - Ridge Buffer, Rx Fire
Cut / Pile off Road - Road Buffer, Rx Fire
Cut / Pile off Road or Trail - Access Buffer, Rx Fire
Cut / Pile, Rx Fire
Rx Fire Only

Summer 2023: Multiple Rounds of Lighting Ignited Wildfires Across Northern CA





Fire Progression

2023 SRF Lightning Complex
CA-SRF-000986

10/09/2023 Day

Marlow, Mosquito, Pearch, and Let er-Buck Fires

Date	Total Acres	Growth
20230817 @ 2049	0ac	+0ac
20230819 @ 1036	396ac	+396ac
20230820 @ 2023	3,039ac	+2,643ac
20230821 @ 2213	3,212ac	+173ac
20230822 @ 0644	3,459ac	+247ac
20230823 @ 2330	4,403ac	+944ac
20230824 @ 2200	5,258ac	+855ac
20230826 @ 2203	6,095ac	+837ac
20230827 @ 2146	8,208ac	+2,113ac
20230828 @ 2150	9,239ac	+1,031ac
20230829 @ 0720	10,774ac	+1,535ac
20230830 @ 0847	12,310ac	+1,536ac
20230831 @ 1151	13,992ac	+1,682ac
20230901 @ 0725	14,138ac	+146ac
20230903 @ 2053	14,427ac	+289ac
20230904 @ 1916	15,103ac	+676ac
20230905 @ 2049	15,295ac	+192ac
20230907 @ 2023	15,339ac	+44ac
20230908 @ 2023	15,676ac	+337ac
20230909 @ 2023	15,947ac	+271ac
20230910 @ 2023	16,399ac	+452ac
20230911 @ 2023	16,651ac	+252ac
20230912 @ 2023	17,263ac	+612ac
20230913 @ 2023	17,761ac	+498ac
20230914 @ 0904	18,740ac	+979ac
20230915 @ 1440	21,272ac	+2,532ac
20230916 @ 1732	23,419ac	+2,147ac
20230917 @ 1922	26,295ac	+2,876ac
20230918 @ 1353	28,725ac	+2,430ac
20230919 @ 2005	30,448ac	+1,723ac
20230920 @ 2130	32,926ac	+2,478ac
20230921 @ 2015	34,015ac	+1,089ac
20230922 @ 1630	37,294ac	+3,279ac
20230923 @ 1536	42,572ac	+5,278ac
20230926 @ 2043	46,960ac	+4,388ac
20230927 @ 1956	47,504ac	+544ac
20230928 @ 1300	47,563ac	+59ac
20230930 @ 1949	47,644ac	+81ac
20231001 @ 2133	47,658ac	+14ac
20231002 @ 2220	47,659ac	+1ac
20231005 @ 2041	47,856ac	+197ac
20231006 @ 2041	48,020ac	+164ac
20231007 @ 2011	48,186ac	+166ac
20231008 @ 2000	48,458ac	+272ac

0 1 2 3 4
Miles

N
W E
S

Acres from Infrared and GPS
NAD 1983 UTM Zone 10N

Marlow
1,997 acres

Siskiyou Wilderness

Blue Creek
1 acre

Mosquito
34,188 acres

Six Rivers National Forest

Iron
20 acres

Monument
2 acres

Let er-Buck
96 acres

Marble Mountain Wilderness

Hancock
1,728 acres

Merrill
2 acres

Klamath National Forest

Pearch
12,152 acres

Bigfoot
1 acre

Creek
8 acres

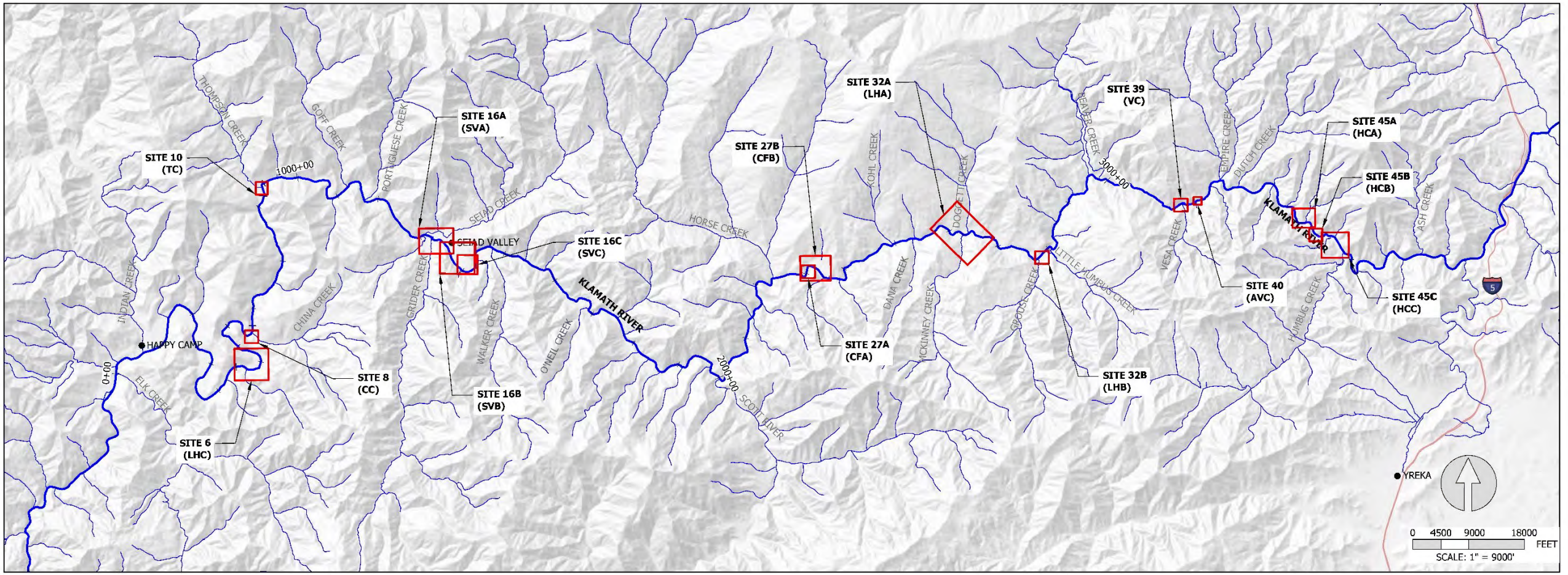
Flat
2 acres

Pony Peak
Cottage Grove
Somes Bar
Orleans
Black Mountain
Forks of Salmon
Yellow Jacket Ridge
Steinacher Ridge
Trail Mountain
Blue Creek
Bluff Creek
Woolley Creek
6965 ft
6820 ft
4912 ft
4860 ft
96

2023 SRF Lightning Complex – Community After Action Review (AAR)

September 20, 2024 - IMT Community Meeting
Karuk DNR, Orleans

2020 Slater Fire Footprint



MID-KLAMATH FLOODPLAIN HABITAT ENHANCEMENT PROJECT

SISKIYOU COUNTY, CA

Stillwater Sciences

850 G ST, SUITE K
ARCATA, CA 95521

P: (707) 822-9607

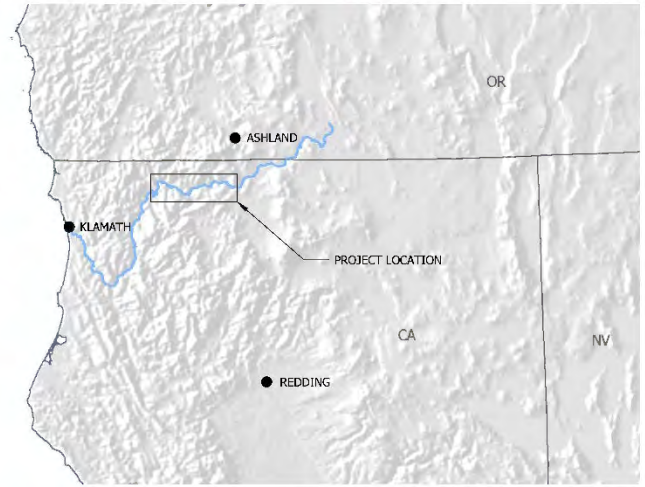
DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE — ADJUST ACCORDINGLY

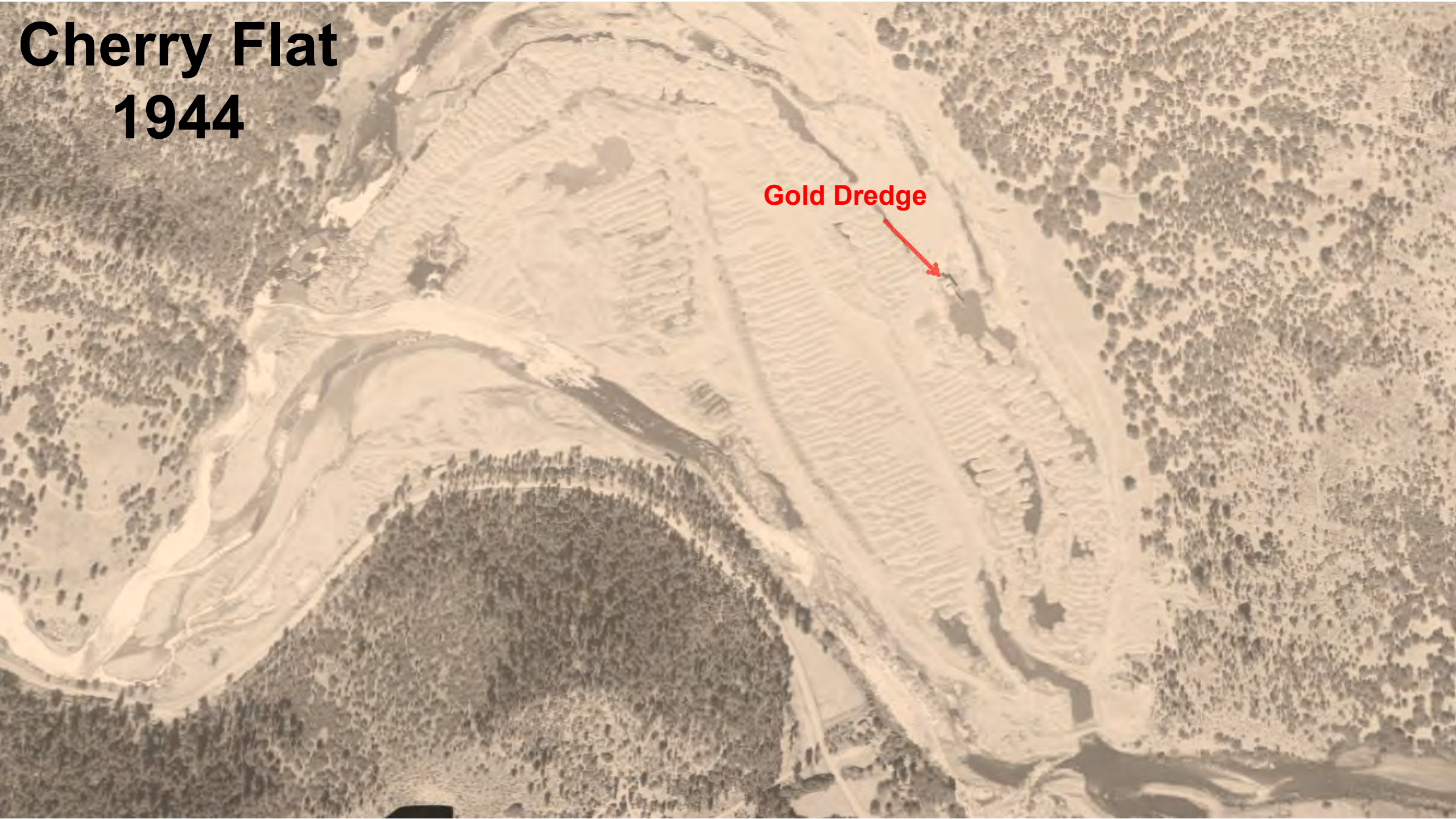
LEGEND

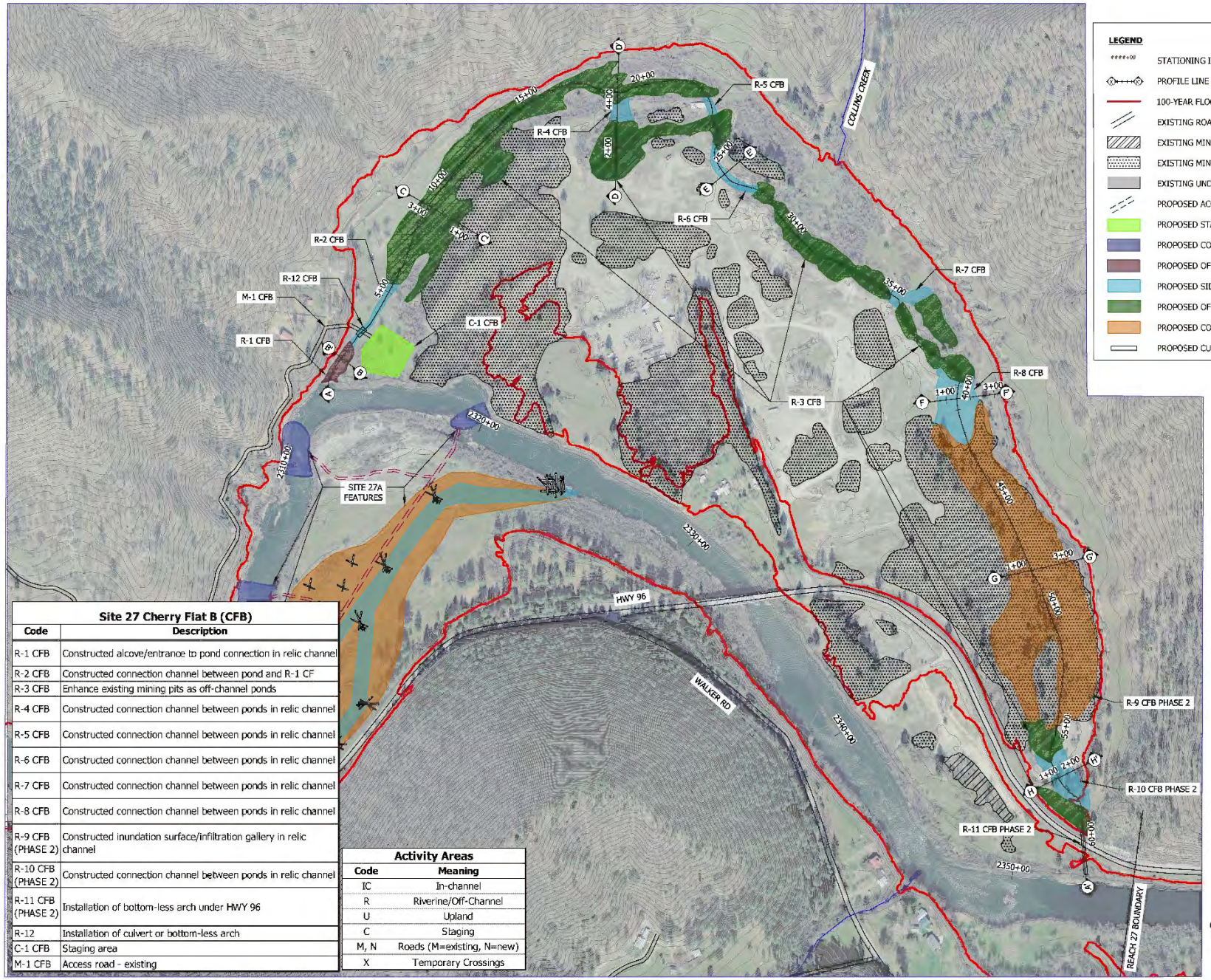
- KLAMATH RIVER
- ####+00 — STATIONING IN FEET
- TRIBUTARIES
- CITY
- SITE VIEW FRAME

Site List

Code	Design Site	Site No.	Reach No.
LHC	Little Horse Creek	6	6
CC	China Creek	8	8
TC	Thompson Creek	10	10
SVA	Lower Seiad Valley	16A	16
SVB	Mid-Seiad Valley	16B	16
SVC	Upper Seiad Valley	16C	16
CFA	Cherry Flat A	27A	27
CFB	Cherry Flat B	27B	27
LHA	Little Humbug Creek A	32A	32
LHB	Little Humbug Creek B	32B	32
VC	Vesa Creek	39	39
AVC	Above Vesa Creek	40	40
HCA	Lower Humbug Creek	45A	45
HCB	Humbug Creek	45B	45
HCC	Upper Humbug Creek	45C	45




Cherry Flat
1944
Gold Dredge



Site 27 Cherry Flat B (CFB)

Code	Description
R-1 CFB	Constructed alcove/entrance to pond connection in relic channel
R-2 CFB	Constructed connection channel between pond and R-1 CF
R-3 CFB	Enhance existing mining pits as off-channel ponds
R-4 CFB	Constructed connection channel between ponds in relic channel
R-5 CFB	Constructed connection channel between ponds in relic channel
R-6 CFB	Constructed connection channel between ponds in relic channel
R-7 CFB	Constructed connection channel between ponds in relic channel
R-8 CFB	Constructed connection channel between ponds in relic channel
R-9 CFB (PHASE 2)	Constructed inundation surface/infiltration gallery in relic channel
R-10 CFB (PHASE 2)	Constructed connection channel between ponds in relic channel
R-11 CFB (PHASE 2)	Installation of bottom-less arch under HWY 96
R-12	Installation of culvert or bottom-less arch
C-1 CFB	Staging area
M-1 CFB	Access road - existing

Activity Areas

Code	Meaning
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

MID-KLAMATH FLOODPLAIN HABITAT ENHANCEMENT PROJECT

SISKIYOU COUNTY, CA

Stillwater Sciences
850 G ST, SUITE K
ARCATA, CA 95521
P: (707) 822-9607

SCALE: AS NOTED
DATE: 1/29/19

DESIGN: JS
DRAWN: RT
CHECKED: JM
APPROVED: ----

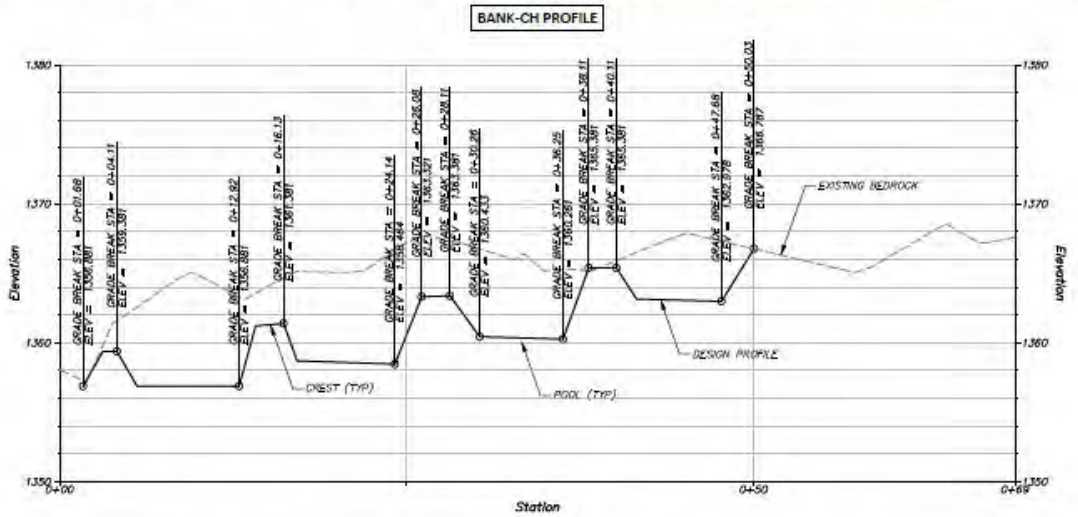
SITE 27B - UPPER CHERRY FLAT (CFB)

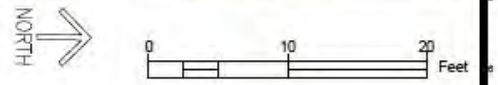
PLAN VIEW

West Fork Beaver Creek Heliwood Loading Project

West Fork Beaver Creek Helicopter Wood Loading Project

East Fork Elk Creek Fish Passage





Mid-Klamath Watershed Council
dkdkd

Cascade Stream Solutions
961 Bellview Ave.
Ashland, Oregon 97520
Phone: (541) 864-0492

Drawing Information	
Date	30 March 2021
Status	30% Submittal
Designer	jh
Drafter	jh
Checked	
File Name	EXIST
Plotted Scale	0 1/2 1

Revisions		
No.	Date	Description

PRELIMINARY
NOT FOR CONSTRUCTION

Elk Creek Barrier Removal

Concept Plan and Profile

Job Number

Sheet Number
1
Sheet 1 of

East Fork Elk Creek Fish Passage

Winter 2025

Summer 2024

Middle Creek Off-Channel Coho Habitat Enhancement

Red Cap at Schnable Bar Phase I and II

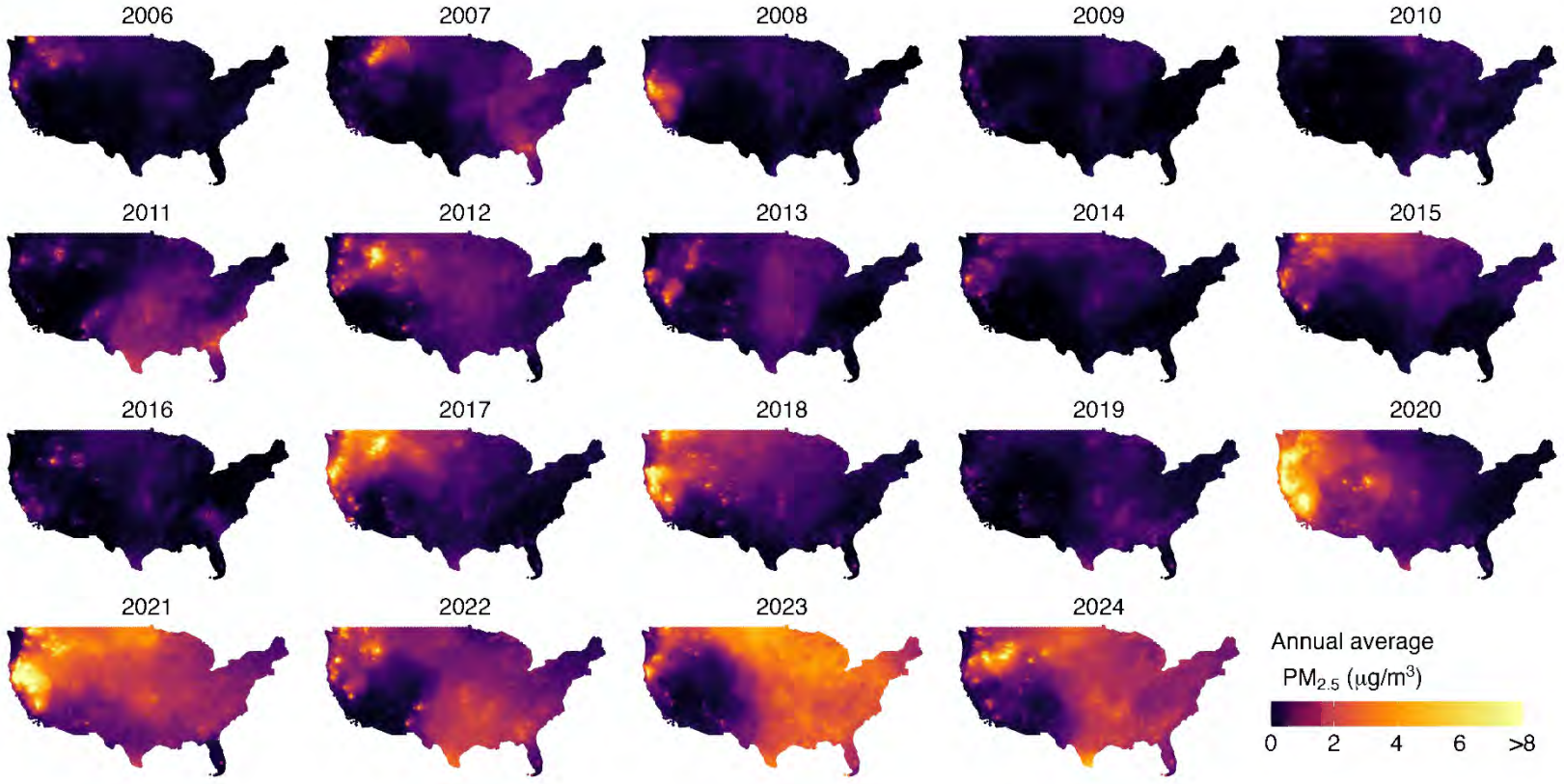

Lower Beaver Creek Aquatic Habitat Restoration Project

2025 Project Work

- Seiad at Panther Gulch – Channel Restoration
- Horse Creek at Fish Gulch – Channel Restoration
- Mill Creek on Indian Creek – Wood Loading
- Doolittle Creek on Indian Creek – Accelerated Wood Loading
- Thompson Creek – Off Channel Pond/Rx Fire
- Middle Creek – OCP/Channel Restoration

June 2024 – Cooley Ranch Burn

U.S. Annual Cumulative Smoke Exposure: 2006-2024

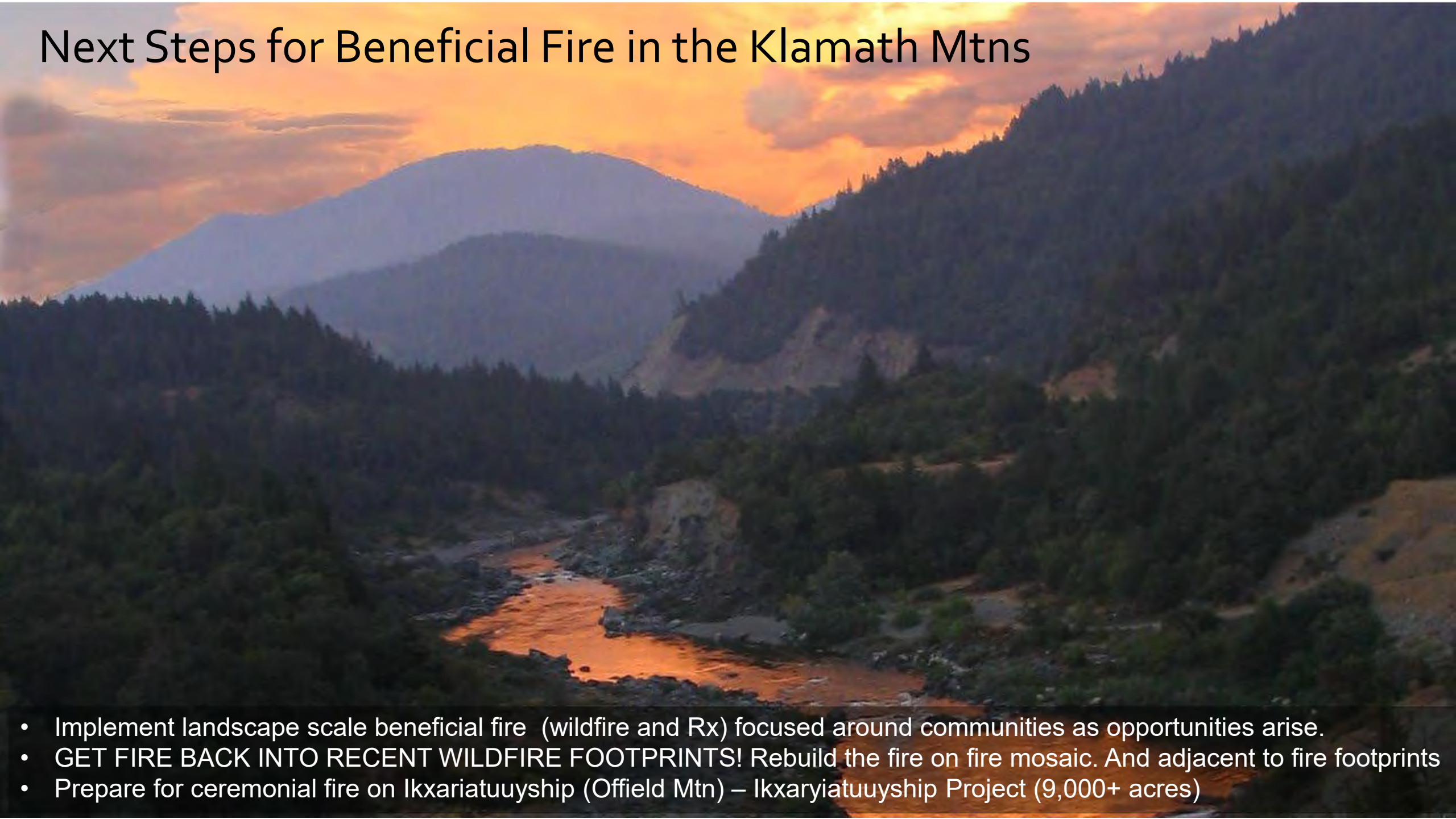


	zip	smokePM	
	<chr>	<dbl>	
1	96093	9.84	Weaverville
2	96010	9.19	Big Bar
3	96048	8.88	Junction City
4	96024	8.87	Douglas City
5	96031	8.85	Forks of Salmon
6	96041	8.69	Hayfork
7	96052	8.64	Lewiston
8	93546	8.48	Mammoth Lakes
9	95527	8.36	Burnt Ranch
10	96076	8.09	Platina
11	95563	8.06	Salyer
12	96091	7.93	Trinity Center
13	96033	7.72	French Gulch
14	95568	7.56	Somes Bar
15	95556	7.50	Orleans
16	96039	7.49	Happy Camp
17	95573	7.40	Willow Creek
18	96049	7.29	Redding
19	95389	7.22	Yosemite Valley
20	96046	7.20	Hyampom

Marshall Burke
Associate professor, Doerr School of Sustainability | Center on Food Security and the Environment
Stanford University


GAS MASK FILTER NATO SPECIFICATION
VBC FOR 40MM GAS MASKS
TYPE:
CBRN Filter-20 SOF

Next Steps for Beneficial Fire in the Klamath Mtns



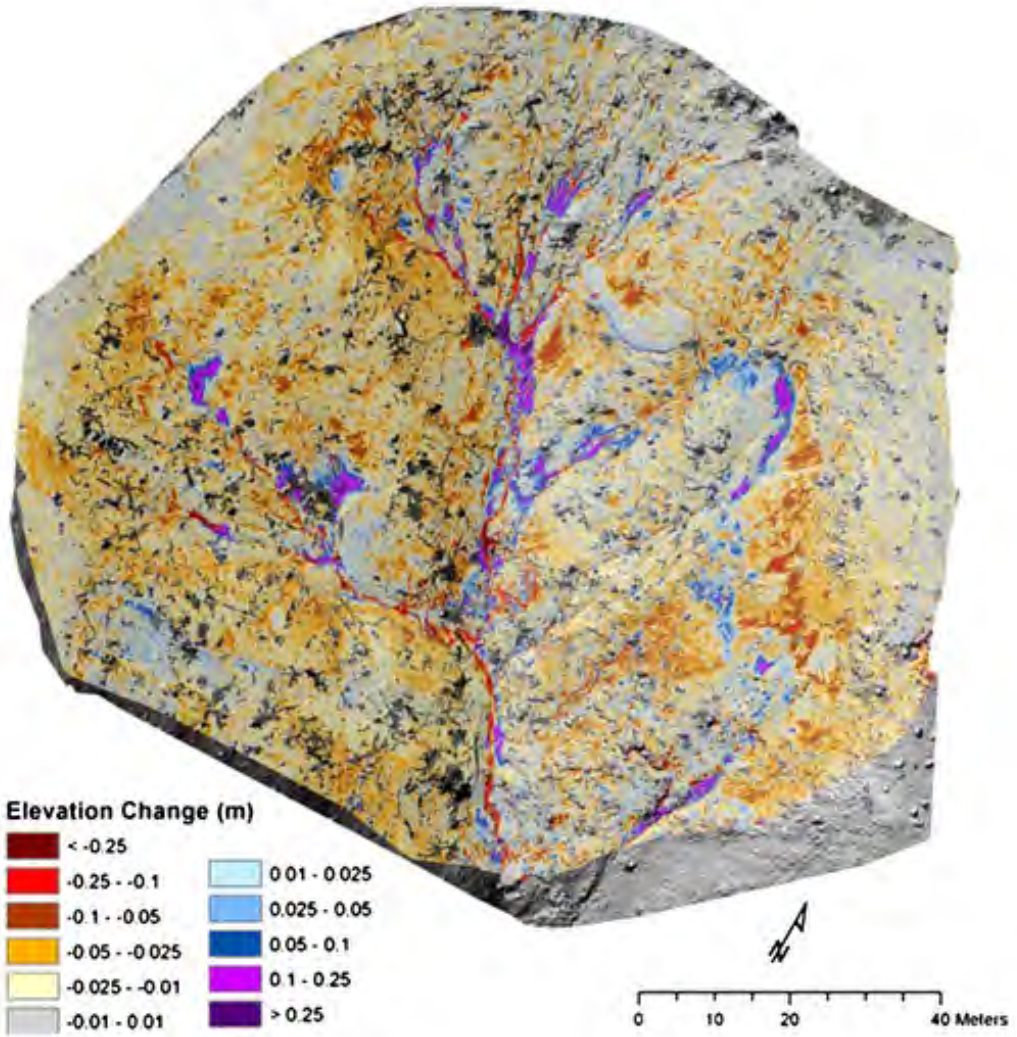
- Implement landscape scale beneficial fire (wildfire and Rx) focused around communities as opportunities arise.
- GET FIRE BACK INTO RECENT WILDFIRE FOOTPRINTS! Rebuild the fire on fire mosaic. And adjacent to fire footprints
- Prepare for ceremonial fire on Ikxariatuuyship (Offield Mtn) – Ikxaryiatuuyship Project (9,000+ acres)

Instream Restoration for Post-Wildfire Sediment Capture

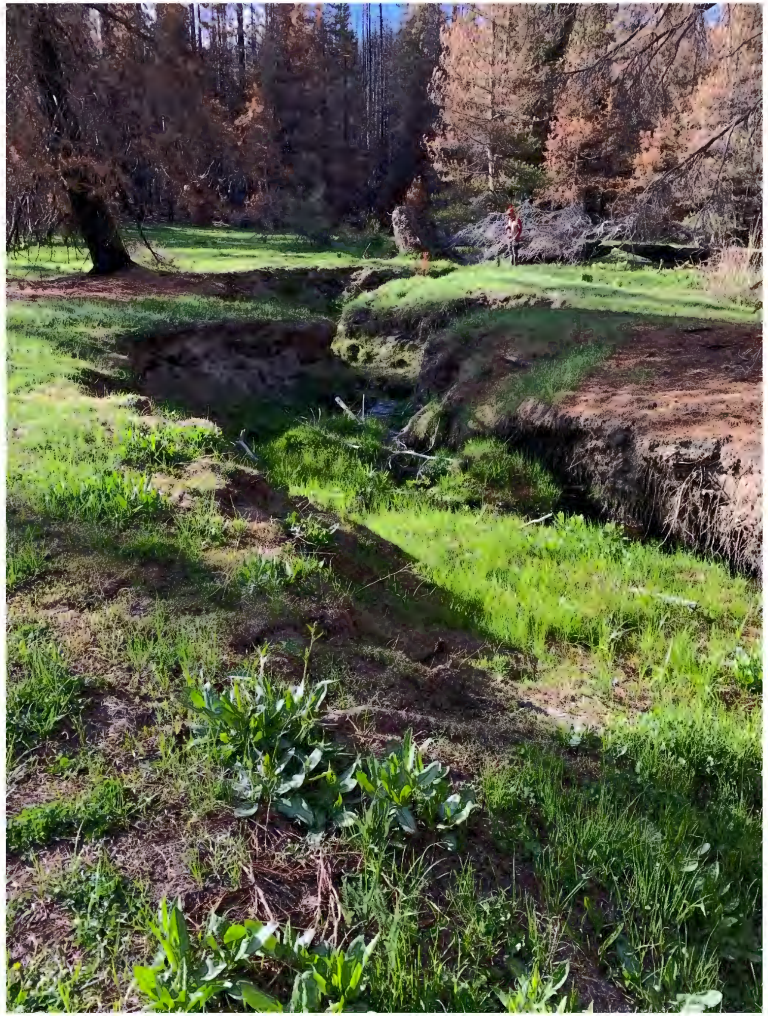
Karen Pope, Adam Cummings, Kate Wilcox, Jordin Jacobs, Joe Wagenbrenner, David Dralle

USDA Forest Service, Pacific Southwest Research Station

Riparian meadows are hotspots for post-fire sediment capture

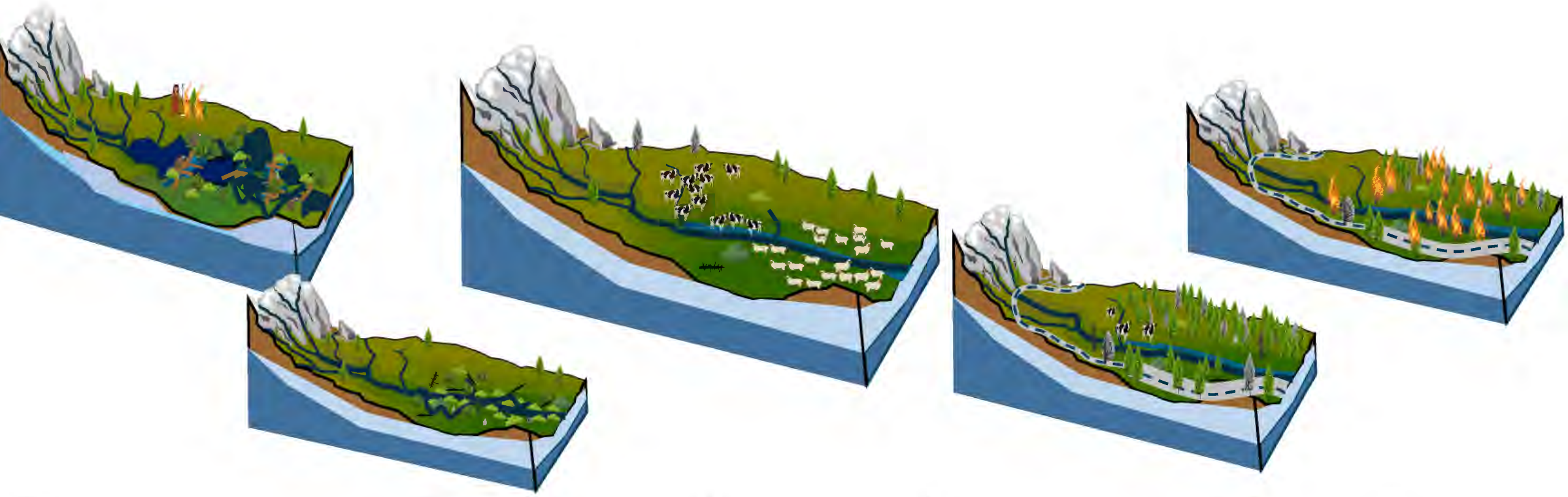


But not if they are degraded!



Wood bridge instead of dam

A Brief History of Meadows



1700 Tribal stewardship

1800 California fur rush

1870 “Hoofed locusts”

1920 Roads and fire suppression

2000

2020 Wildfires

August, 1935 AMERICAN FORESTS 385

How DYNAMITE streamlines streams

Straightening of Pequest River in New Jersey by CCC workers stopped its yearly flooding. Completion of new channel is seen at right. Note temporary dam at left to provide volume of water for scouring blasted channel.

Explosion of dynamite charge by propagation excavates new channel.

Immediately after explosion, water is entering new channel, whose banks will be smoothed and "stream-lined" by the speedier flow of water.

CROOKED STREAMS are a menace to life and crops in the areas bordering on their banks. The twisting and turning of the channel retards the flow and reduces the capacity of the stream to handle large volumes of water. Floods result. Crops are ruined. Lives are lost. Banks are undermined, causing cave-ins that steal valuable acreage.

In many instances straightening out a stream has doubled its capacity for disposing of run-off water.

DYNAMITE may be used most efficiently and economically in taking the kinks out of a crooked stream. The dynamite is loaded along the length of "cut-off" channel. When fired, the dirt and other debris is heaved high in the air and is scattered over the adjoining territory—leaving practically no spoil-banks. In addition to the material actually thrown out, much dirt is loosened and is later scoured out by the water which rushes swiftly through the straightened channel.

Du Pont Dynamite has straightened many thousands of miles of crooked streams. Du Pont engineers have worked for years to develop the best blasting methods for the cleaning out and straightening of streams. All their data is in a 48-page book, "Ditching with Dynamite." It is for your use. Write for it.

Dynamite can help you do other jobs, too. It can help you build highways, dams; fight soil erosion; work quarries. Du Pont has an explosive for every purpose.

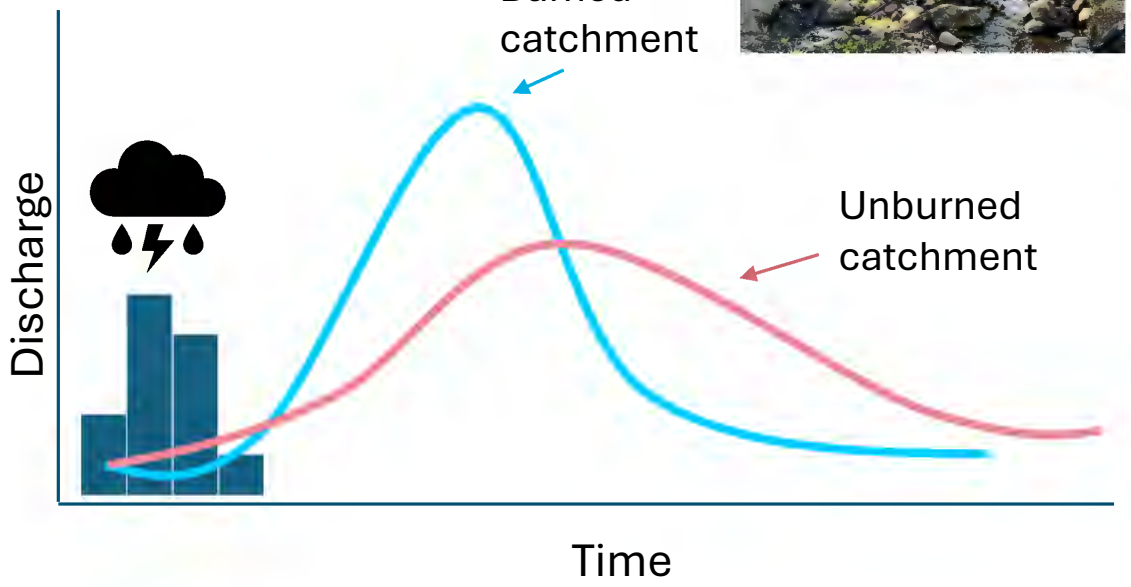
DU PONT

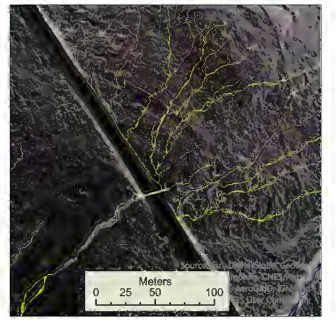
E. I. du Pont de Nemours & Co. (Inc.)
Explosives Department
1107 du Pont Building
Wilmington, Del.

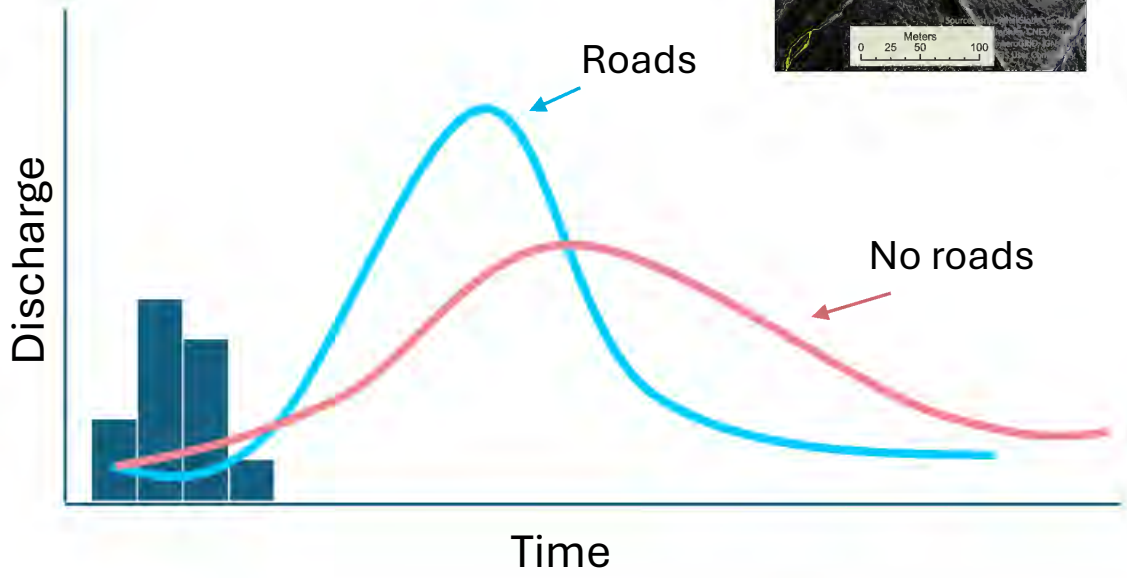
The old perspective: “Crooked streams are a menace to life… “

- “straightening out a stream has doubled its capacity for disposing of run-off water.”
- “DuPont Dynamite has straightened many thousands of miles of crooked streams.”
- “Do it yourself. All their data is in a 48-page book, Ditching with Dynamite”

And altered upland forest hydrology







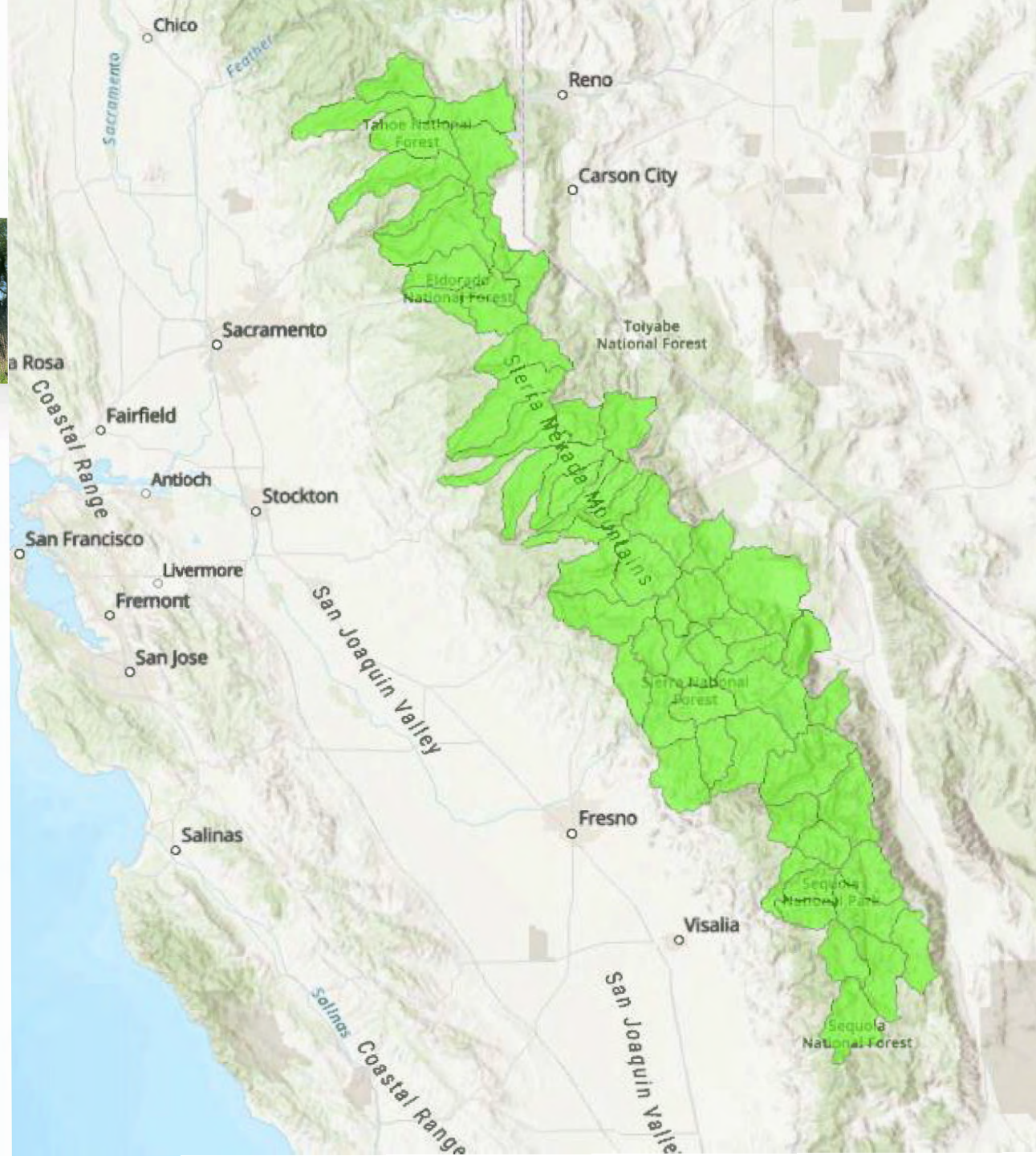
Wildfire: Scott 1997; Moody et al. 2008; Leopardi & Scorzini 2015; Kean et al. 2016; Havel et al. 2018; Srivastava et al. 2018; Williams et al. 2022. **Roads**: Wemple & Jones, 2003; Dymond et al. 2014; Wemple et al. 2016; Surfleet & Marks 2021.

Human-moderated meadow evolution, last 150 years

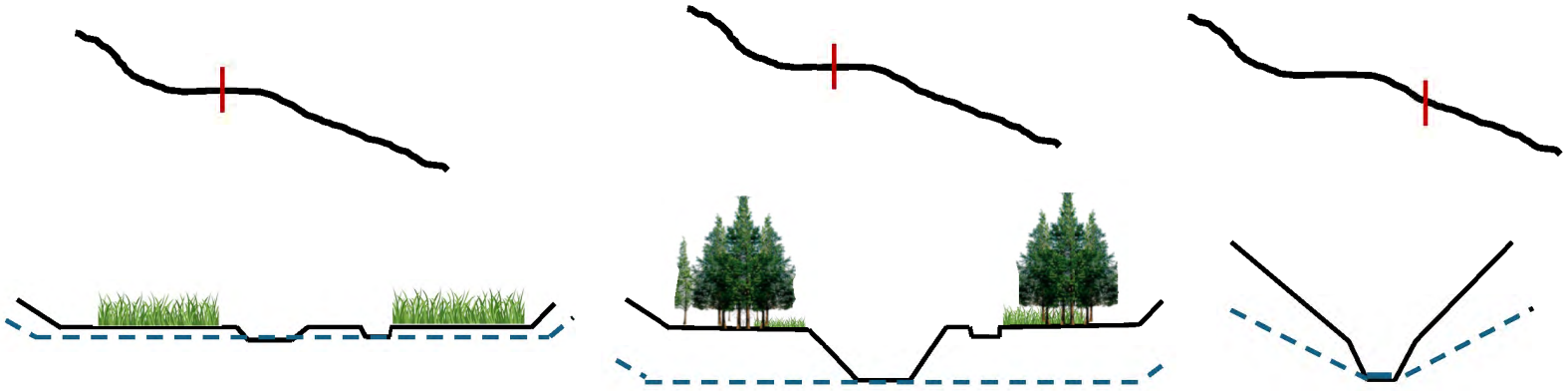
Human-moderated meadow evolution, next 50 years

Reset the baseline of meadows

- Discover where and how frequently meadows historically occurred.
- **Ignore unique vegetative characteristics of meadows.**
- Use a publicly available dataset of over 11,000 hand-digitized meadow polygons
- Model area = 60 HUC10s from Tahoe NF to Sequoia NF
- Model resolution = 10-m pixel



What is a lost meadow?

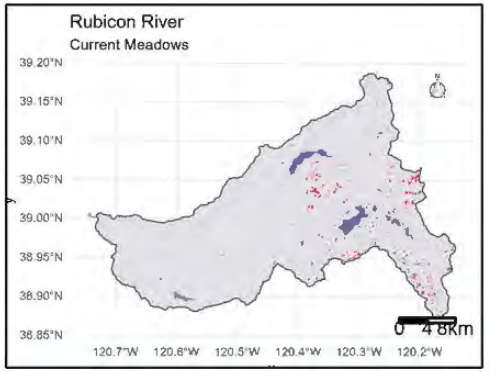


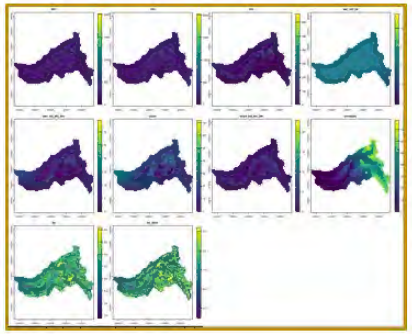
Existing meadow: Wide, flat floodplain where water accumulates. Expect shallow channels, high groundwater elevation, and predominantly graminoids and forbs.

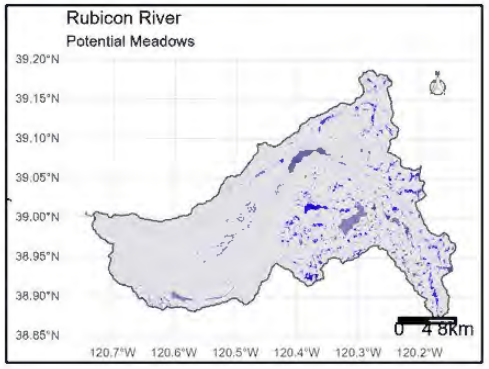
Model-predicted potential meadow: Wide, flat floodplain where water accumulates. Expect deeper channels, lower groundwater elevation and predominantly shrubs and trees.

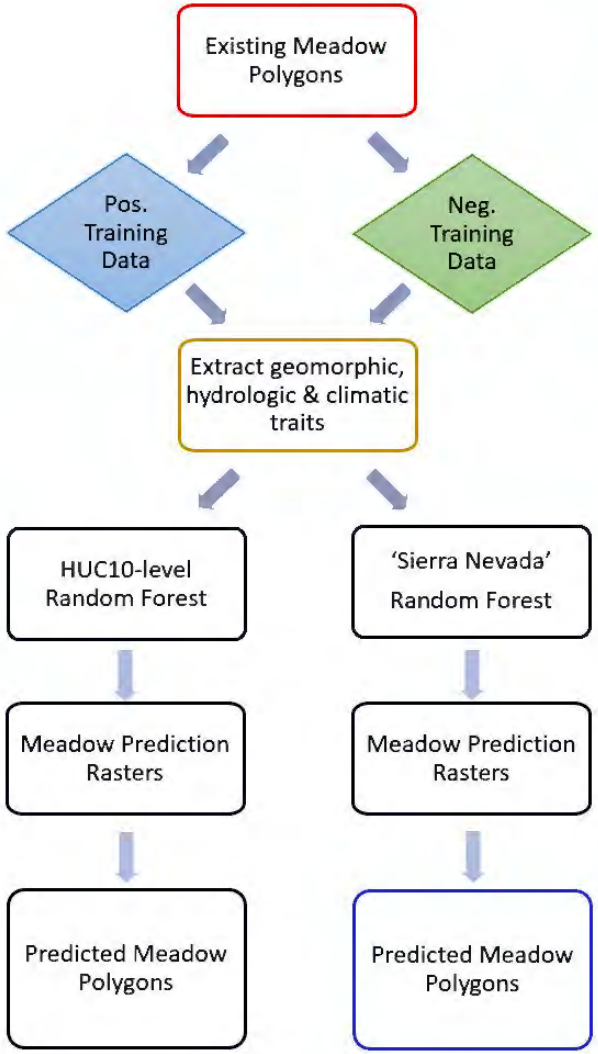
Not predicted as meadow: Confined channel without a flat floodplain.

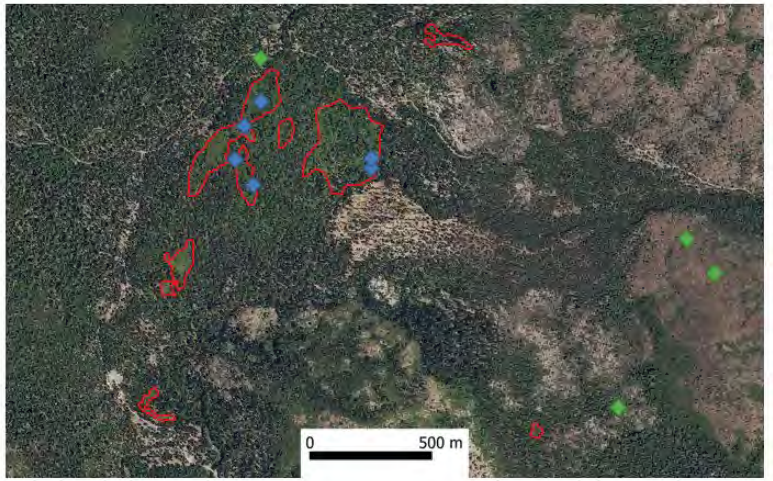
Tapped the power of machine learning

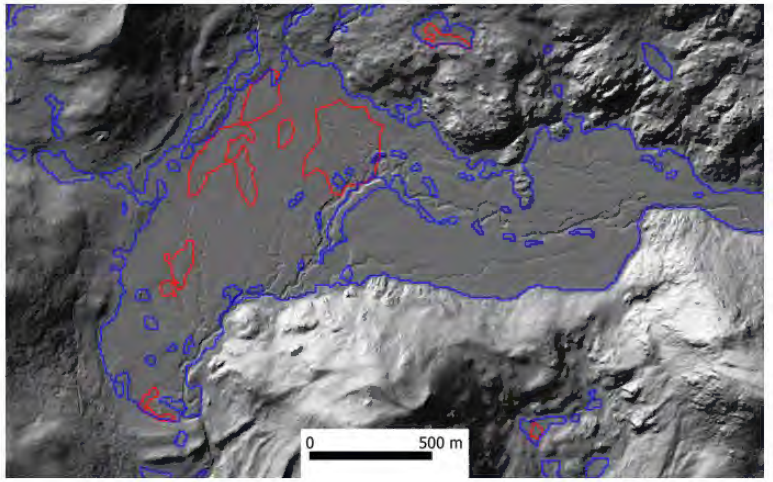






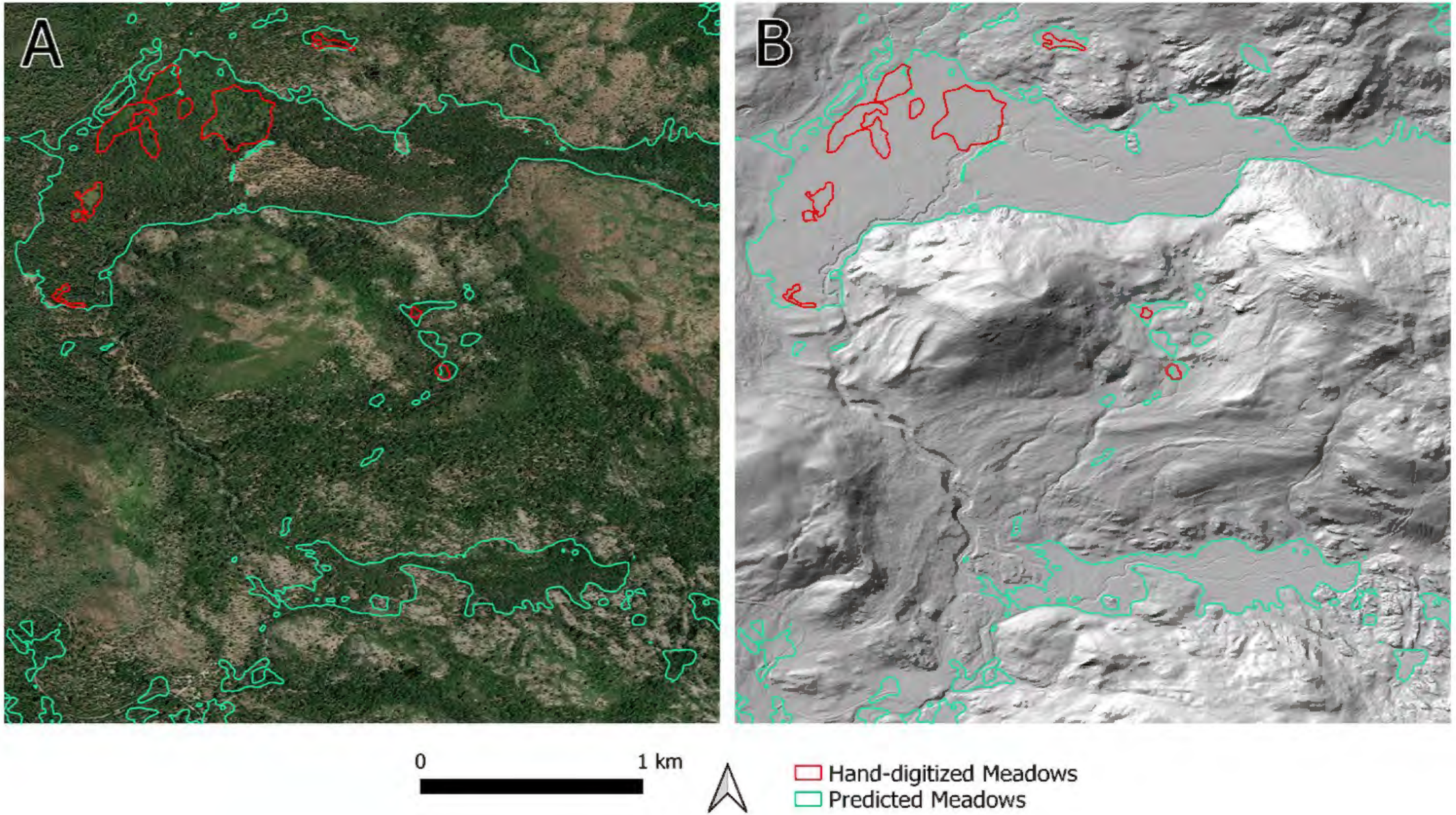




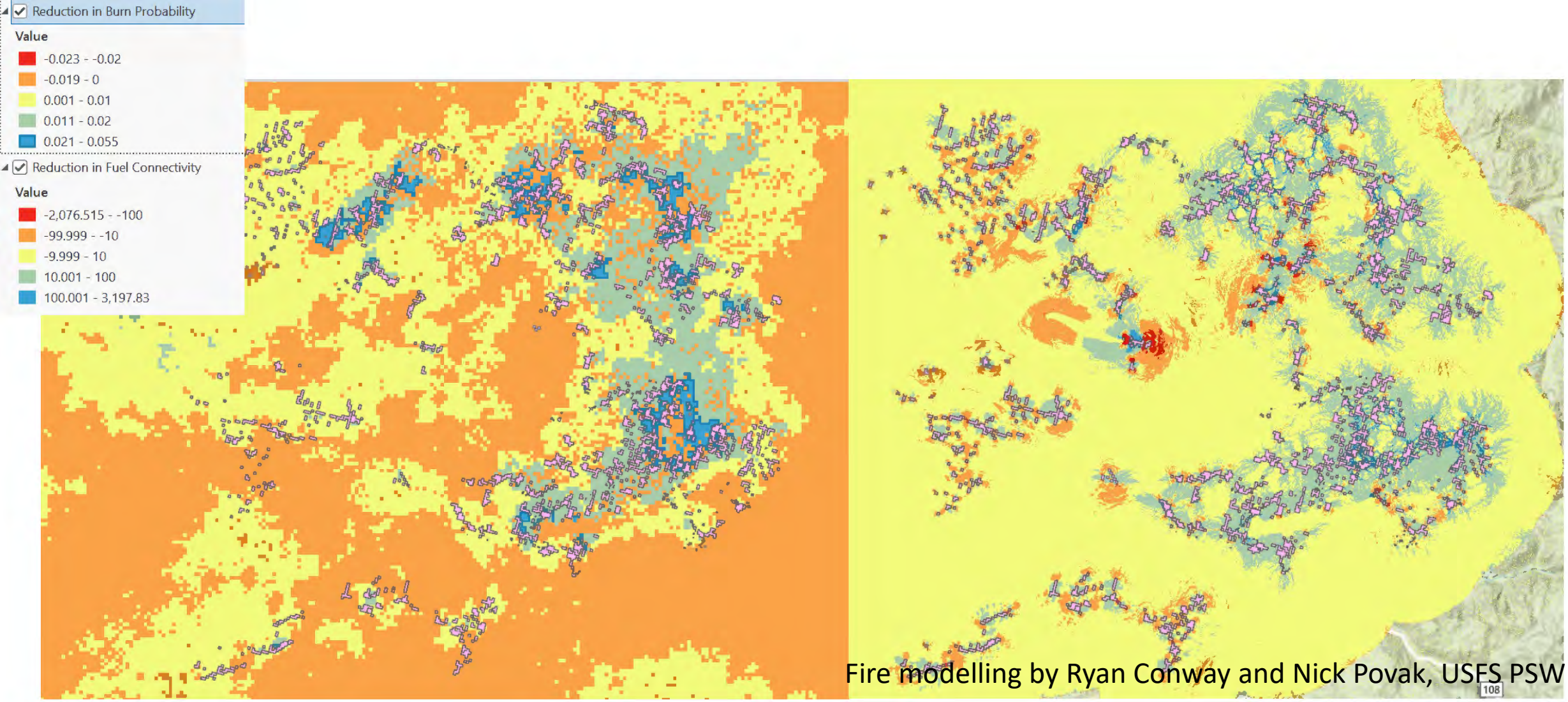


Cummings, Pope & Mak. 2023. Landscape Ecology

Opportunities for restoration: Likely >3x more meadow area historically

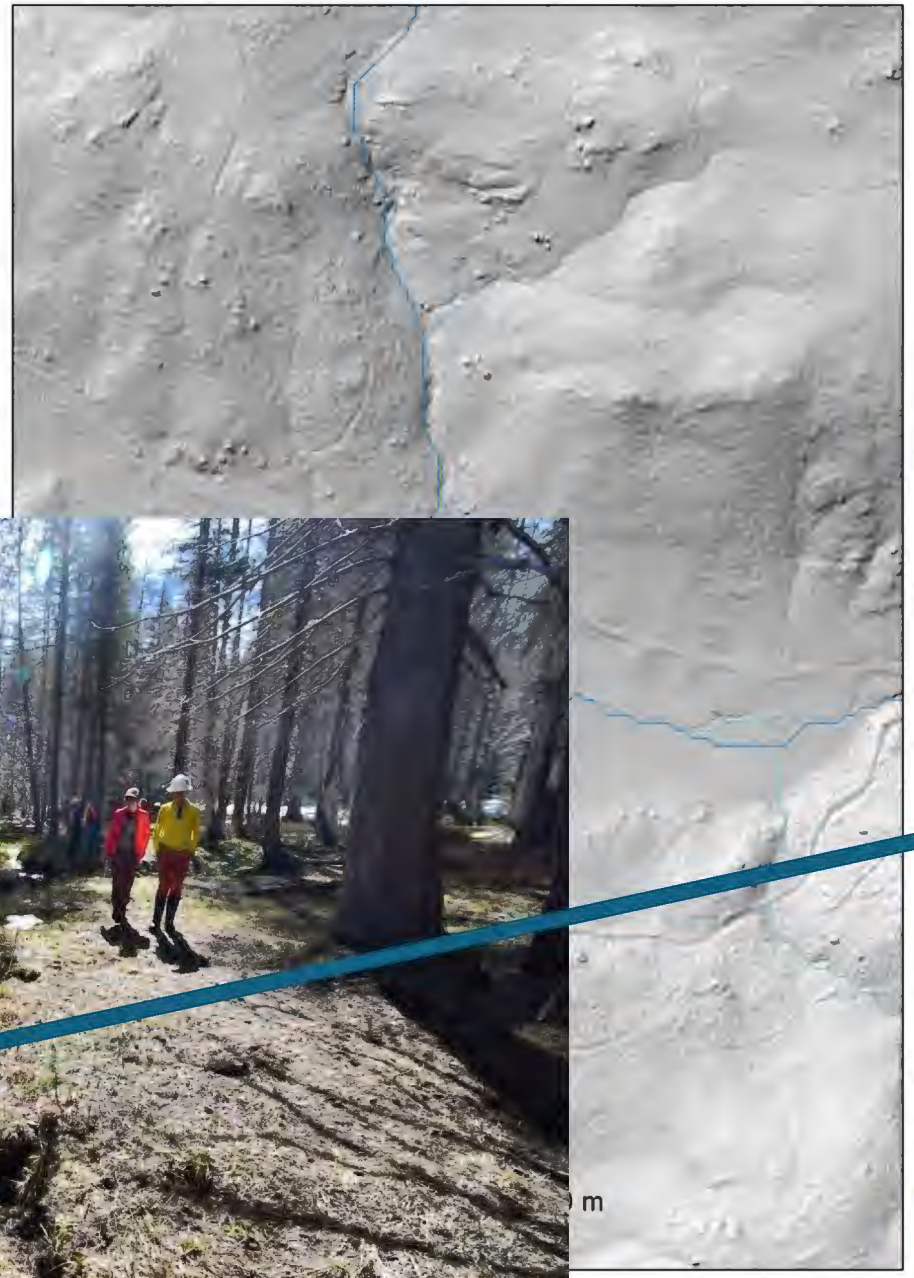


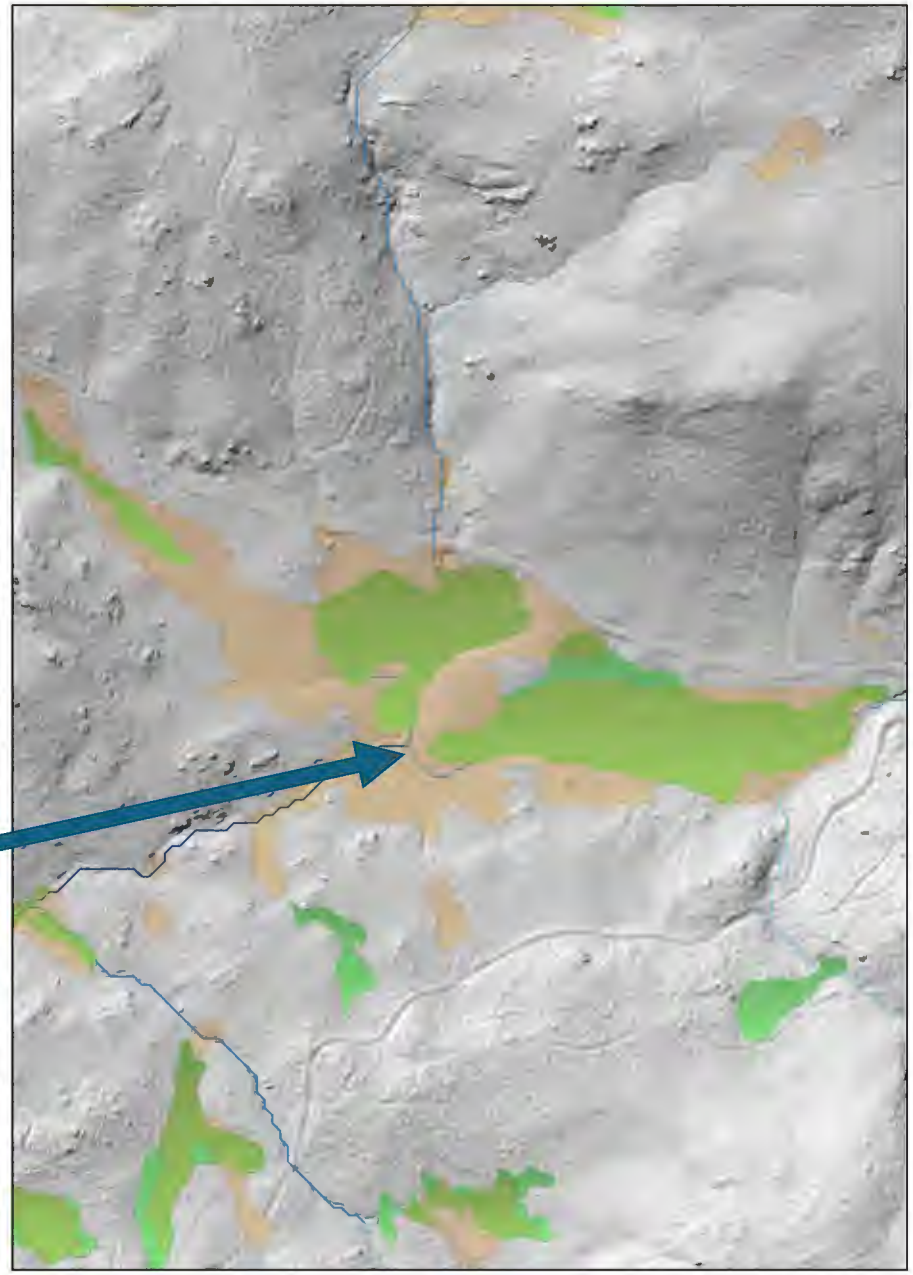
Imagine the possibilities!



If we work at scale, potential for meadow restoration to affect fire behavior.


East Fork Deer Creek
0
2
4 km
Predicted Meadow
Meadows



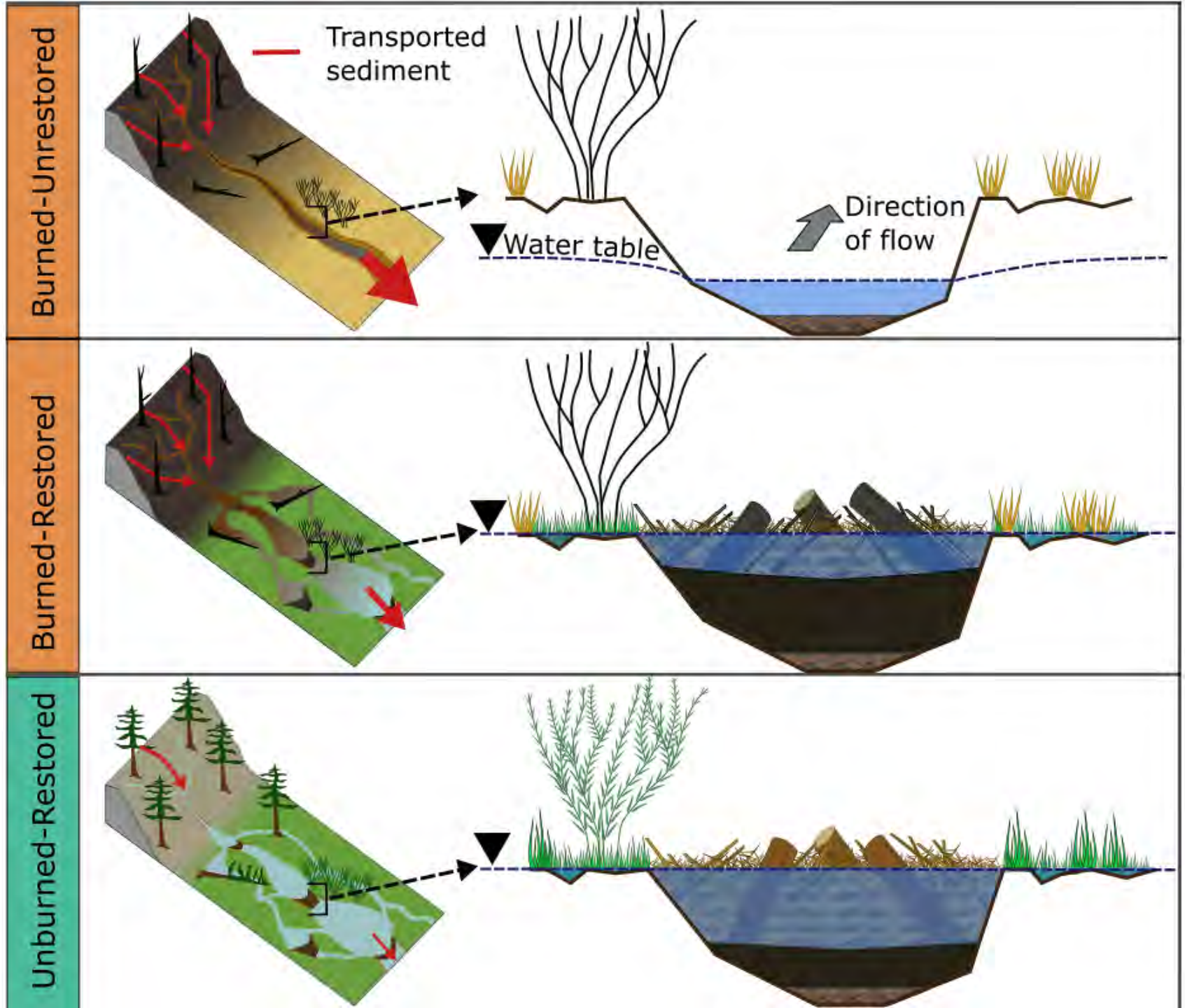


Can we apply low-tech, nature-based restoration approaches to increase scale?

- Use locally sourced materials (wood, rock, sod) to add structure to initiate hydrological and biological processes.
- Work with the system (e.g., stream energy to deliver sediment, plant roots to lock in the sediment, beavers to develop complexity and storage).
- Apply a conscious effort to use cost-effective, minimal disturbance treatments (such as beaver dam analogs).
- Engage with local communities.

Experiment to test effects of low-tech process-based restoration in burned and unburned forests

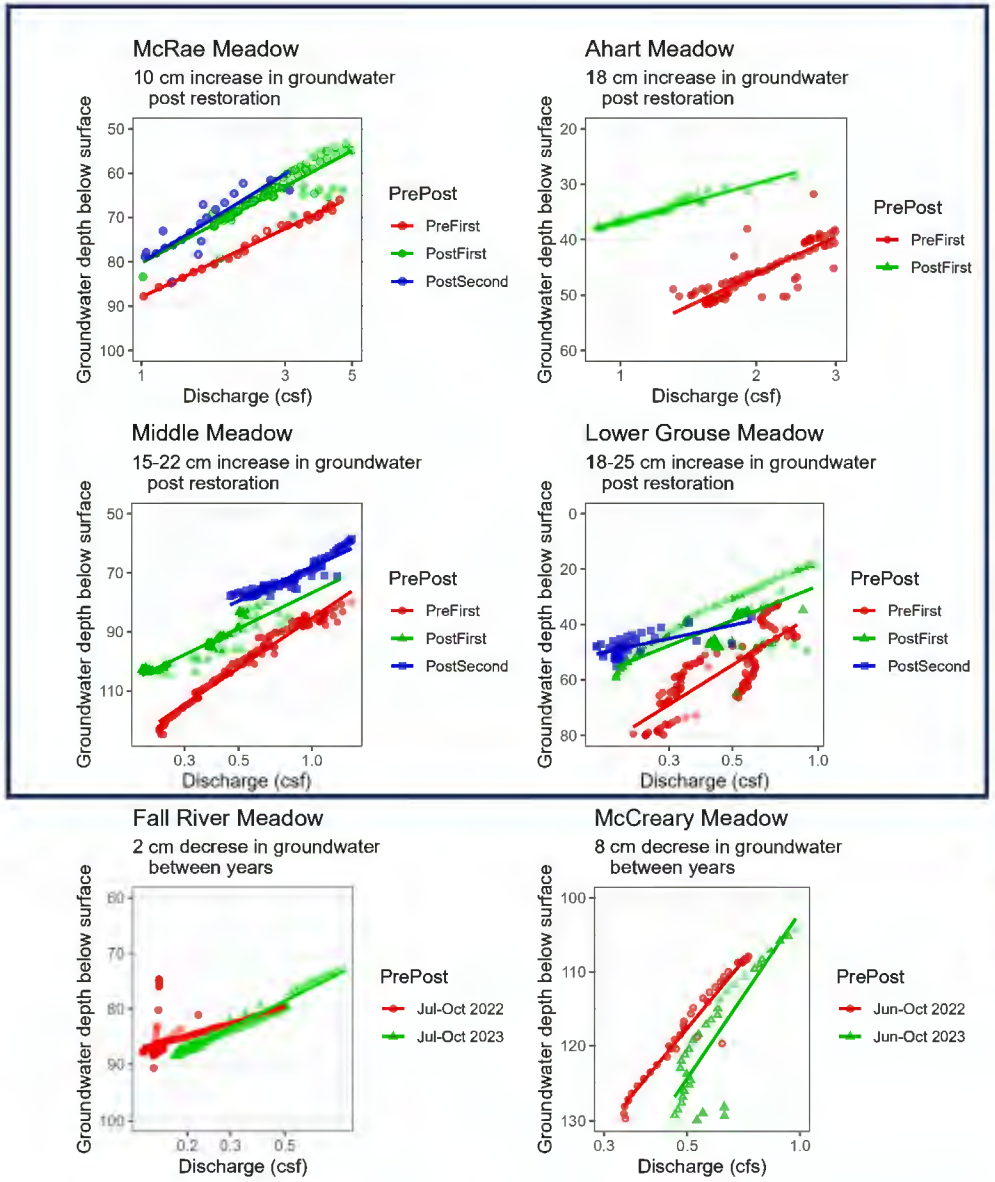
- Six meadows in the Plumas and Sierra National Forests
- Compared burned and unburned and treated vs. untreated
- Joined forces with Cal Poly Humboldt and Fresno State
- 2021-2025

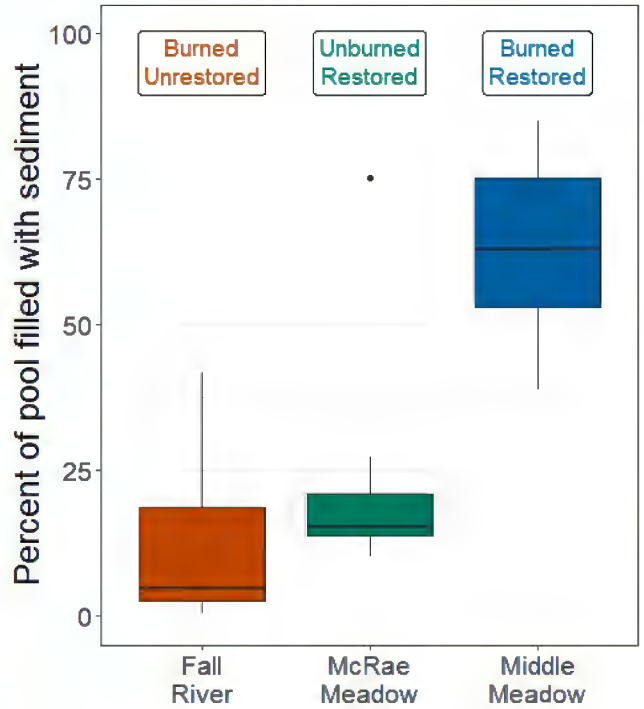

Burned-Unrestored
Transported sediment
Water table
Direction of flow
Burned-Restored
Unburned-Restored

What is success?

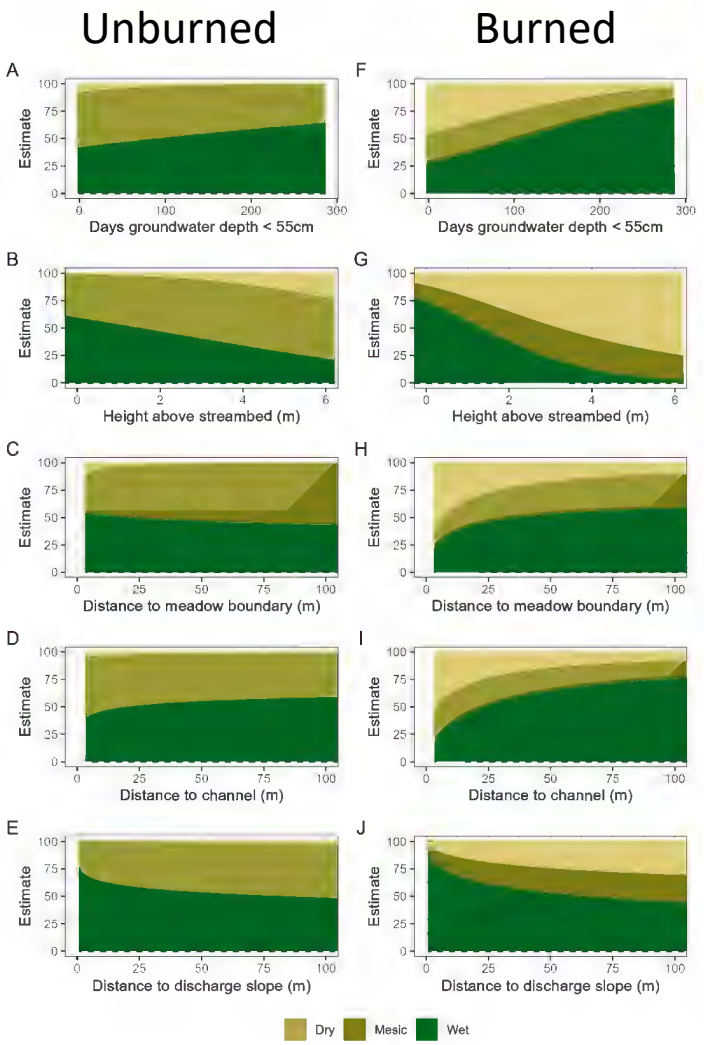
- Increase surface water retention and complexity
- Raise groundwater elevation
- Capture sediment
- Increase wet meadow vegetation area and productivity

Rapid and persistent hydrological response following restoration





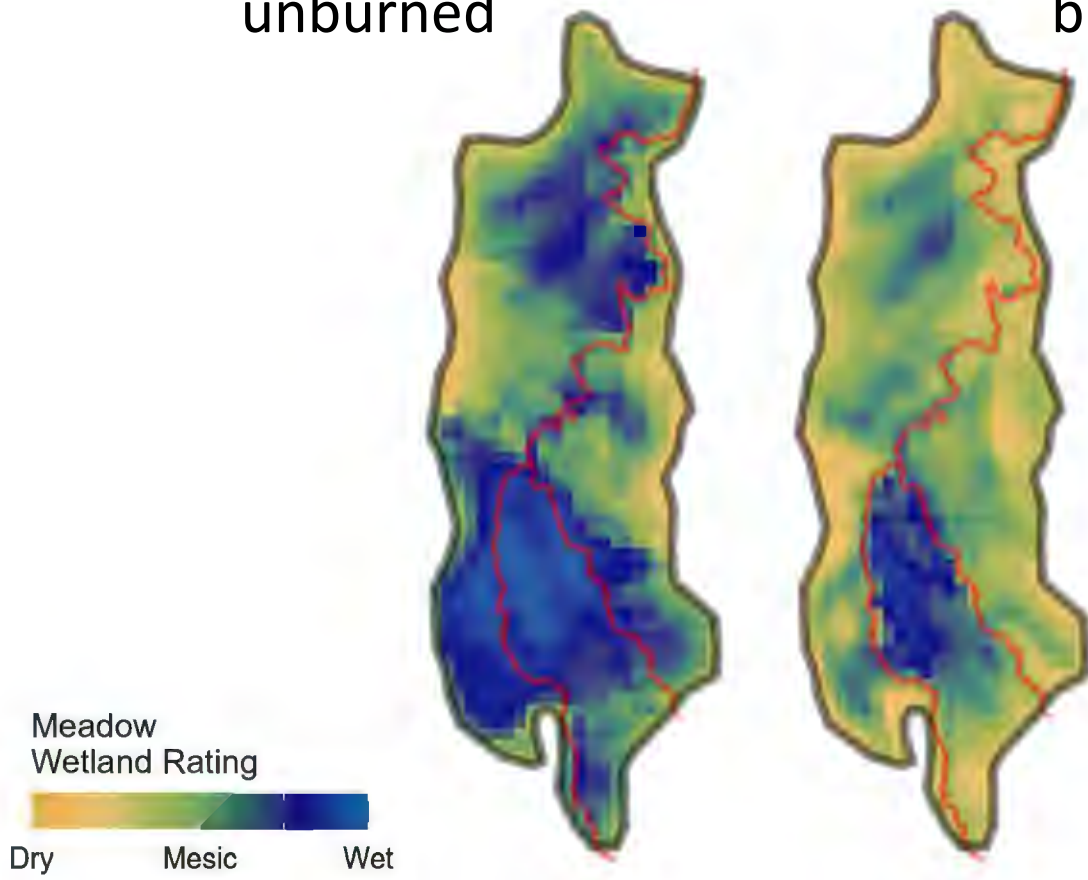
Modeled post-fire vegetation recovery in degraded meadows



Fire presents an opportunity to rapidly gain or loose meadowlands

Degraded, unburned

Degraded, burned



Key Takeaways

- It is easy to forget what we've lost.
- Resetting the baseline presents opportunities for landscape scale restoration efforts.
- Low-tech process-based restoration can rapidly increase groundwater storage and activate channel aggradation, especially in burned landscapes.
- Without restoration, fire rapidly converts meadow vegetation to dry-adapted communities.
- Imperative to ramp up restoration efforts.

Park Fire
Big Chico Creek, August 24th, 2024

Park Fire slides from Wolfy Rougle and Faith Churchill, Butte County RCD

Approach to Restoration

Increase Ground Cover

- >45% ground cover reduces erosion by 75%
- Contour felling trees, broadcasting chips/slash

Improve Roads

- Replace burned culverts
- Armor critical dips
- Clean out ditches

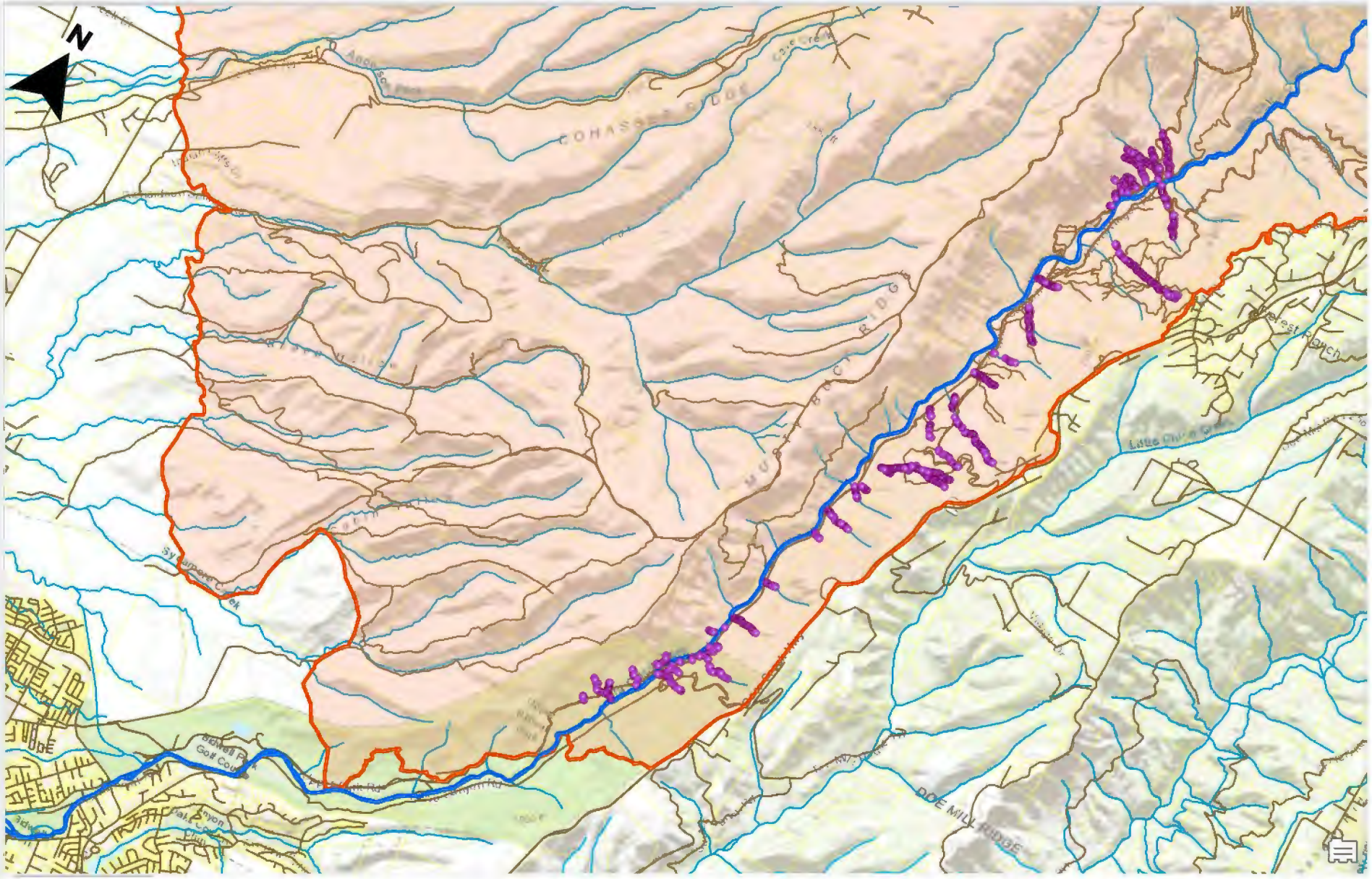
Capture Sediment in the Creeks

- Process-Based Restoration approach
- Rock-Log Hybrid Leaky Weir

Photo: Jason Halley, CSU Chico

RESOURCE CONSERVATION DISTRICT BUTTE COUNTY

Built! 1,783 structures. Work took place 9/30 - 1/9



RESOURCE CONSERVATION DISTRICT BUTTE COUNTY

Collaboration

Incredible partnerships…

- ***Big Chico Creek Ecological Reserve***
- ***Butte County RCD***
- ***City of Chico***
- ***Higgins Ridge Neighborhood***
- ***Mechoopda Indian Tribe***
- ***California Department of Fish & Wildlife***
- ***U.S. Fish and Wildlife Service***
- ***U.S. Army Corp of Engineers***
- ***Butte County Fire Safe Council***
- ***Cal Fire***
- ***USDA - PSW Research Station***
- ***California Conservation Corps***
- ***Mooretown Rancheria***
- ***Central Valley RWQCB***
- ***Symbiotic Restoration***
- ***StreamWise***

and the financial support of Sierra Nevada Brewery, CSU-Chico, Prop 68 funds from the CCC, Vina Groundwater Sustainability Agency, and many generous small donors to BCCER

Total implementation cost: **$511,000**

RESOURCE CONSERVATION DISTRICT BUTTE COUNTY

Nearly 60,000 cubic feet of sediment captured to date!

Photos: Jason Halley, CSU Chico

RESOURCE CONSERVATION DISTRICT BUTTE COUNTY

Conclusions & Implications

- Time to act, not just stare into the abyss
- Requires:
  - Teamwork,
  - creativity,
  - understanding of natural processes,
  - hard work,
  - optimism in the healing potential of nature
- Imperative to build strong collaboration across disciplines and communities

Collaborators/Colleagues

ORISE Fellows: Kate Wilcox, Jordin Jacobs, Matt Berry

Cal Poly Humboldt: Margaret Lang, Emma Sevier, Christa Meingast

Fresno State

Kevin Swift

Swift Water Design Crew

Sierra NF, Plumas NF

Join the fun!

CalPBR.org

The Sierra Meadows Partnership

sierrameadows.org

klamathmeadows.org

Additional Materials

Scientific Manuscript describing the model:

Cummings, Adam K., Karen L. Pope, and Gilbert Mak. **"Resetting the baseline: using machine learning to find lost meadows."** *Landscape Ecology*

Scientific Manuscript describing applications of the model:

Pope, Karen L., and Adam K. Cummings. **"Recovering the lost potential of meadows to help mitigate challenges facing California's forests and water supply."** *California Fish and Wildlife Journal.*

A 2 hour recorded workshop that describes the Lost Meadows Model, how to access the data, and example applications.

Bringing beneficial fire into the restoration toolbox

Lenya Quinn-Davidson
UC Agriculture and Natural Resources

Why burn…?

- Fuels reduction
- Invasive species control
- Habitat restoration and maintenance
- Forest resilience
- Cultural resources
- Training/inspiring
- Community building
- Much more…

Who gets to burn…?

Photo by Will Harling

Cultural Fire Management Council


Photo by Will Harling


Cultural Fire Management Council


Photo by Lenya Quinn-Davidson

Not long ago in California…

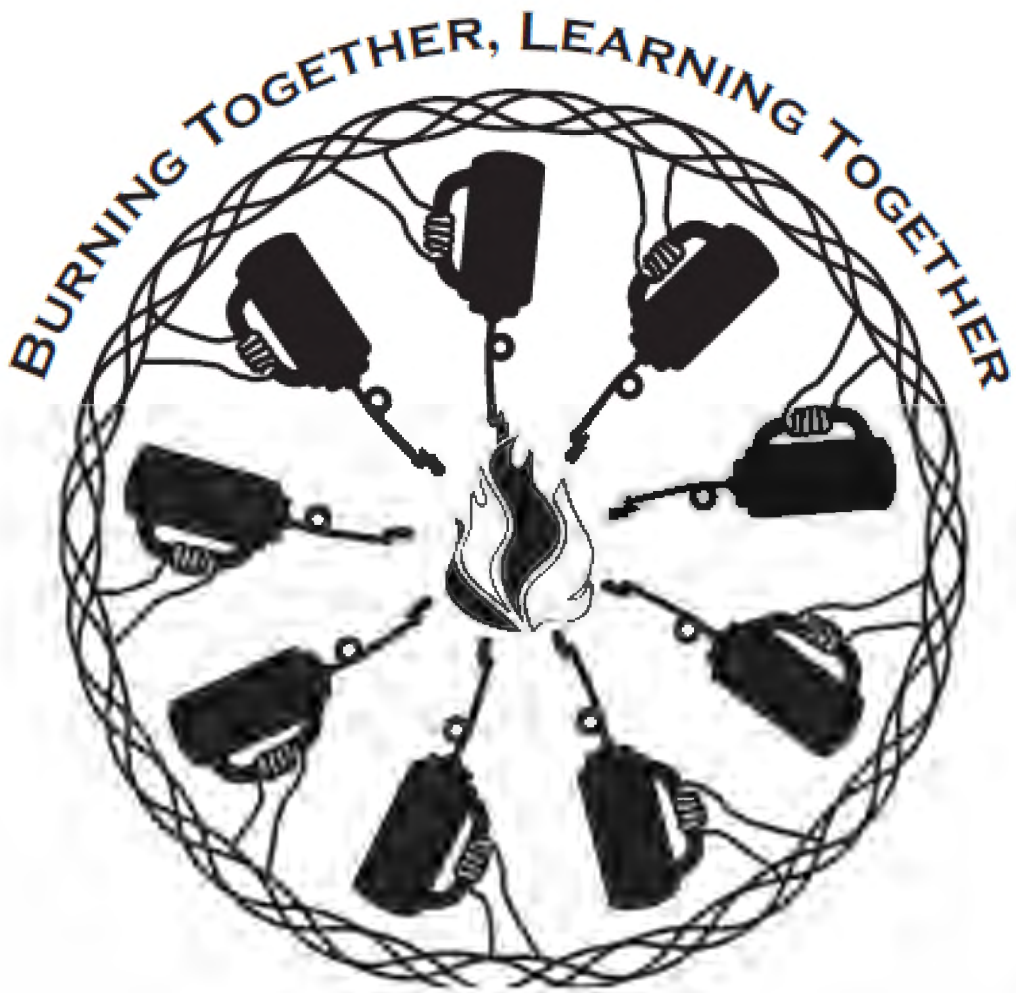
- Not a priority or even a conversation
- Unclear laws and permitting
- <5 private burn bosses statewide
- Almost no training opportunities for non-agency practitioners
- Paralyzing liability concerns
- Little to no insurance options
- No formal recognition, support, or protections for cultural practitioners
- “the public doesn’t support prescribed fire”

Northern California
Prescribed Fire Council

HEALTHY FORESTS

PRESCRIBED FIRE

norcalrxfirecouncil.org



Don Hankins

Margo Robbins

Karuk WTREX

Prescribed Burn Associations (PBAs)

From 0 to 32 since 2017!

Photo by Henri Holbrook

Photo by Miller Bailey

Photo by Lenya Quinn-Davidson

California PBAs

- Grassroots, community-led movement
- Everyone is welcome
- Prescribed fire doesn’t need to be expensive or overly bureaucratic…
- …but it should be fun, and it should involve food and drink!

GOOD FIRE

Current Barriers to the Expansion of Cultural Burning and Prescribed Fire in California and Recommended Solutions

BY: SARA A. CLARK, ANDREW MILLER, AND DON L. HANKINS
FOR THE KARUK TRIBE

CA state-certified burn boss (CARX)
SB1260, Jackson 2018

Photo by Lenya Quinn-Davidson

Photo by Henri Holbrook

CA state-certified burn boss (CARX)
SB1260, Jackson 2018

Gross negligence liability standard
SB332, Dodd 2021

Photo by Lenya Quinn-Davidson

Photo by Henri Holbrook

CA state-certified burn boss (CARX)
SB1260, Jackson 2018

Gross negligence liability standard
SB332, Dodd 2021

Prescribed Fire Claims Fund
SB926, Dodd 2022

Photo by Lenya Quinn-Davidson

Photo by Henri Holbrook

CA state-certified burn boss (CARX)
SB1260, Jackson 2018

Gross negligence liability standard
SB332, Dodd 2021

Prescribed Fire Claims Fund
SB926, Dodd 2022

Private insurance for Rx fire and cultural burning
2024

Photo by Lenya Quinn-Davidson

Photo by Henri Holbrook

CA state-certified burn boss (CARX)
SB1260, Jackson 2018

Gross negligence liability standard
SB332, Dodd 2021

Prescribed Fire Claims Fund
SB926, Dodd 2022

Private insurance for Rx fire and cultural burning
2024

Potential for Tribal authority over permitting
SB310, Dodd 2024

Photo by Lenya Quinn-Davidson

Photo by Henri Holbrook

Not long ago in California…

- ~~Not a priority or even a conversation~~
- ~~Unclear laws and permitting~~
- ~~<5 private burn bosses statewide~~
- ~~Almost no training opportunities for non-agency practitioners~~
- ~~Paralyzing liability concerns~~
- ~~Little to no insurance options~~
- ~~No formal recognition, support, or protections for cultural practitioners~~
- ~~"the public doesn't support prescribed fire"~~

Where to start?

Resources & training

- Local PBAs (www.calpba.org)
- Partnerships with Tribes and cultural organizations (TERA, CFMC)
- Other NGOs (WRTC, MKWC, ACR)

Resources & training

- Private burn bosses (55+ in CA)
- UC ANR Fire Network
- Prescribed Fire Training Exchanges (TREX)

What about liability?

- Burn permit compliance = due diligence
- Gross negligence for fire suppression costs
- $2 million coverage through Claims Fund for projects led by burn boss or cultural practitioner
- Private insurance available on top of Claims Fund
- Partnership with CAL FIRE and other agencies

My Fire Truths

Fire is a human right


Fire is free


Photo by Zeke Lunder


Photo by Miller Bailey

Fire is safe

Between 2019-2024,
California PBAs implemented 460
broadcast burns with
no escapes and no damages

(Quinn-Davidson and Wara,
unpublished data)

Fire is connected to everything


Fire is beautiful

Fire is joyous!

Photo by Ben Wheeler

PBR needs PBAs!

Thank you!

Lenya Quinn-Davidson

UC ANR Fire Network Director

lquinndavidson@ucanr.edu

UC ANR
FIRE NETWORK