WE CAN HAVE FROGS AND CATCH FISH TOO

Reversing widespread legacy impacts of introduced sportfish on declining amphibians in glacial lake basins of the Klamath Mountains

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HML People

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Braden Herman

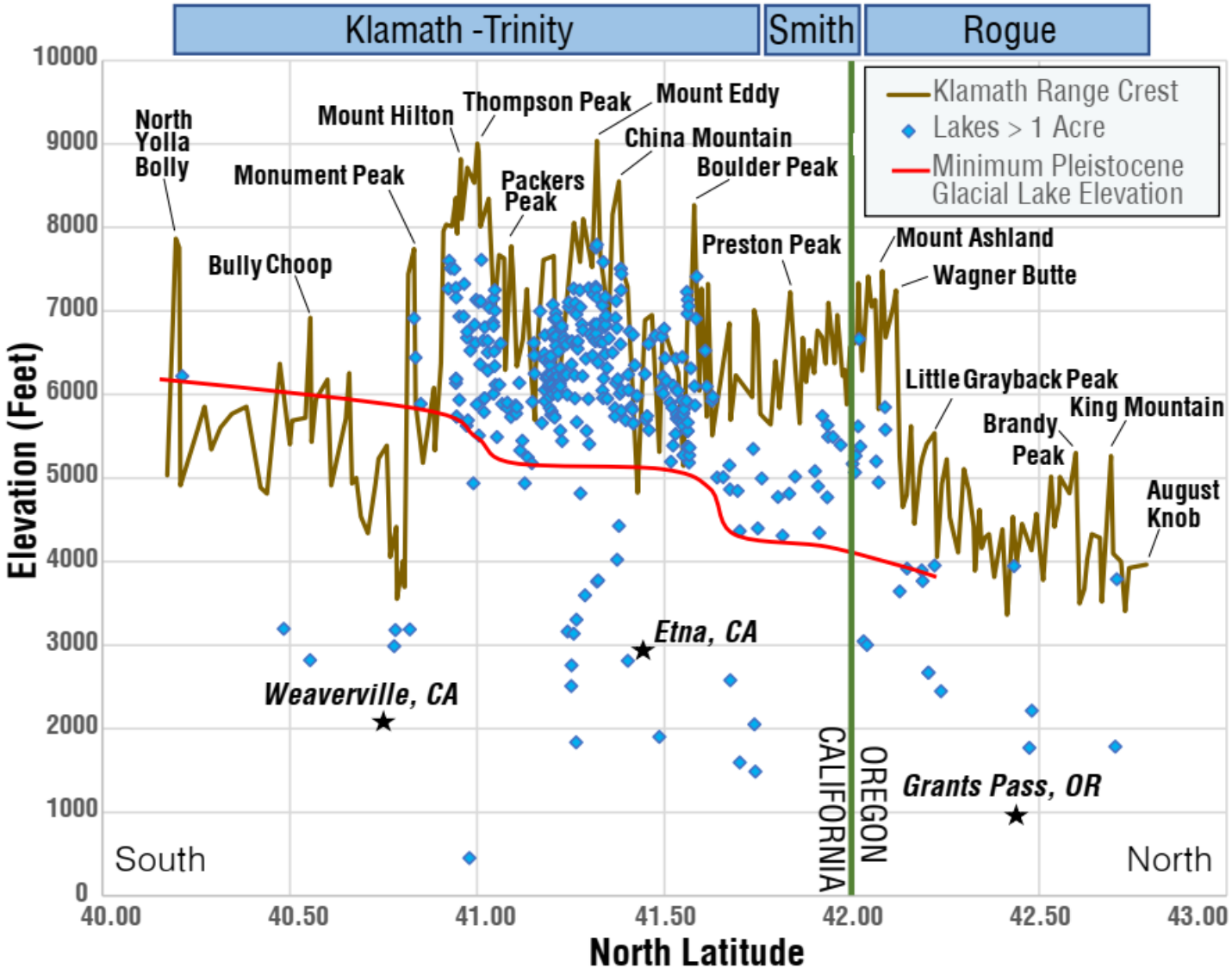
Amanda Nordstrom

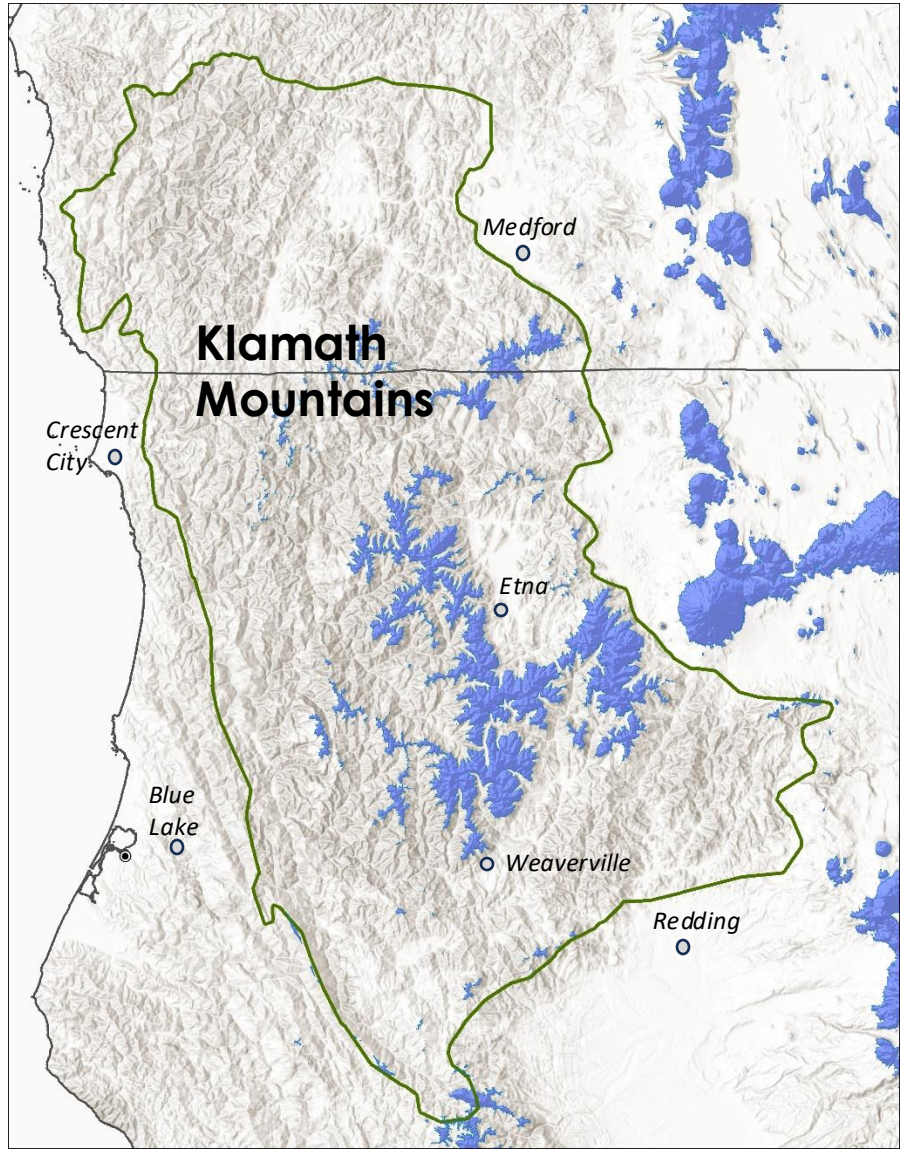
+ over 40 seasonal staff from 2021-2024

Outline

- Klamath High Mountain Wetland Habitats
- Unique Communities and Biodiversity
- A New Fishery is Born
- What Could Go Wrong?
- Measuring Ecological Change After Policy Shifts
- Prioritizing Fishery Lakes and Conservation Lakes
- Targeted Restoration
- Promoting Responsible Fisheries

Pleistocene Glaciers Left Hundreds of Lake Basins Behind



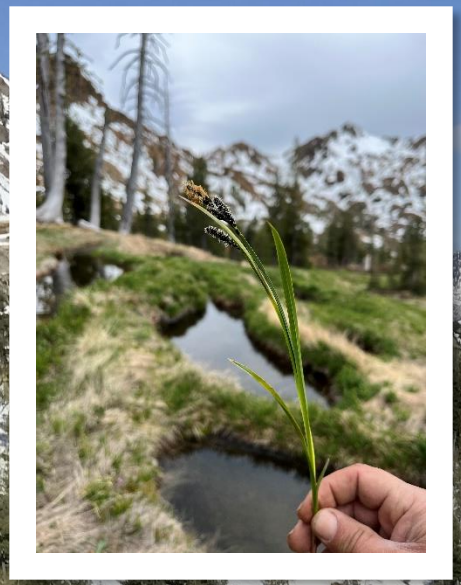



Kalmia Lake

Overlooking Caribou Lake

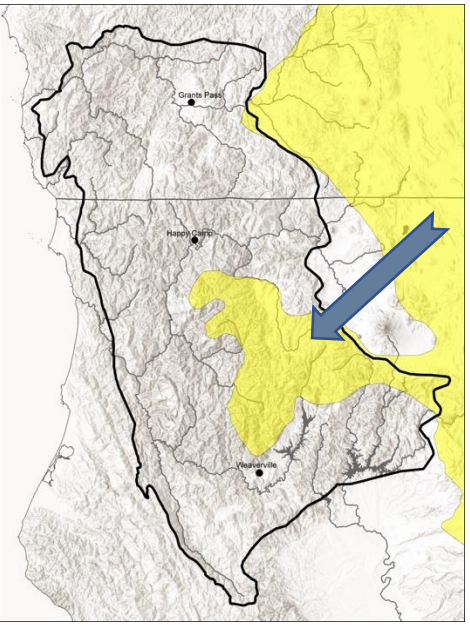

ABCs

Scott Headwater View

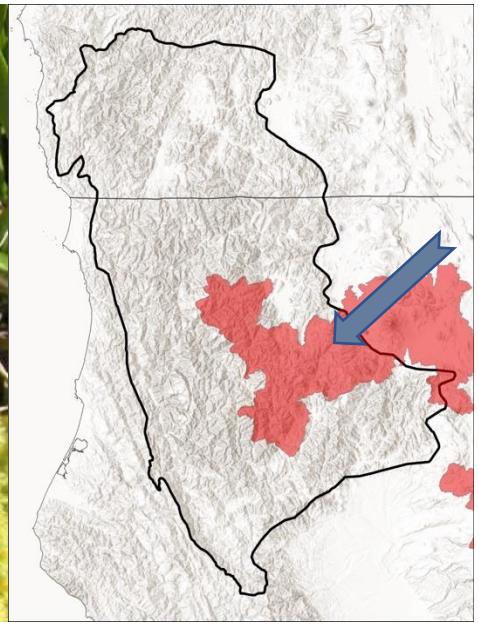


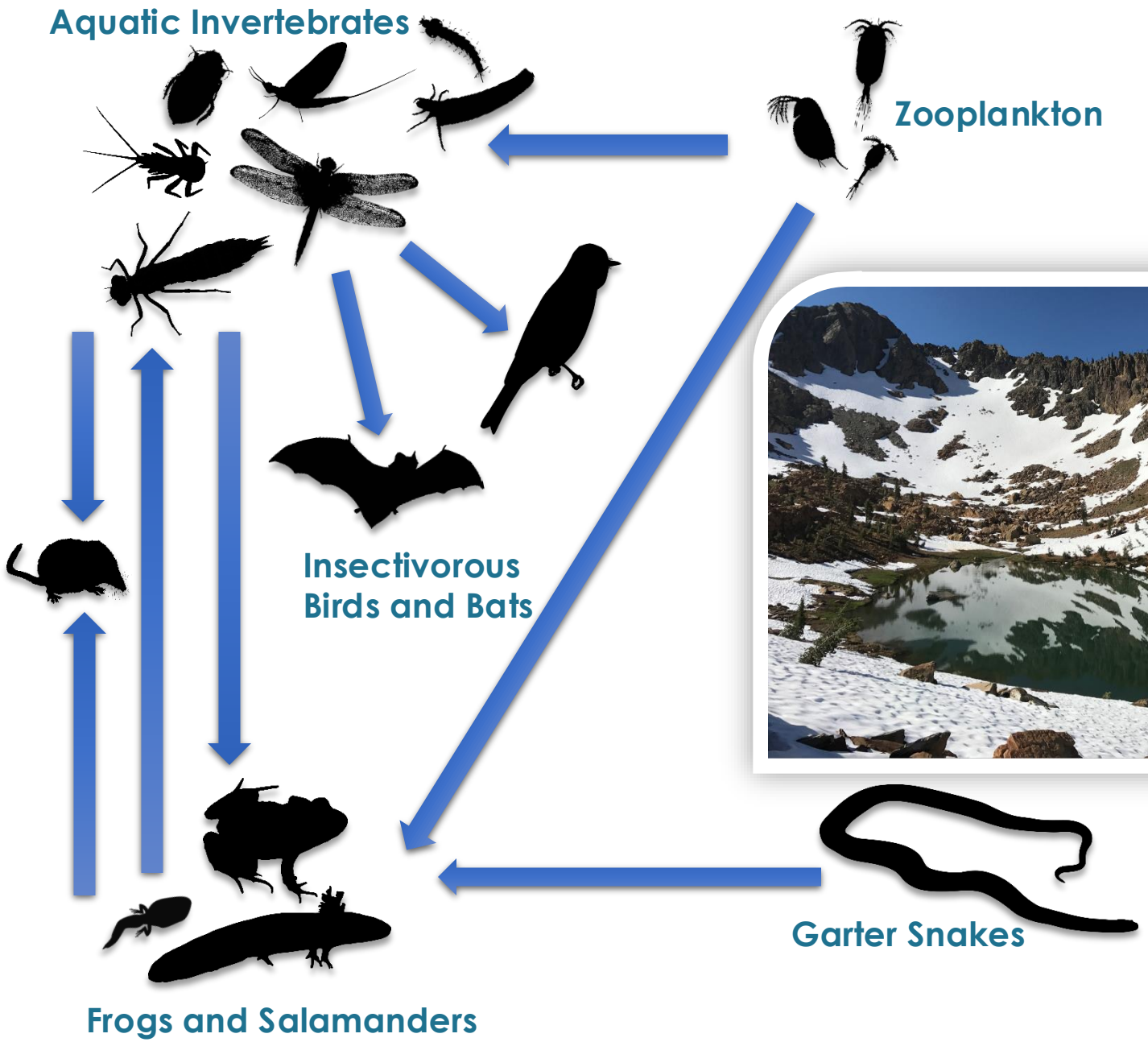
Klamath Mountains
Post Ice Age Colonization

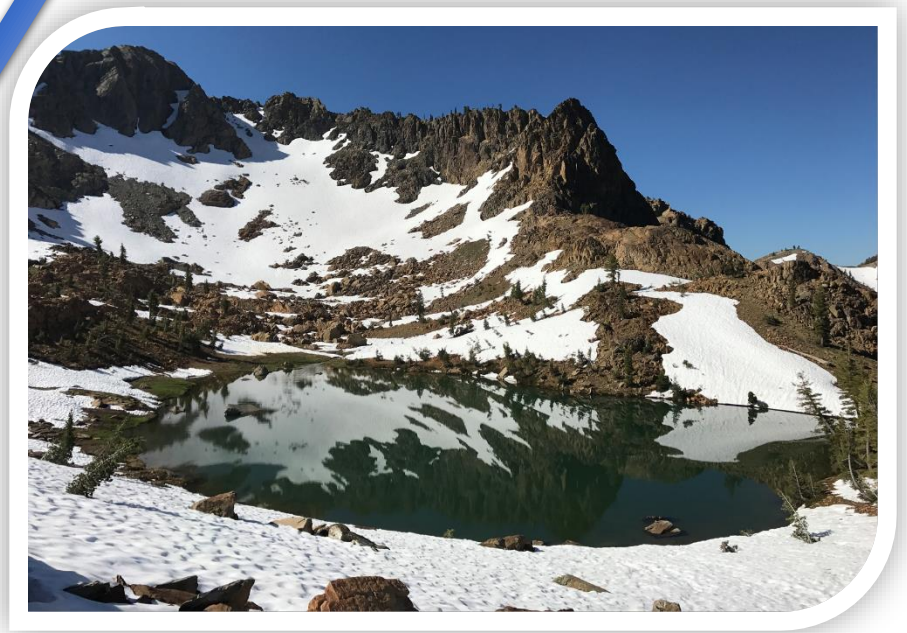
Long-toed Salamander
Ambystoma macrodactylum



Cascades Frog
Rana cascadae





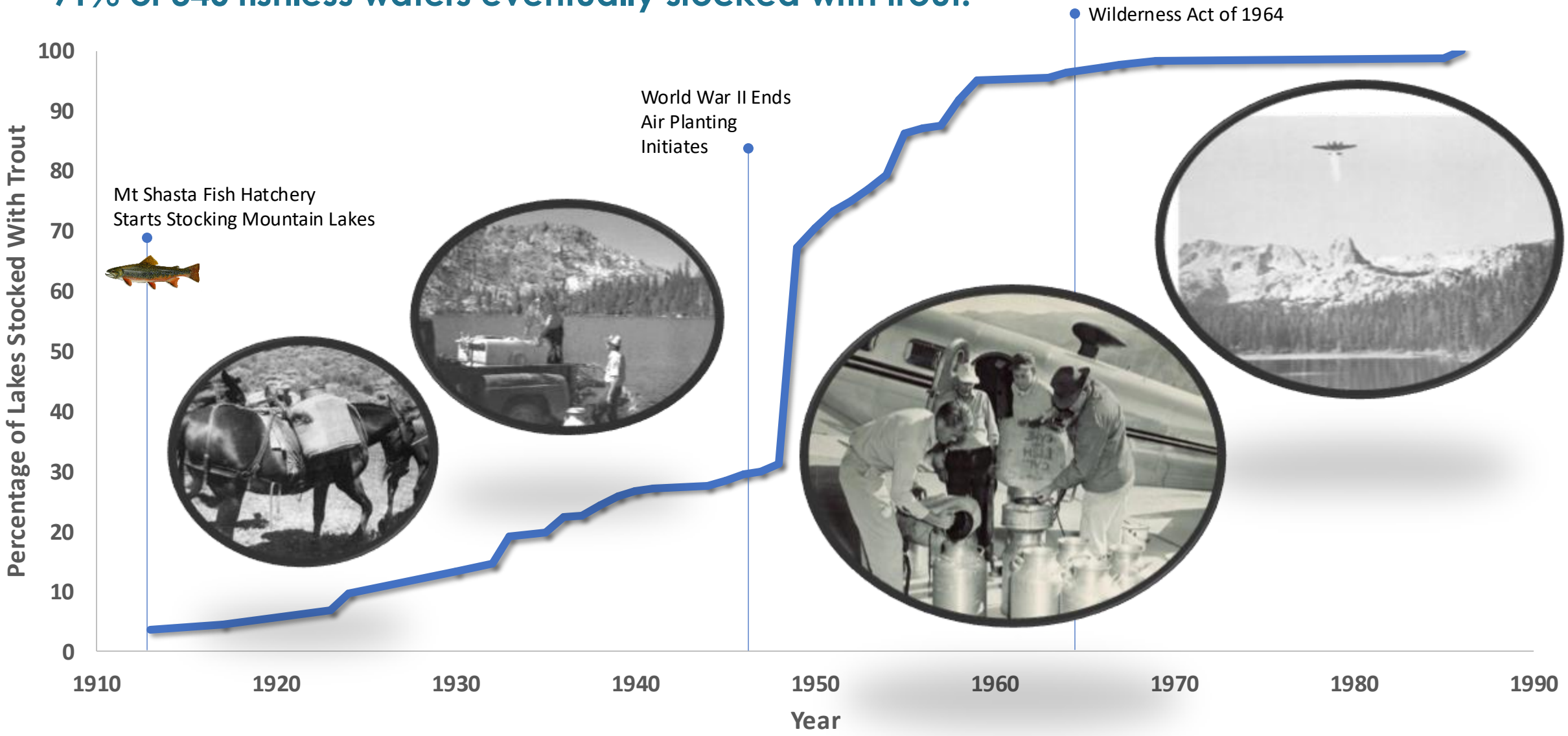


Klamath Mountain Lake Ecosystems

Amphibians can represent substantial biomass in mountain lakes

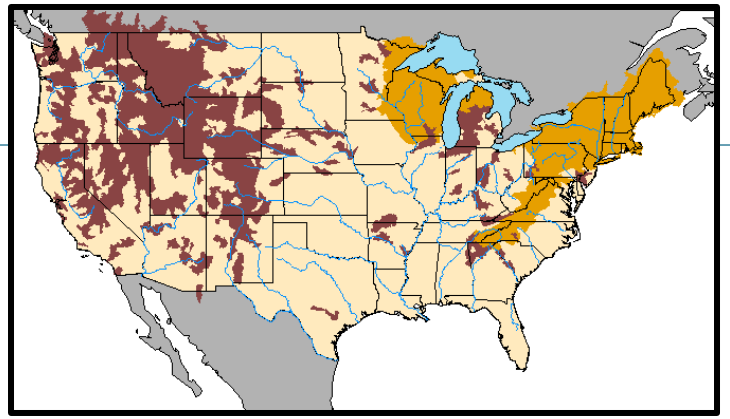
Stocking Chronology Across Lakes of the Klamath Mountains

91% of 340 fishless waters eventually stocked with trout!

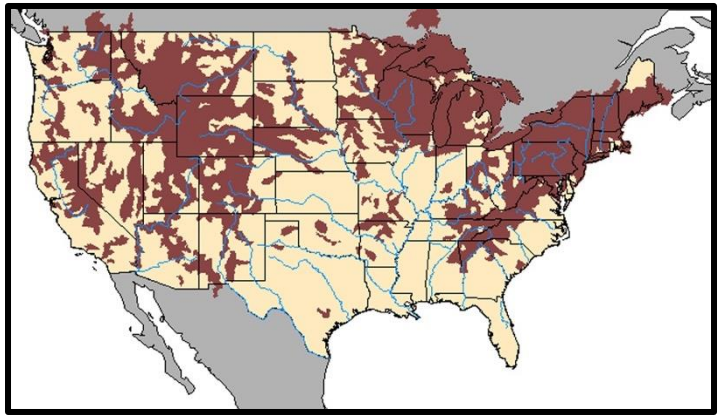


Trout Species in the Klamath Mountains

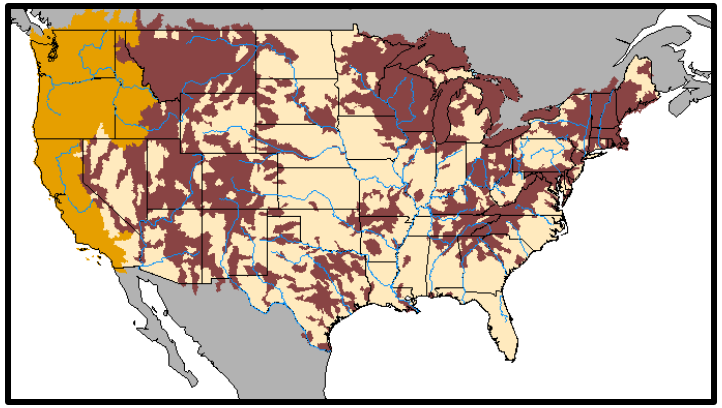
- Brook Trout (*Salvelinus fontinalis*)
  - Native to the East Coast
  - Can spawn in lakes
  - Stocking period: 1912-2016 (at least 286 lakes)

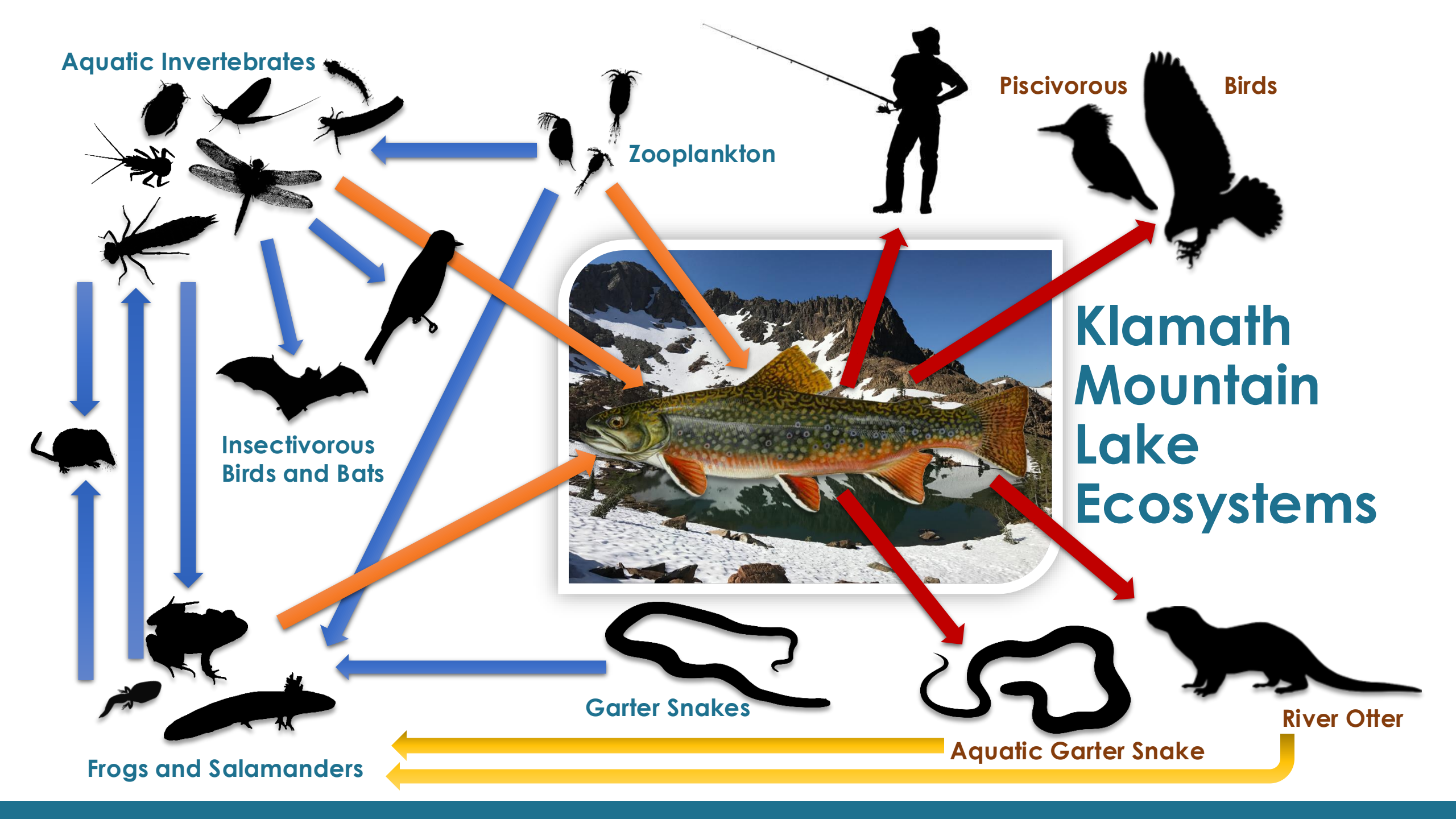


- Brown Trout (*Salmo trutta*)
  - Native to Europe
  - Requires streams to spawn
  - Stocking period: 1917-2007 (at least 44 lakes)



- Rainbow Trout (*Oncorhynchus mykiss*)
  - Regionally native
  - Requires streams to spawn
  - Stocking period: 1930-Present (at least 241 lakes)




Aquatic Invertebrates
Zooplankton
Piscivorous Birds
Insectivorous Birds and Bats
Klamath Mountain Lake Ecosystems
Garter Snakes
Aquatic Garter Snake
River Otter
Frogs and Salamanders

Cascades Frog *(Rana cascadae)*

Life History

- High-elevation specialist
- Lake and pond breeder
- Long-lived

Status

- California Species of Special Concern
- Petitioned for California ESA threatened status (2017)

Major Threats

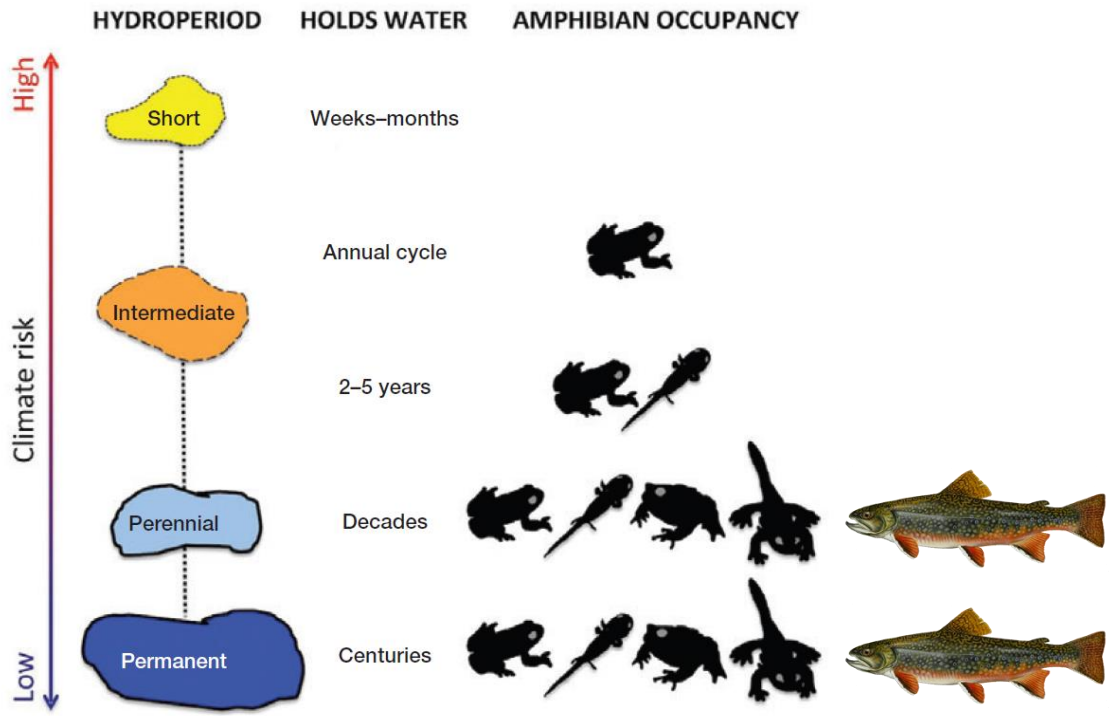
- Invasive Fishes
- Habitat Loss/Alterations
- Disease

Hydrology is Destiny For Amphibians…

REVIEWS REVIEWS REVIEWS *Front Ecol Environ* 2014; 12(4): 232–240, doi:10.1890/130145

Amphibians in the climate vice: loss and restoration of resilience of montane wetland ecosystems in the western US

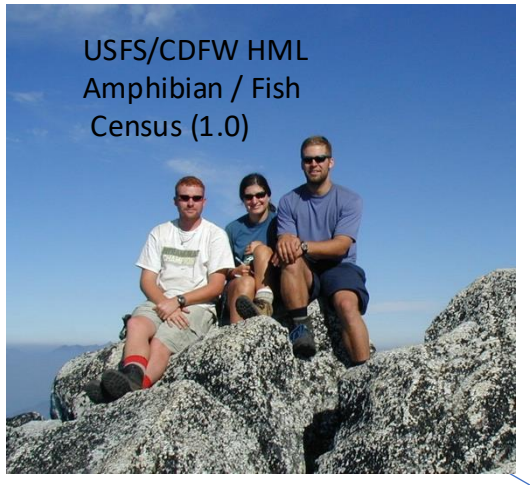
Maureen E Ryan[1,2*], Wendy J Palen[2], Michael J Adams[3], and Regina M Rochefort[4]




A
B
C

Stocking Cessation Chronology Across Lakes of the Klamath Mountains

(Data from 250 lakes with known final stocking dates)



The 'Great' Airplane Stocking Event (1949)

USFS/CDFW HML Amphibian / Fish Census (1.0)

USFS/CDFW first HML Amphibian / Fish Census

CDFW Gets Sued For Stocking Practices

CDFW Hatchery Stocking EIR Published

Only Rainbow Trout Stocked after 2016

Cascades Frog Petitioned For CESA Protections

Need More Data!

Percentage of Lakes No Longer Stocked

100
90
80
70
60
50
40
30
20
10
0

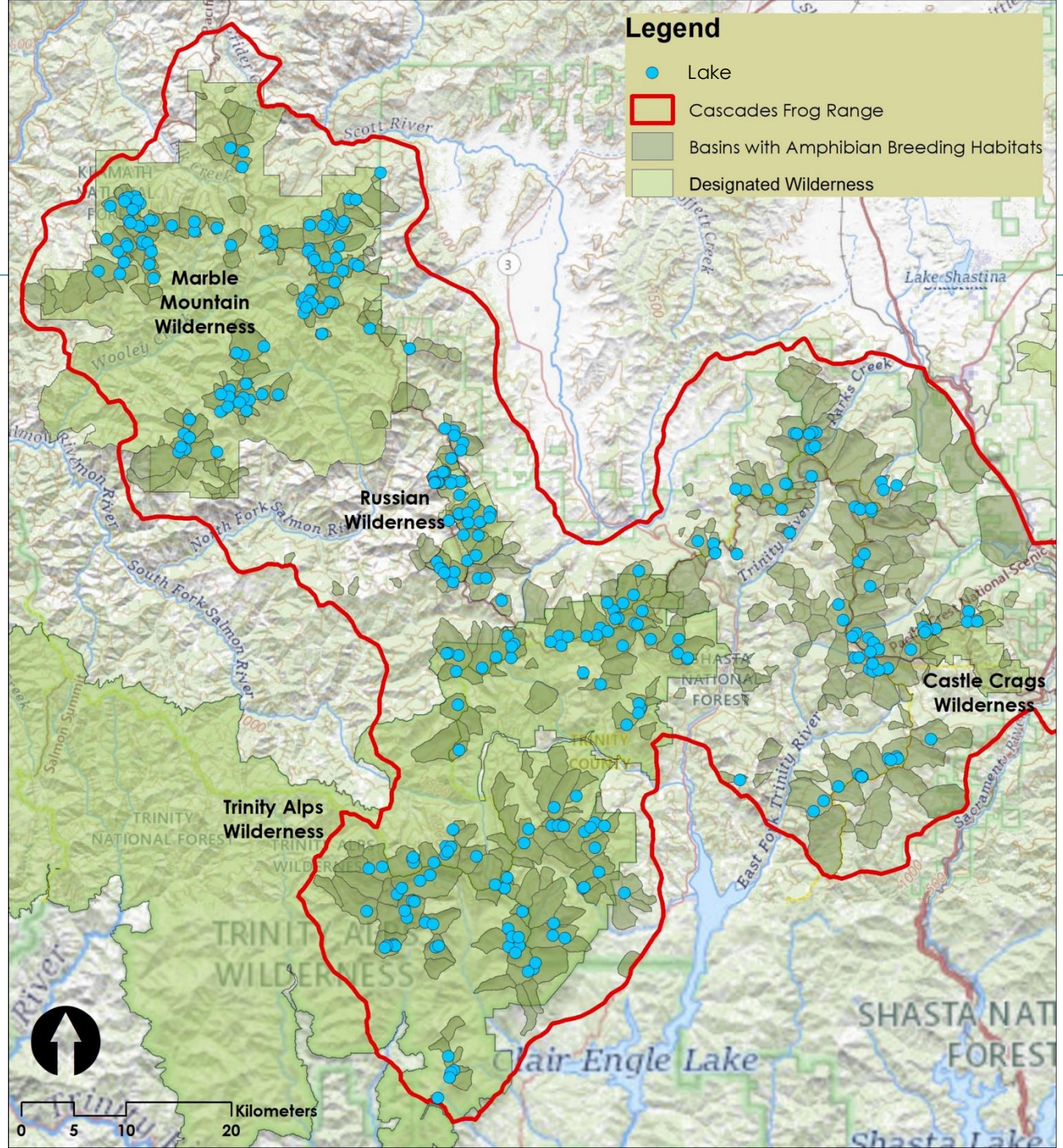
1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020

Last Year Stocked

State Wildlife Grant 2021-2024

HML 2.0

- Survey for Cascades Frogs across their historic Klamath Range.
- Survey for non-native fish in lakes across the historic range of Cascades Frogs.
- Compare survey results to previous robust effort over 20 years ago (HML 1.0).
- Use current data to inform a new range-wide fisheries management and conservation strategy.

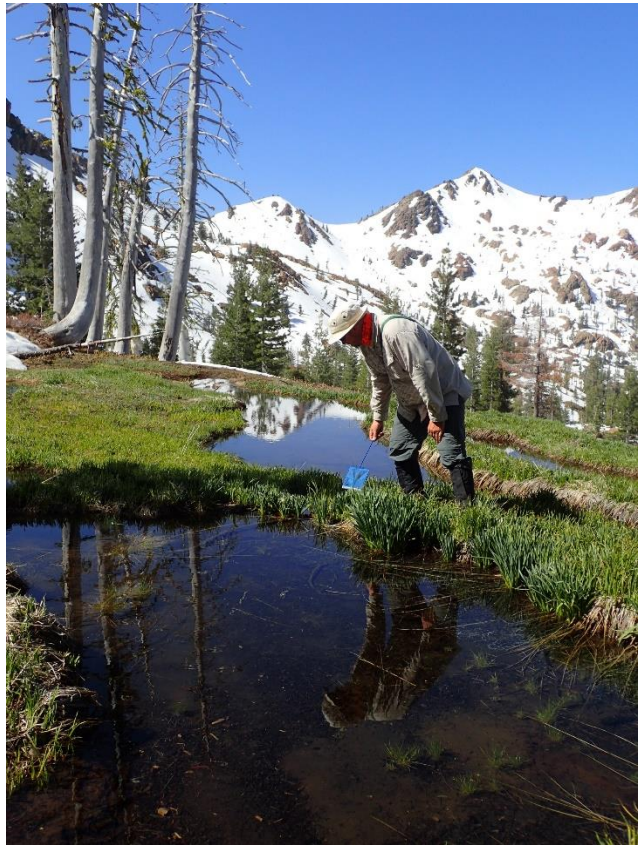


Survey Methods

Exact same methods as 20 years ago with a few new tricks….

Amphibians and Reptiles

Visual Encounter Surveys

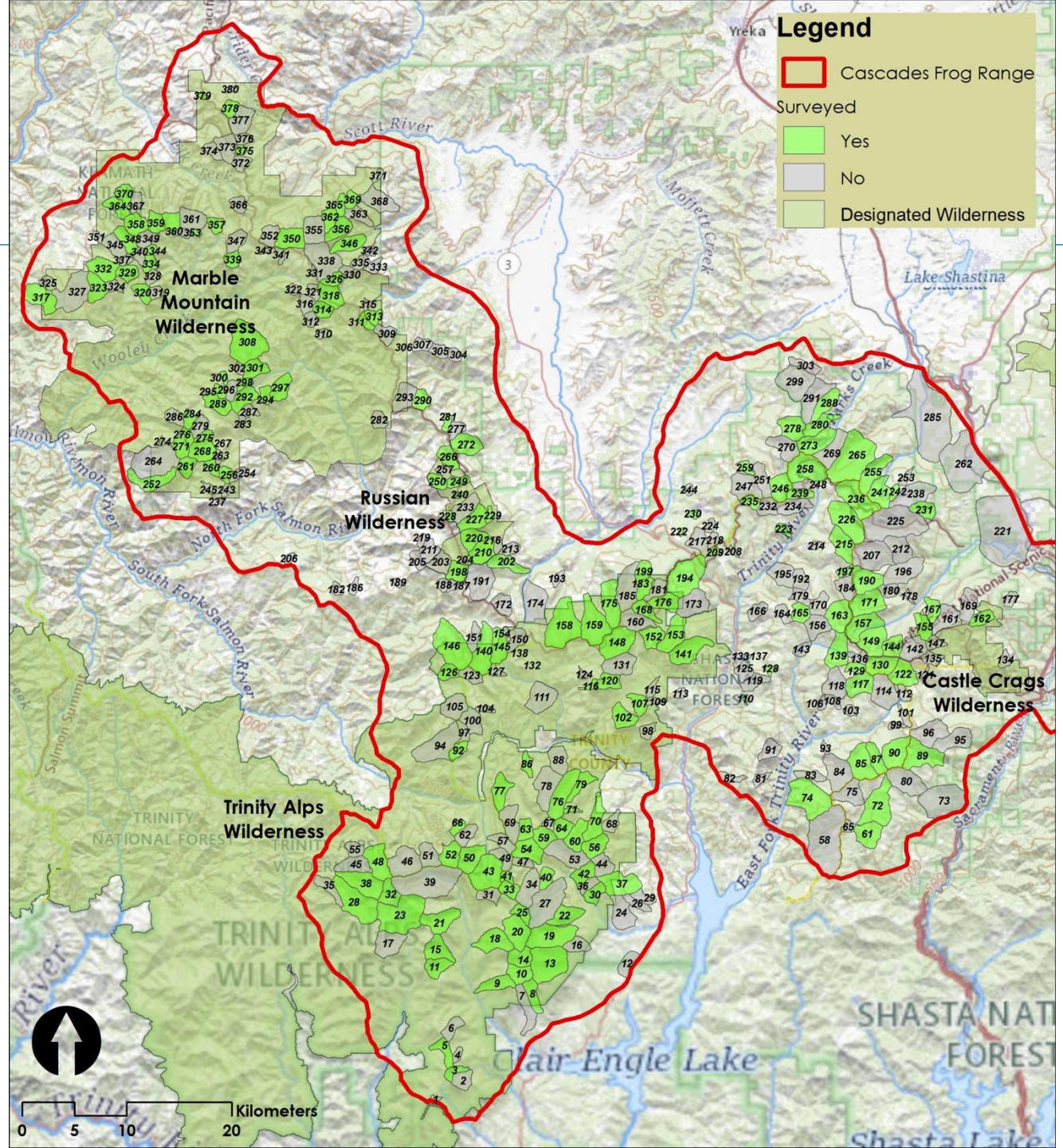


Fishes

Gill Netting and Visual Encounter Surveys

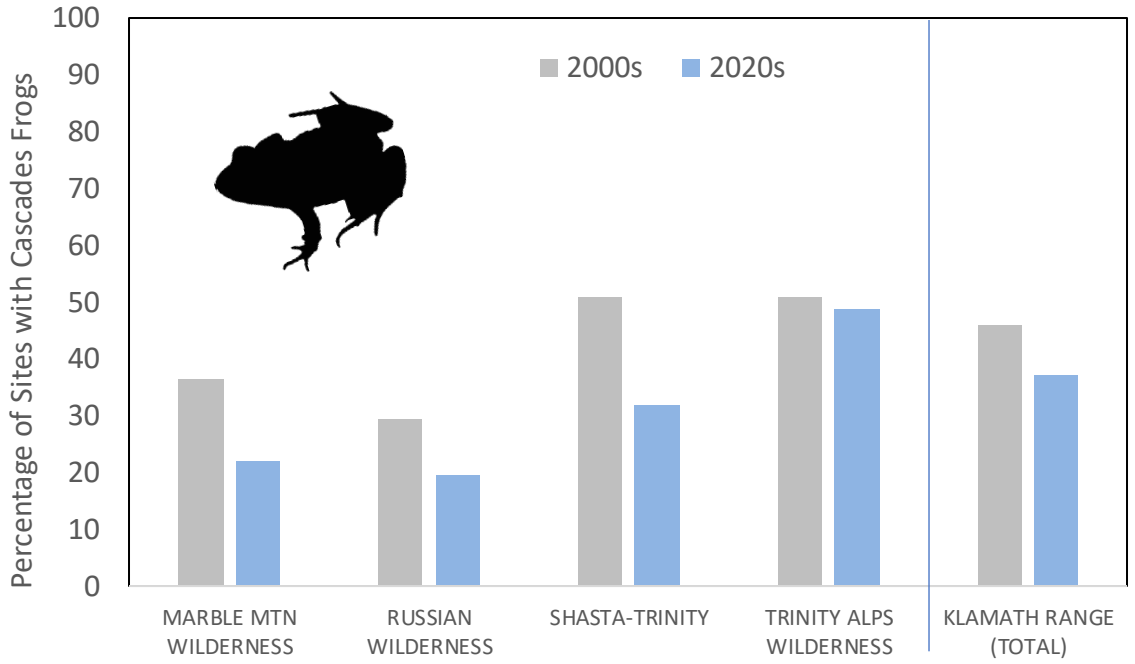
2021-2024 Survey Effort

- Surveyed ~1400 sites for amphibians across 224 basins
- >550 identical sites surveyed between the 2 periods:
  (1999-2002) and (2021-2024)
- 261 lakes gill net sampled for trout
  (Only 26 lakes remain to surveyed in 2025!)



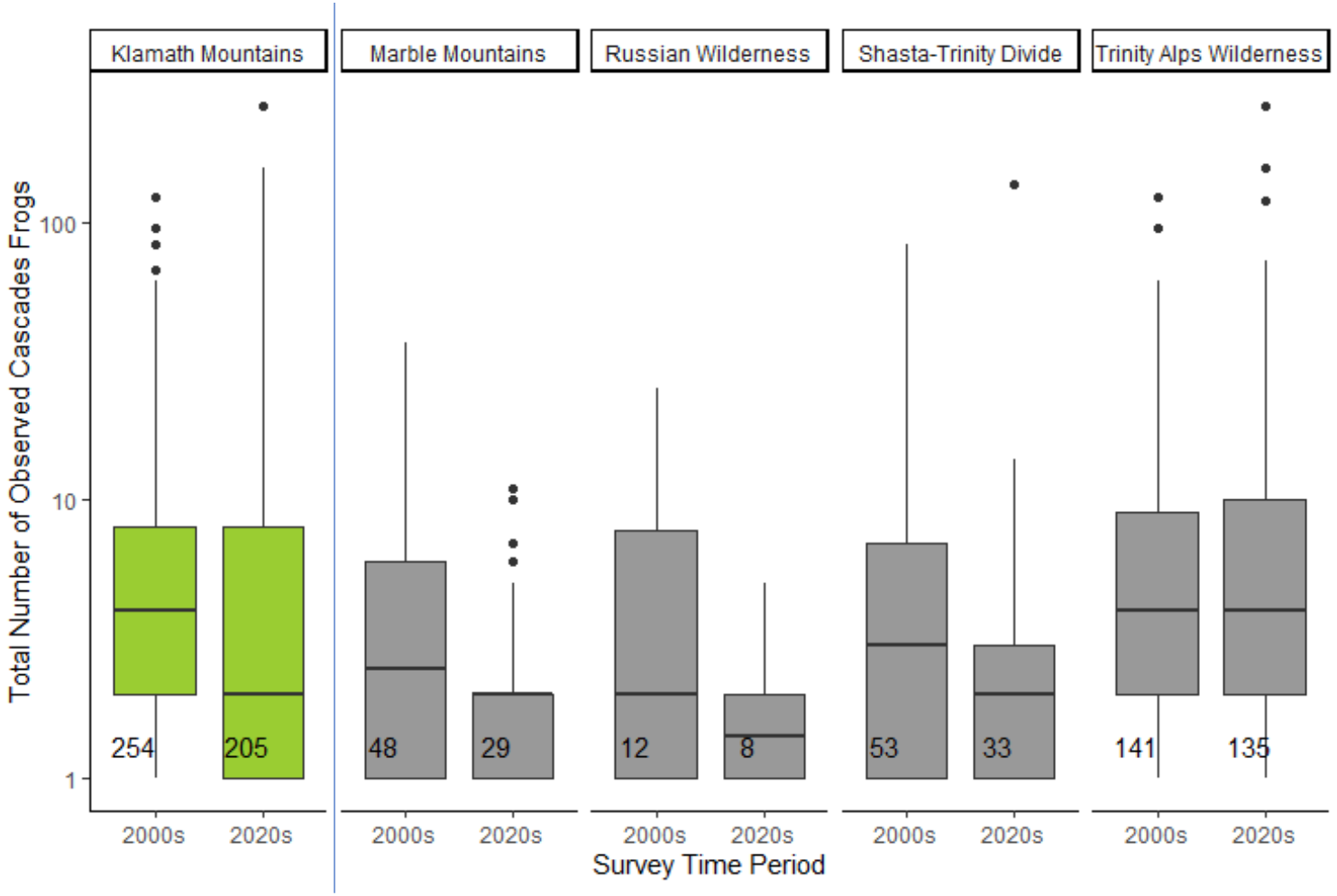
Cascades Frog Site Occupancy in the Klamath Range Across 559 Sites Separated By ~ 20 Years

Current survey found them at ~17% fewer sites relative to 20 years ago



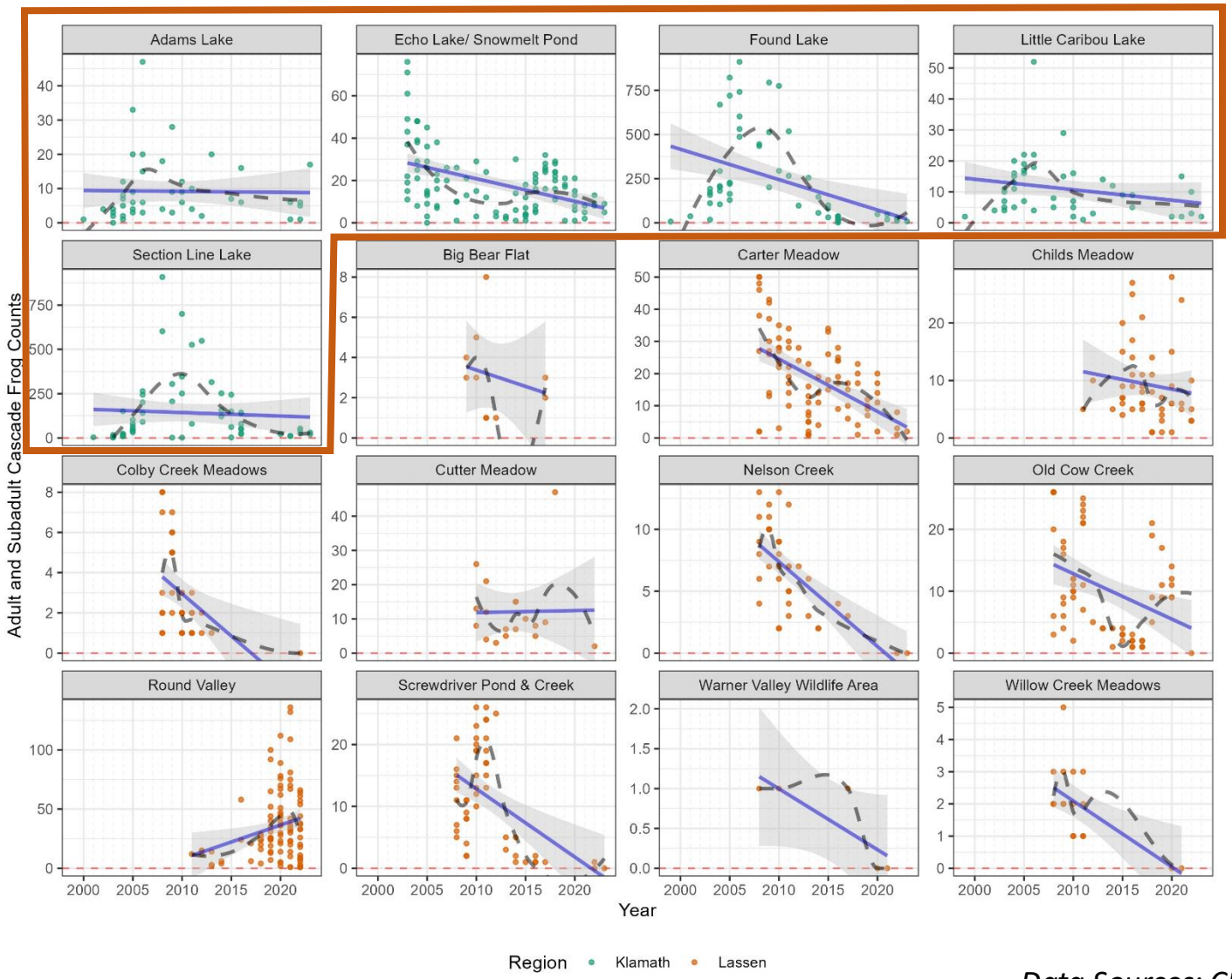
Data Sources: CDFW, US Forest Service

Current Cascades Frog survey counts across 559 Klamath Mountain sites are ~ 50% lower than those observed ~20 years ago.



Data Sources: CDFW, US Forest Service

Cascades Frog count trends across 16 CMR sites in the Klamath and Cascades ranges 2003-2023



Data Sources: CDFW, US Forest Service. Graphic: Adam Cummings

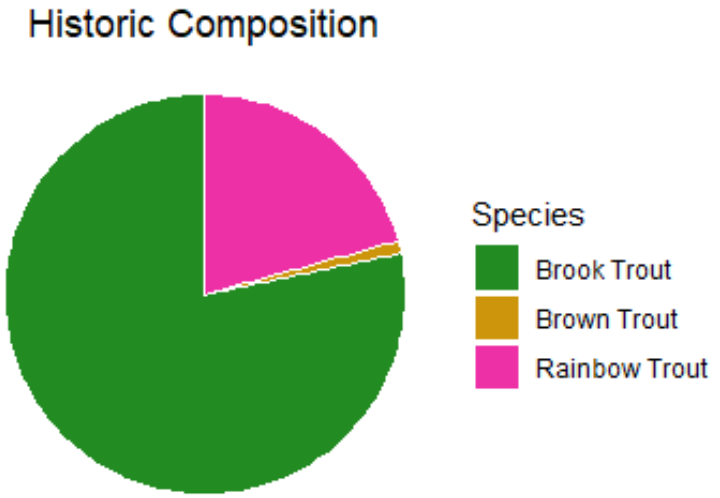
Fishery Status Within the Cascades Frog Range

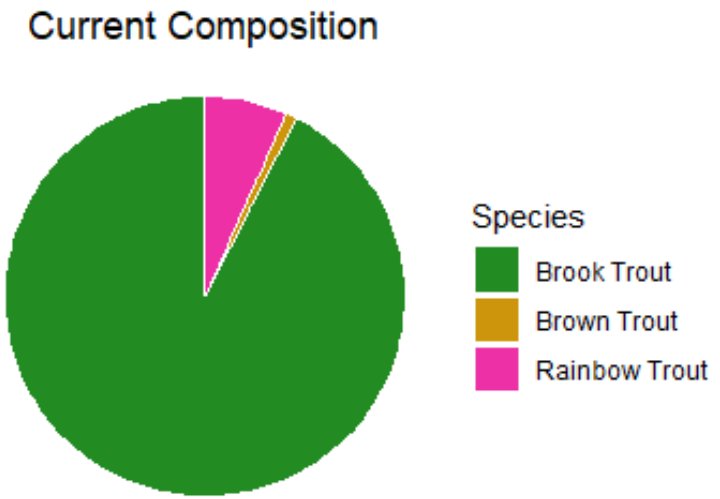
Stocking History

- 279 Lakes(90%) historically stocked.

Current Trout Population Status (after ceasing stocking for many years)

- Present in 209 (75%) of historic stocked waters.
- Natural reproduction in at least 84% of waters.
- No longer present in 70 (25%) historically stocked waters
- **Additionally found in 66 meadow systems.

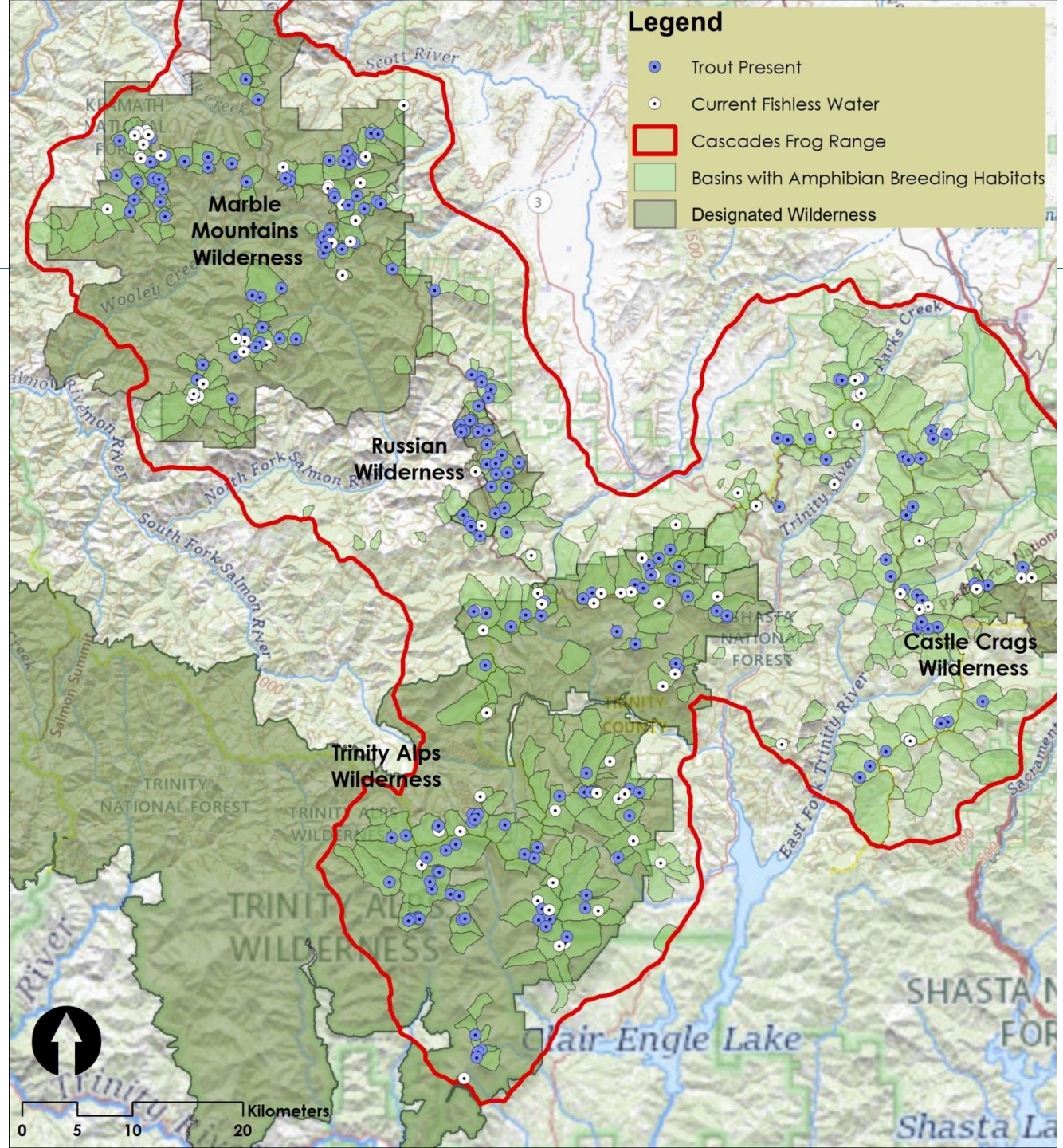




Data Sources: CDFW, US Forest Service

Current Trout Distribution

- Present in 209 lakes (75%)
- 89% of combined lake surface area.
- No longer present in 70 lakes (25%)
- But only ~11% of combined lake surface area.



Individual Lake Management Options

1) Passive
Maintain Healthy Naturalized Trout Populations

2) Active
Resume Trout Stocking in Select Lakes

3) Passive
Maintain Currently Fishless Waters

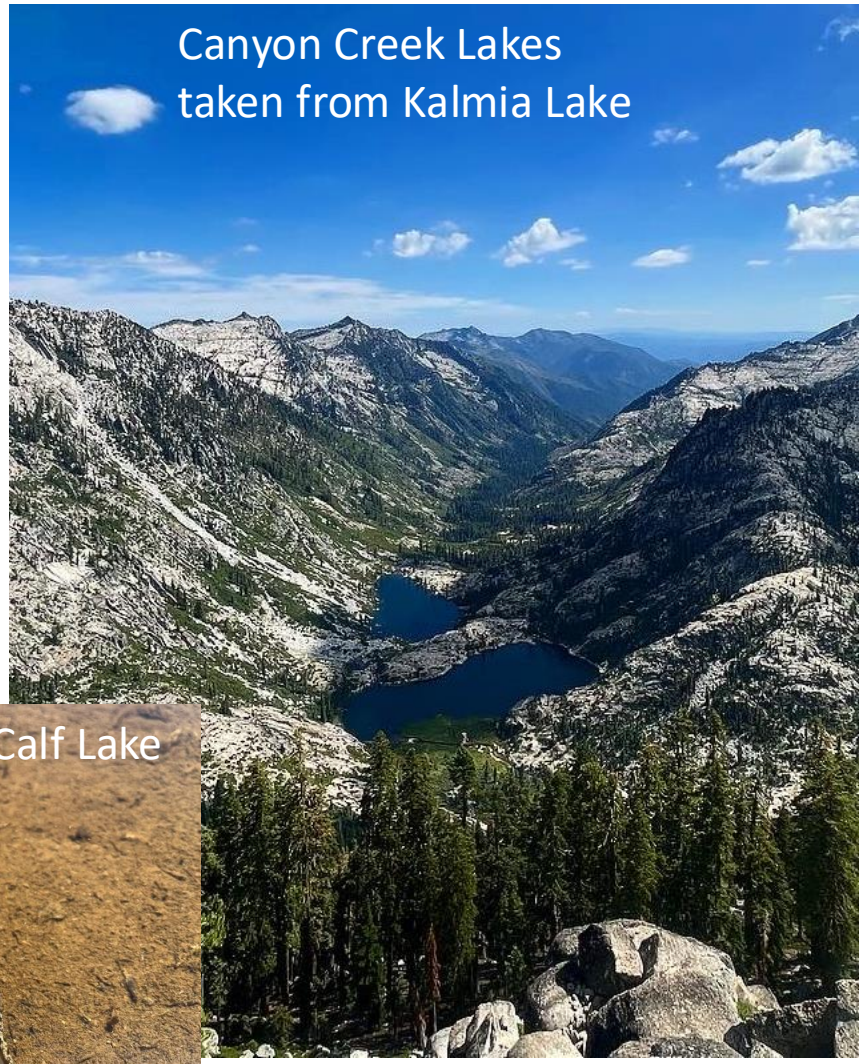
4) Active
Remove Trout at Critical Climate-Resilient Locations

Considerations for Managed Fisheries in High Lakes

What is best for the fish?
- Fish health
- Fish persistence
- Natural vs stocked populations

What is best for the angler?
- Popularity
- Hiking distance
- Fish Quality/ multiple species

What is best for the amphibians?
- Breeding habitats
- Adjacent permanent waterbodies
- Dispersal corridors
  - Fish Removal in key habitats



Initial Lake Screening For Restoration Prioritization

- Lakes in Cascades Frog Range= 311
- Current Trout Presence= 209
- Feasibility (<3 ha, <10 m deep)= 114
- MCDA Analysis on 114 lakes
- List of 25 Potential Restoration Lakes

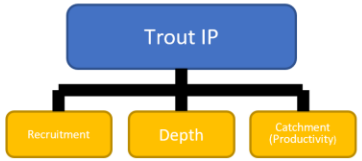
Overlooking Grizzly Lake

Multi Criteria Decision Analysis (MCDA)

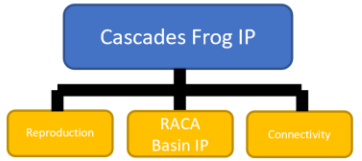
- Used in wildlife resources for balancing finite resource use by multiple conflicting interest groups

Steps:

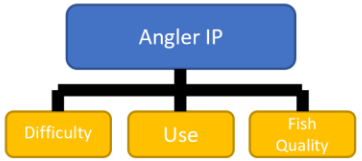
1. Intrinsic Potential (IP) for Interest group
2. Use a weighted scoring to determine importance of lake for each interest group.
3. Calculate restoration value and fishery quality scores separately.



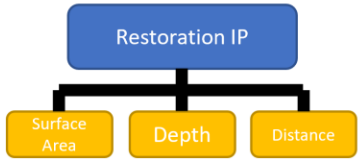
Lake	Criteria 1	Criteria 2	Criteria 3	Total Score
Salmon Lake	2	1	0	3



Lake	Criteria 1	Criteria 2	Criteria 3	Total Score
Salmon Lake	2	2	2	6



Lake	Criteria 1	Criteria 2	Criteria 3	Total Score
Salmon Lake	0.66	0.5	1	2.167



Lake	Criteria 1	Criteria 2	Criteria 3	Total Score
Salmon Lake	2	1	1	4

Table assessing overall importance of a lake for trout

Lake	Trout	Frog	Angler	Resto Potential	Total
Weight	**5**	**1**	**3**	**1**	
Salmon Lake	**5***3 =15	**1***6 =6	**3***2.167 =6.5	**1***4= 4	31.5

Table assessing overall importance of a lake for Cascades Frogs

Lake	Fish	Frog	Angler	Resto Potential	Total
Weight	**1**	**5**	**1**	**3**	
Salmon Lake	**1***3 =3	**5***6 =30	**1***1.66 = 1.66	**3***4 = 12	47.167

Table assessing overall importance of a lake for angler opportunities

Lake	Trout	Frog	Angler	Resto Potential	Total
Weight	**3**	**1**	**5**	**1**	
Salmon Lake	**3***3 =9	**1***6 =6	**5***1.66 = 8.3	**1***4 = 4	29.83

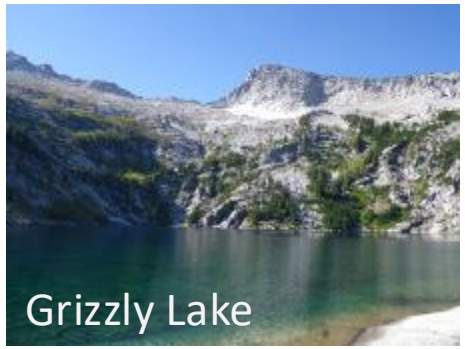
$$Site\ Resto\ Score = \frac{(Frog * 2)}{Trout + (Frog * 2) + Angler}$$

$$Salmon\ Lake\ = \frac{(46.66*2)}{30+(46.66*2)+27.33} = 0.61$$

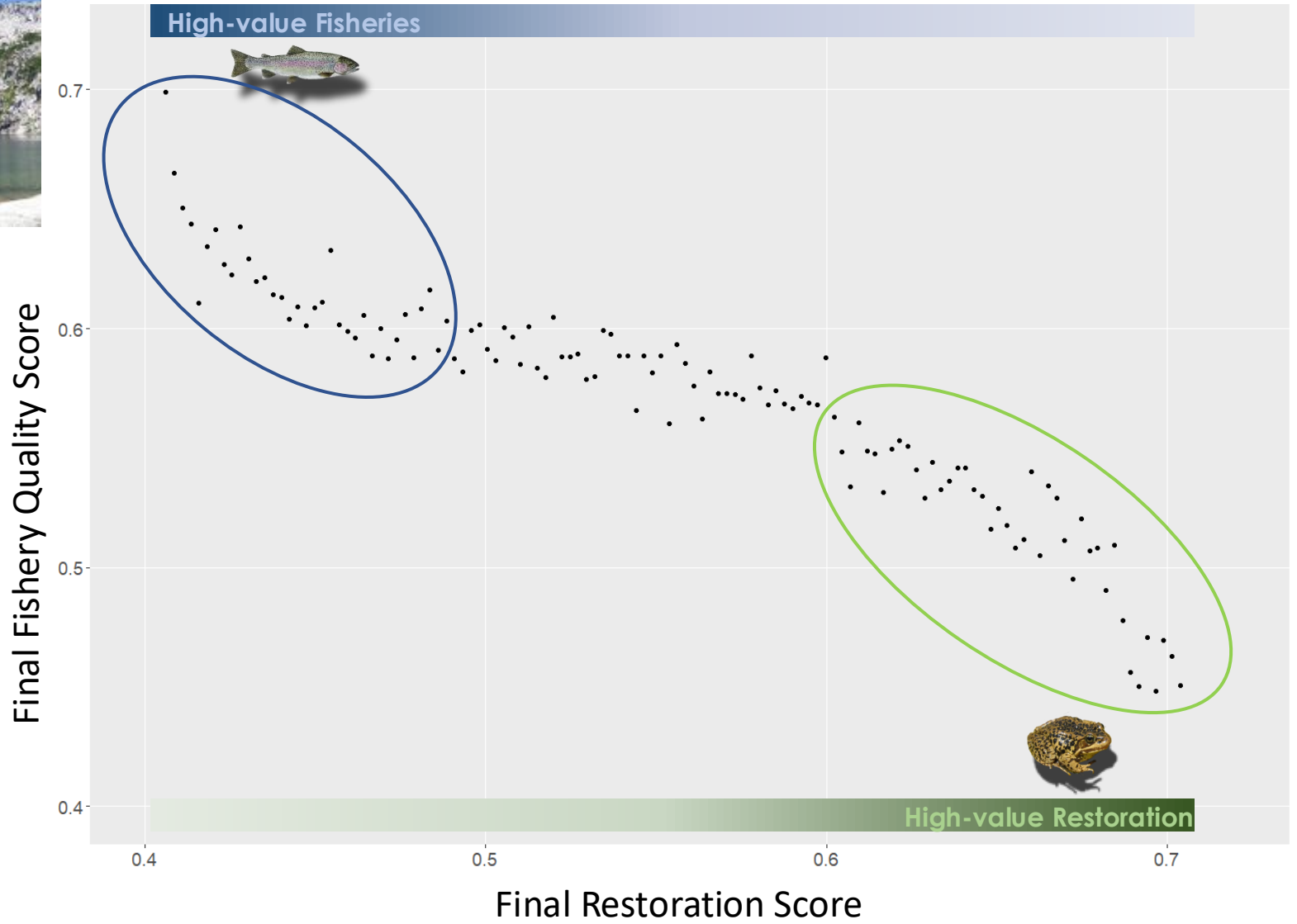
$$Site\ Fishery\ Quality\ Score = \frac{(Trout * 2) + (Angler * 0.5)}{Frogs + (Trout * 2) + Angler}$$

$$Salmon\ Lake = \frac{(30 * 2) + (27.33 * 0.5)}{46.66 + (30 * 2) + 27.33} = 0.60$$

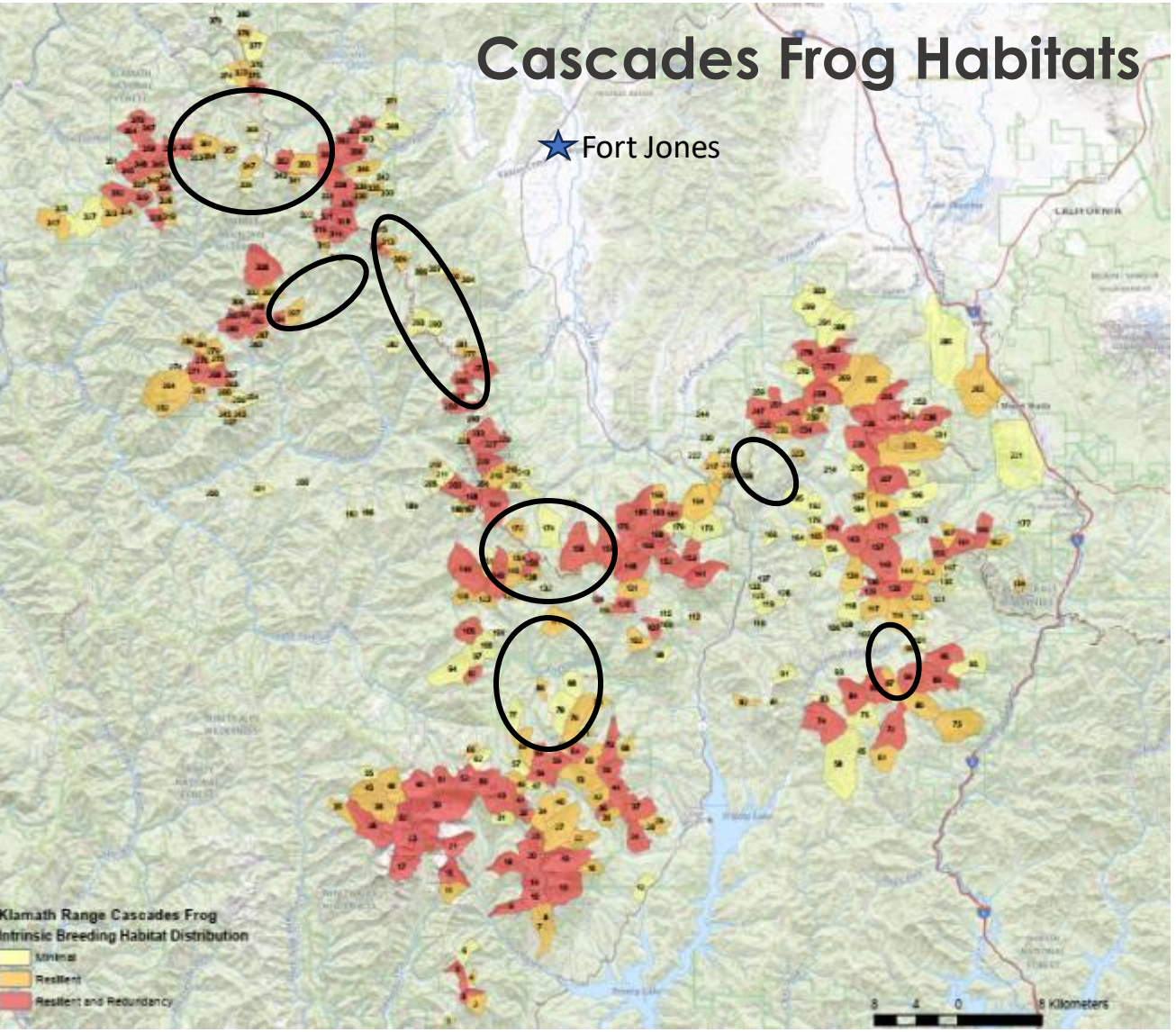
Final MCDA Results

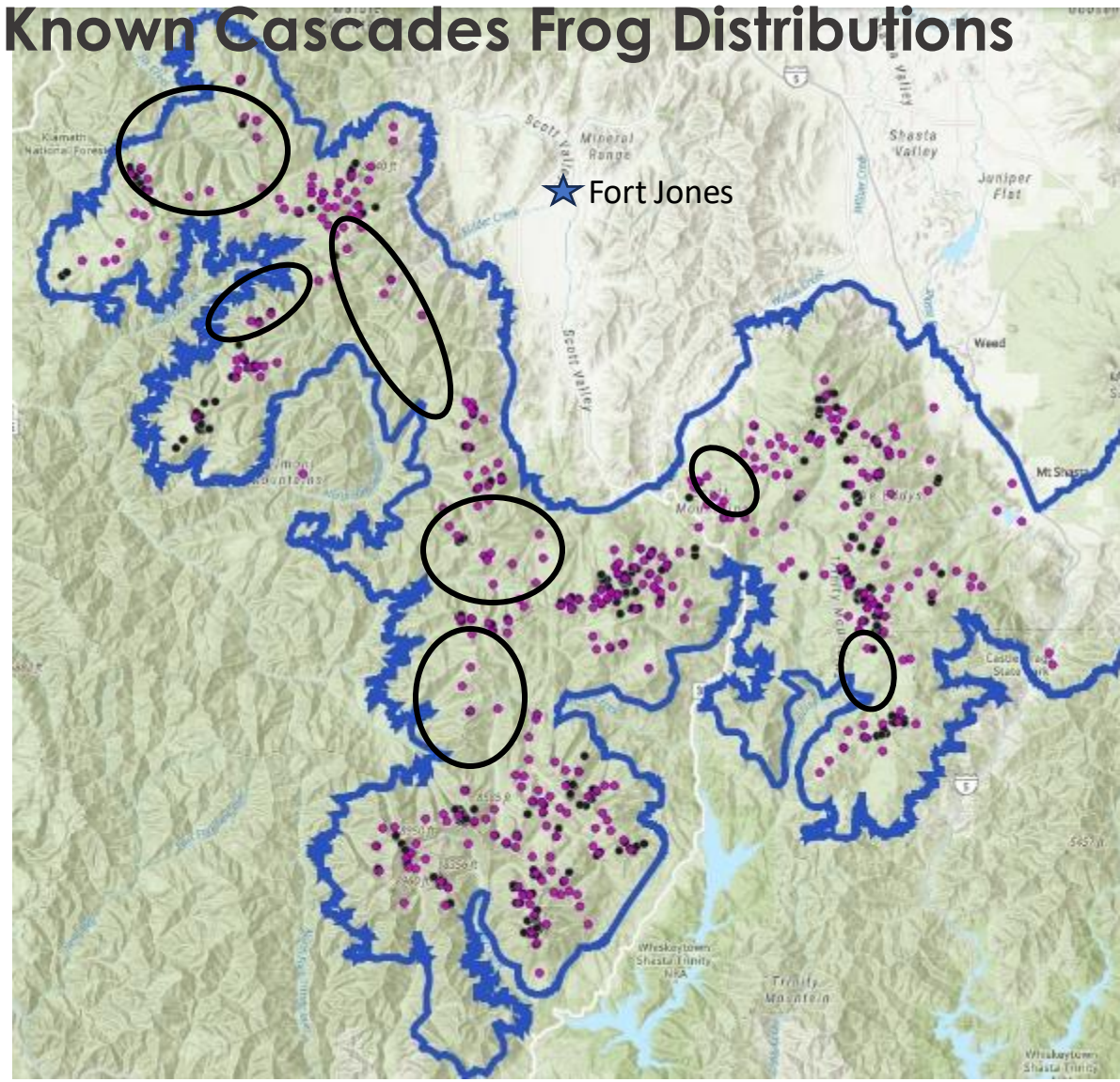


Relationship Between Weighted Fishery Quality and Restoration Scores for 114 Candidate Lakes



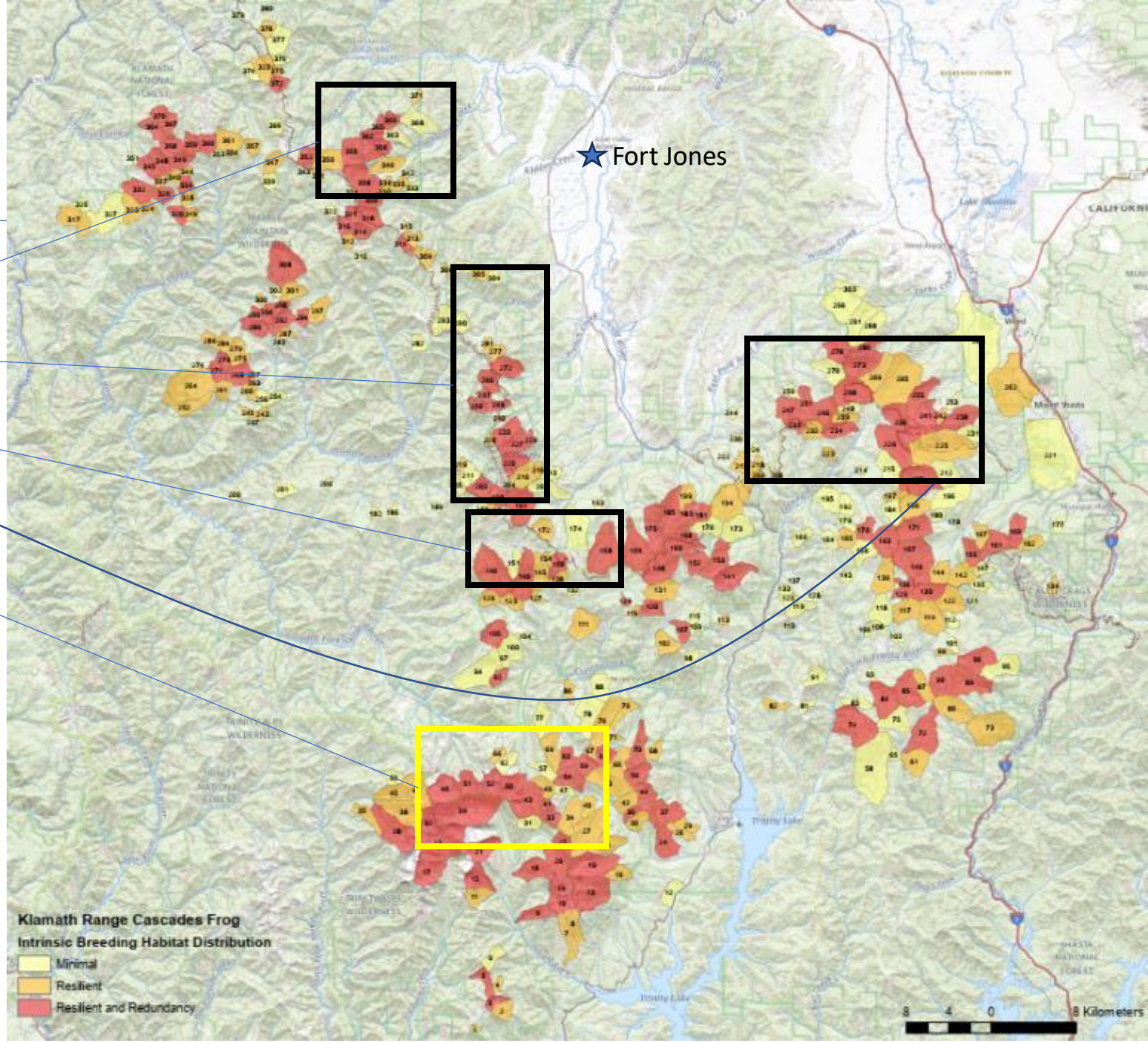
Cascades Frog Metapopulation Structure



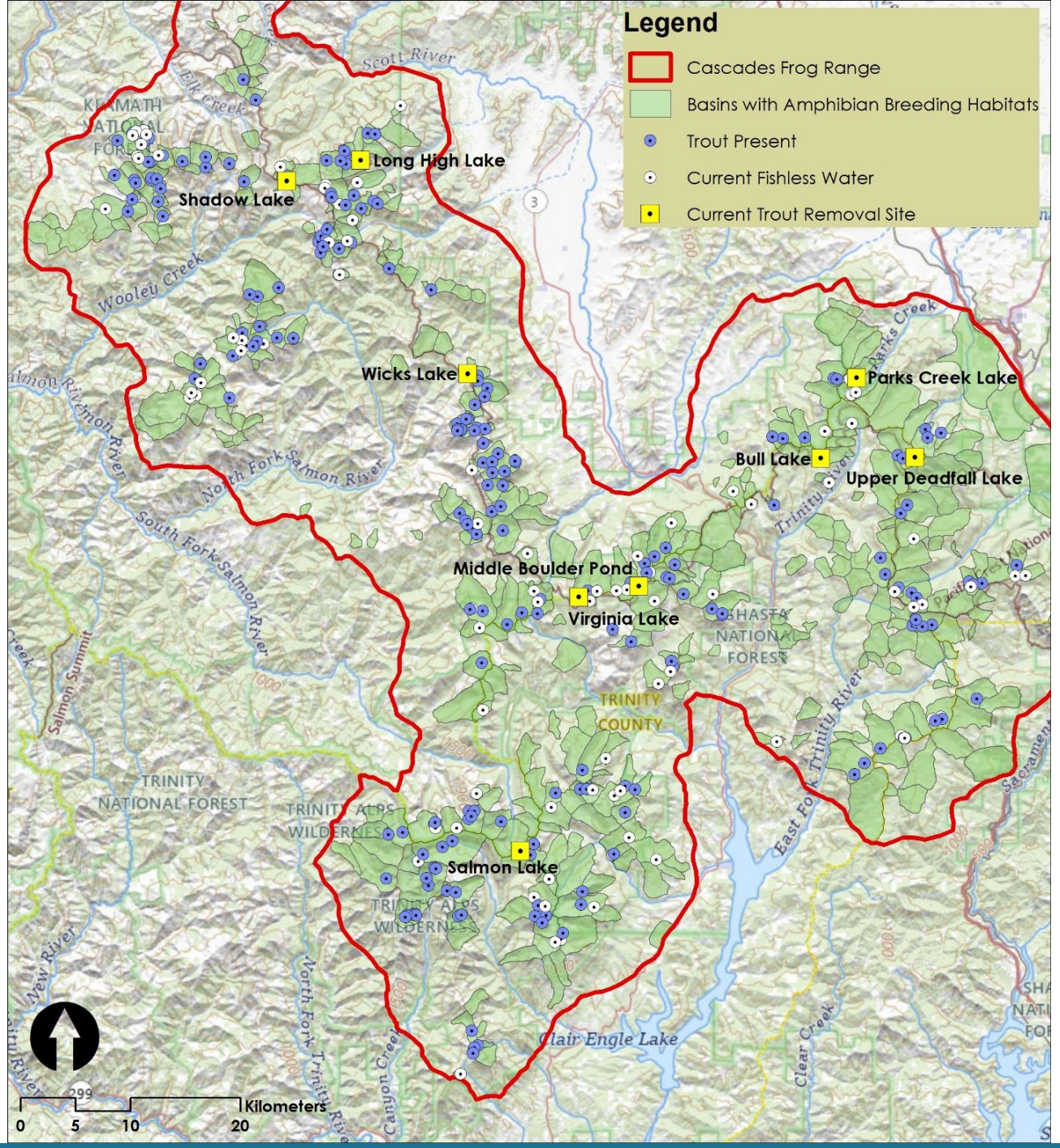


Restoration: Regions of Focus

- NE Marble Mountains (2 sites)
- Russian Wilderness (1 Site)
- Northern Trinity Rim (2 sites)
- Scott-Eddy Mountains (3 sites)
- NEW IN 2025: Trinity Alps (2 sites)



Current Trout Distribution and Lake Restoration Sites

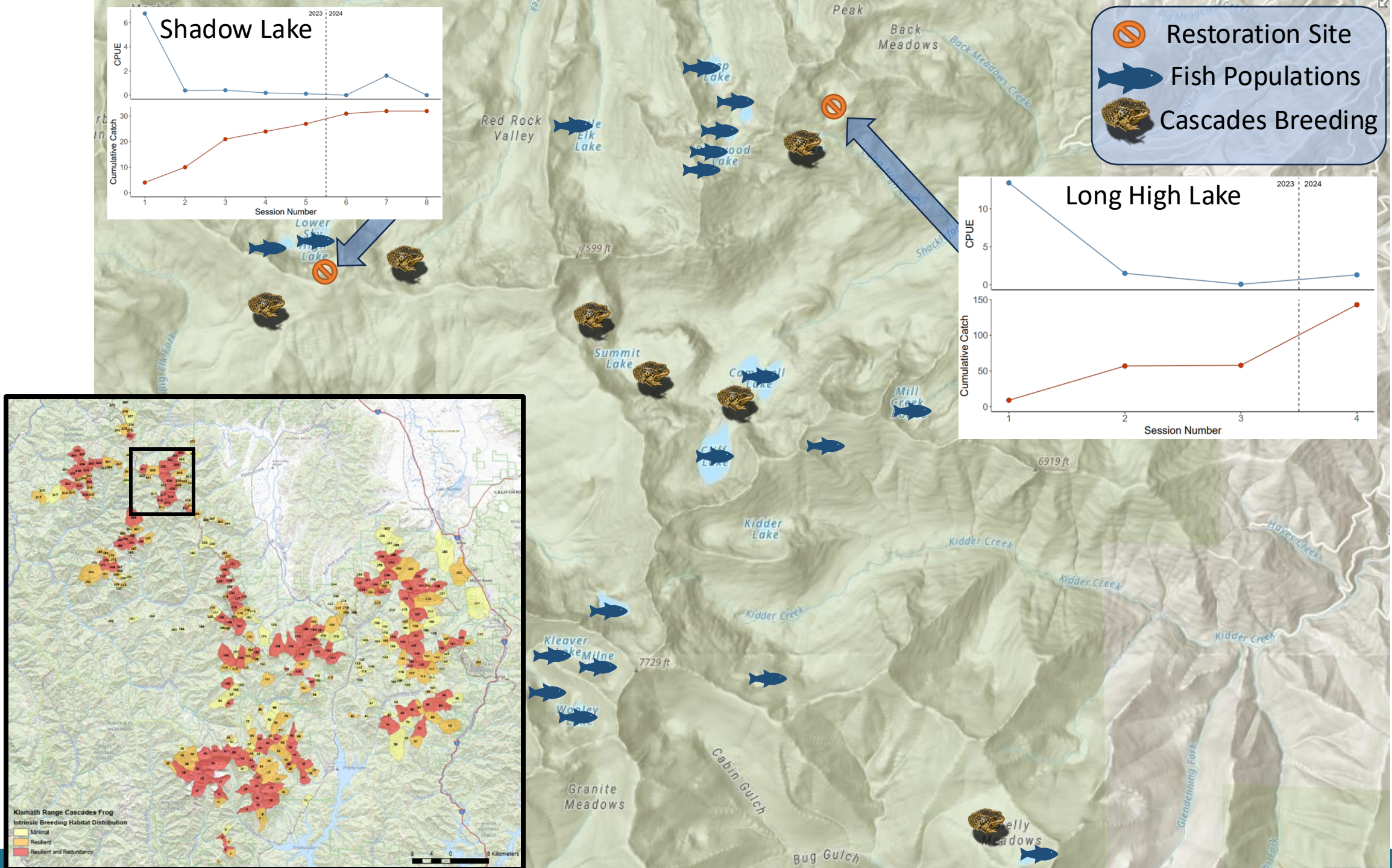


Marble Mountain Wilderness

- Long High Lake
- Shadow Lake


Long High Lake


Shadow Lake

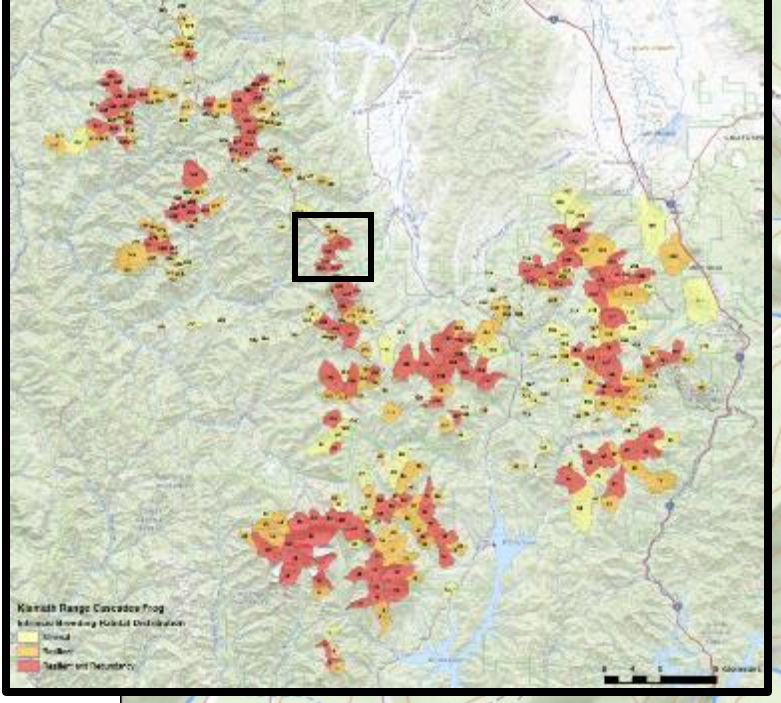

Restoration Site
Fish Populations
Cascades Breeding
Shadow Lake
2023
2024
CPUE
Cumulative Catch
Session Number
Long High Lake
2023
2024
CPUE
Cumulative Catch
Session Number
Klamath Range Cascades Frog
Intrinsic Breeding Habitat Distribution
Minimal
Resilient
Resilient and Redundancy
8 Kilometers
Peak
Back Meadows
Back Meadows Creek
Red Rock Valley
Elk Lake
Lower Sky High Lake
7599 ft
Summit Lake
Mill Creek
6919 ft
Kidder Lake
Kidder Creek
Hayes Creek
Kleaver Lake
Milne
7729 ft
Wooley
Cabin Gulch
Granite Meadows
Bug Gulch
Glendenning Fork

Russian Wilderness and Northern Trinity Alps

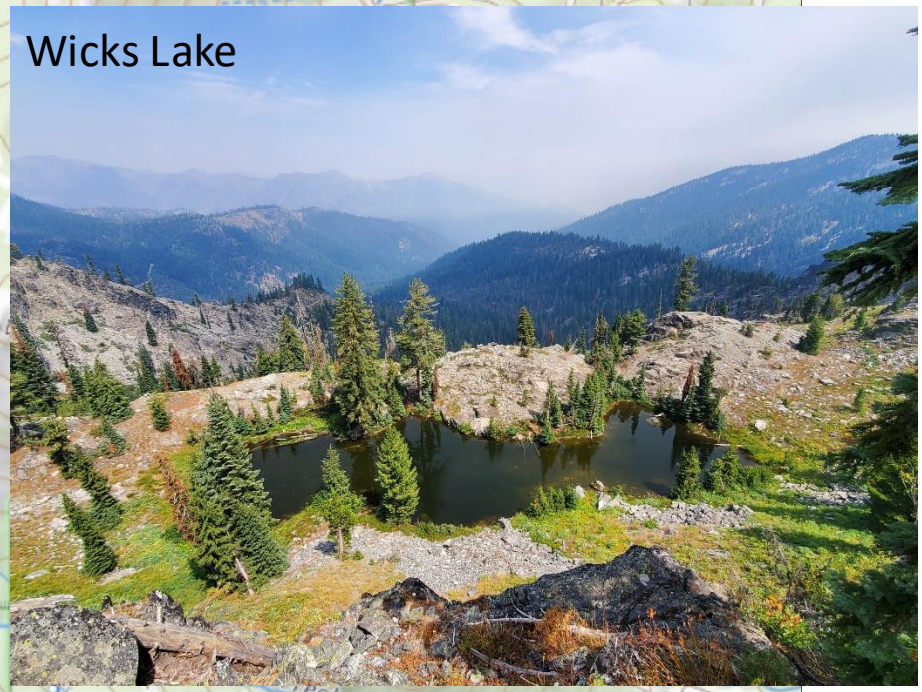
- Wicks Lake
- Virginia Lake
- Middle Boulder Pond

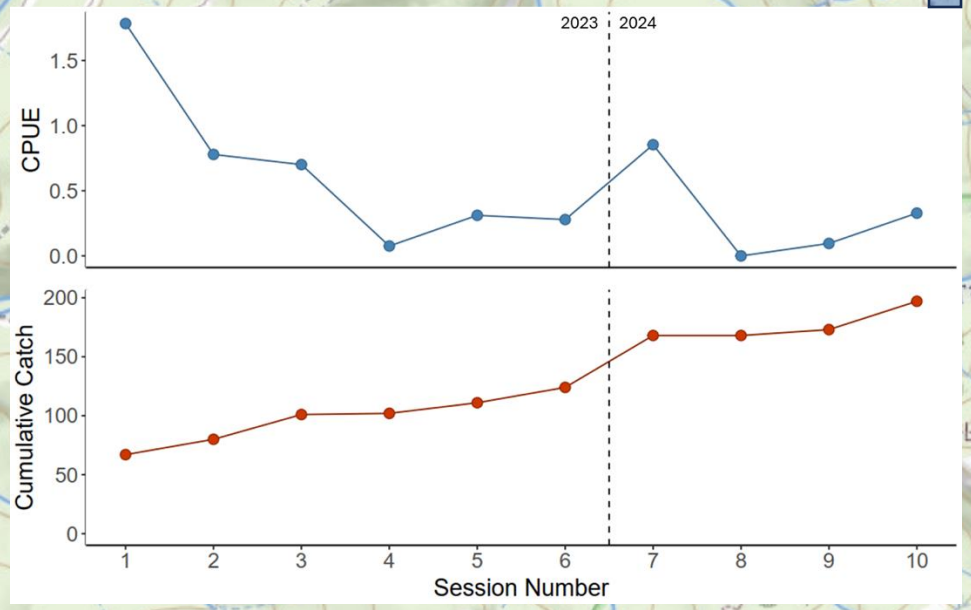

Virginia Lake


Middle Boulder Pond



Wicks Lake

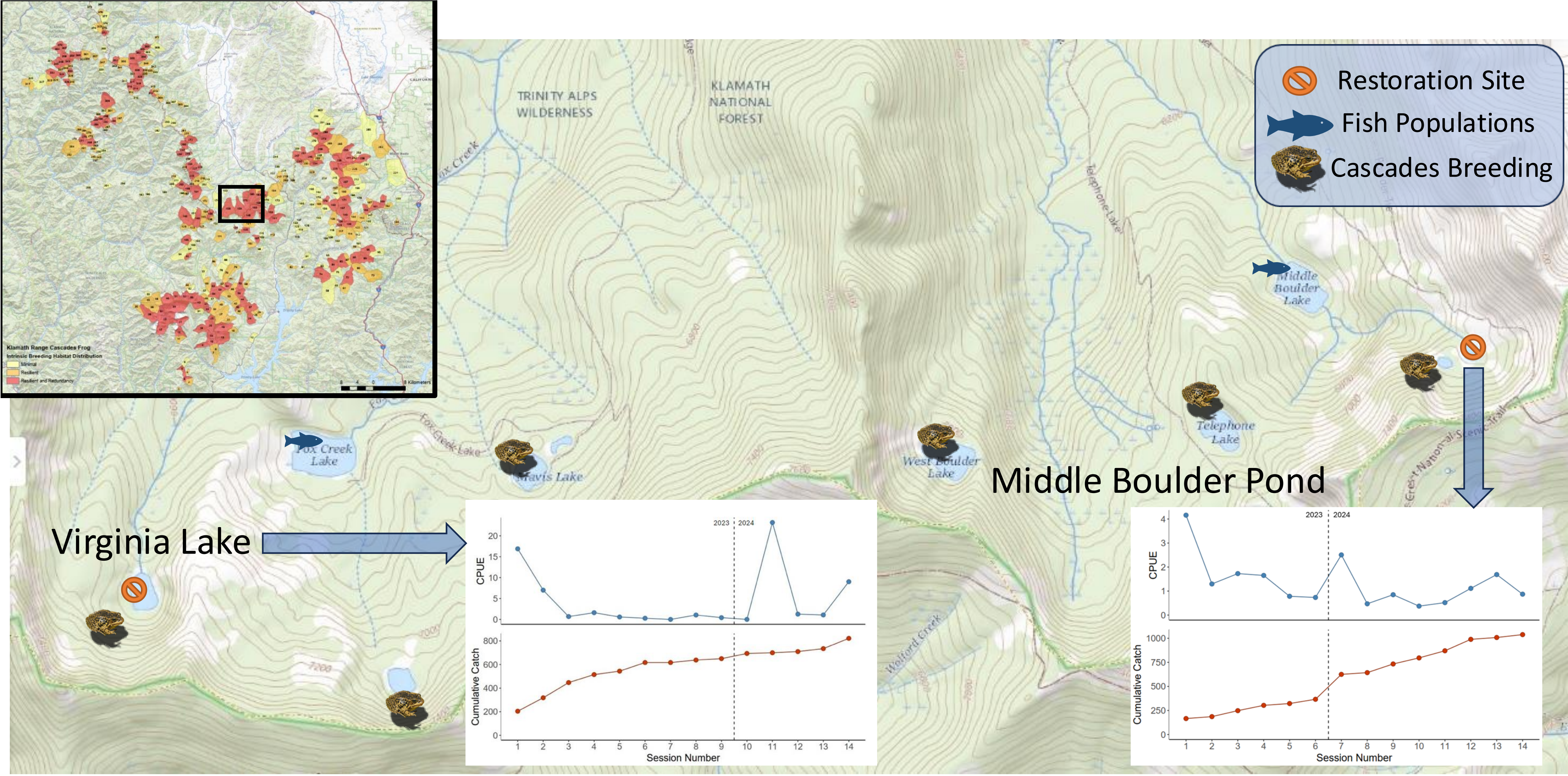




Restoration Site

Fish Populations

Cascades Breeding

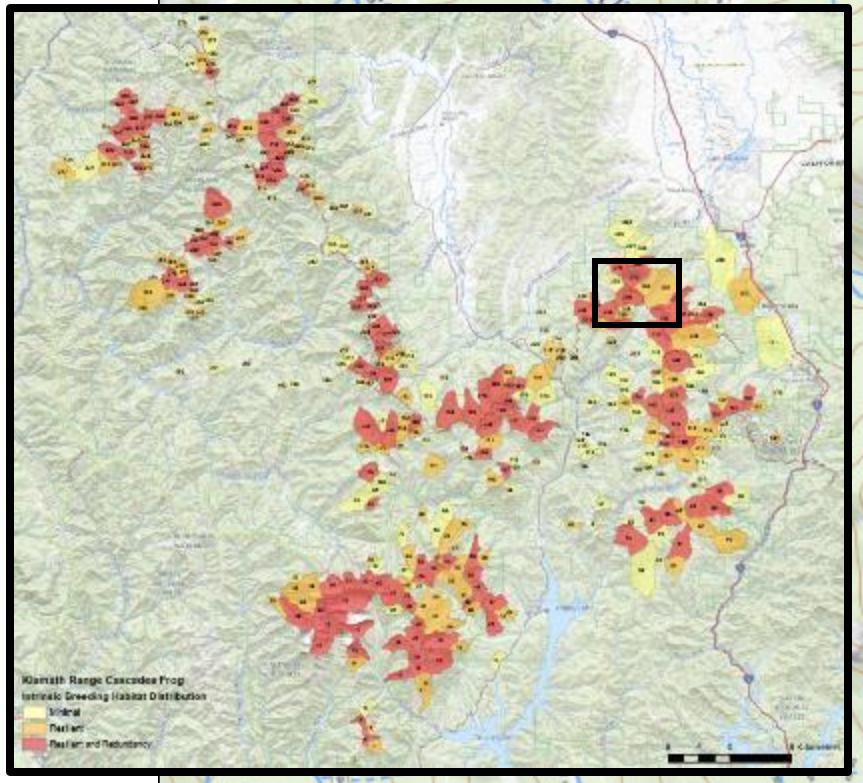


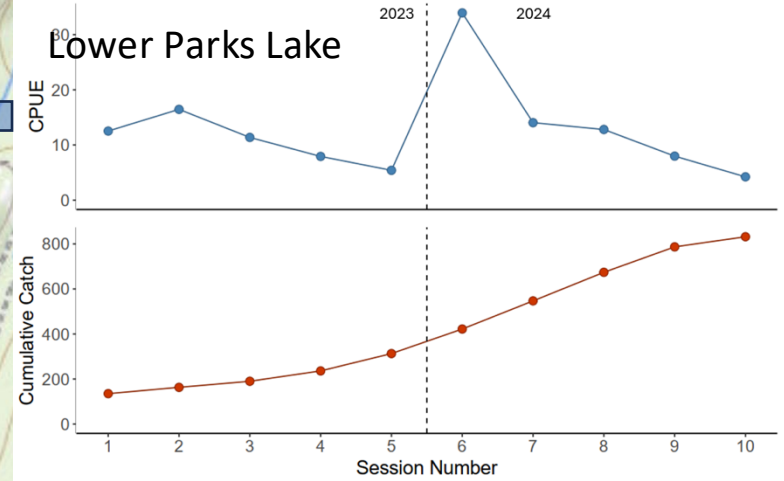
Klamath Range Cascades Frog
Intrinsic Breeding Habitat Distribution
Minimal
Resilient
Resilient and Redundancy
Restoration Site
Fish Populations
Cascades Breeding
TRINITY ALPS WILDERNESS
KLAMATH NATIONAL FOREST
Middle Boulder Lake
Telephone Lake
West Boulder Lake
Mavis Lake
Fox Creek Lake
Middle Boulder Pond
Virginia Lake
CPUE
Cumulative Catch
Session Number
2023
2024

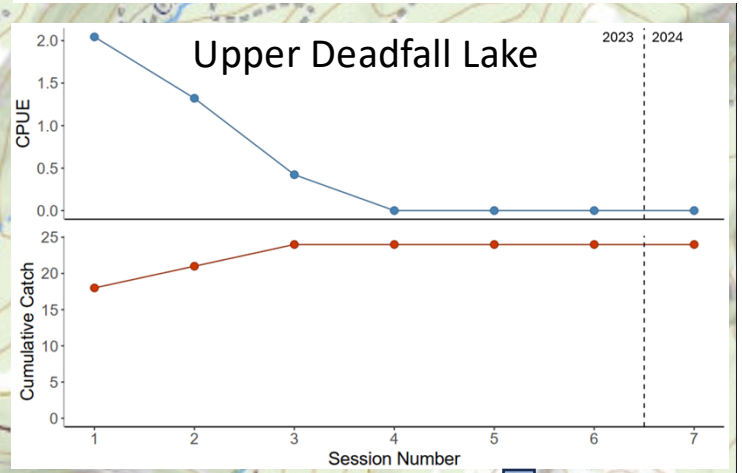
Scott-Eddy Shasta-Trinity Mountains

- Upper Deadfall Lake
- Bull Lake
- Lower Parks Creek Lake

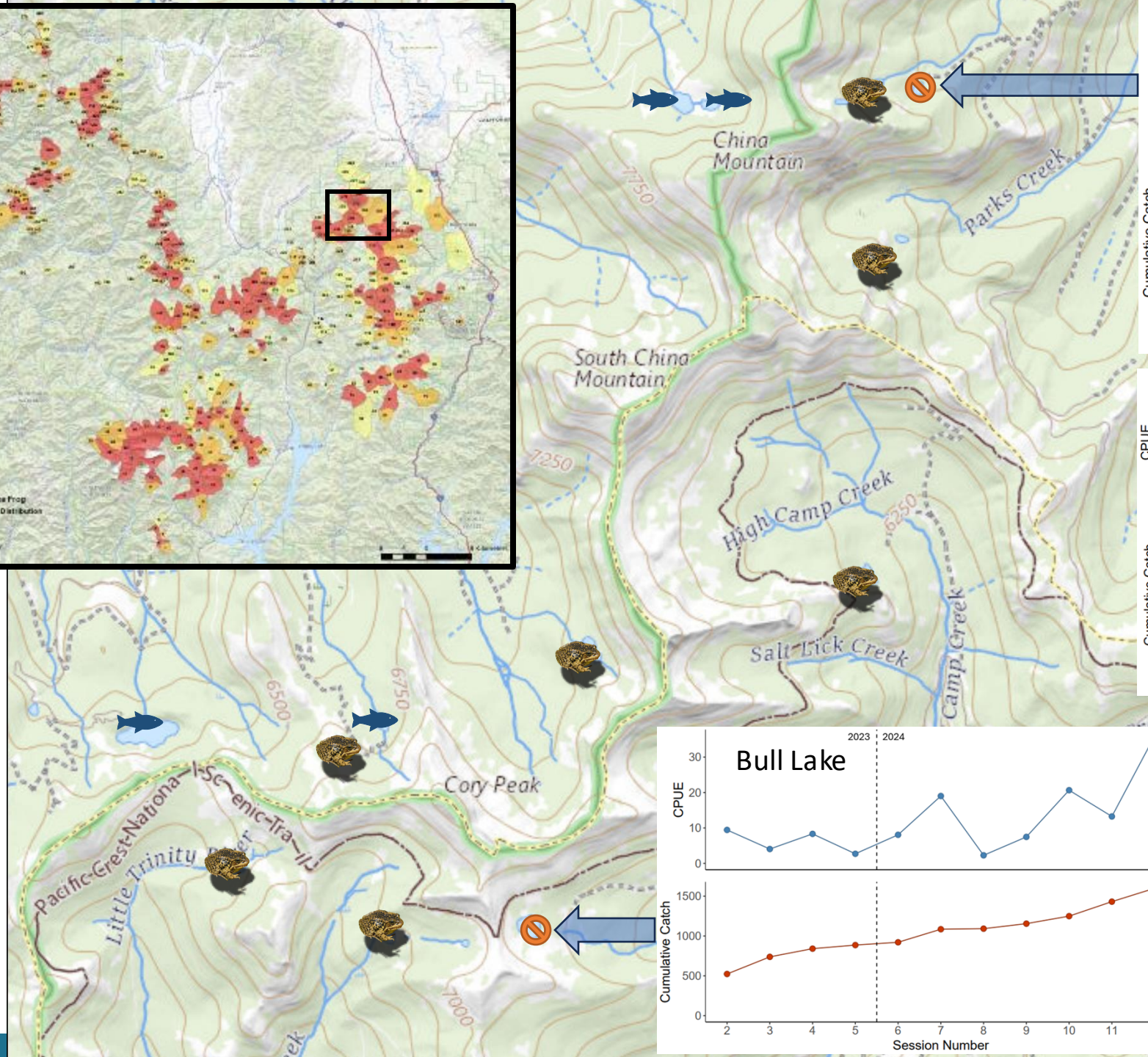
Upper Deadfall Lake


Klamath Range Cascades Frog
Intrinsic Breeding Habitat Distribution
Moderate
Resilient
Resilient and Redundancy


Lower Parks Lake
2023
2024
CPUE
Cumulative Catch
Session Number


Upper Deadfall Lake
2023
2024
CPUE
Cumulative Catch
Session Number

Bull Lake
2023
2024
CPUE
Cumulative Catch
Session Number


China Mountain
South China Mountain
Parks Creek
High Camp Creek
Salt Lick Creek
Camp Creek
Cory Peak
Pacific Crest National Scenic Trail
Little Trinity
TRINITY MOUNTAINS
7750
7250
6750
6500
6250
7000
8000
8250
8500

Effort in a broader context

- We are removing Brook Trout from 8 lakes representing 3.8% of current 209 lakes with trout.
- This is only 1.1% of the combined lake surface area containing trout populations.
- The lakes we are restoring are high-value conservation habitats.

Heather Lake

Management Moving Forward

1) Maintain Healthy Naturalized Trout Populations
   - Remote, little used water bodies

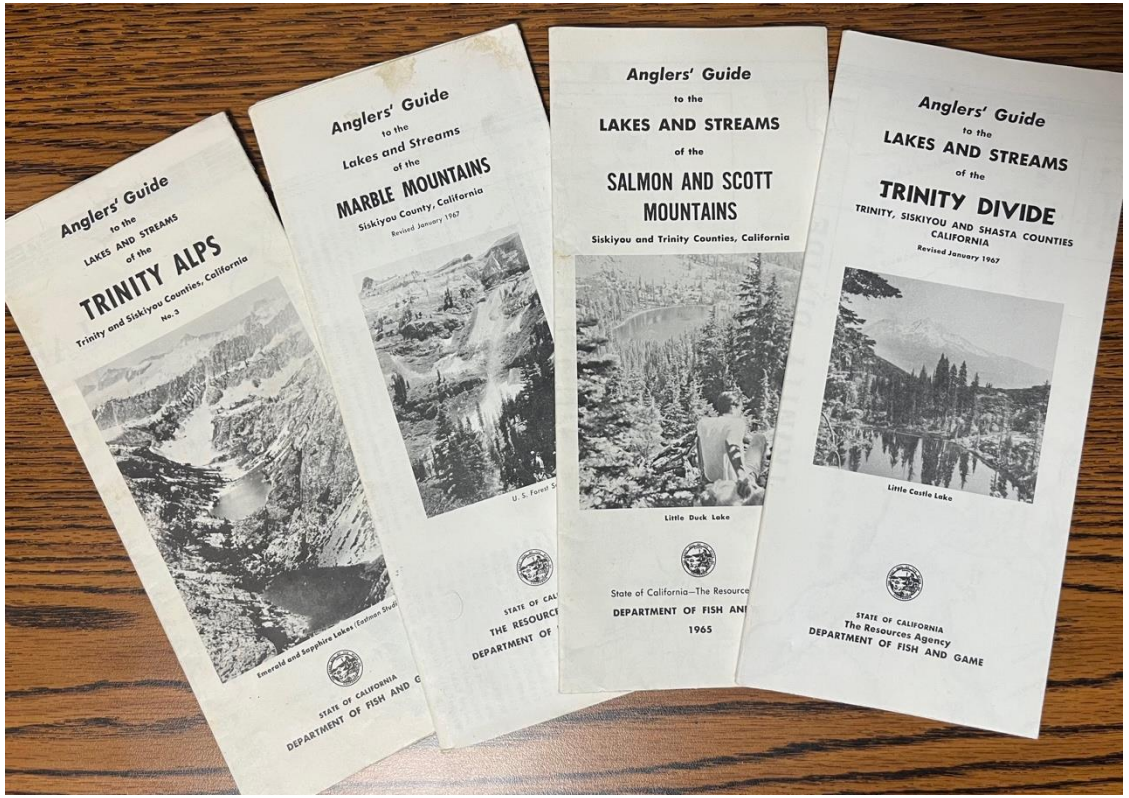
2) Resume Trout Stocking in Select Lakes
   - Popular, high use lakes for public benefit

3) Maintain Currently Fishless Waters
   - Free Frog Restoration!

4) Remove Trout at Critical Climate-Resilient Locations
   - Finish sites we started
   - start a few more sites in 2025

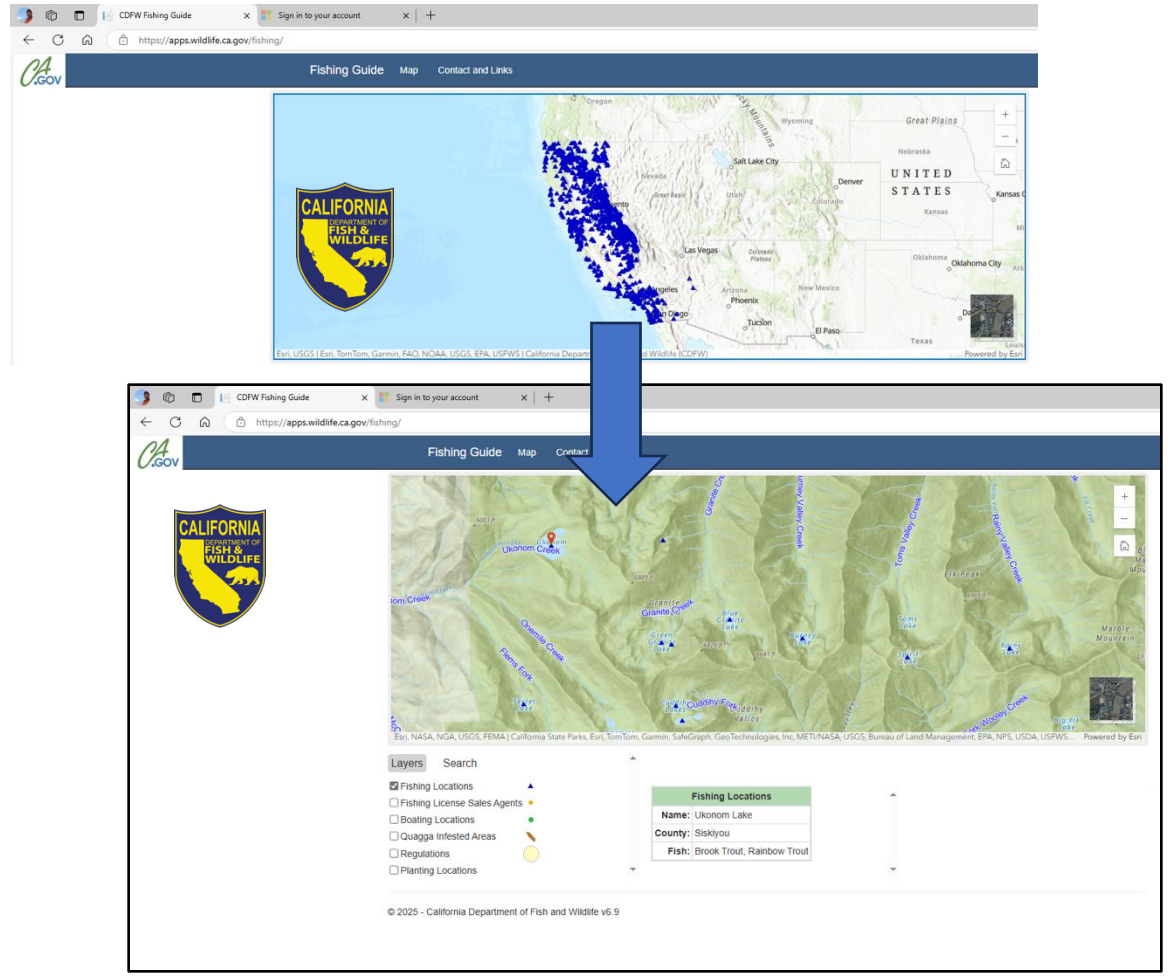
Modernizing Angler Resources

Update Heirloom (1960s) Regional Tri-fold Angling Guides



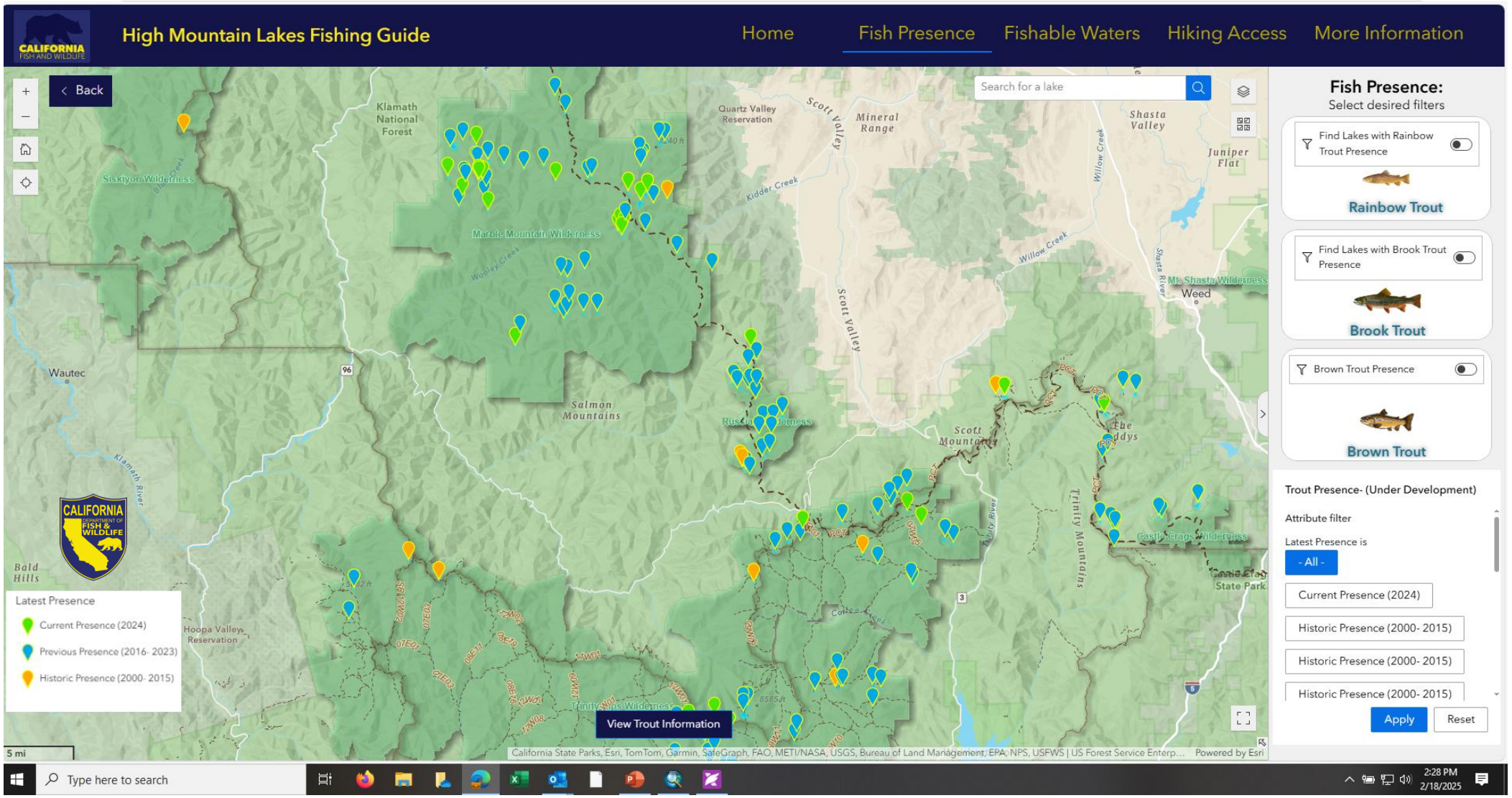
CDFW Statewide Inland Fishing Guide

https://apps.wildlife.ca.gov/fishing/



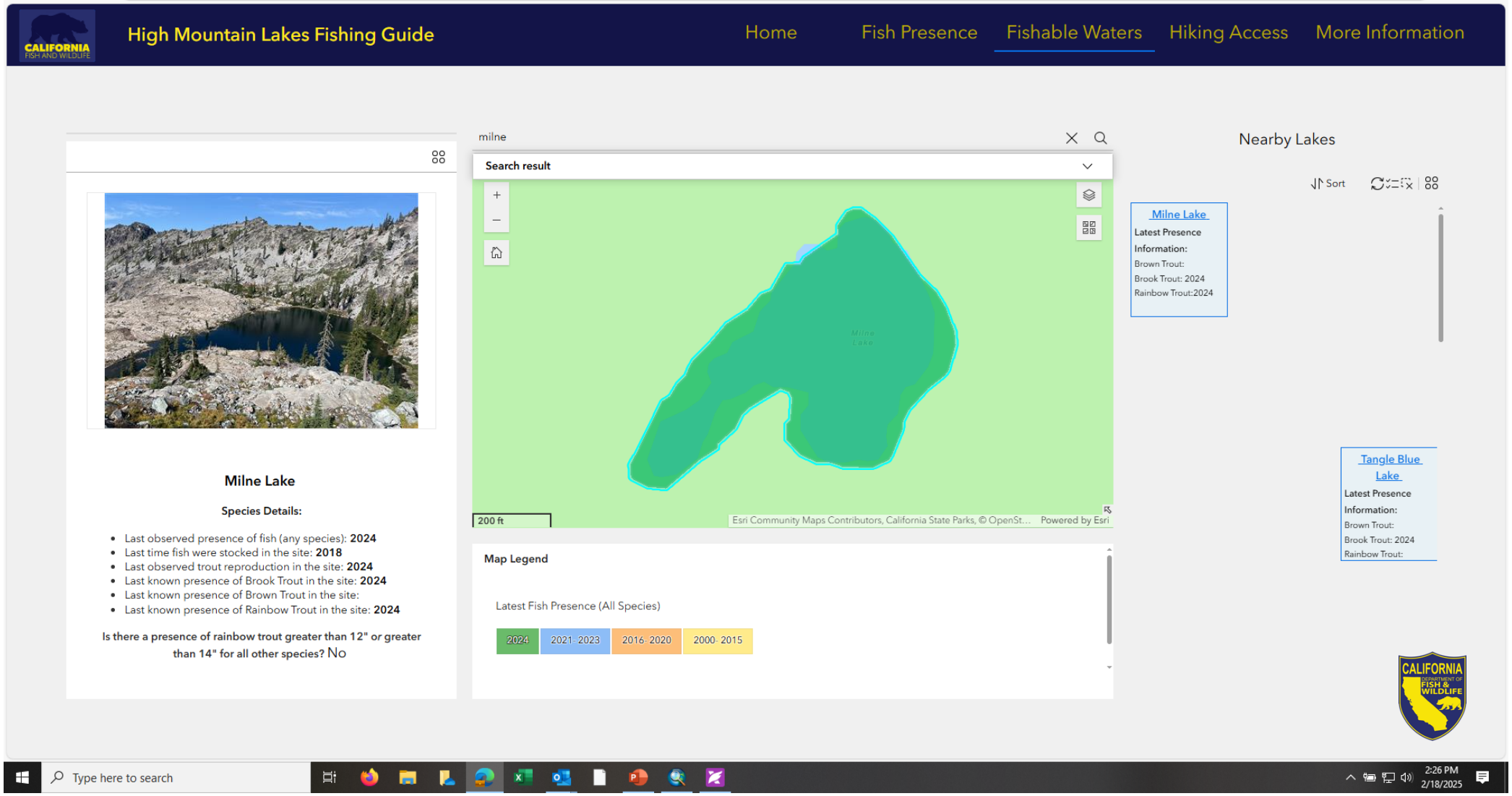
Modernizing Angler Resources

CDFW Region One—Interactive High Mountain Lakes Fishing Directory (*In Development*)



Modernizing Angler Resources

CDFW Region One—Interactive High Mountain Lakes Fishing Directory (*In Development*)



Outreach

- Many hundreds of backcountry users (2020-2024)
- Cal Trout (2023-25)
- Trout Unlimited (2023-25)
- Top of the State Backcountry Horsemen (2023)
- Scott Watershed Information Forum (2024-25)
- Trinity County Watershed Center (2024-25)
- Shasta-Trinity National Forest (2023-25)
- Klamath National Forest (2023-25)
- Quartz Valley Tribe, Karuk Tribe (2023-25)
- Siskiyou County Board of Supervisors (2023-24)
- Siskiyou County Fish and Game Commission (2023-24)
- Mendocino Audubon (2024)
- The Wildlife Society (2024 Meeting)
- Klamath Meadows Partnership (2023-25)
- Bigfoot Trail Alliance (2023-25)
- Science on Tap Humboldt (2023)