WiFi “Tech Guest”
Username: fish0001
Password: RkwJ1

Klamath Basin Fisheries Collaborative

Research & Monitoring of Fish and Other Aquatic Organisms – Life History and Population Health

Please contact Jacob Krause at jrkrause@usgs.gov for more information

USGS
science for a changing world

Endangered suckers nearing extirpation in Upper Klamath Lake

Jacob Krause, Supervisory Research Fish Biologist, Western Fisheries Research Center

Brian Hayes, Rachael Paul-Wilson, and Maria Dzul

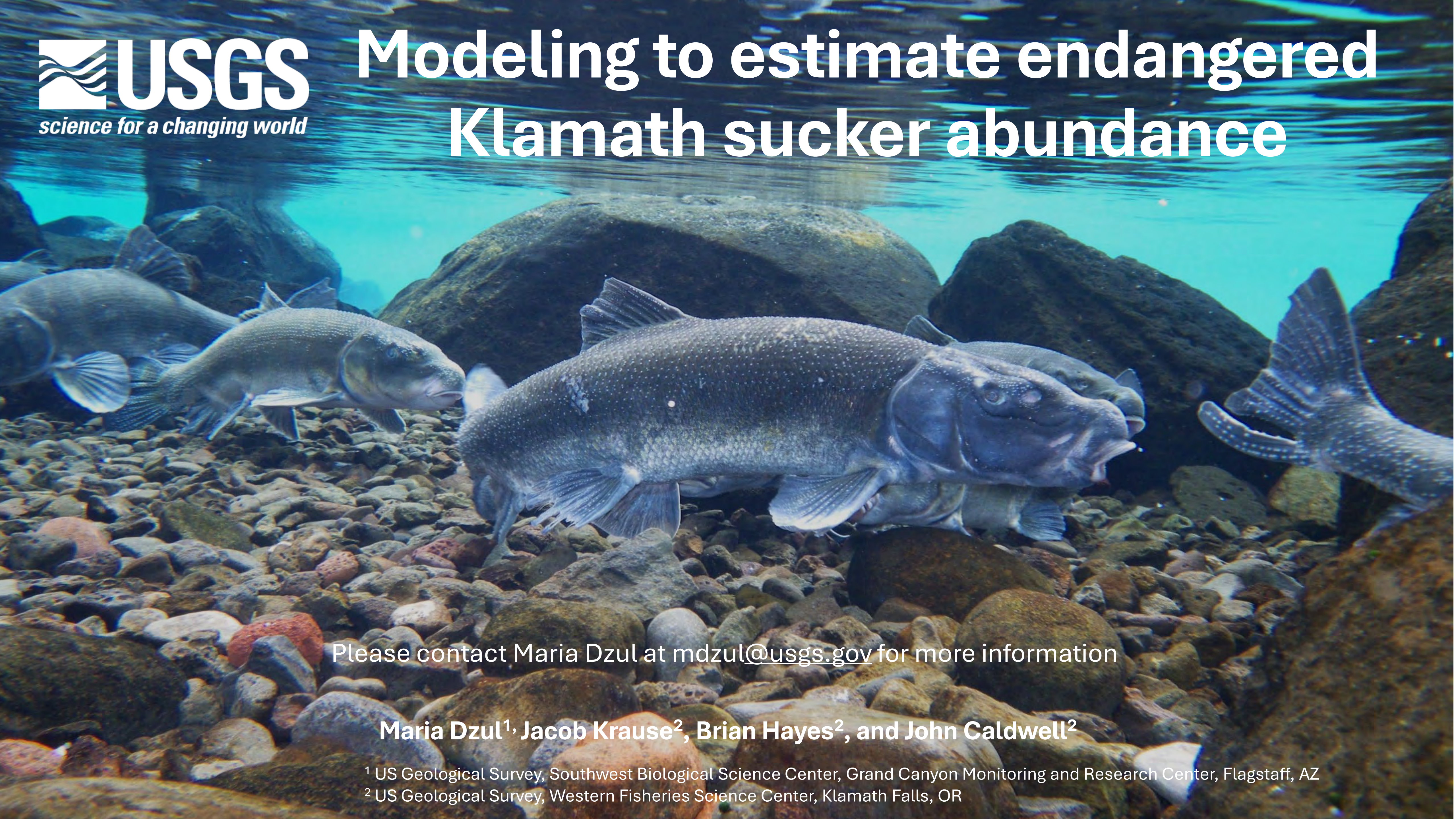
Photo by Jason Ching

Pacific States Marine Fisheries Commission — Idaho · Oregon · Alaska · Washington · California

The Klamath Tribes — Klamath · Modoc · Yahooskin

U.S. Fish & Wildlife Service — Department of the Interior

Bureau of Reclamation



USGS
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Modeling to estimate endangered Klamath sucker abundance

Please contact Maria Dzul at mdzul@usgs.gov for more information

Maria Dzul[1], Jacob Krause[2], Brian Hayes[2], and John Caldwell[2]

[1] US Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, Flagstaff, AZ
[2] US Geological Survey, Western Fisheries Science Center, Klamath Falls, OR

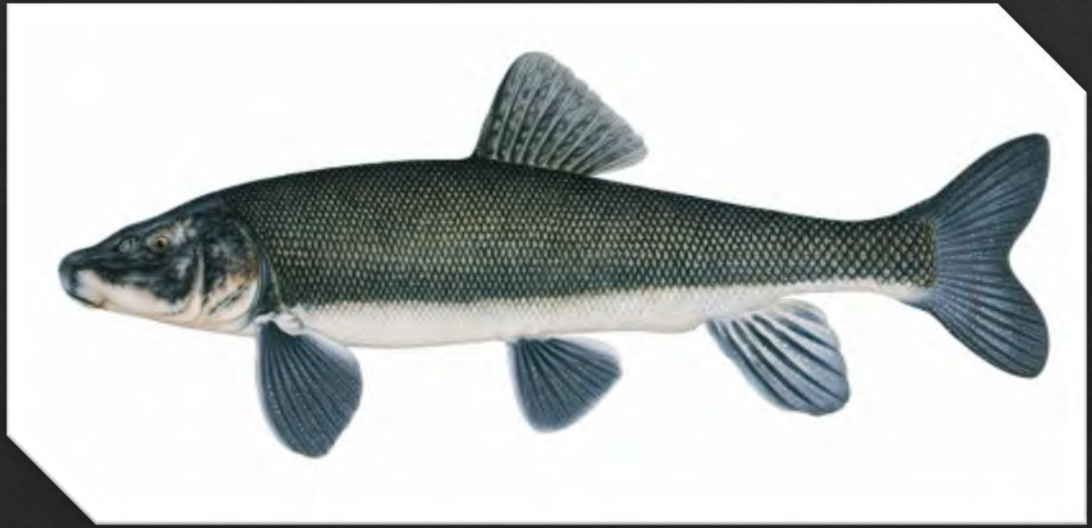
The Klamath Tribes' c'waam and koptu Assisted Rearing Methodology

Carlie Sharpes Barrera

c’waam and koptu – Endangered and Endemic

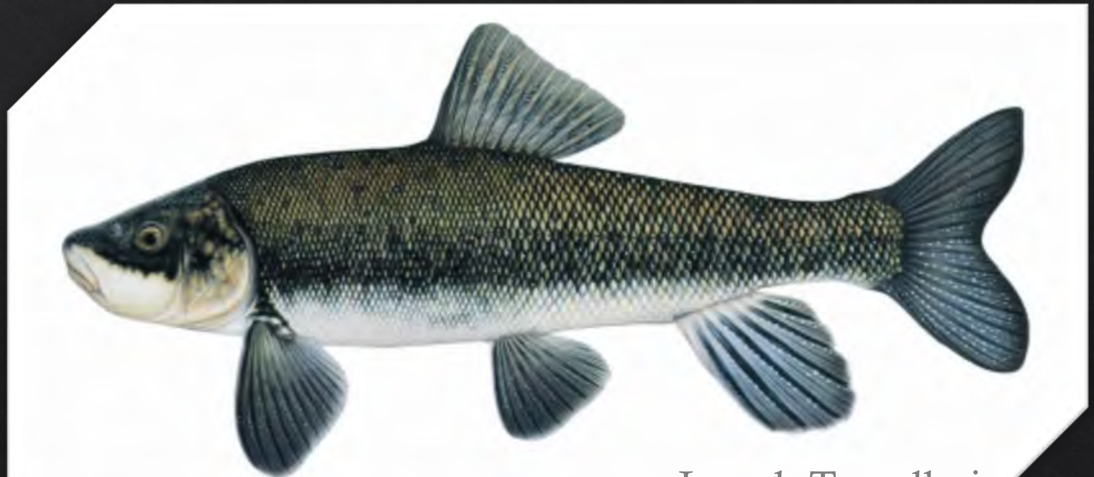
c’waam Lost River sucker
Deltistes luxatus

Up to 34” (~860 mm)
Can live past 40 years
-- 57 years is the oldest aged fish



koptu Shortnose sucker
Chamistes brevirostris

Up to 20” (~510 mm)
Can live up to 24 years



Joseph Tomelleri

Terwilliger, L. J., et al. (2010). “Age, growth, and longevity of Lost River sucker (Deltistes luxatus) and shortnose sucker (Chasmistes brevirostris) in Upper Klamath Lake, Oregon.” Transactions of the American Fisheries Society, 139(4), 1090-1103.

Cultural Importance

- Traditional survival food at the end of winter/ early spring
- Tribal members still rely on subsistence hunting and fishing
- Interconnected relationship with natural environment
- **1986**: End of tribal harvest;
  Federal recognition restored
- **1988**: federal ESA listing

1905 Sucker Harvest and Drying

Habitat Loss and Alteration

1905

Present Day

Steady Population Decline

- Insufficient juvenile survival and recruitment events since early 1990s
- Graph showing realized proportional change in population size from 2000-2022
- Several factors may contribute:
  - Habitat alteration, ecosystem change
  - Nutrient loading → hypereutrophic conditions
  - Predation
  - Disease and parasites
- Assisted rearing is necessary, began circa 2016-2018

(Krause, Paul-Wilson, & Harris, 2023)

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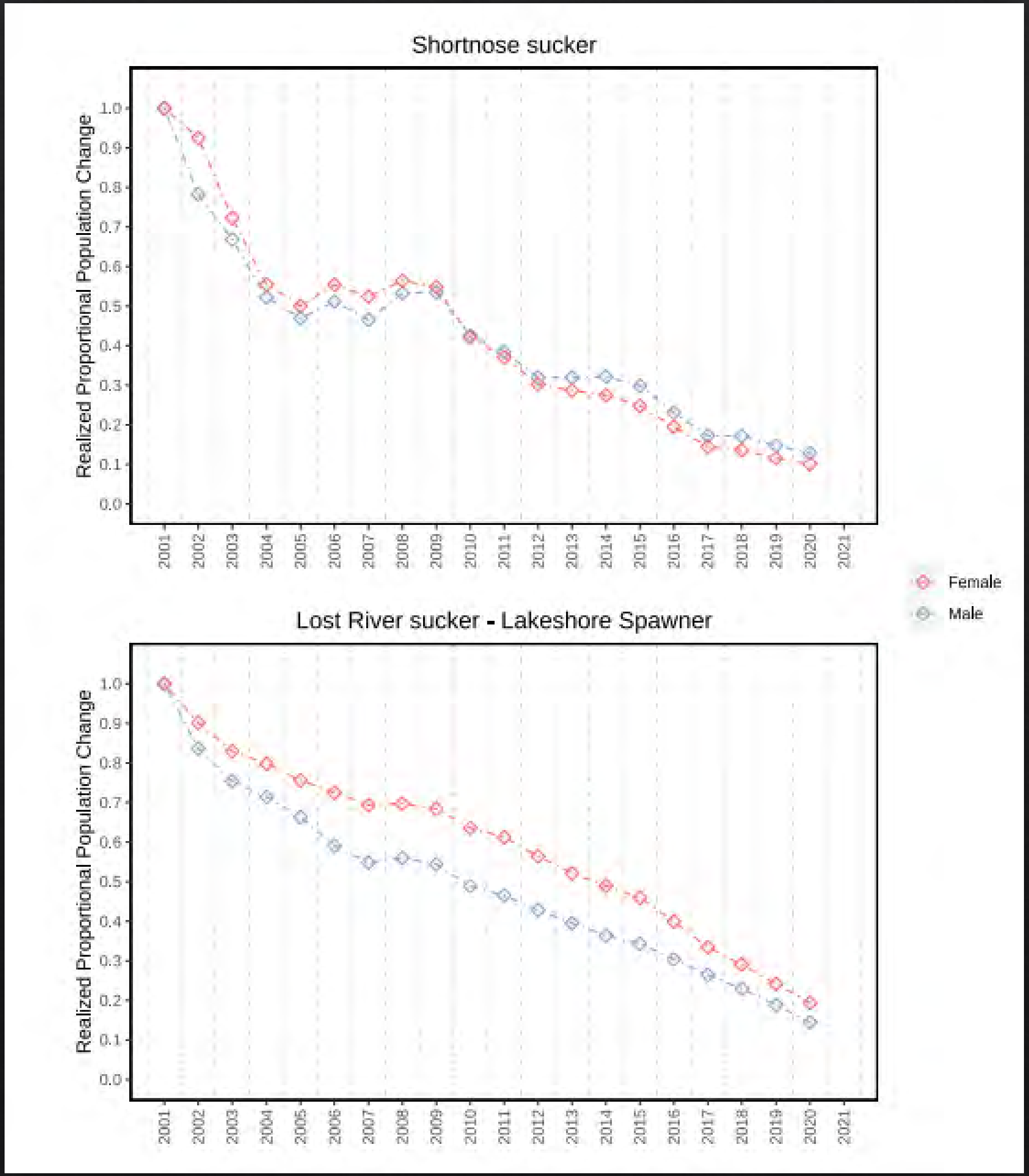


Rearing Goals

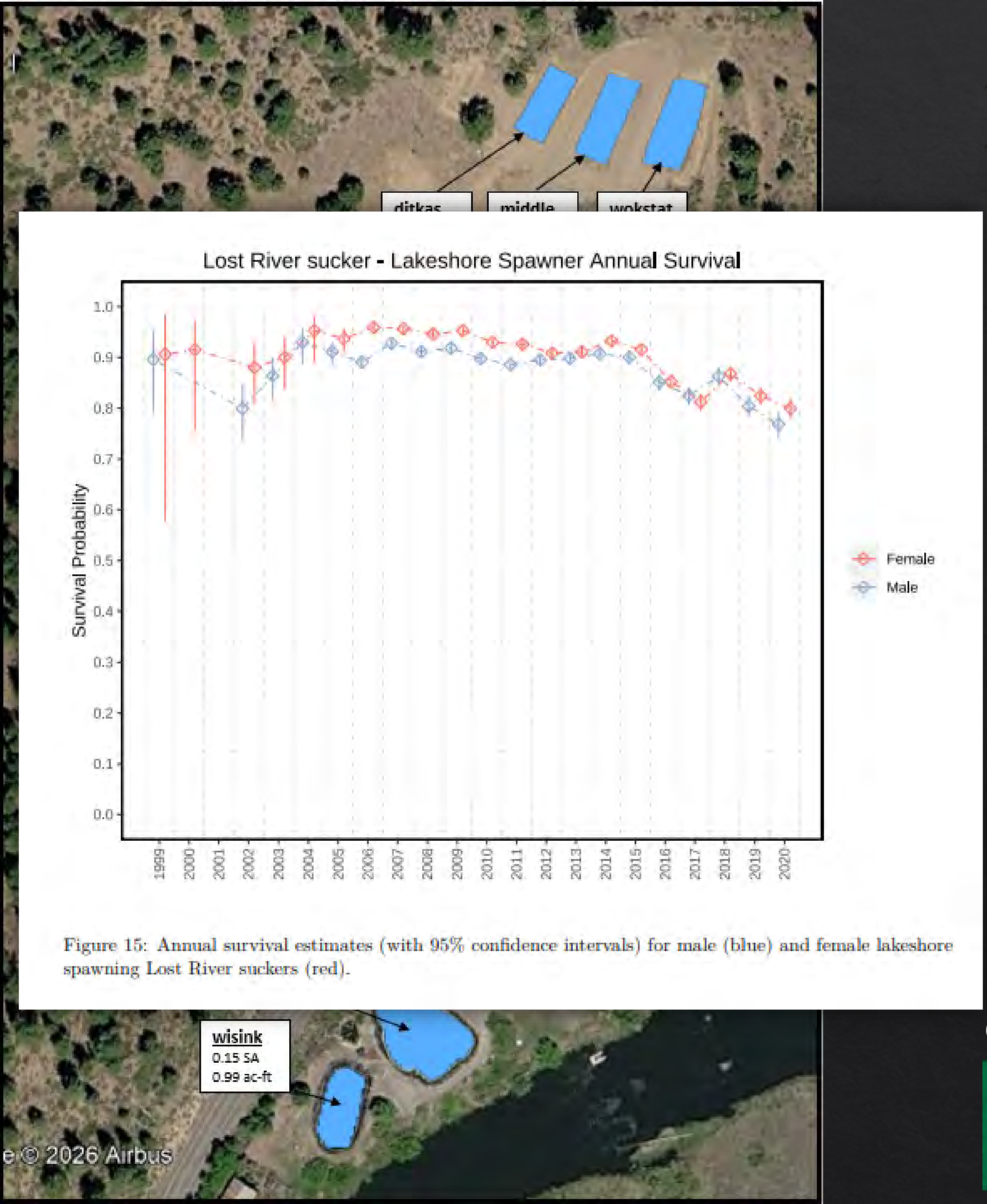


Figure 15: Annual survival estimates (with 95% confidence intervals) for male (blue) and female lakeshore spawning Lost River suckers (red).

- ~0.99 surface acres of pond space
- Release juveniles past survival bottleneck
- Size goal of ~ 300 mm in TL prior to release
- Estimated 4 years of rearing
- Coordinate with organizations to hold suckers in more safe locations

(Krause, Paul-Wilson, & Harris, 2023)

USGS science for a changing world

Nutrient Challenges

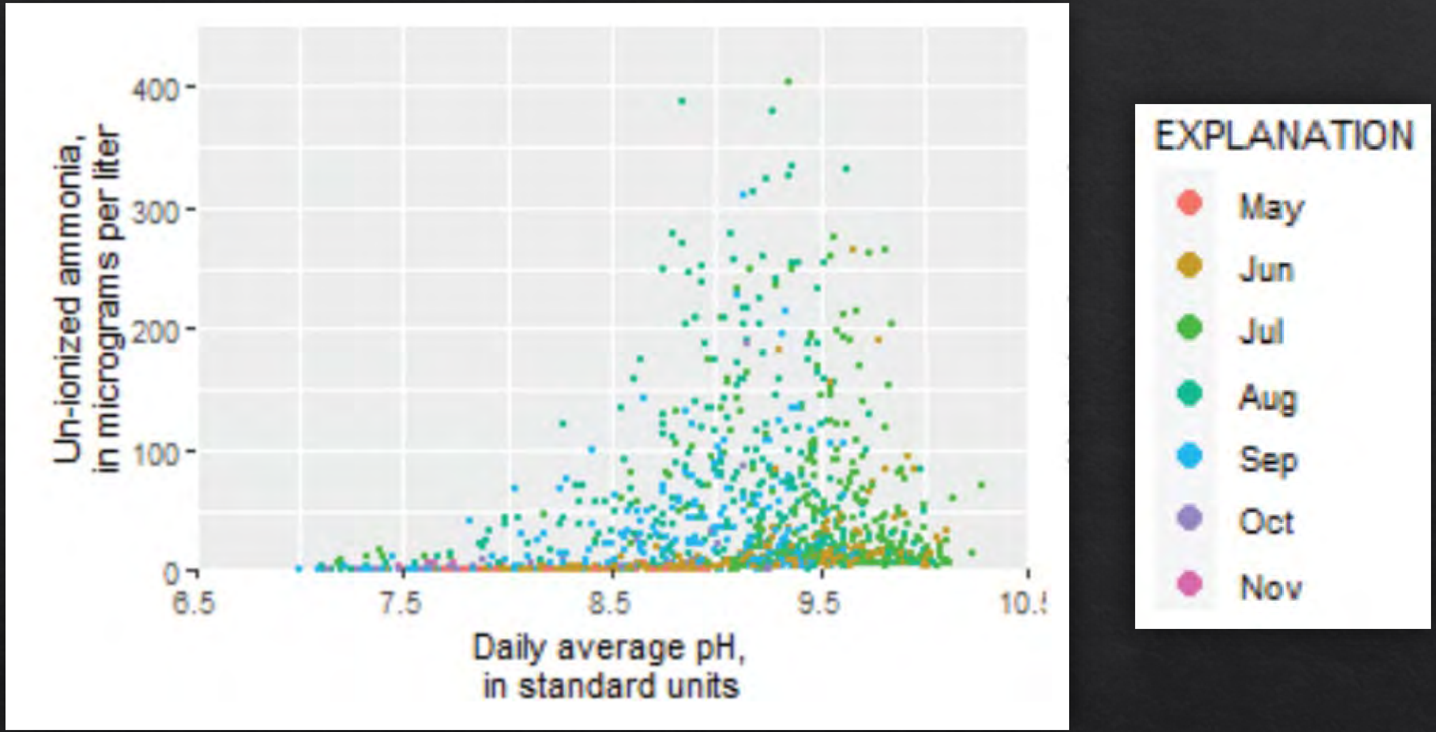
Site	TN (µg/L)	TP (µg/L)	N: P
TKT Well 1	1470	233	6:1
Mid UKL	1844	214	9:1

- High N:P ratios (>20:1) suppress harmful algae spp.
- Excess primary productivity increases pH and NH_3
- Mitigation in 2025:
  - Lanthanum clay based P binder
  - Biodegradable peroxide based algaecide
  - Peat moss as a pH buffer

Walker, J.D., and Kann, J. 2022. Water and nutrient balances of Upper Klamath Lake, water years 1992-2018. The Klamath Tribes Water Resources Repository.
Kann, J. 2018. Upper Klamath Lake 2017 Data Summary Report. The Klamath Tribes Water Resources Repository.
Mischke, C.C. 2019. Fertilizing Fish Ponds. SRAC, Publication No. 0469.

Upper Klamath Lake (UKL) Conditions

- High pH can have several adverse physiological effects on fish
- Optimum pH: < 9.0 standard units
- High pH can increase NH_3 toxicity



Water-quality variable	Units	24-hour lethal concentration for 50 percent of population	99th or 1st percentile value of daily averages or weekly estimates during 2005–19
Water temperature	Degrees Celsius	>30.76–31.93	24.38
pH	Standard units	>10.38–10.96	10.04
Dissolved oxygen	Milligrams per liter	<1.14–2.01	1.76
Un-ionized ammonia	Micrograms per liter	>510–1,290	264

(Wherry, 2022)

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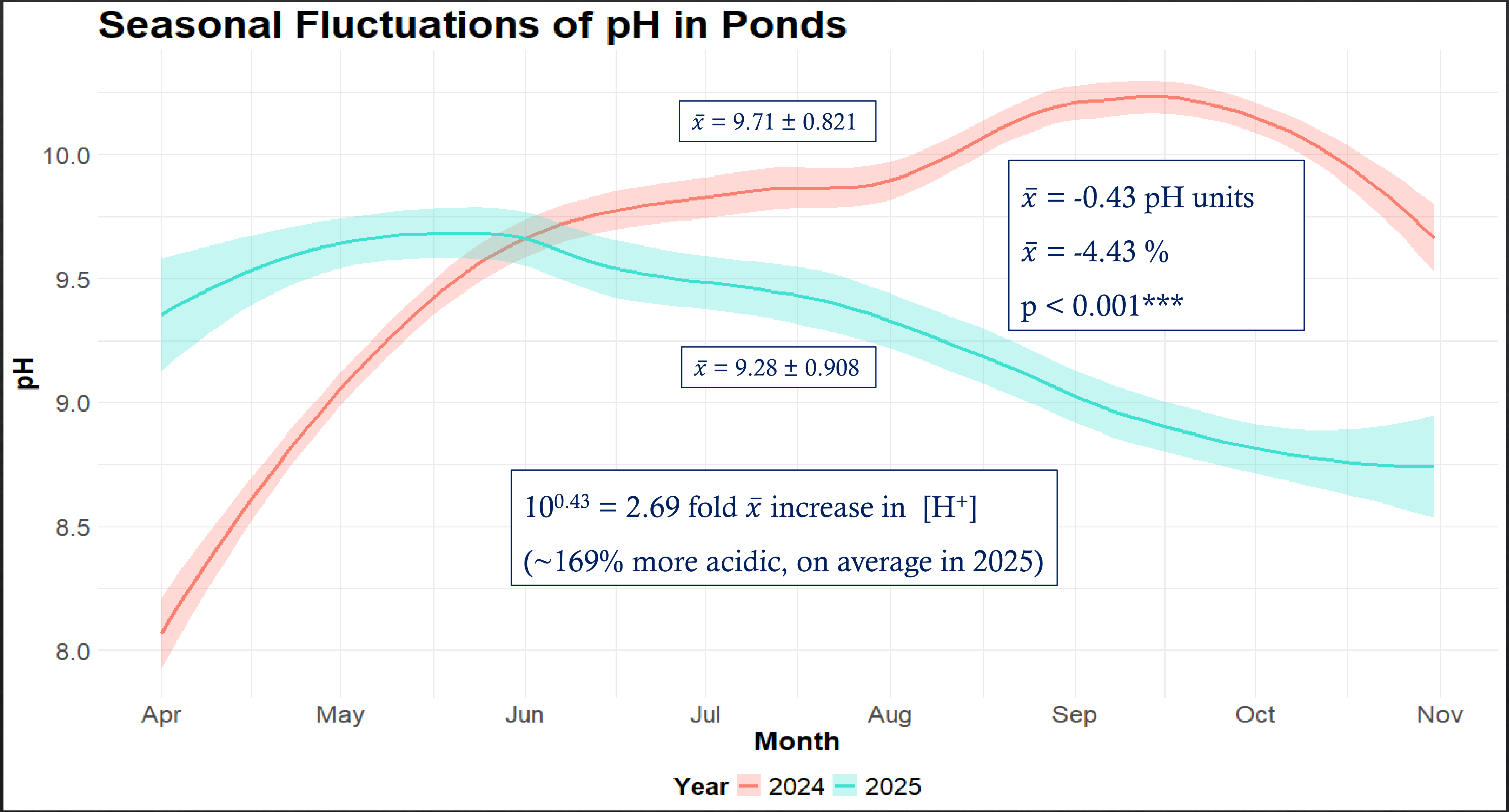
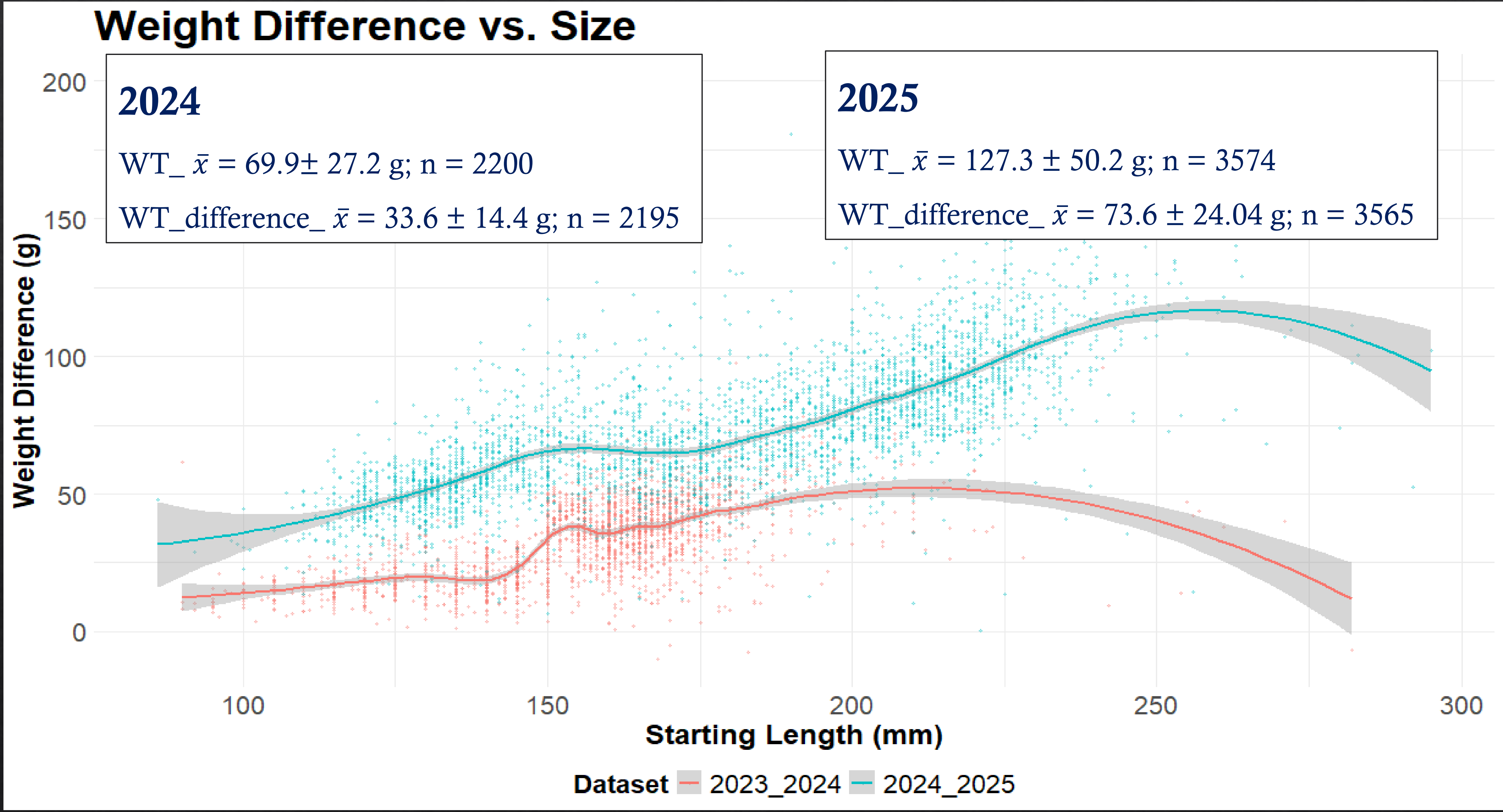


Seasonal Fluctuations of pH in Ponds
$\bar{x}$ = 9.71 ± 0.821
$\bar{x}$ = 9.28 ± 0.908
$\bar{x}$ = -0.43 pH units
$\bar{x}$ = -4.43 %
p < 0.001***
$10^{0.43}$ = 2.69 fold $\bar{x}$ increase in [H^+]
(~169% more acidic, on average in 2025)
pH
10.0
9.5
9.0
8.5
8.0
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Month
Year
2024
2025


Weight Difference vs. Size
2024
WT_ x̄ = 69.9± 27.2 g; n = 2200
WT_difference_ x̄ = 33.6 ± 14.4 g; n = 2195
2025
WT_ x̄ = 127.3 ± 50.2 g; n = 3574
WT_difference_ x̄ = 73.6 ± 24.04 g; n = 3565
Weight Difference (g)
200
150
100
50
0
100
150
200
250
300
Starting Length (mm)
Dataset
2023_2024
2024_2025

Mass-Standardized Growth Rate (MSGR)

- Scales growth relative to body mass
- Allows fair comparison of individuals across sizes

M_1 = initial mass of the fish (grams)

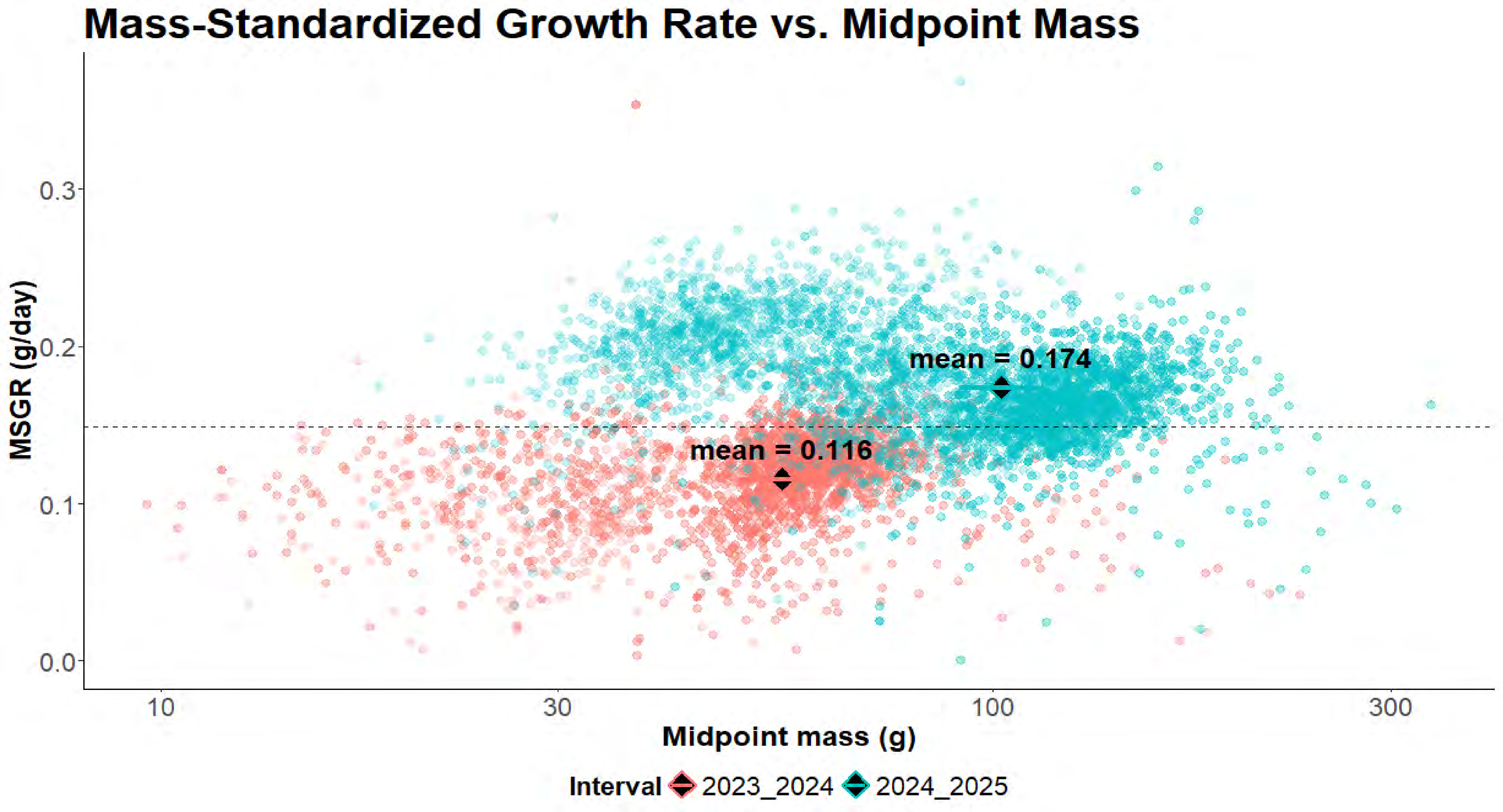
M_2 = final mass of the fish

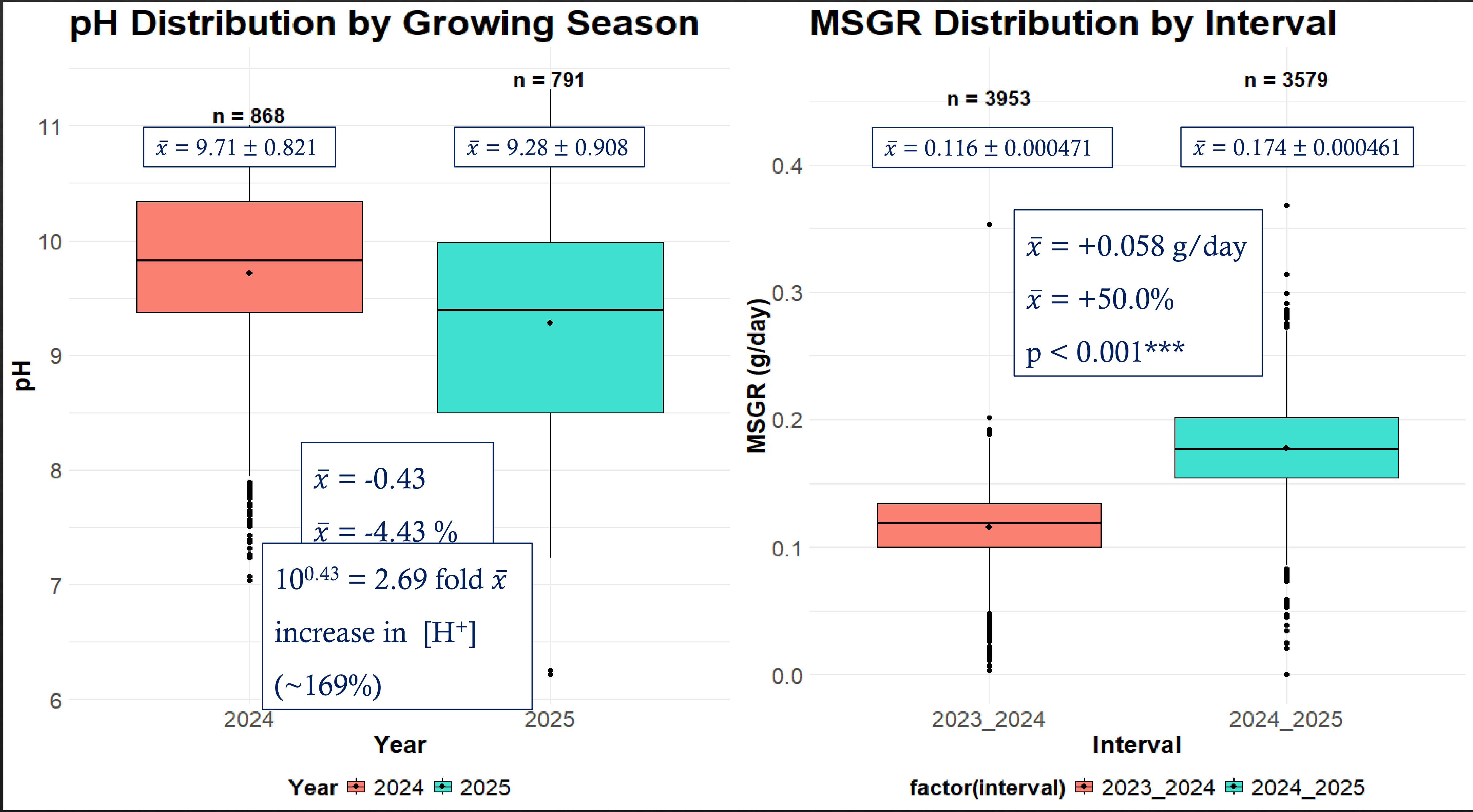
t = time interval between measurements

b = scaling exponent = 0.743

$$MSGR = \frac{\left(M_2^b - M_1^b\right)}{t}$$

```
lm(formula = log(g) ~ log(M_mid) + interval, data = growth_intervals)
```


Mass-Standardized Growth Rate vs. Midpoint Mass
MSGR (g/day)
0.0
0.1
0.2
0.3
mean = 0.174
mean = 0.116
10
30
100
300
Midpoint mass (g)
Interval 2023_2024 2024_2025


pH Distribution by Growing Season
n = 868
$\bar{x}$ = 9.71 ± 0.821
n = 791
$\bar{x}$ = 9.28 ± 0.908
$\bar{x}$ = -0.43
$\bar{x}$ = -4.43 %
$10^{0.43}$ = 2.69 fold $\bar{x}$
increase in $[H^+]$
(~169%)
pH
11
10
9
8
7
6
2024
2025
Year
Year 2024 2025
MSGR Distribution by Interval
n = 3953
$\bar{x}$ = 0.116 ± 0.000471
n = 3579
$\bar{x}$ = 0.174 ± 0.000461
$\bar{x}$ = +0.058 g/day
$\bar{x}$ = +50.0%
$p < 0.001$***
MSGR (g/day)
0.4
0.3
0.2
0.1
0.0
2023_2024
2024_2025
Interval
factor(interval) 2023_2024 2024_2025

Conclusion

- Ability to mitigate adverse water quality conditions
- Evidence for accelerated growth rate correlation with improved water quality
  - Cannot infer causation
- Improves hatchery methodology
  - Release beyond early life-stage bottleneck

PC: Paul Wilson

Thank you! Questions?

Carlie Sharpes Barrera
Email: carlie.sharpes@klamathtribes.com
Direct Line: (541) 827-5242

Partners for Fish & Wildlife

U.S. Fish & Wildlife Service — Department of the Interior

RTR Real Time Research

Bureau of Reclamation

USGS science for a changing world

PC: Paul Wilson

Suckers Discussion

Data methodologies, standardization, and needs

Klamath Basin Fisheries Collaborative

Thermal Refugia – Temperature and Fish Behavior

Defining salmonid-relevant water quality thresholds in Upper Klamath Lake

Jonny Armstrong, Hannah Barrett, Melanie Davis (COOP) — OSU

Jordan Ortega — Klamath Tribes Ambodat Department

Bill Tinniswood, Mark Hereford, Ben Ramirez — ODFW

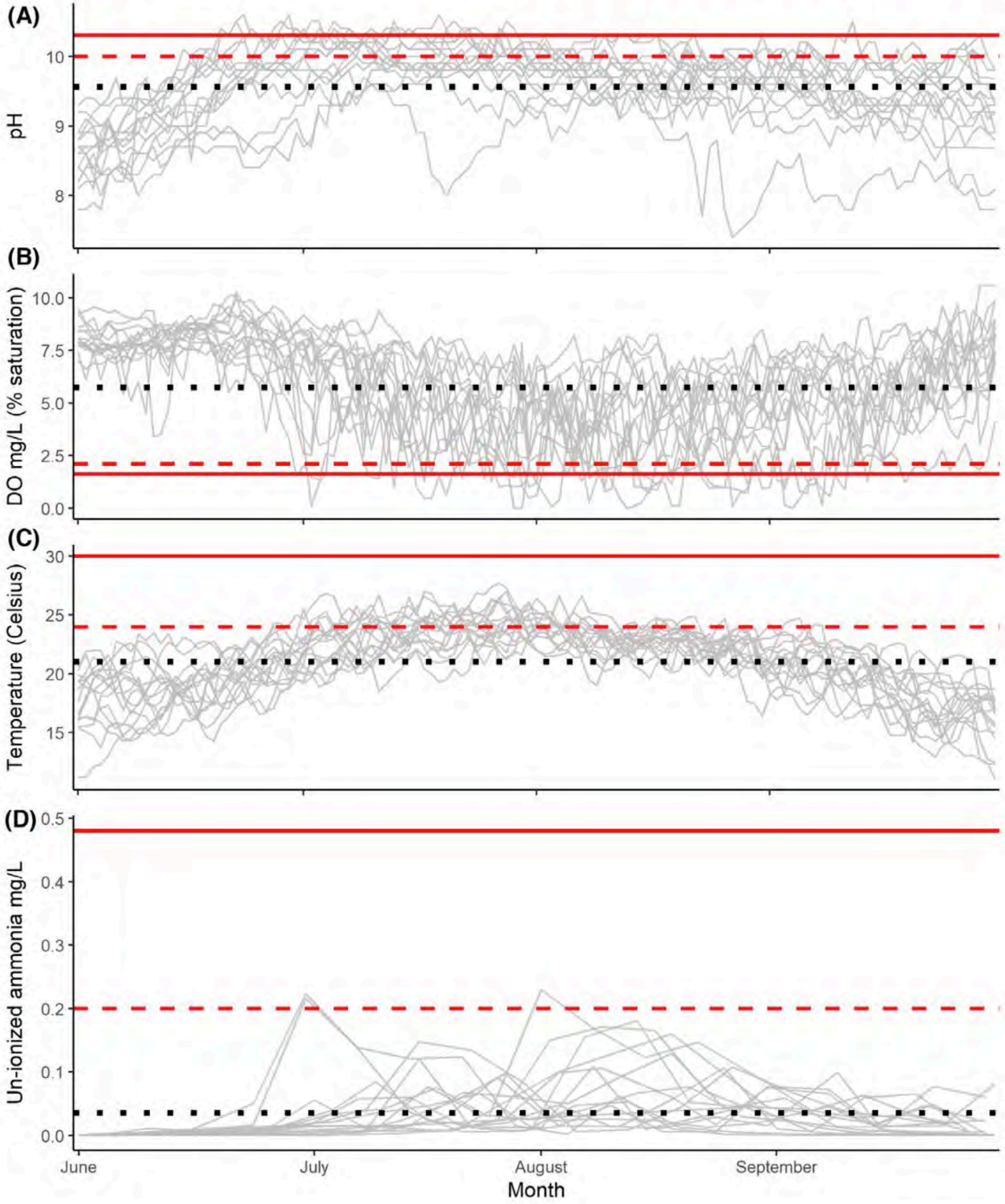
Jacob Krause, Summer Burdick, and others — USGS

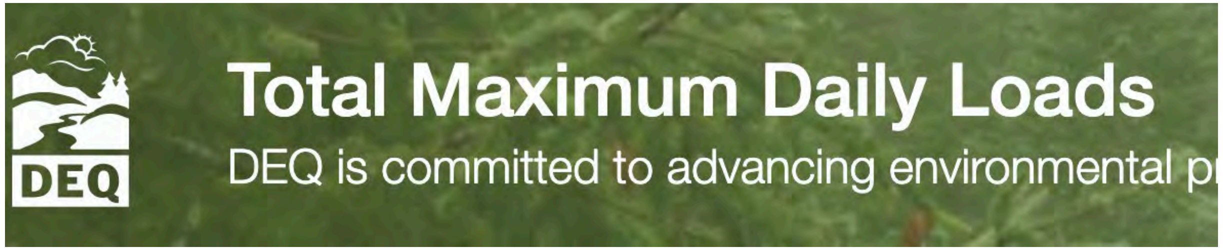
Summer water quality threatens fish

Restoring water quality in Upper Klamath Lake

Charles Erdman TU

Brian Marker, Ducks Unlimited





North American Journal of Fisheries Management 42:1414–1432, 2022
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ISSN: 0275-5947 print / 1548-8675 online
DOI: 10.1002/nafm.10850

FEATURE ARTICLE

Water and Endangered Fish in the Klamath River Basin: Do Upper Klamath Lake Surface Elevation and Water Quality Affect Adult Lost River and Shortnose Sucker Survival?

Jacob R. Krause* and **Eric C. Janney**
U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station, 2795 Anderson Avenue, Suite 106, Klamath Falls, Oregon 97603, USA

Summer M. Burdick
U.S. Geological Survey, Western Fisheries Research Center, Columbia River Research Laboratory, 5501A Cook-Underwood Road, Cook, Washington 98605, USA

Alta C. Harris and **Brian S. Hayes**
U.S. Geological Survey, Western Fisheries Research Center, Klamath Falls Field Station, 2795 Anderson Avenue, Suite 106, Klamath Falls, Oregon 97603, USA

What are water quality thresholds for salmonids?

Why can’t we predict these thresholds from lab studies?

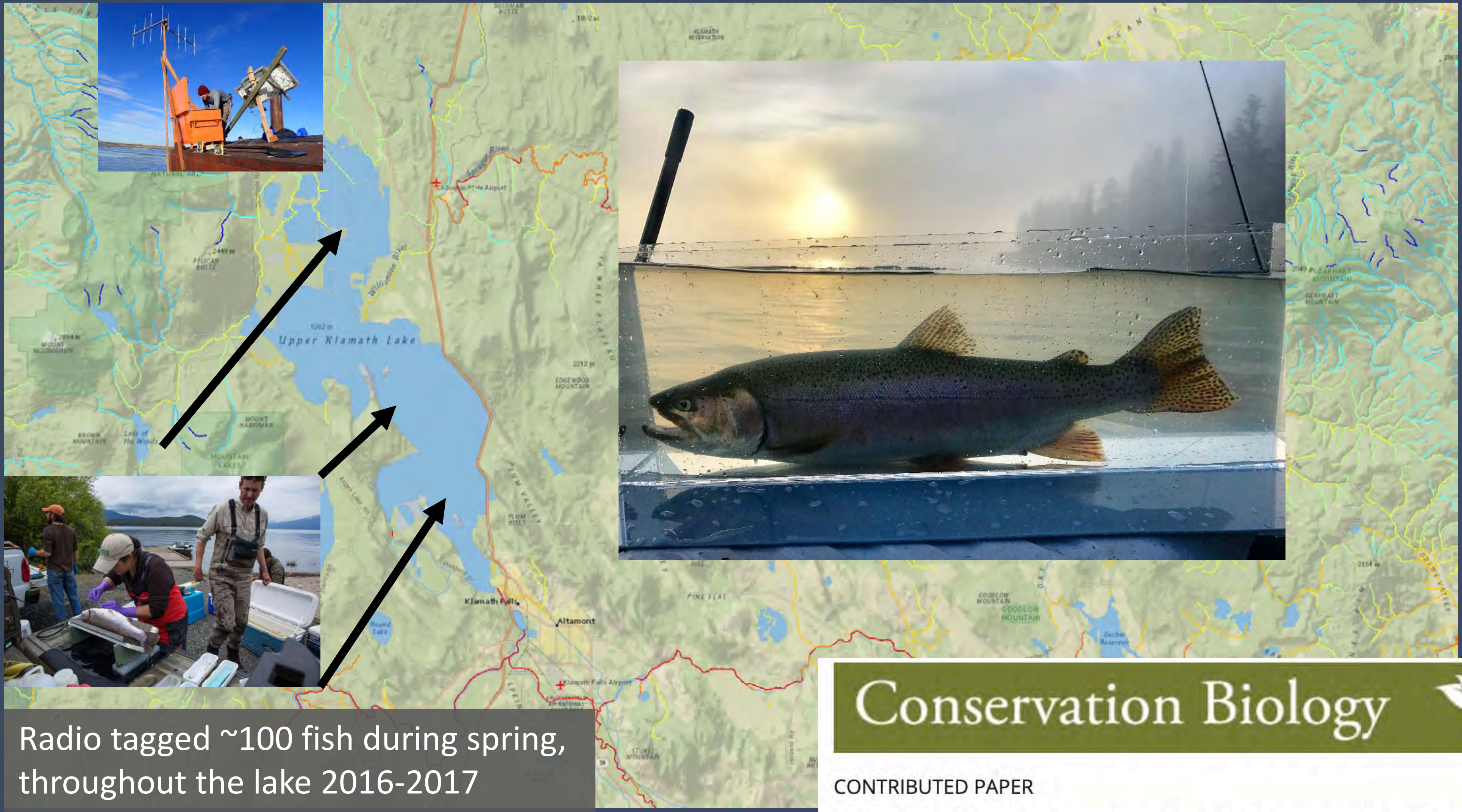
- Physiological studies have variable results
- Not clear what physiological benchmarks predict habitat use
- Lack of study on multiple stressors

There is no substitute for empirical data

Redband trout

- Evolutionary history in region (tens of thousands of years)
- Life-cycle mimics that of salmon
- What can they tell us about patterns of habitat use?

Radio telemetry work



Radio tagged ~100 fish during spring, throughout the lake 2016-2017

Conservation Biology

CONTRIBUTED PAPER

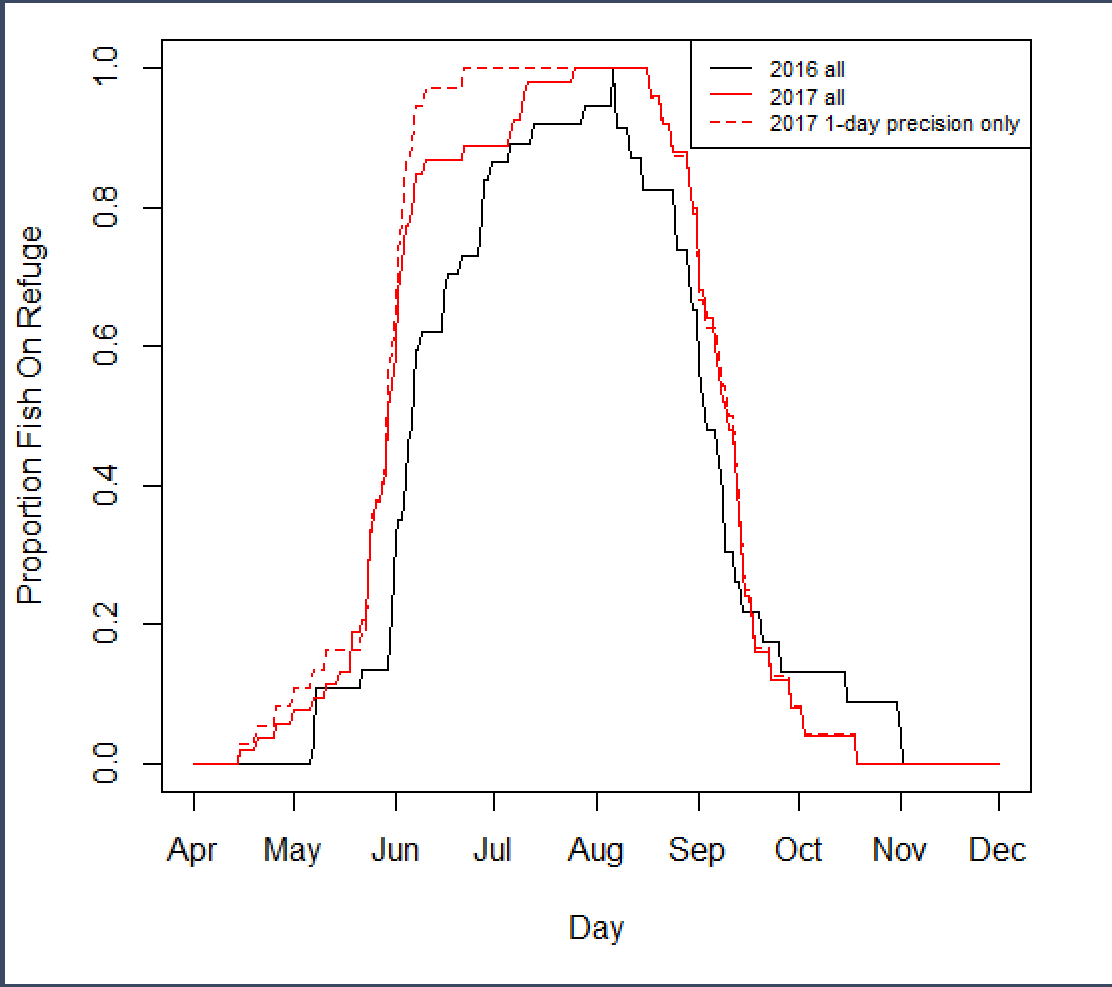
Contribution of warm habitat to cold-water fisheries

Nick Hahlbeck, William R. Tinniswood, Matthew R. Sloat, Jordan D. Ortega, Matthew A. Wyatt, Mark E. Hereford, Ben S. Ramirez, David A. Crook, Kara J. Anlauf-Dunn, Jonathan B. Armstrong

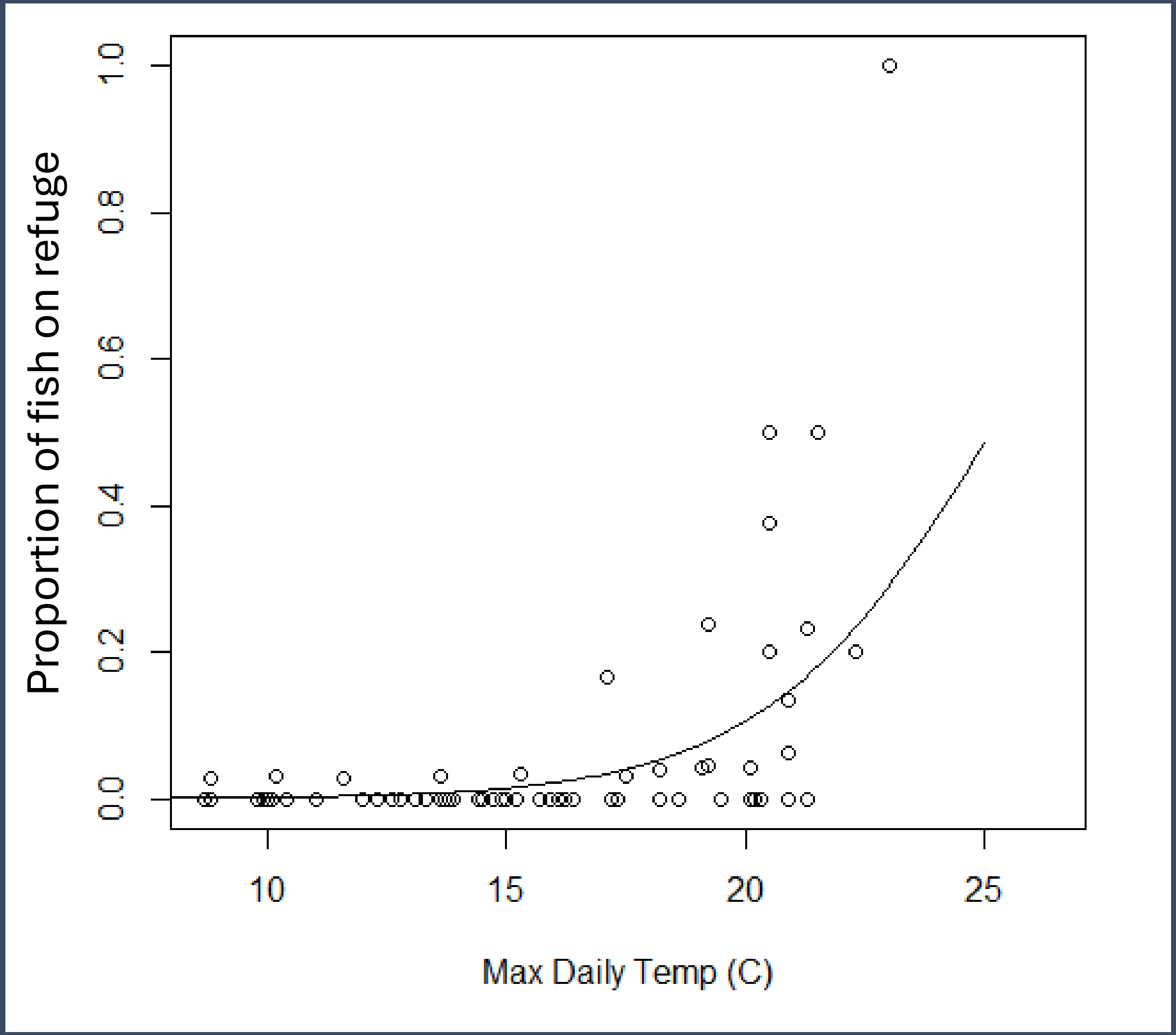
Complete migration to lake tributaries during summer

Movements up to ~40 km

1. Quantify timing of refuge use



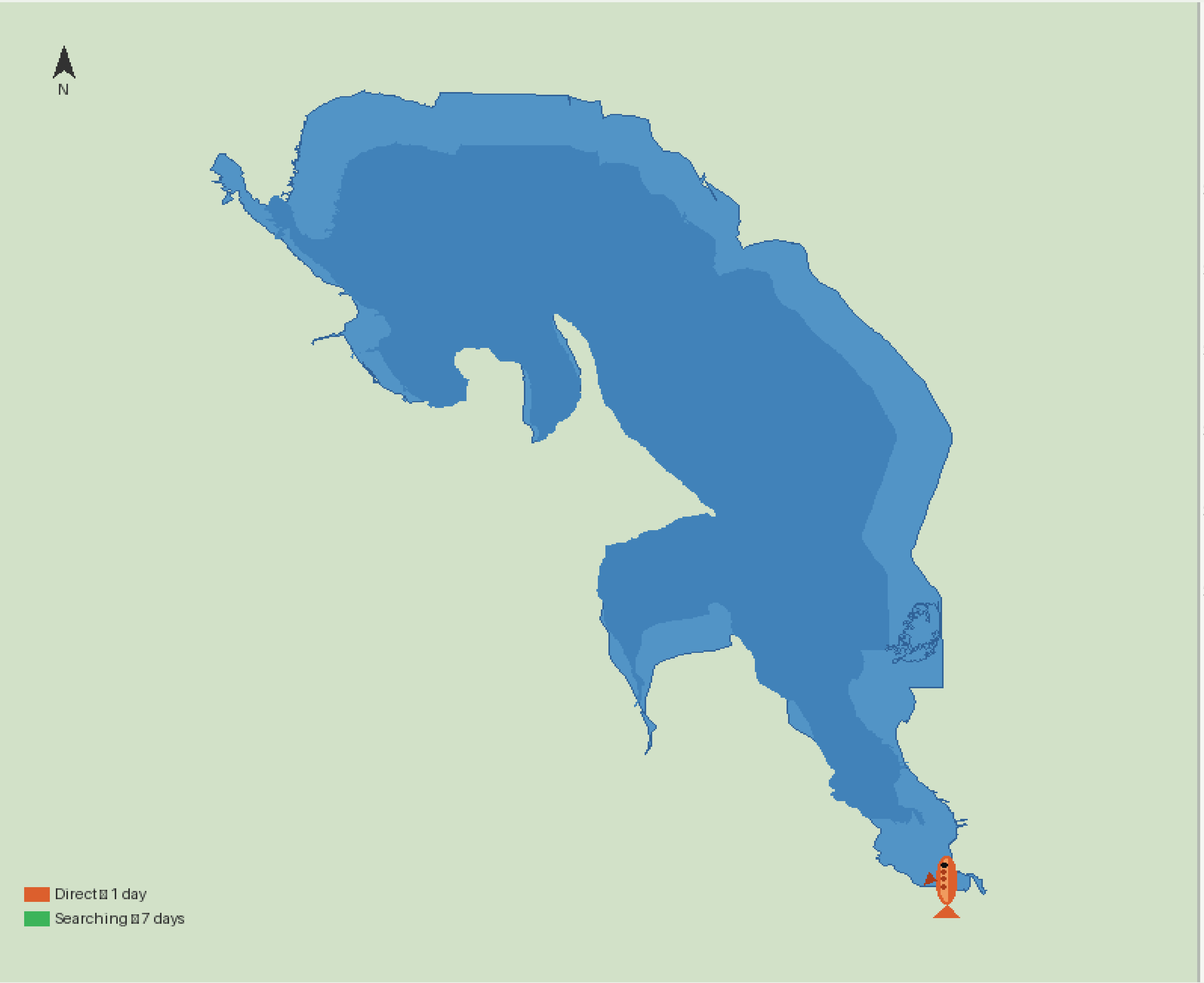
2. Relate to water quality variables

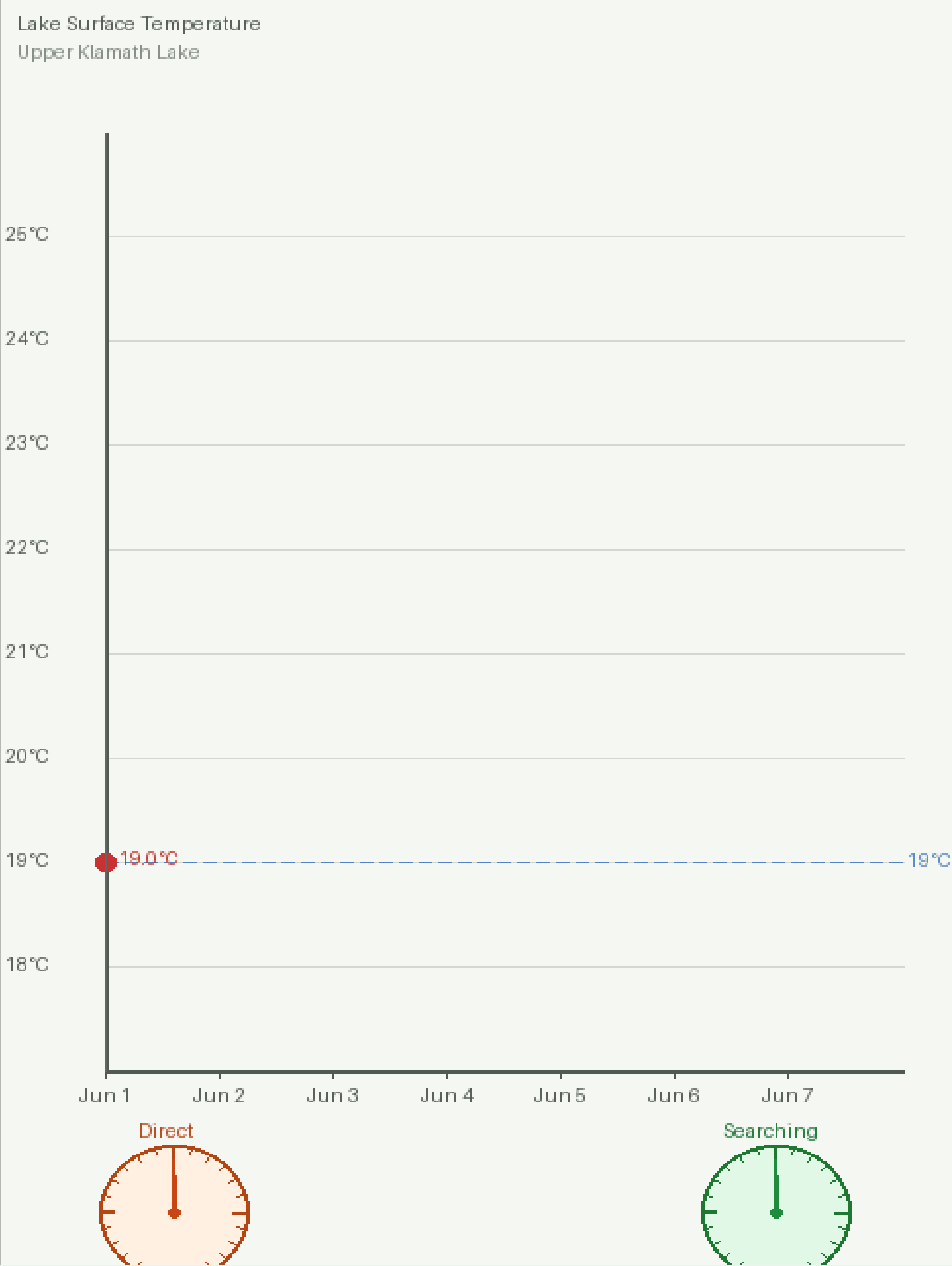


Problem: We know the conditions when fish arrived at refuges but not necessarily those that triggered migration

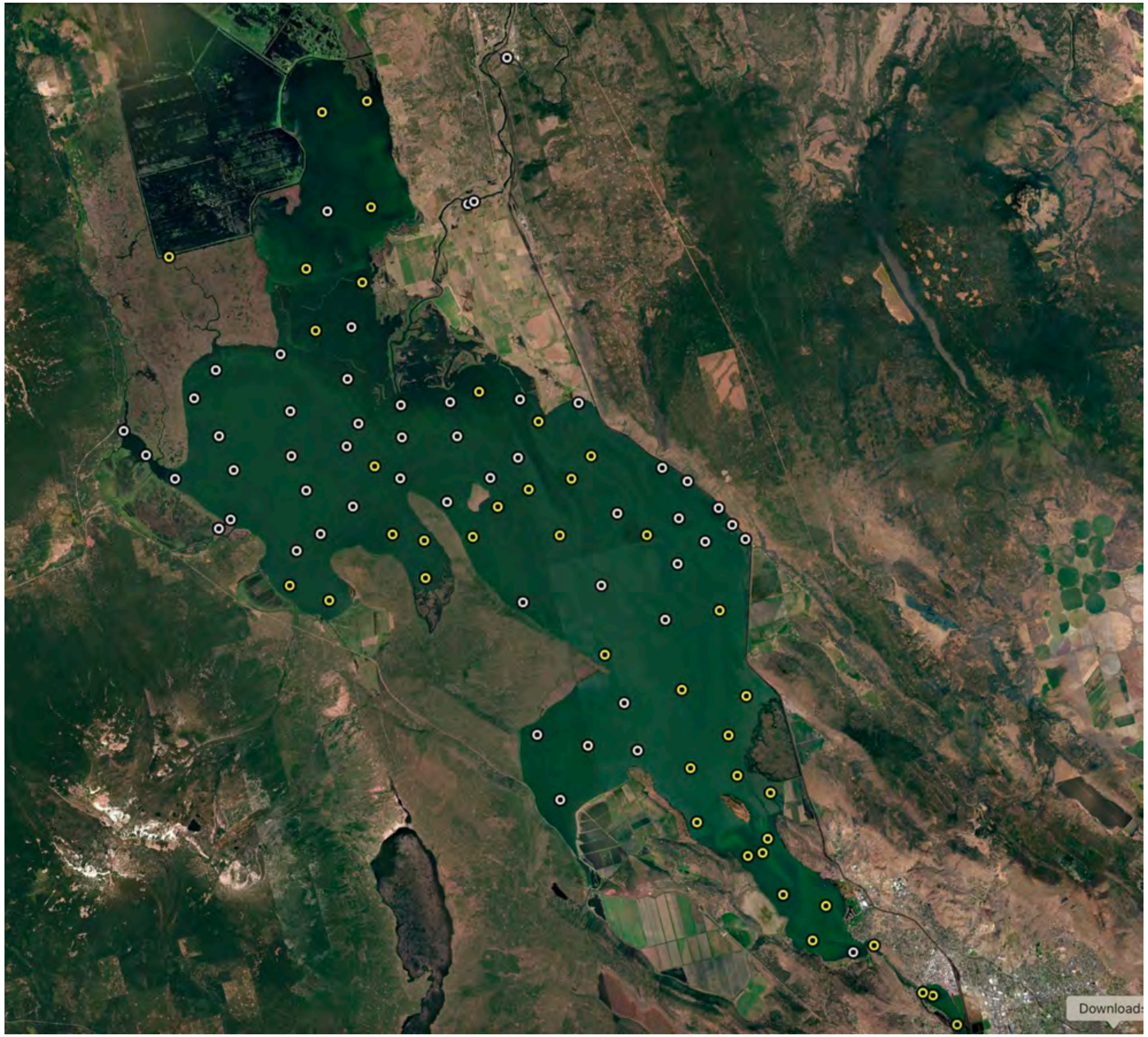
Migration behavior and inference into water quality thresholds

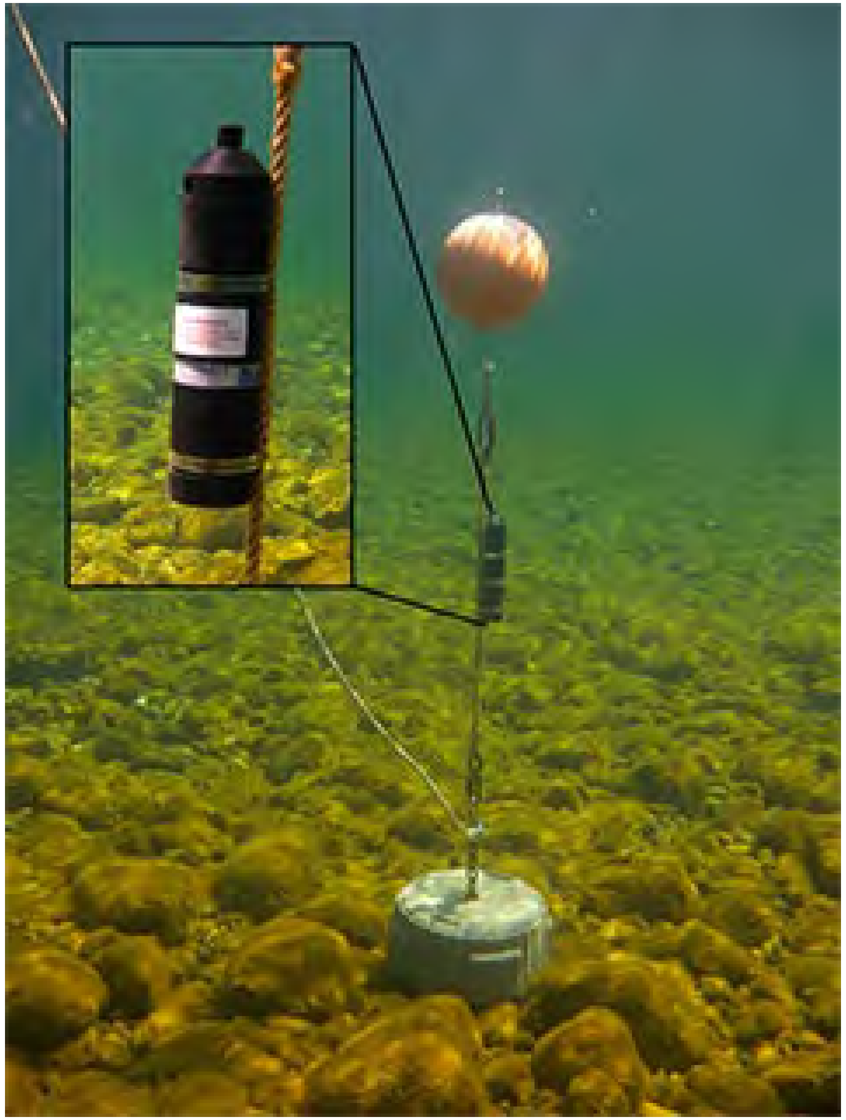
Migration behavior and inference into water quality thresholds





Solution: Monitor the process of migration using USGS Acoustic Receiver Array

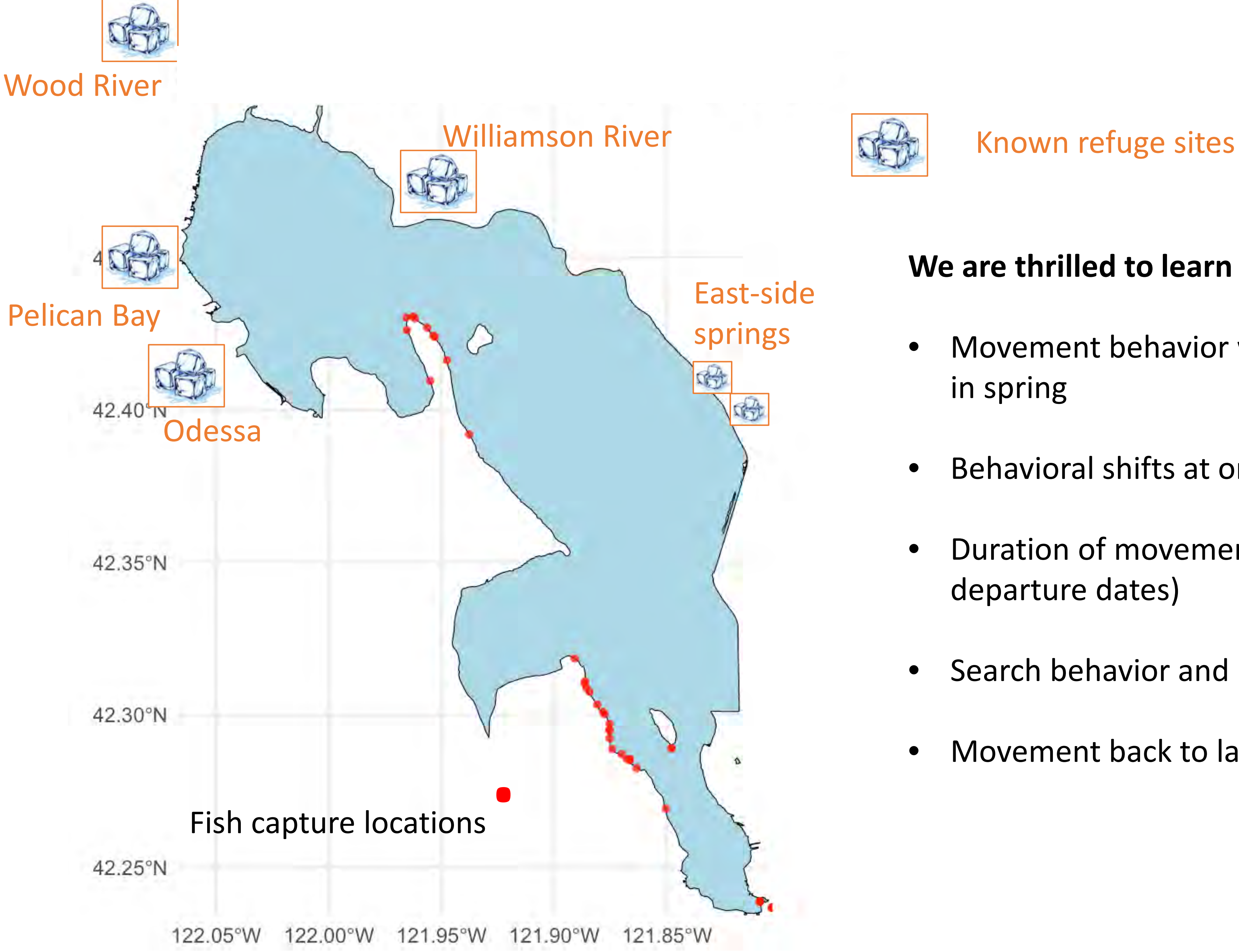




50 V9 tags deployed from March-31 to April-5 2026

Tags

- ID + Temperature
- Ping every 15 min
- << 2% burden



We are thrilled to learn about:

- Movement behavior while using lake as foraging habitat in spring
- Behavioral shifts at onset of emigration
- Duration of movement to refuge (i.e. arrival and departure dates)
- Search behavior and movement path
- Movement back to lake in fall

Next steps

- Collect and analyze acoustic telemetry
- Analyze PIT tag data
- Develop statistical model integrating telemetry datasets and information on migration duration
- Estimate water quality thresholds for use of lake

Thanks!

- Partners: Klamath ODFW, Klamath Tribes, USGS Klamath Falls Field Station
- Funding: OWEB, NW CASC
- Volunteer Anglers, Landowners
- All of the scientists and conservation practitioners in the basin who have supported past and present redband trout studies

Break

Back at 3:25

Klamath Basin Fisheries Collaborative

Dam Passage and Removal – Fish Monitoring Post-Dam Removal

Using Radio Telemetry to Monitor Spawning Migration and Dam Passage Success in Fall-Run Chinook Salmon in the Klamath Basin, Post-Dam Removal

Oregon Department of Fish and Wildlife

Carolyn Malecha – ODFW, carolyn.j.malecha@odfw.oregon.gov

Mark Hereford, OR Dept. of Fish and Wildlife, mark.e.hereford@odfw.oregon.gov
Bob Pagliuco, NOAA Restoration Center, bob.pagliuco@NOAA.gov
Cyril Michel, University of Santa Cruz, NMFS SWFSC Affiliate, cyril.michel@noaa.gov
Jordan Ortega, Klamath Tribes, jordan.ortega@oregonstate.edu
Alex Corum, Karuk Tribe, acorum@karuk.us
James Whelan, California Trout, jwhelan@caltrout.org

Repopulation of Chinook Salmon in Upper Klamath Lake and It’s Major Tributaries

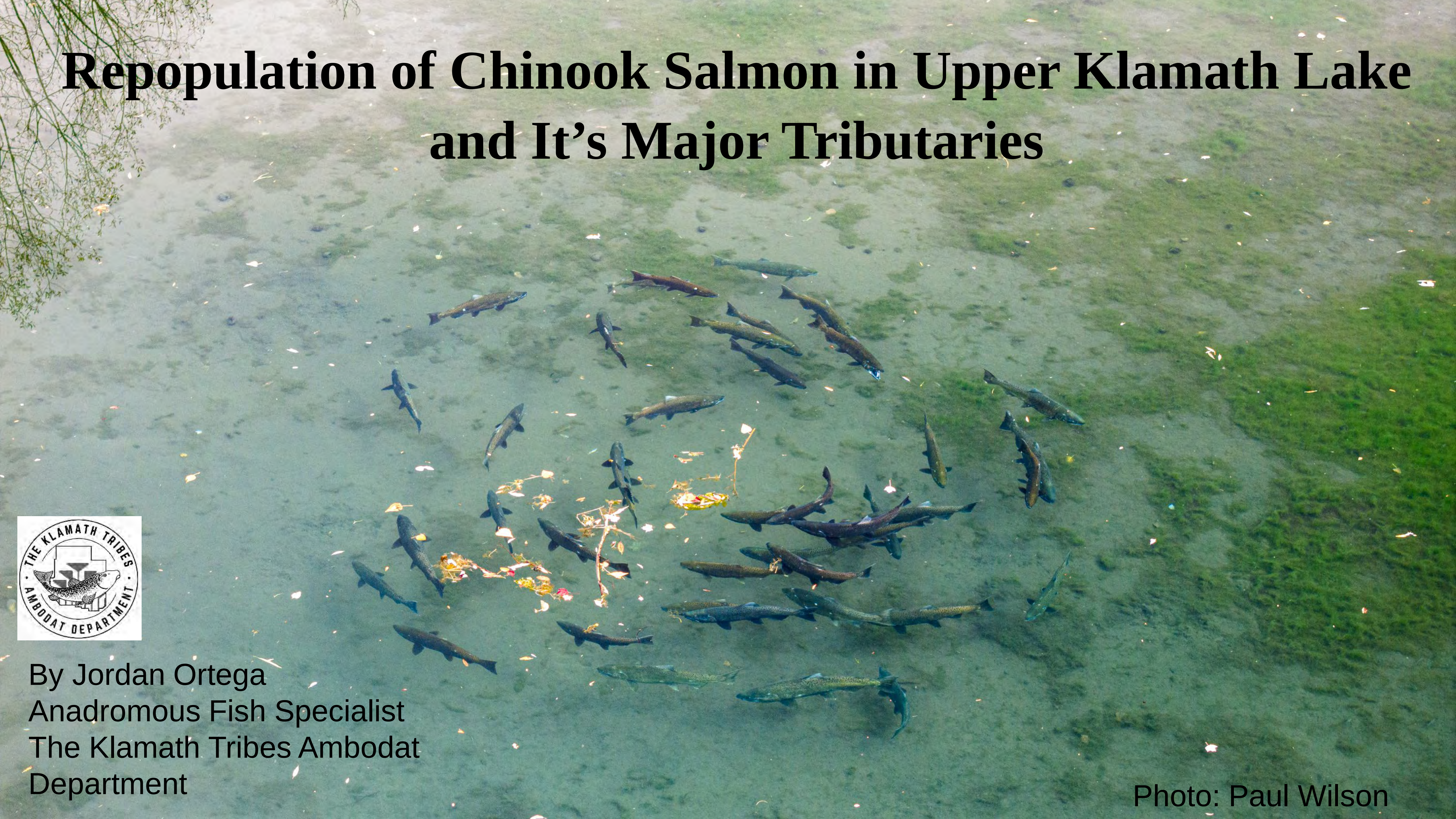


Photo: Paul Wilson

By Jordan Ortega
Anadromous Fish Specialist
The Klamath Tribes Ambodat Department

Klamath Dam Removal

- 4 dams removed August 2024
  - 3rd largest producer of Chinook on west coast
  - 2-4% of historical abundance
  - 751 km of stream habitat upstream of dams

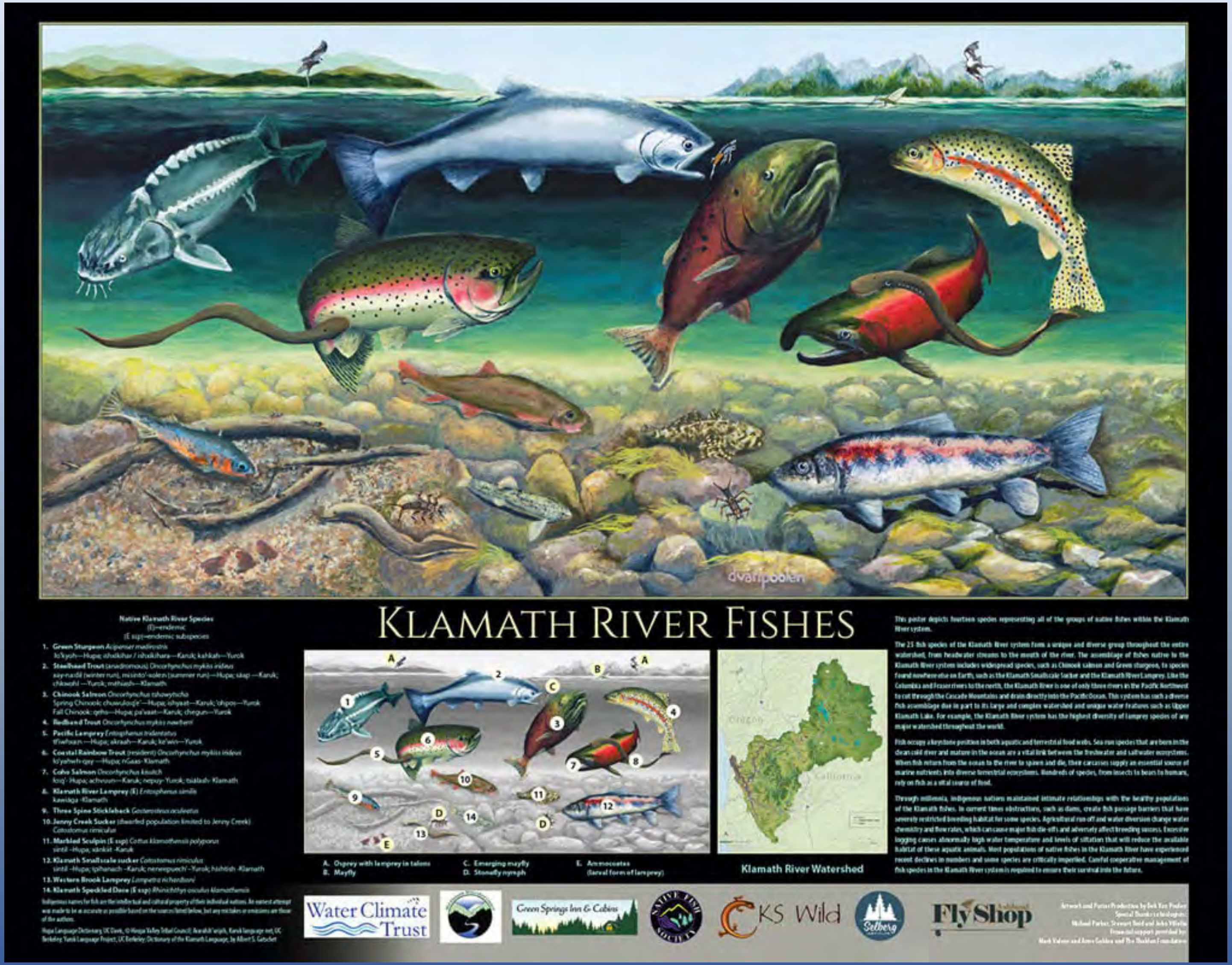

Photo Paul Wilson
Photo Paul Wilson

The Klamath Tribes

- Federally recognized tribe.
- Reserved Treaty Rights Area
- Restoring salmon essential given the loss of traditional subsistence fisheries

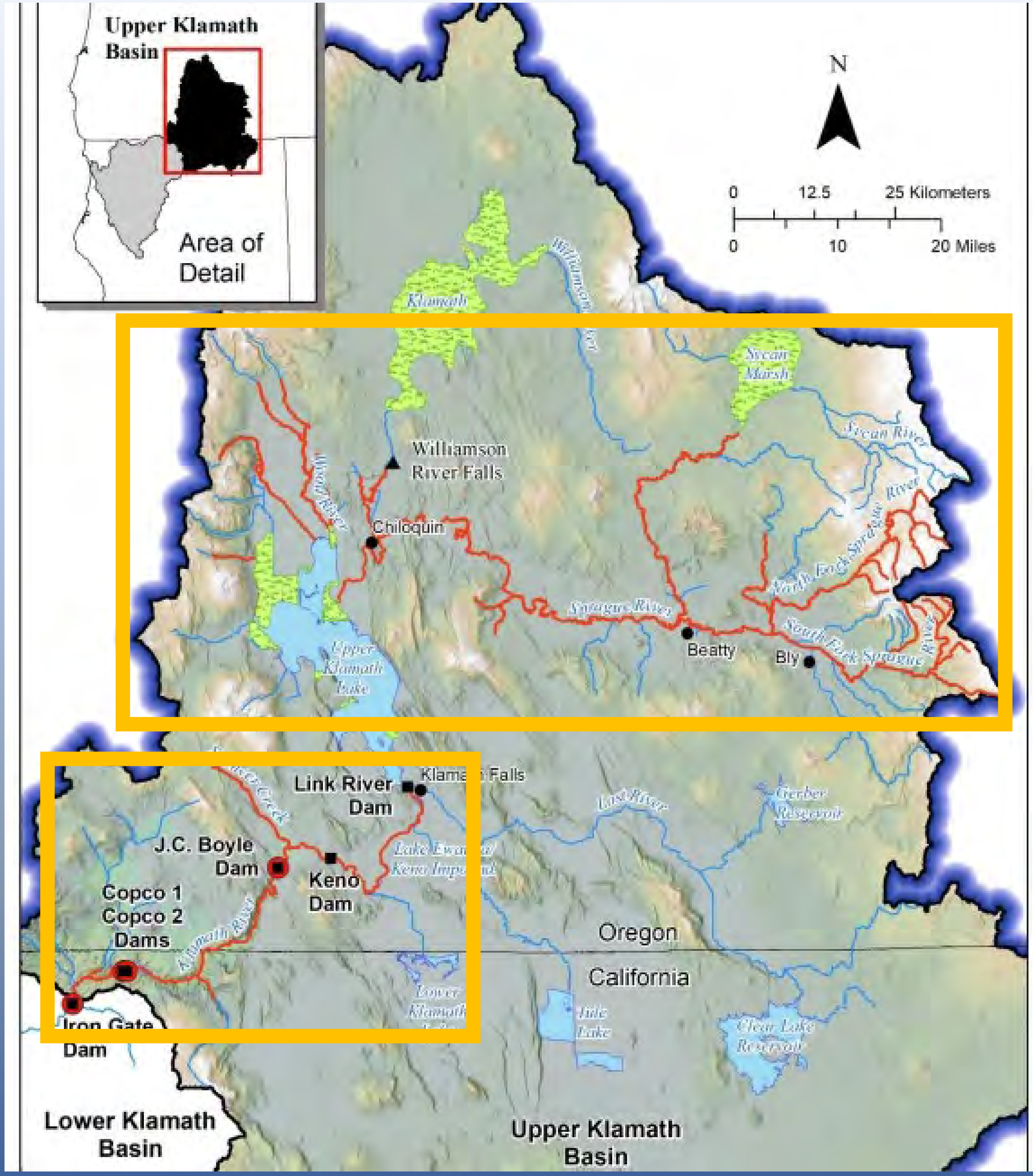
The Monitoring Challenge

- Spatial Challenge
  - So much space!
- Temporal Challenge
  - Fish moving throughout time!

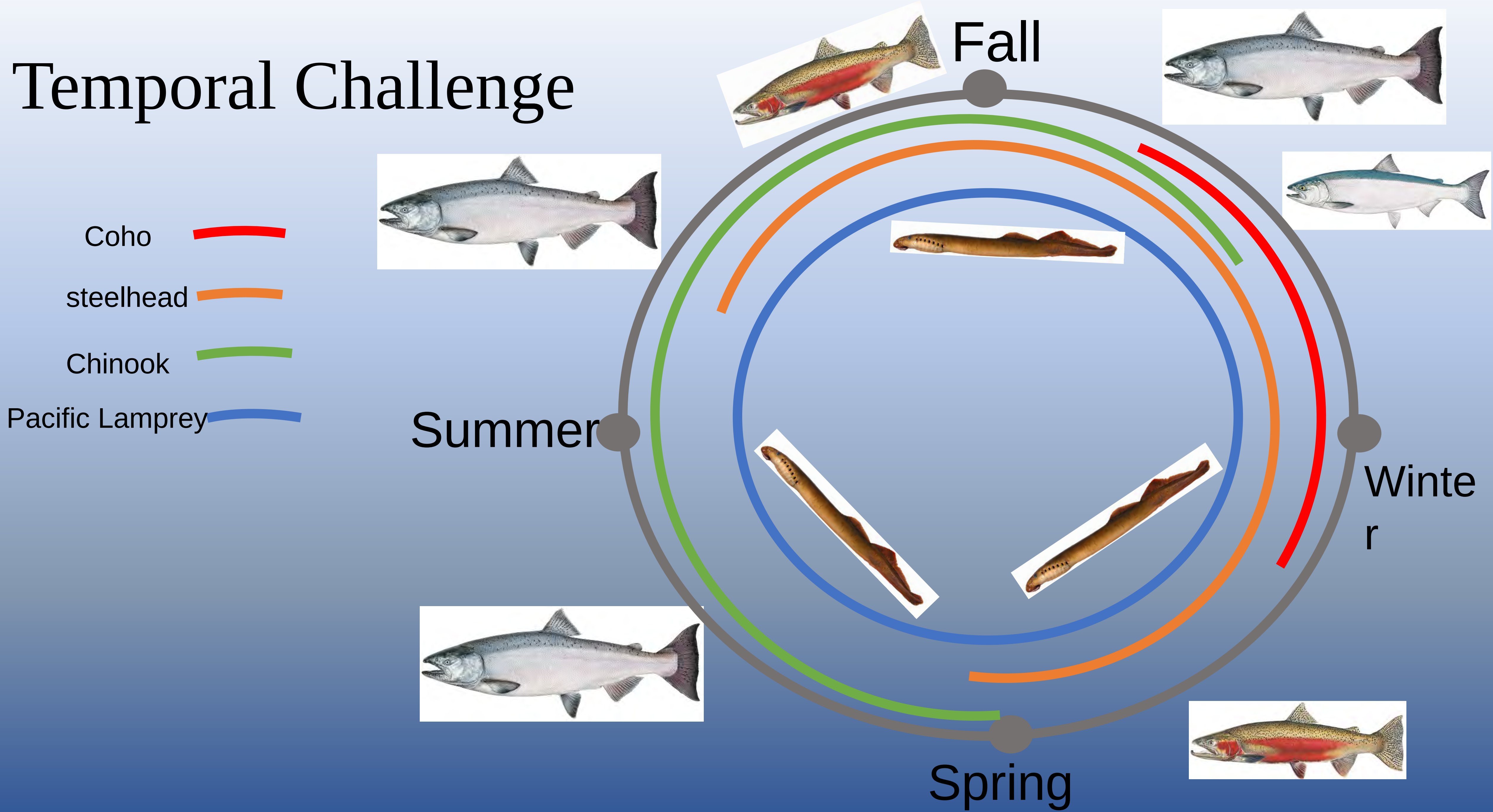


Spatial Challenge

- 152.5 km between Iron Gate dam and UKL (including tributaries)
- 598.5 km upstream of UKL



Temporal Challenge



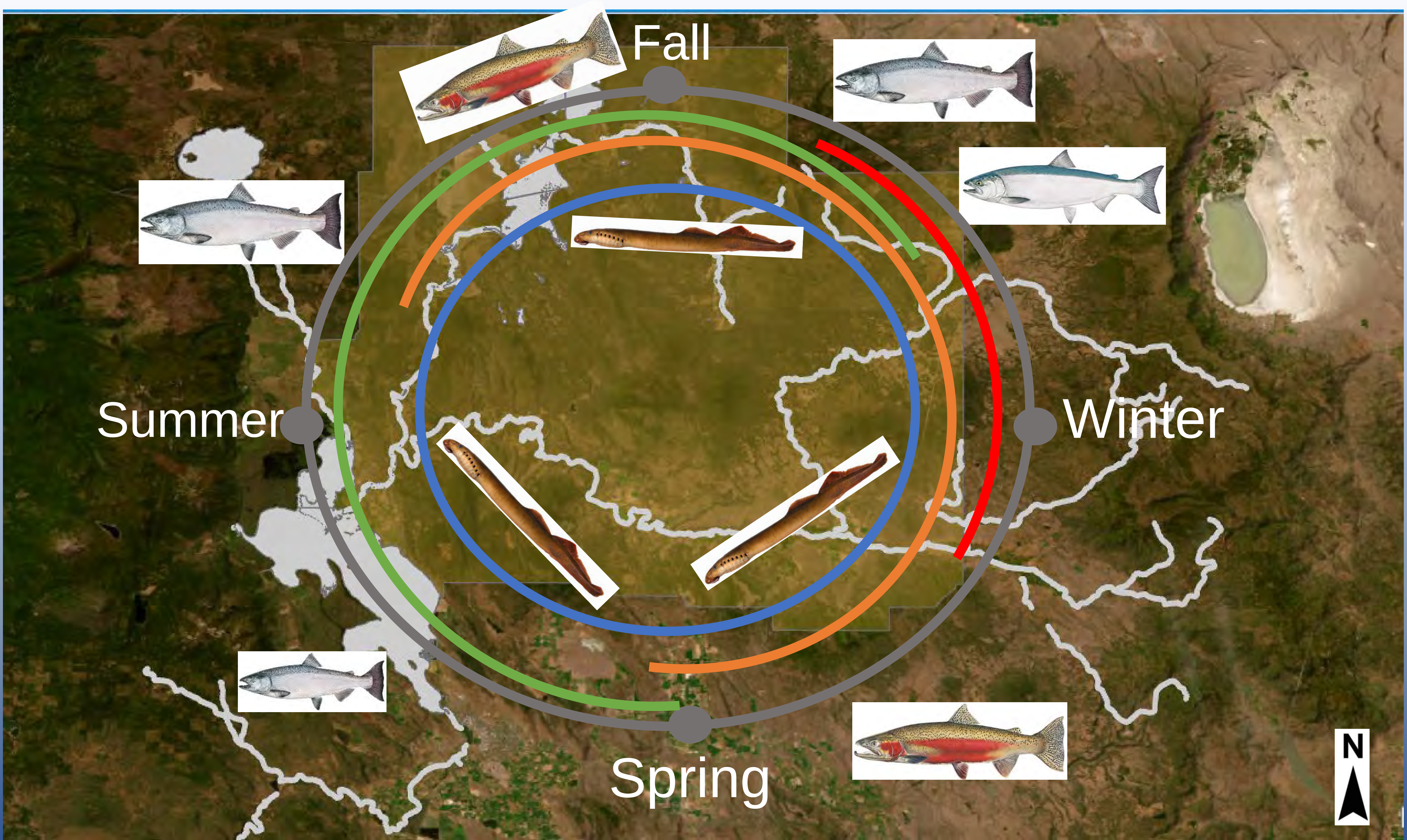

Fall
Summer
Winter
Spring
N

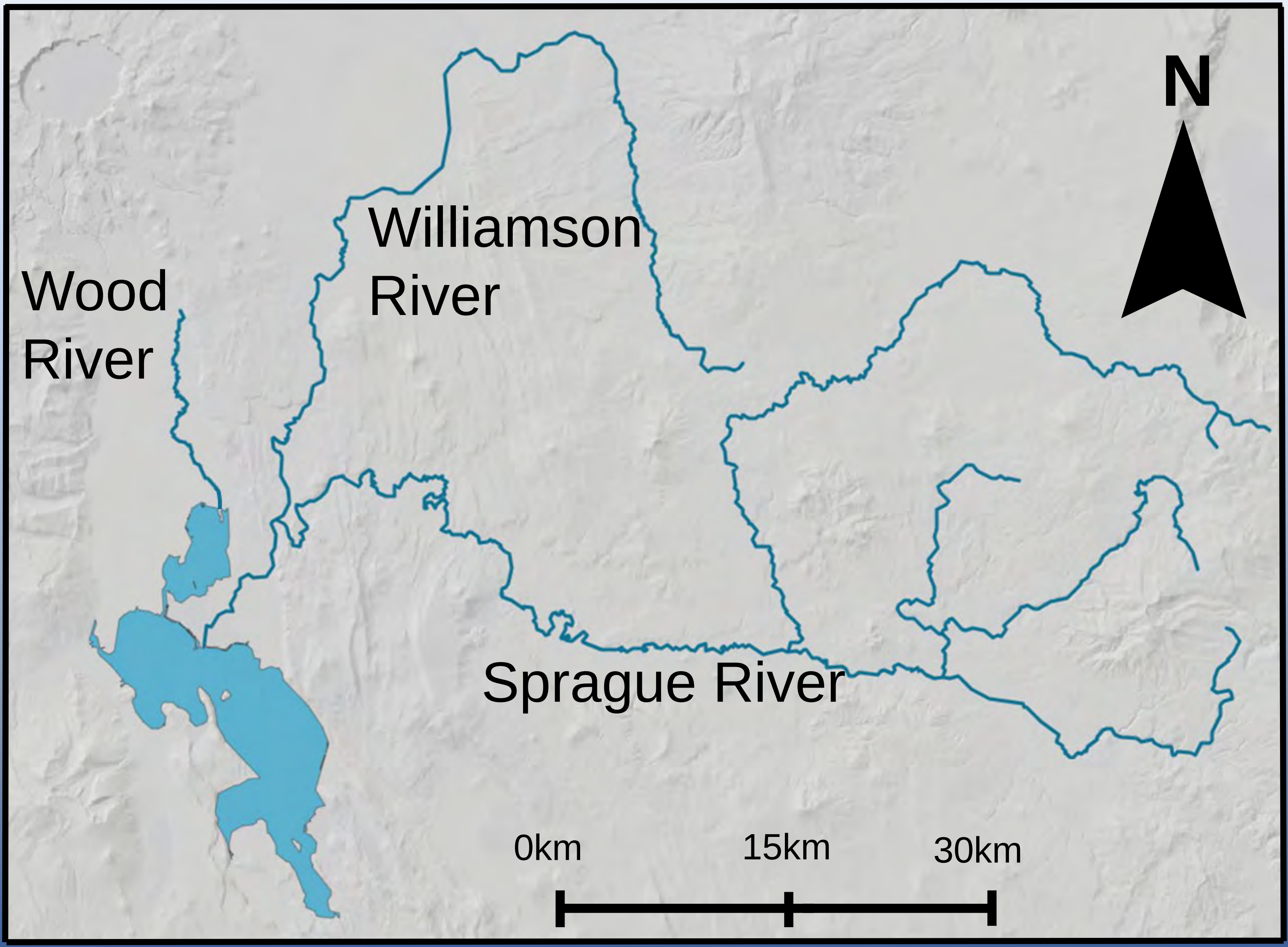

Photo: Paul Wilson

Monitoring Strategy

- Radio Telemetry
- Motion Sensing Camera
- Visual Surveys

Focal Area

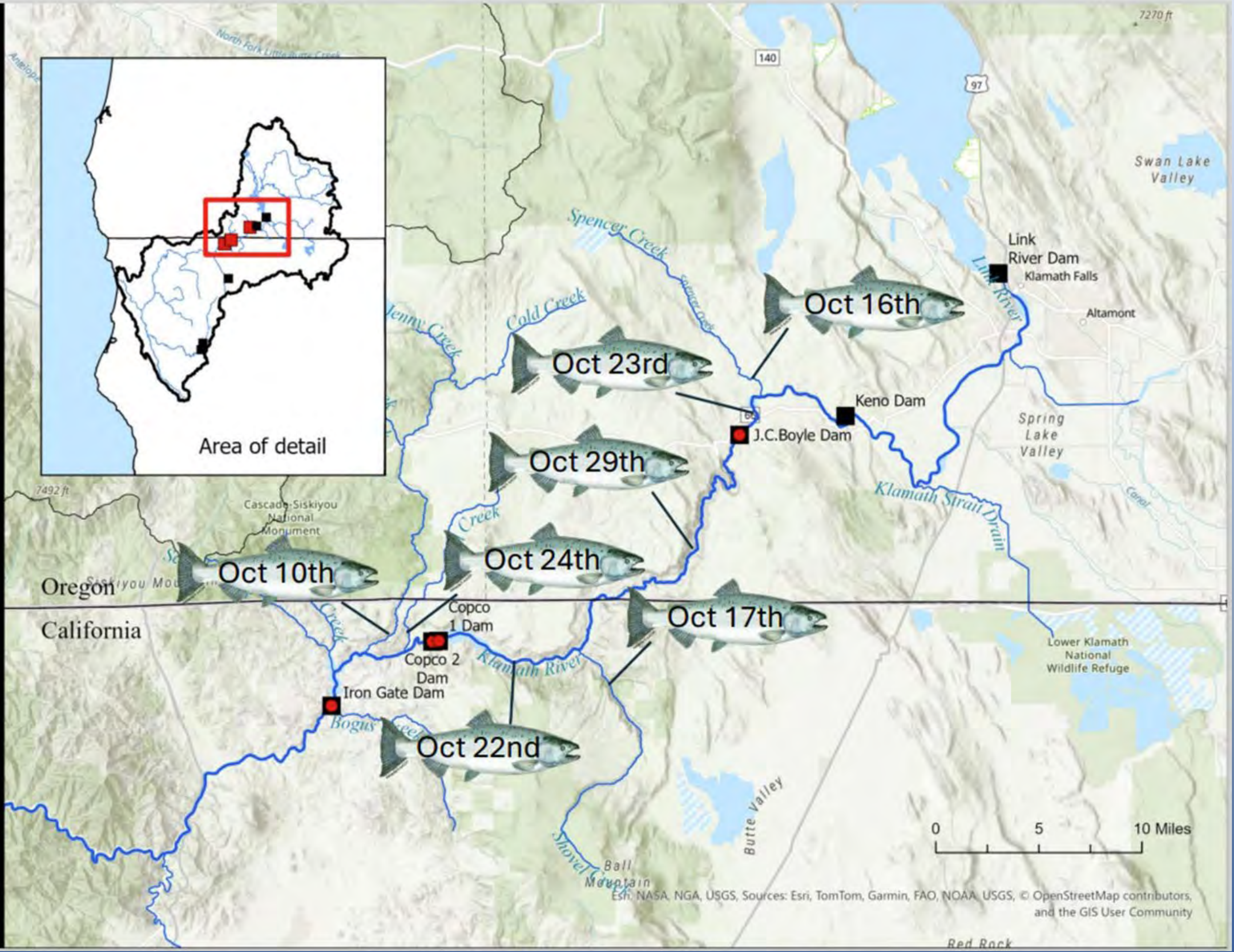
- Klamath Tribes monitoring focus is major tributaries of UKL
- ODFW, Karuk Tribe USFWS, CalTrout etc. monitor Downstream



2024 Chinook Salmon Run: First Year Post-Removal

First observations of fall-run Chinook Salmon

- Oct 10th - Jenny Creek, CA
- Oct 16th - Spencer Creek, OR
- Oct 17th - Shovel Creek, CA
- Oct 22nd – Klamath River, CA above former Copco 1 Dam
- Oct 23rd – Klamath River, OR above former JC Boyle Dam
- Oct 24th – Fall Creek Hatchery, CA
- Oct 29th – Klamath River, OR below former JC Boyle Dam



Slide by Mark Hereford

2025 Monitoring Objectives

- Spatial Distribution
- Run Phenology
- Size, Sex, and Age Structure
- Hatchery Contribution
- Run Size

Photo Paul Wilson

Methods

- Spatial Distribution
  - Visual surveys
- Run Size & Timing
  - Redd counts
  - Live fish counts
- Population Characteristics
  - Carcass collection
    - Size distribution
    - Age Distribution
    - Hatchery Contribution

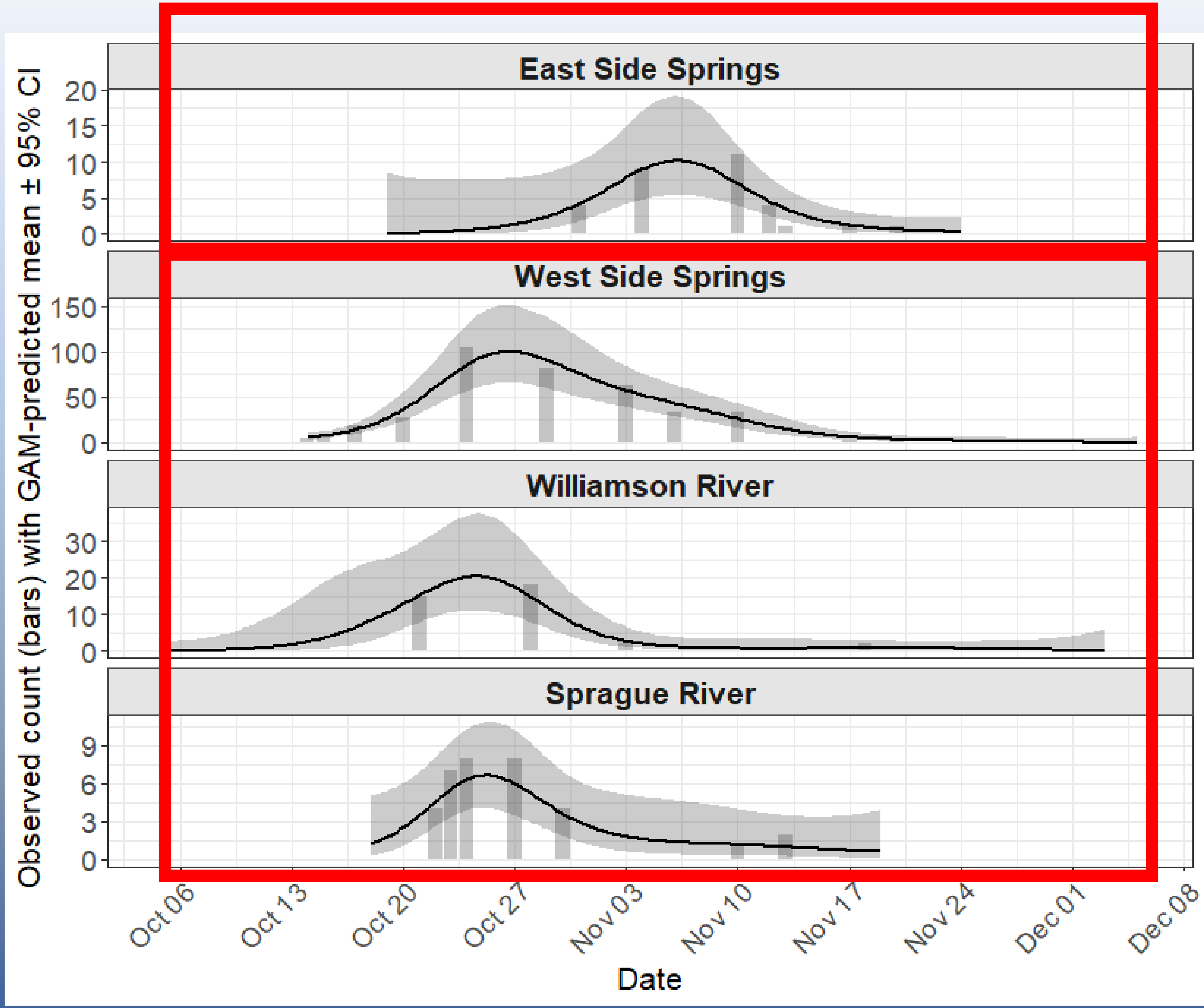
Spatial Distribution

- Widespread spawning distribution

- Farthest upstream observation
  - 150 km to UKL
  - 580 km to ocean

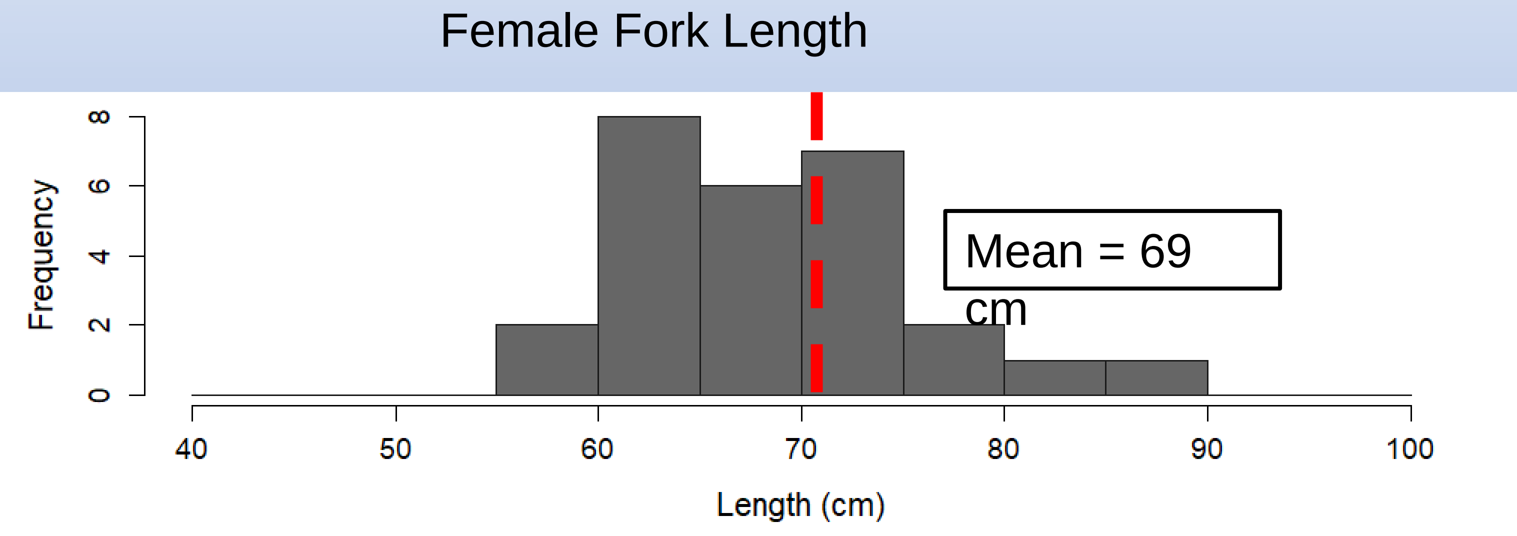
Run Phenology

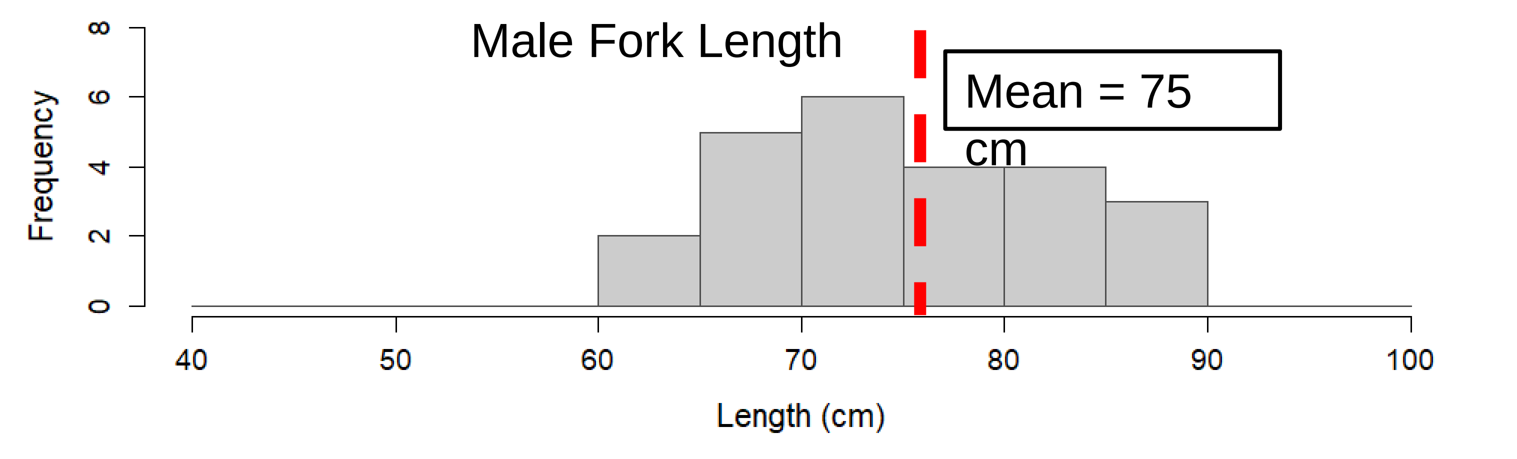
- Spawning activity spanned 1.5 months
- Peak spawning late October at West Side Springs, Williamson, Sprague
- Peak spawning 2-weeks later at East Side Springs



Sex, Size, and Age

- Approximately even sex ratio
- Males > Females
- Consisted of age 3 & 4 adults
  - No jacks observed





Hatchery Contribution

2025 UKL Miscellaneous Tribs Survey CWT and Hatchery Contribution								
CWT	Location	Release type a/	Brood year	Sample number	Production multiplier b/	Production estimate c/	Sample expansion d/	Expanded estimate e/
60032	IGH	AF	2022	3	4.0363	12.1090	3.9000	47.2251
60478	IGH	AF	2021	1	1.0101	1.0101	3.9000	3.9394
60788	IGH	AF	2021	1	1.0157	1.0157	3.9000	3.9614
61546	IGH	F	2021	1	1.0146	1.0146	3.9000	3.9570
62269	IGH	F	2021	1	1.0056	1.0056	3.9000	3.9218
CWT sample subtotal =				**7**				
Hatchery contribution of carcasses sampled subtotal =						**16**		
Total of estimated hatchery contributions =								**63**
a/	Release type; F=fingerling, Y=yearling, AF=advanced fingerling							
b/	Production multiplier is the ratio of # of fish released/fish marked							
c/	Production estimate is the sample number multiplied by the production multiplier							
d/	Sample expansion is the ratio of the estimated total run size and the number of carcasses sampled							
e/	Expanded estimate is the production estimate multiplied by the sample expansion							

63/219=29 %

★ Majority of run was *wild fish!*

Run Size

- Groundwater Portions of UKL
  - *Trapezoidal approximation method* to calculate area under the curve (AUC)

Run Size = AUC/Residence Time = $\sum \left[\frac{(C_i + C_{(i+1)})}{2} \times \Delta t \right]$

- Williamson, Wood, Sprague
  - *Redd count* based run size estimate
    - Number of Redds x 2 = Run Size

Run Size

- Upper Klamath Lake: 219
- Williamson: 82
- Sprague: 22
- Wood: 12

TOTAL RUN SIZE (minimum) = ***335 Fall Chinook***

Photo: Paul Wilson

Next Monitoring Steps…

- Returning adults encouraging but does not reveal if they will be able to establish self sustaining populations

- To evaluate reproductive success we implemented a monitoring strategy that includes the use of rotary screw traps

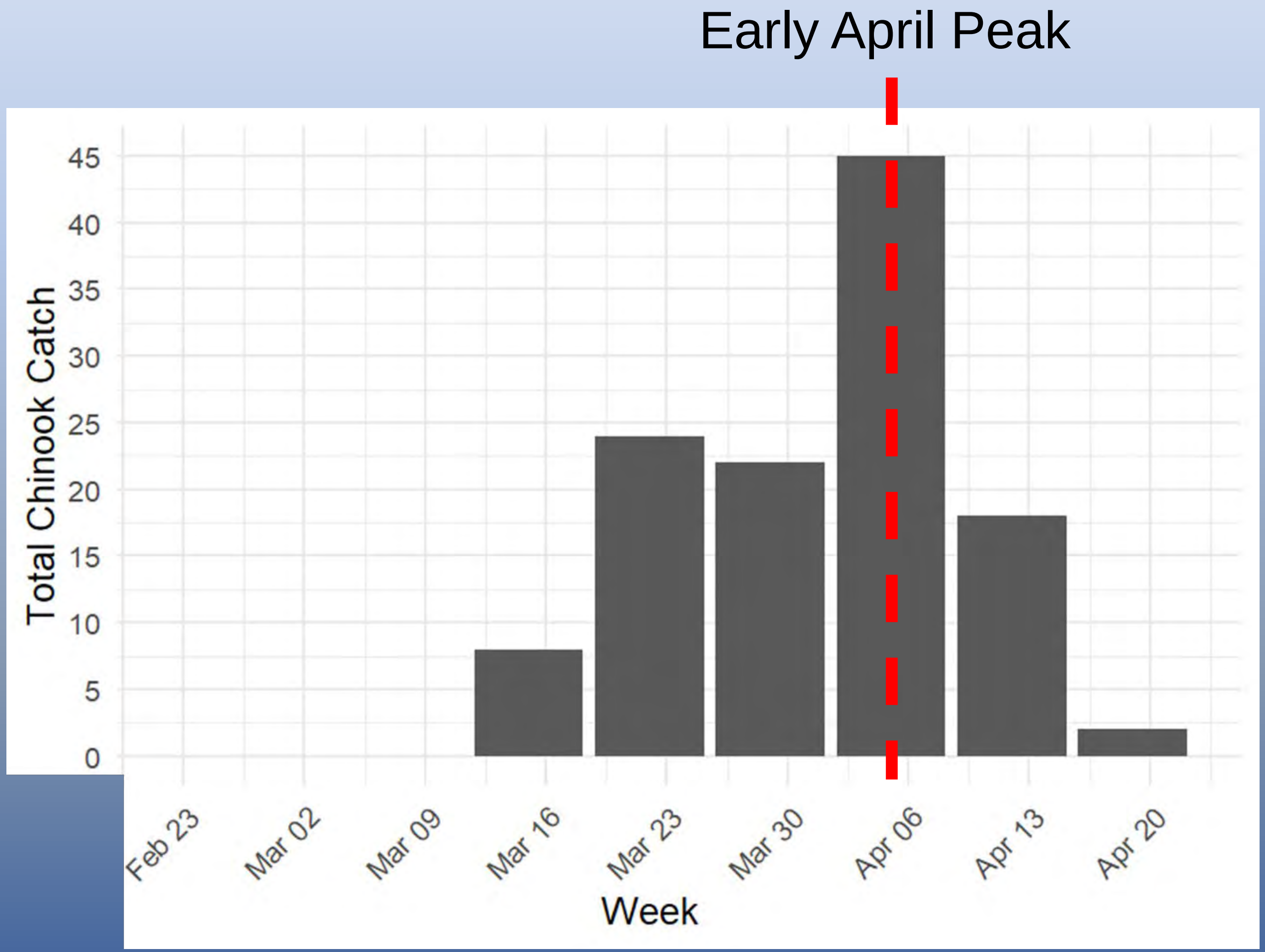
Photo Mark Martin

Juvenile Chinook Salmon Monitoring

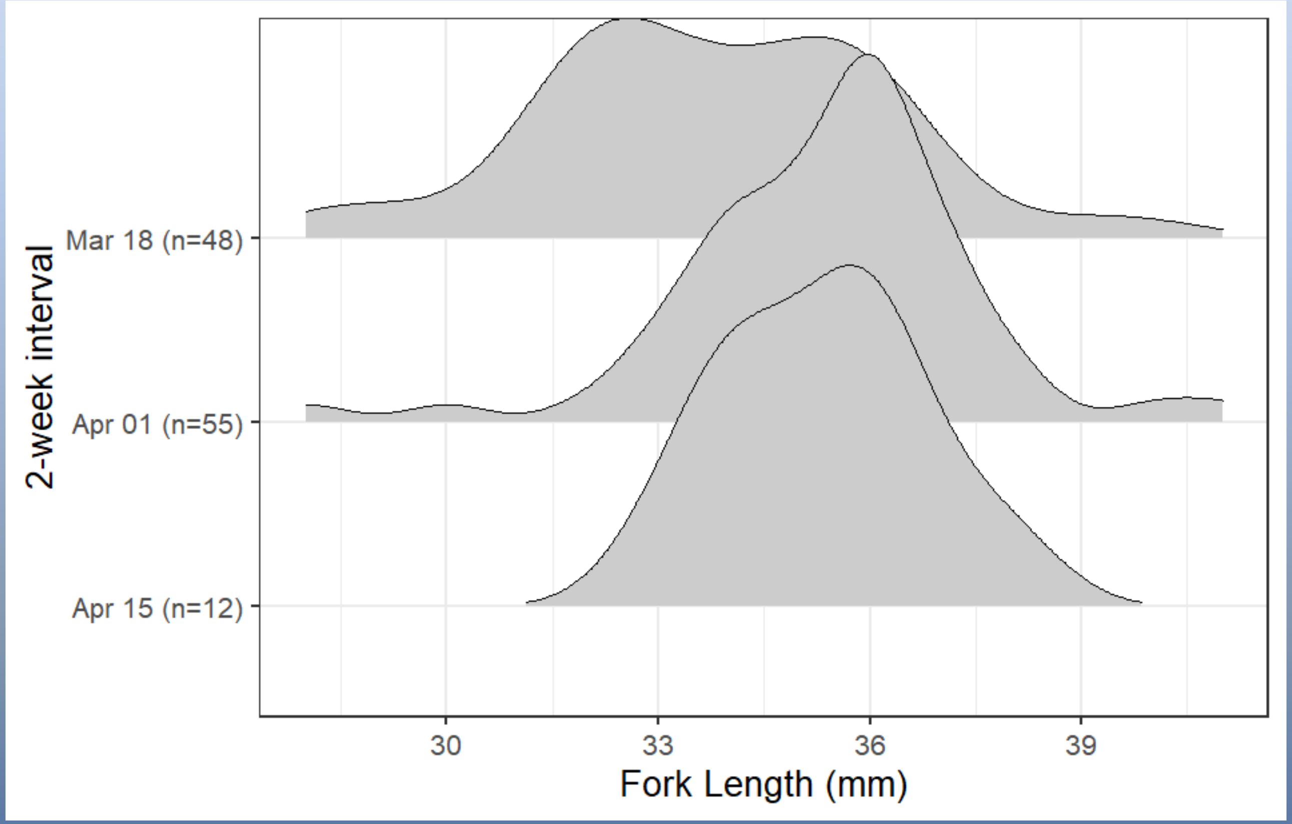
- Operating two 5-ft rotary screw traps
  - Sprague River
  - Williamson River

Catch Through Time

Photo: Paul
Wilson



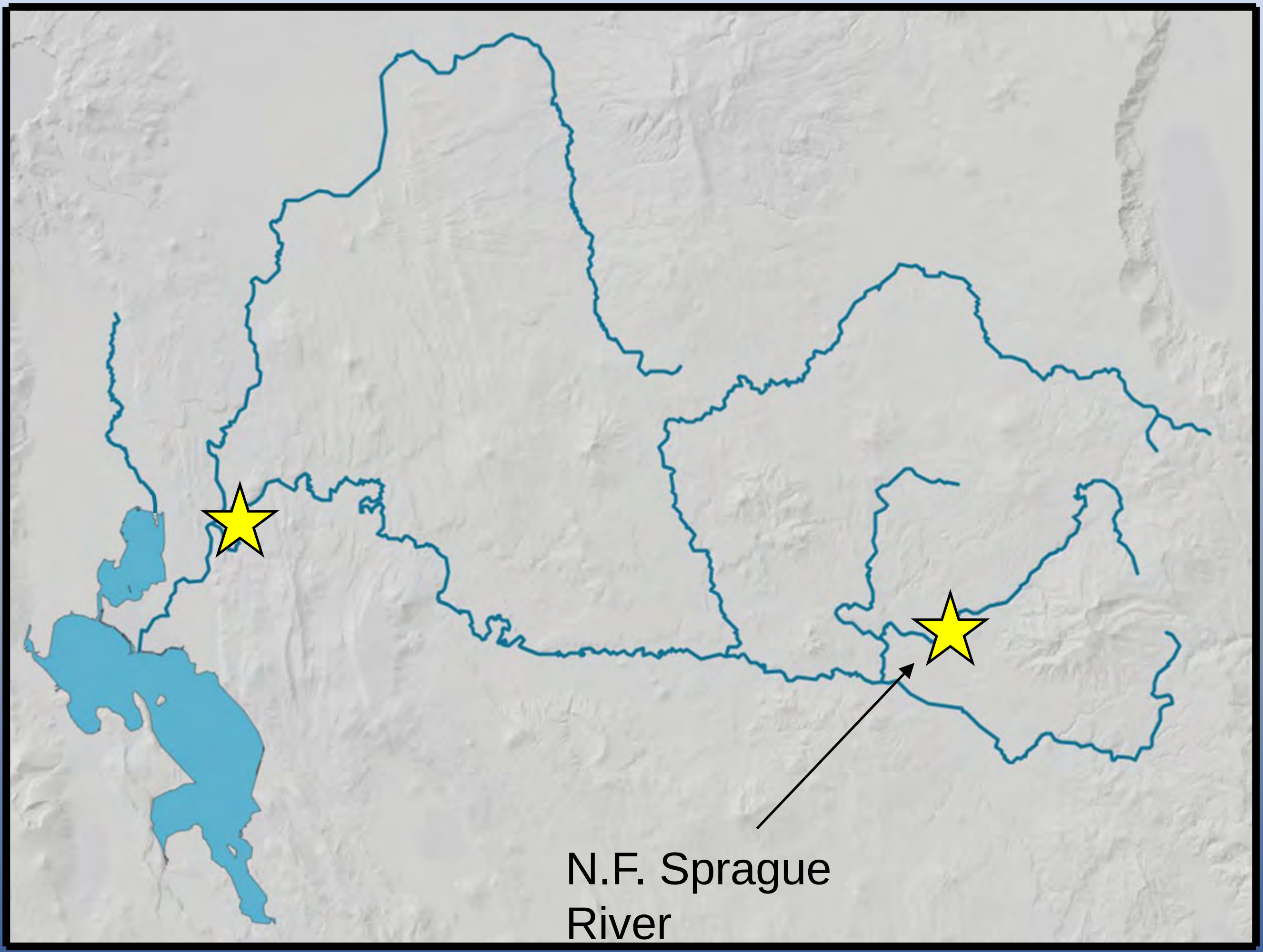
Size Through Time



Chinook size indicates growth and downstream movement of the 2026 cohort

Screw Trap Highlight

- Released Fall 2025 on North Fork Sprague
- 3 captured April 2026
    - Over-wintered in Sprague
- Distance of > 130km



2025 Chinook Monitoring Take Home…

- Adults distributed upstream rapidly across a broad spatial extent

- Evidence of successful spawning as indicated by the presence of recently emerged chinook fry

- Early response underscores the importance of restoring connectivity in large watersheds

- Continued monitoring by The Klamath Tribes Ambodat Department

Photo Paul Wilson

Our Partners

CALIFORNIA TROUT
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GREAT SEAL OF THE KARUK TRIBE

CALIFORNIA
DEPARTMENT OF FISH & WILDLIFE

Klamath River Effectiveness Monitoring

James Whelan

2025-2026

Please contact James Whelan at jwhelan@caltrout.org for more information

Photo by Michael Weir

Klamath
Basin
Fisheries
Collaborative

KBFC Database Updates

Klamath PIT Tag Database

Monica Diaz, PSMFC Project Lead Supporting the KBFC.
KBFC Leadership Team

KBFC Updates

Klamath PIT Tag Database

KBFC Purpose

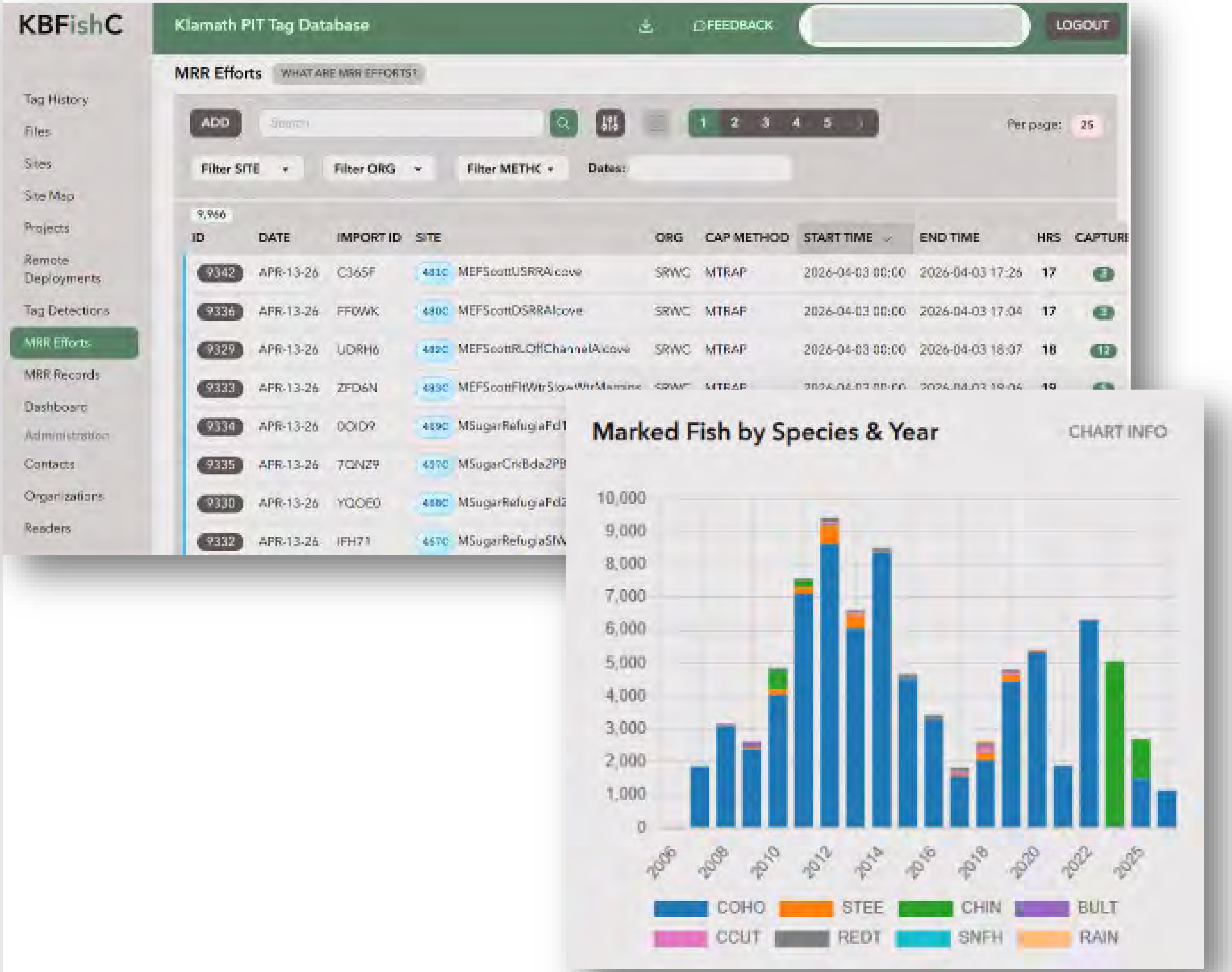
- Facilitate access to fisheries PIT tag data and associated metadata
- Build a network of collaborators
- Advance research to inform fisheries management and restoration actions

KBFC Updates

Klamath PIT Tag Database

About the KBFC Database

- Standardized database to view, input, and download PIT tag data.
- Data derived from monitoring and research activities in the Klamath Basin.
- Used to inform fisheries management and restoration actions.



KBFC Updates

Klamath PIT Tag Database

Survey123 for data entry

- Digital Survey123 forms for recording data.
- Uses SerialMagicKeys to transfer PIT tag data from the reader to the Survey123 form.
- Easy, automated, and accurate data upload to servers.

Mark, Recapture, Recovery (MRR) form

Remote deployment form

2026 Planned Updates

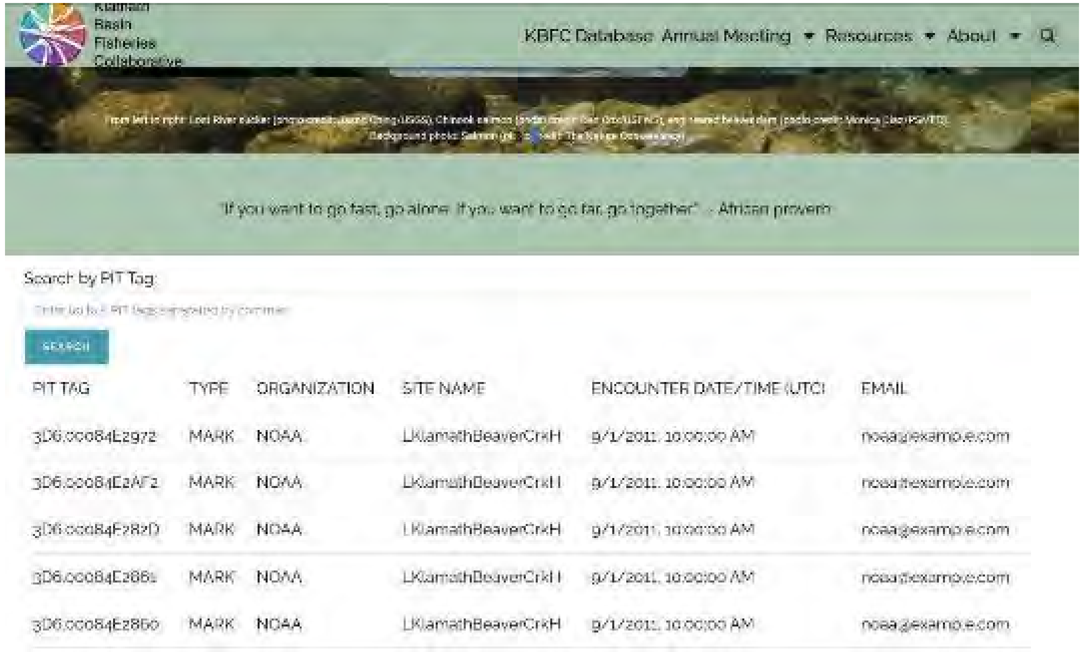
- Leadership oversees the database development
- March Leadership meeting
  - Identified area of improvement
  - Create a streamlined/ more self-sustaining database

KBFC Updates

Klamath PIT Tag Database

Planned 2026 Improvements and Changes

- Control over data visibility
- Finalizing public tag search feature on the KBFC website.
- Continuing support for Hexadecimal and Decimal PIT tag upload.
- Increased data download limits.
    - o Up to 100,000 records
- Data availability grid



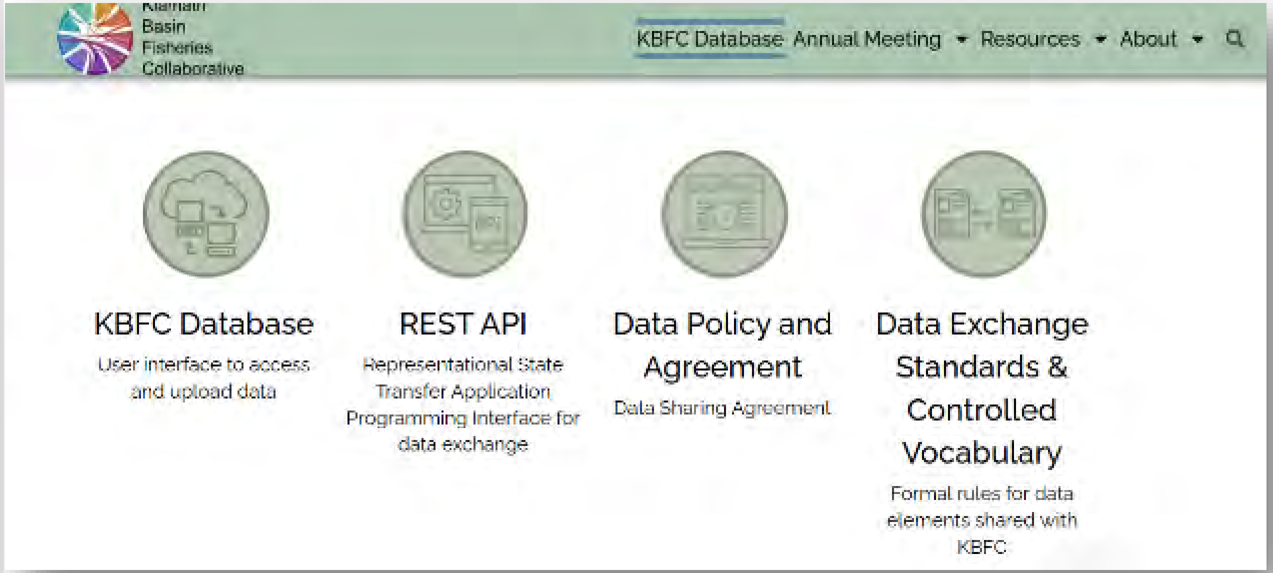
New Support Contact:

kbfc-support@psmfc.org

- for your database related questions and concerns.
- created to streamline and speed up database issue resolution.

Next Steps

- Anticipate updates implemented and ready to be used by mid-June 2026
- Updates to Data Sharing Agreement(DSA) to reflect current features once updates implemented
- Can view more information on the KBFishC.org including
  - the data fields in the DES and Controlled vocabulary
  - Revised DSA once posted



Salmon Discussion

Data methodologies, standardization, and needs

Upcoming Events of Interest

USFWS Klamath Basin Monitoring Strategy (KBMS)

June 16-17

Hybrid
Ashland, OR

https://ifrmp.org/basin-strategy/post-dam/

Klamath Basin Monitoring Program (KBMP)

June 18

Hybrid
Yreka, CA

www.kbmp.net

KBFC Leadership Meeting

September 17

Virtual

Emerging Technologies and Information Sessions (ETIS)

October 26 -28

Stevenson WA

https://pnamp.org/projects/2026-etis/

Klamath Basin Fisheries Collaborative