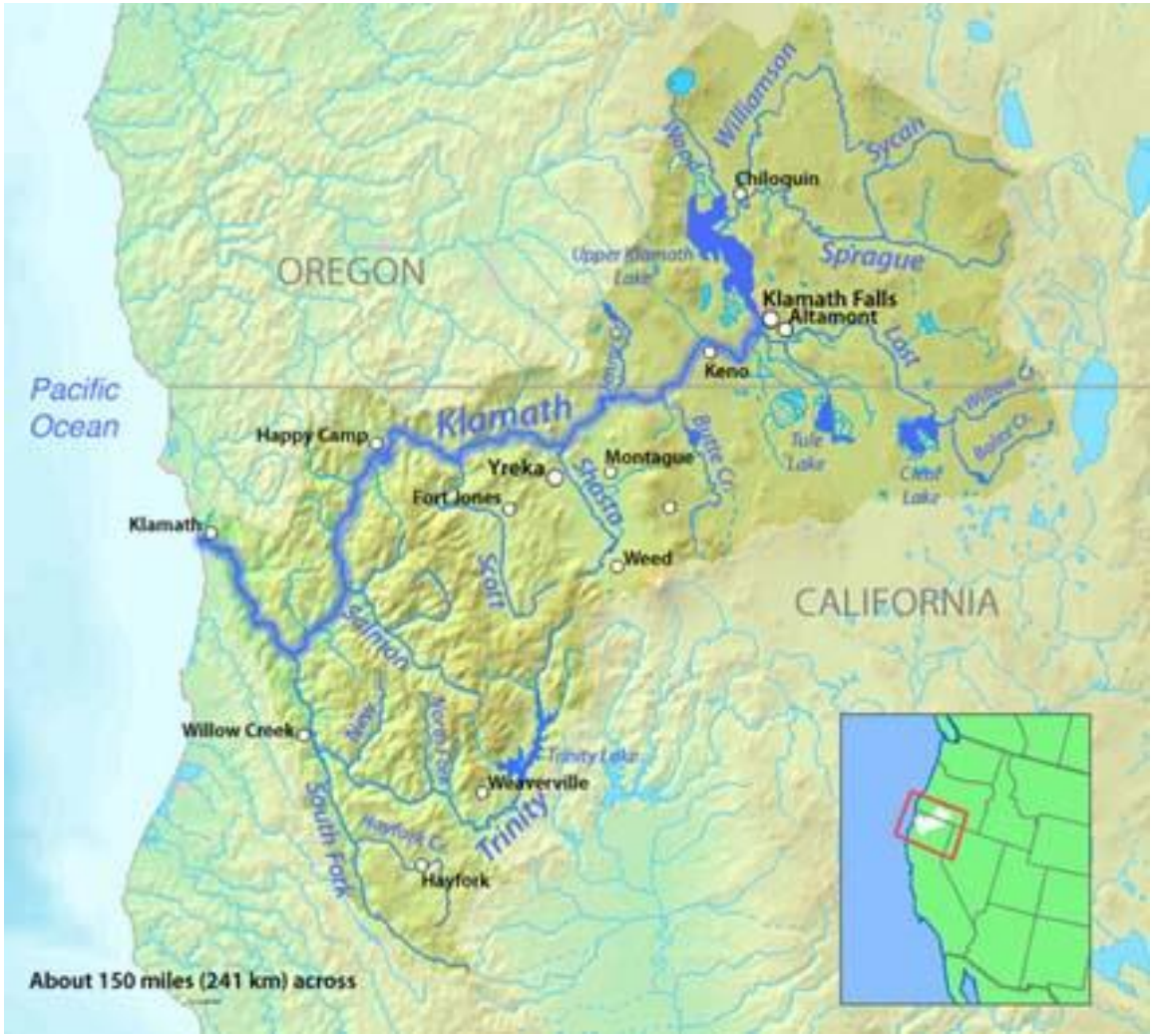
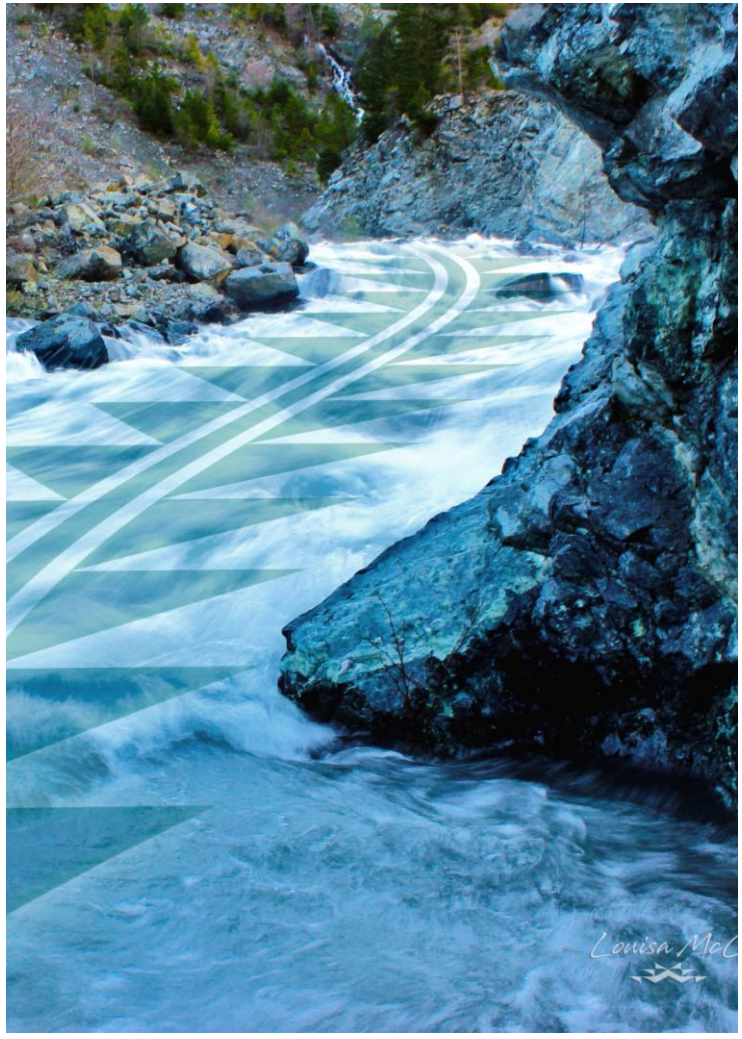
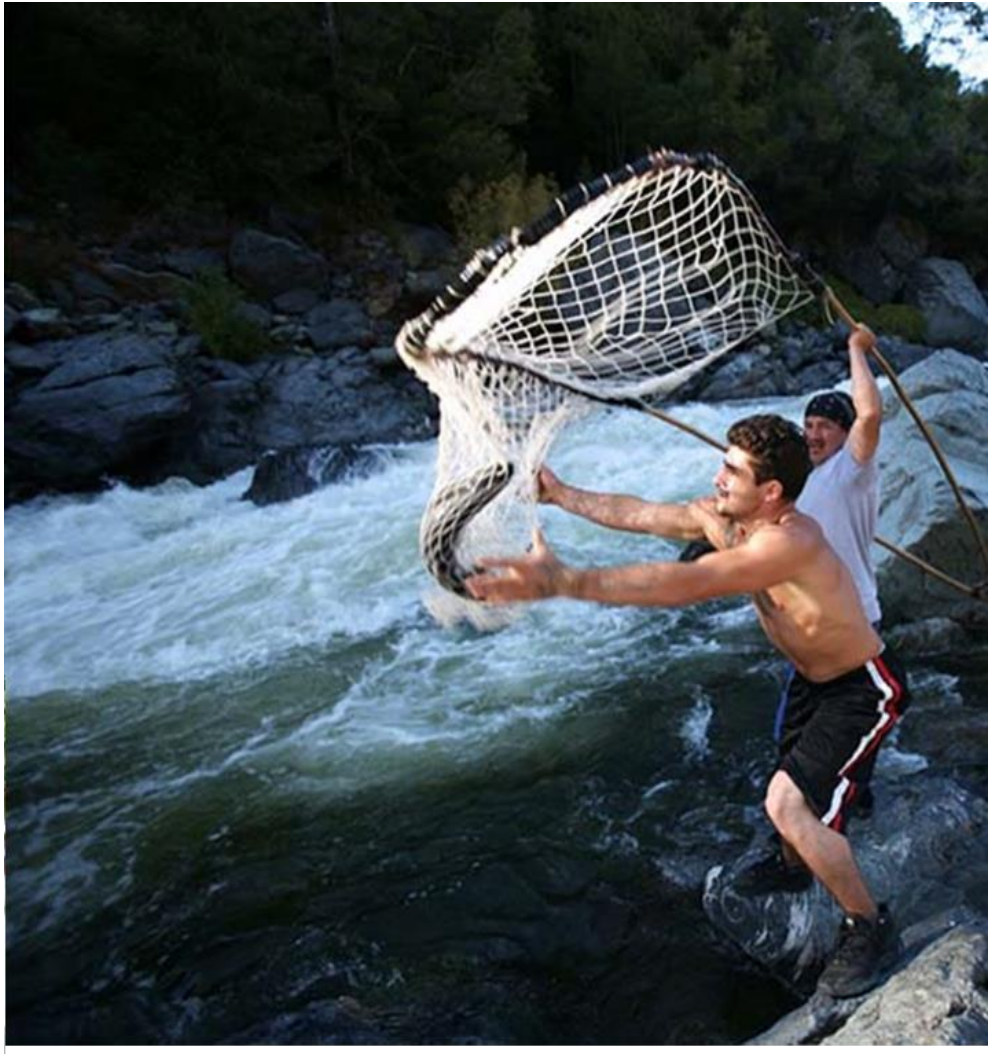
EPA-Tribal Partnership for Water Quality Monitoring: Karuk and Yurok Tribes on Klamath River Dam Removal


OREGON
CALIFORNIA
Pacific Ocean
Williamson
Sycan
Chiloquin
Upper Klamath Lake
Sprague
Klamath Falls
Altamont
Keno
Lost
Klamath
Happy Camp
Yreka
Montague
Fort Jones
Shasta
Butte Cr.
Tule Lake
Klamath
Scott
Weed
Salmon
Willow Creek
Trinity Lake
Weaverville
Trinity
South Fork
Hayfork
About 150 miles (241 km) across



Karuk & Yurok Tribes



Stewardship and Cultural Fire

- Increases the health and abundance of cultural foods, medicines & resources.
    - Deciduous trees rather than conifers
    - Meadows for grazing
- Decreases density of invasive understory, allowing for greater water availability.
    - Important management tool for climate change

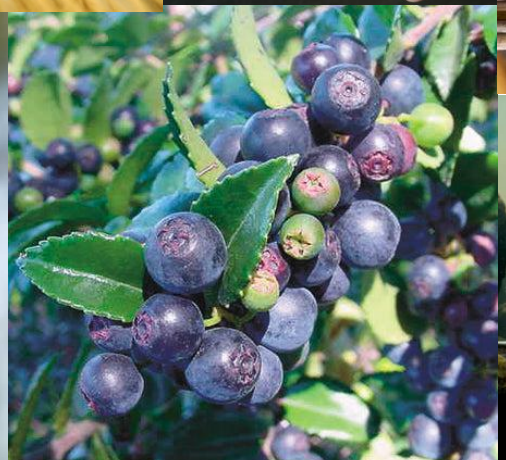
Place & Peoples:
non-human & human interactions











Dams on the Klamath


Copco No.1
JC Boyle
Copco No.2
Iron Gate
OREGON
CALIFORNIA
Pacific Ocean
Klamath
Chiloquin
Klamath Falls
Altamont
Keno
Happy Camp
Yreka
Fort Jones
Montague
Weed
Klamath
Willow Creek
Weaverville
Trinity Lake
Shasta
Scott
Salmon
Butte Cr.
Tule Lake
Lost
Willow Cr.
Boles Cr.
Upper Klamath Lake

Klamath Fish Kill

- 34,000-78,000 adult salmon dead without spawning due to fish disease and water diversions

- Nothing in oral history of either tribe describing an event like 2002

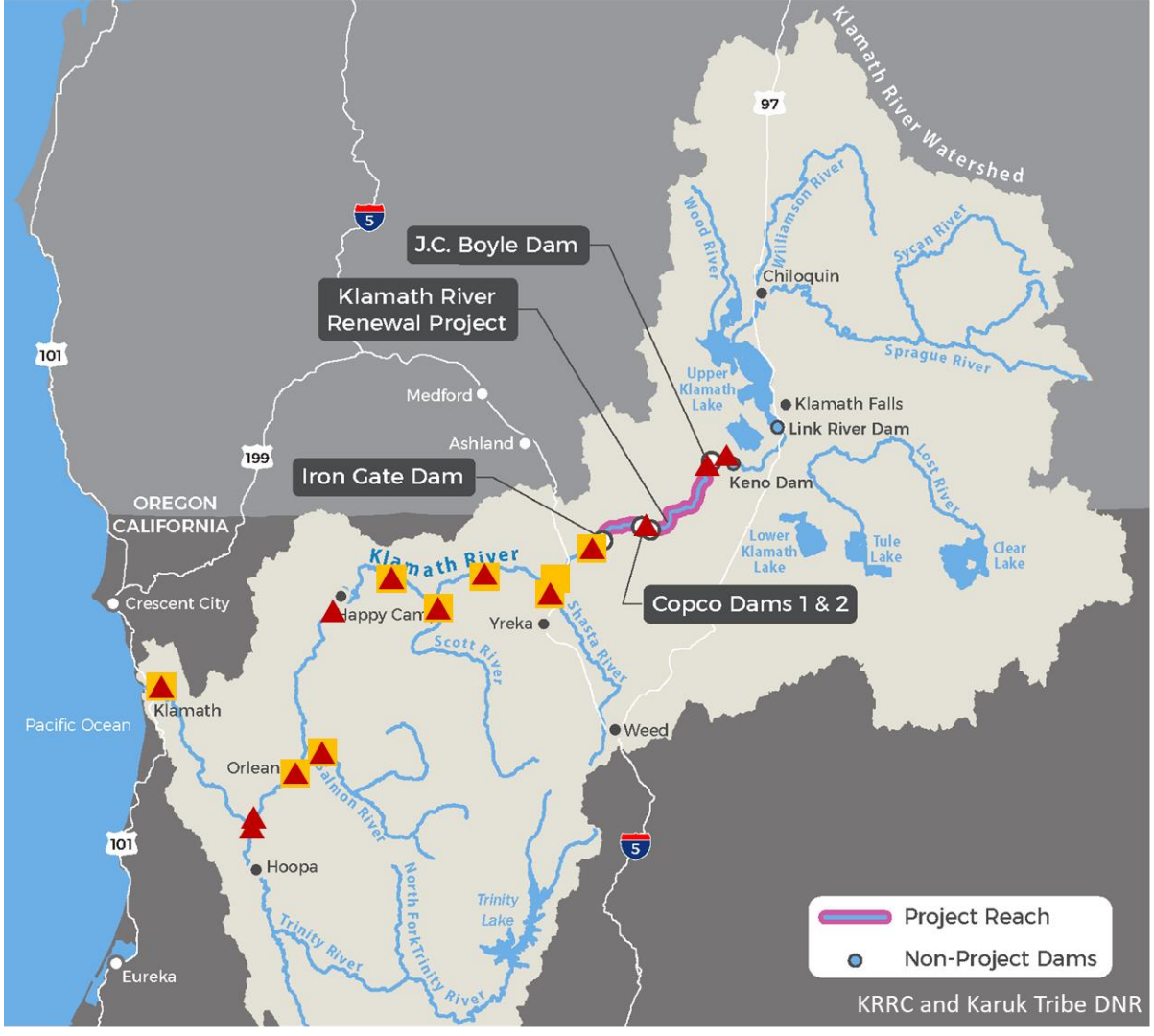
World Renewal Philosophy *(Pikyav)*

Actively caring for self, communities, ecosystems, and really the whole world, is the underlying principle of pikyav… [We] have a deeply rooted responsibility to repair and restore social, cultural, and ecological relationships… Fixing the world is ever-emergent, a way of continually bringing balance to the world and the peoples who live in relation with the world. – Carolyn Smith, Karuk anthropologist and basketweaver


UN-DAM THE KLAMATH
DAMS KILL MORE THAN FISH
FIRST THE BUFFALO NOW THE SALMON
Un-Damn the Klamath River
LOOK AT THE RIVER NOW
SAVE THE RIVER SAVE THE SALMO
UN-DAM the KLAMATH
UN-DAM THE KLAMATH NOW!

History of EPA Partnership

- EPA began funding Tribes for CWA in 2000, dam removal monitoring in 2011
- Supplementing nutrient grab samples at higher resolution
- Public Health- Harmful Algae Blooms (HABs)
- More recently-funded real-time WQ stations after KHSA


Klamath River Watershed
J.C. Boyle Dam
Klamath River Renewal Project
Iron Gate Dam
Copco Dams 1 & 2
97
5
101
199
Medford
Ashland
OREGON
CALIFORNIA
Crescent City
Pacific Ocean
Klamath River
Happy Camp
Yreka
Scott River
Shasta River
Klamath
Orlean
Salmon River
Hoopa
Trinity River
North Fork Trinity River
Trinity Lake
Weed
Eureka
Wood River
Williamson River
Sycan River
Chiloquin
Sprague River
Upper Klamath Lake
Klamath Falls
Link River Dam
Keno Dam
Lost River
Lower Klamath Lake
Tule Lake
Clear Lake
Project Reach
Non-Project Dams
KRRC and Karuk Tribe DNR

Continuous Monitoring

- Continuous data collected every 15 min using YSI data sondes
- Temperature, conductivity, dissolved oxygen, pH, turbidity
- 11 sites covering 200 miles of main stem and four tributaries
- 25 years of records

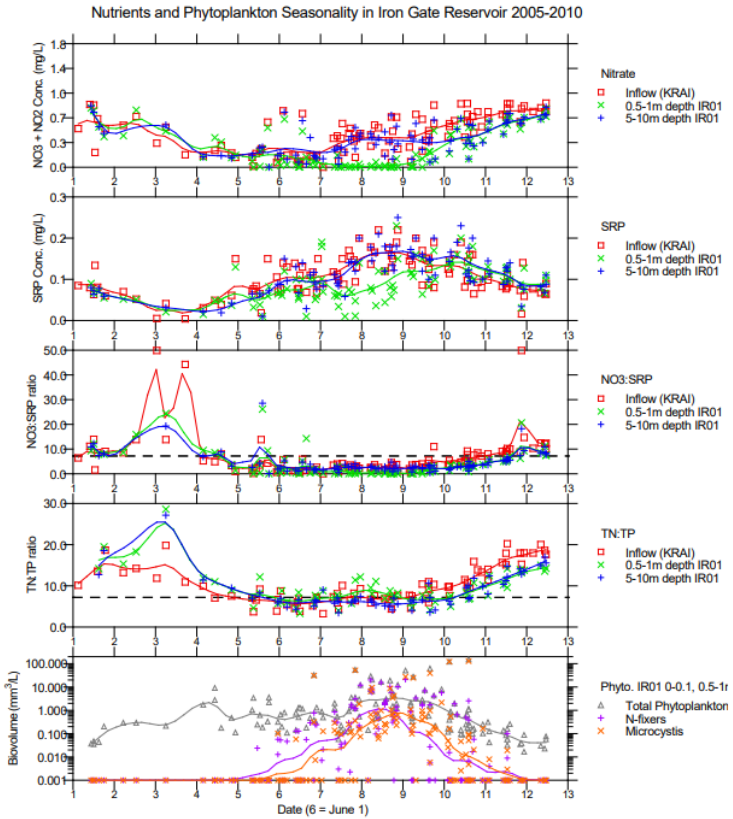
Grab Samples

- Biweekly-monthly
- Nutrients, carbon, sediment, chlorophyll, heavy metals, toxins
- 14 sites covering 240 miles of mainstem and 4 tributaries
- 25 years of records

The Effects of Altered Diet on the Health of the Karuk People report, authored by Kari Marie Norgaard

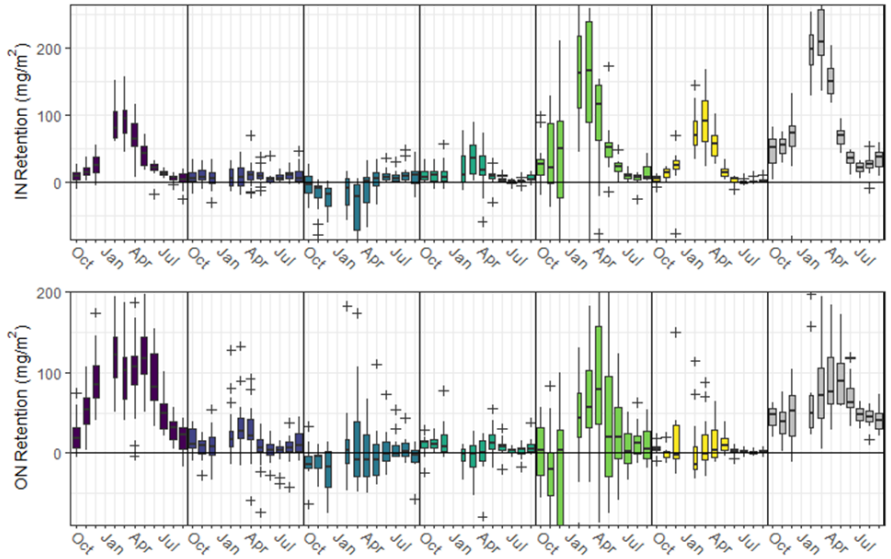
Áama / Bioneers

Nutrients & Nutrient Retention



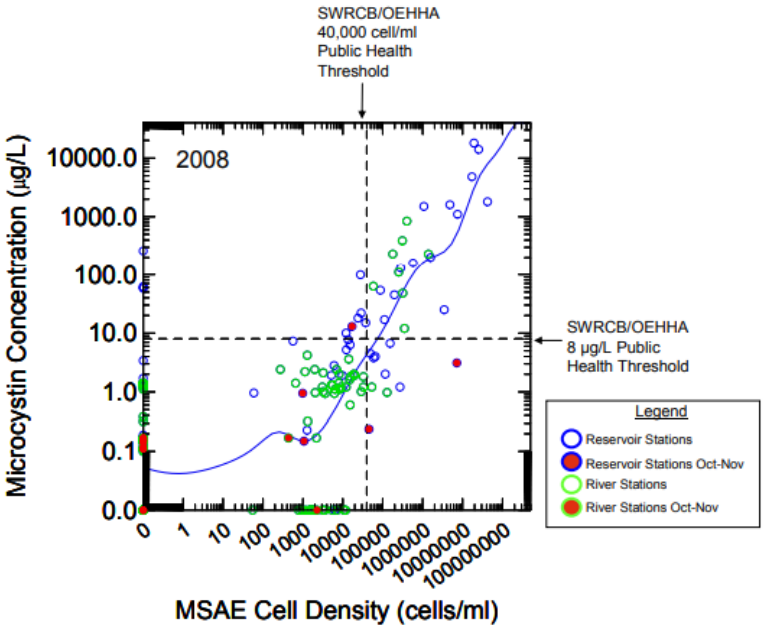
- Reservoirs were generally a nutrient sink, but released phosphorus during peak water quality impairment and salmon migration periods
- Long-term phytoplankton records

Nutrients & Nutrient Retention



- 19 year nutrient budgets establishing baseline conditions
- Driving forward study of seasonality, discharge relationships, and long-term trends

Toxic Algae & Microcystin



- Harmful algal blooms in reservoirs exported dangerous levels of toxins downriver
- Tribal research showed relationship between algal blooms and toxin concentrations
- Tribes developed public health standards and signposting

Microcystin & Public Health Monitoring

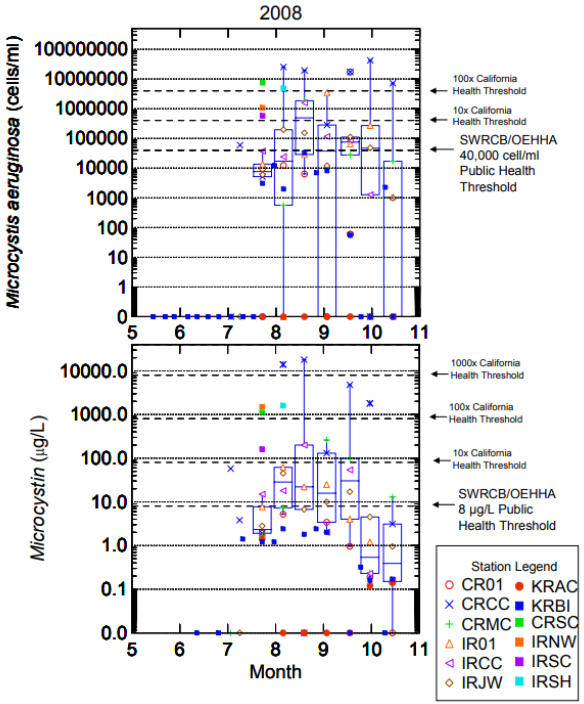
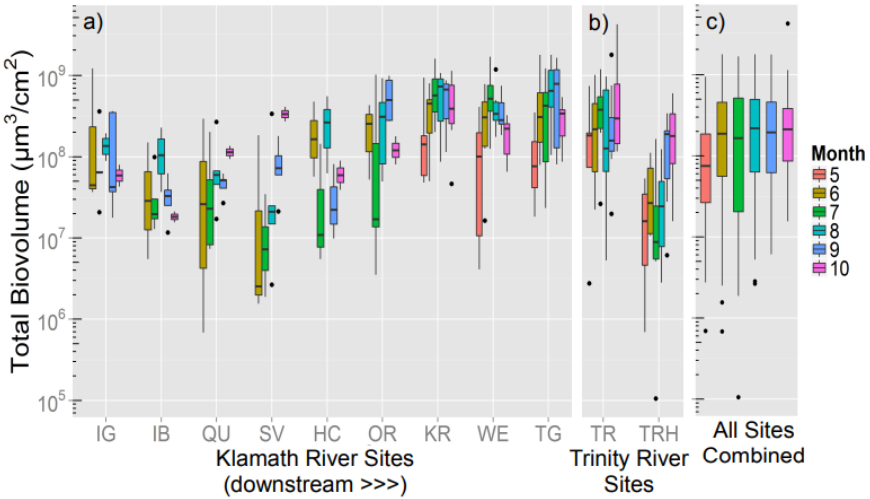


Figure 2. Time-series of MSAE cell density (a) and microcystin toxin concentration (b) for Copco and Iron Gate Reservoir stations, 2008. The box plot (blue box) is for standard reservoir stations CR01, CRMS, CRCC, IR01, IRCC, IRJW only; the river stations KRAC and KRBI, and additional reservoir stations CRSC, IRNW, IRSC, and IRSH are shown independently.

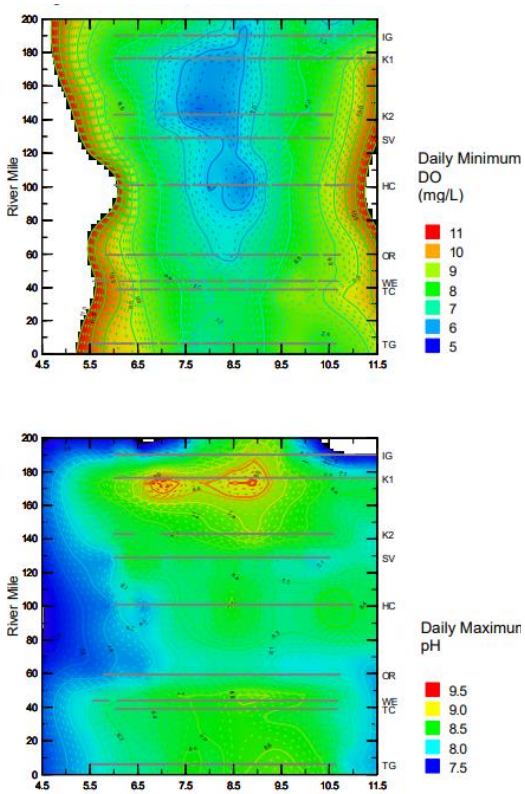
- Regular exceedances far above public health guidelines
- Impairing cultural and ceremonial use
- Bioaccumulating in traditional foods (mussels)

Periphyton Studies



- Establishing baseline conditions before dam removal
- Trends in cyanobacteria, nitrogen fixers, indicators of degraded conditions

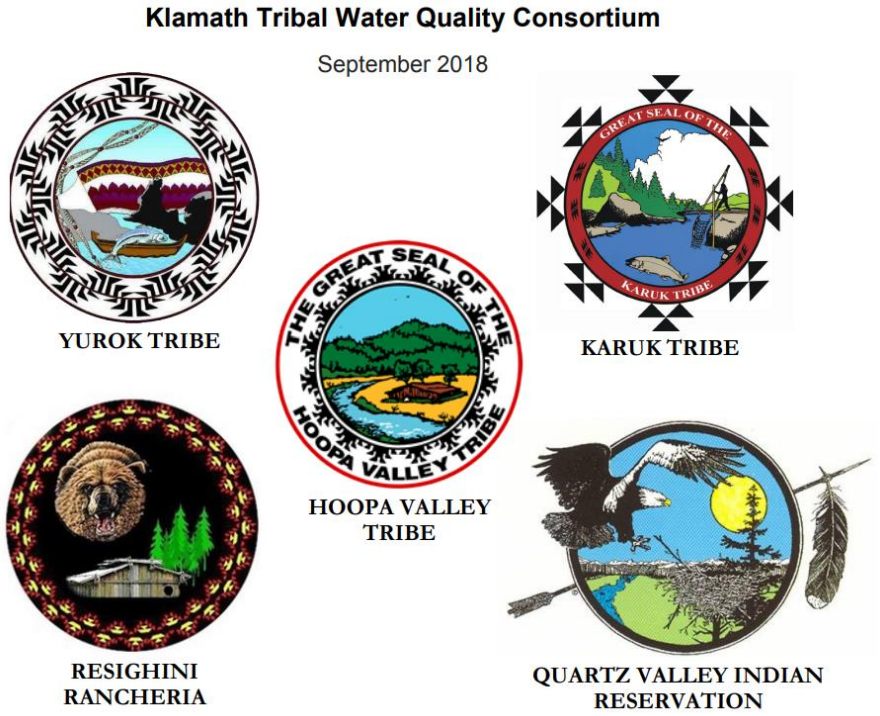
Water Quality Continuous Monitoring



Threshold	Month	Percent of Measurements Exceeding Thresholds												
		Mainstem									Tributaries			
		Primary Stations						Supplemental Stations			Primary Stations				Supp.
		RM 189.73 Iron Gate (IG)	RM 128.58 Seiad Valley (SV)	RM 59.12 Orleans (OR)	RM 43.50 Weit-chpec (WE)	RM 42.50 Tully Creek (TC)	RM 5.79 Tur-war (TG)	RM 176.08 Above Shasta (K1)	RM 142.61 Above Scott (K2)	RM 100.66 Happy Camp (HC)	Shasta (SH)	Scott Mouth (SC)	Salmon (SA)	Trinity (TR)	Scott Gage (SRGA)
D.O. <90%	6	13	19	4	6	0	7	36		5	37		10	0	6
	7	20	28	14	13	15	23	46	55	42	49	16	18	6	24
	8	24	34	14	14	11	18	52	43	55	41	25	30	11	42
	9	39	28	10	15	8	17	38	39	50	21	22	29	11	44
	10	74	14	6	6	5	16	25		0	1	11	13	14	36
	6 to 10	33	25	10	12	8	16	41	45	42	33	17	21	8	31
D.O. <85%	6	5	3	0	3	0	2	17		0	17	2	1	0	1
	7	12	13	1	4	6	12	34	42	12	33	4	6	0	13
	8	14	18	3	7	4	7	41	21	32	20	16	10	1	32
	9	24	10	1	7	1	8	11	12	14	4	11	7	1	29
	10	61	3	0	2	1	5	0		0	0	3	0	2	12
	6 to 10	22	9	1	5	2	7	23	23	19	17	7	5	1	18
D.O. <8 mg/L	6	20	21	5	6	0	3	36		1	50	12	5	0	5
	7	53	50	33	25	26	28	61	79	75	74	36	24	12	32
	8	55	51	26	23	20	21	69	66	74	67	51	35	17	46
	9	50	29	9	13	4	11	38	35	40	26	20	13	3	37
	10	62	1	0	1	1	3	1		0	0	0	0	1	5
	6 to 10	48	31	16	16	11	14	46	56	56	49	25	17	8	27
D.O. <6 mg/L	6	0	0	0	0	0	0	0		0	3	0	0	0	0
	7	1	1	0	0	0	0	0	9	0	9	0	0	0	3
	8	3	0	0	0	0	0	3	3	3	2	0	0	0	2
	9	6	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	11	0	0	0	0	0	0		0	0	0	0	0	0
	6 to 10	4	0	0	0	0	0	1	3	1	3	0	0	0	1
pH >8.5	6	6	16	2	5	2	3	29		0	65	25	0	1	1
	7	10	30	9	18	13	7	41	14	6	53	35	4	5	7
	8	53	40	19	34	23	17	47	38	21	68	39	4	9	18
	9	47	32	12	36	19	24	35	24	8	73	36	3	8	10
	10	6	11	10	23	3	14	6	15	2	38	34	0	11	3
	6 to 10	23	26	11	24	14	13	35	25	11	60	34	3	6	9
pH >9.0	6	0	0	0	0	0	0	2		0	0	0	0	0	0
	7	0	1	0	0	0	0	5	0	0	0	0	0	0	1
	8	3	6	0	0	0	0	8	0	0	1	3	0	0	3
	9	9	1	0	0	0	0	2	0	0	0	4	0	0	0
	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	6 to 10	2	2	0	0	0	0	4	0	0	0	1	0	0	1
Water Temp. >22 C	6	0	7	5	3	1	1	9	6	2	29	5	0	1	1
	7	22	69	59	59	48	41	53	76	82	68	41	24	40	18
	8	21	65	65	60	54	37	53	67	75	48	42	21	46	21
	9	0	4	5	7	1	2	7	5	8	4	6	2	2	1
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6 to 10	9	31	28	29	24	17	27	38	49	31	20	10	21	10

- Monitoring and tracking exceedances of water quality standards for temperature, dissolved oxygen, and pH

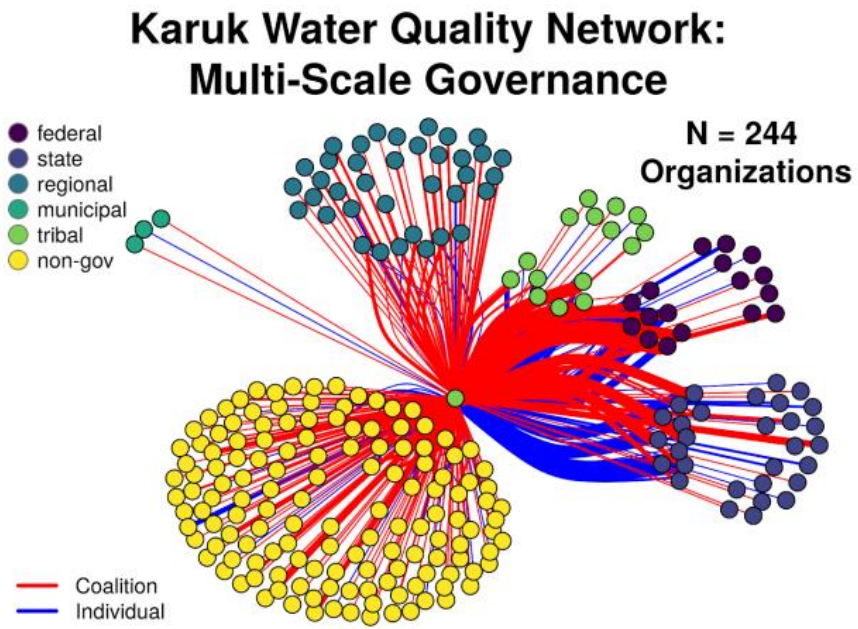
Klamath Tribal Water Quality Consortium



www.klamathwaterquality.com

- Formed in response to the 2002 Fish Kill event to “to prevent future disasters through sound scientific research, data analysis, and thorough planning."
- Coordinates a collaborative effort for mid and lower Klamath River water quality data collection
- Studies:
  - Nutrient loading and retention
  - Continuous water quality data analyses
  - Periphyton
  - HABs
  - Macrophytes
  - Ecosystem metabolism

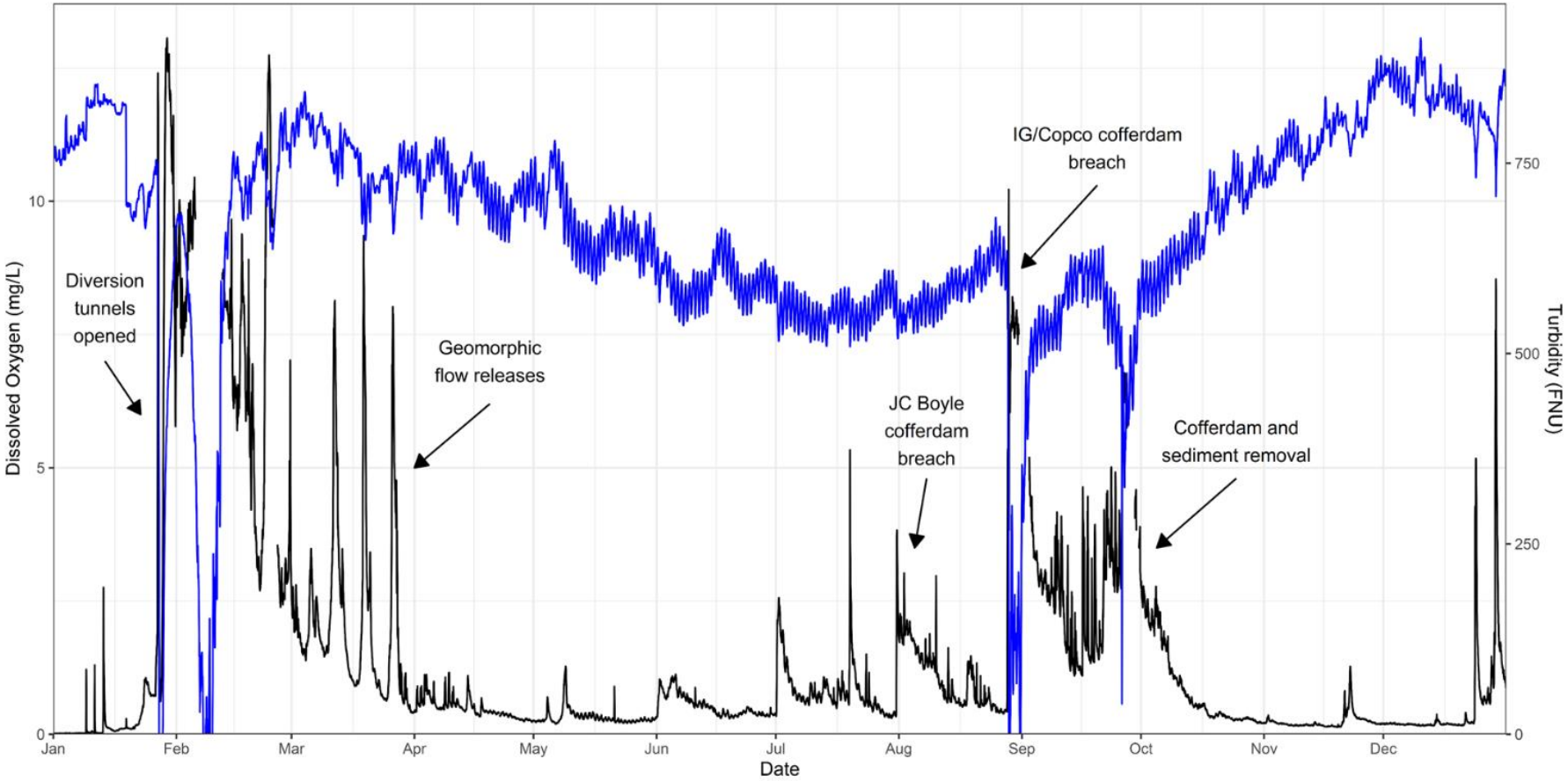
Networked Water Governance



- "Polycentric" water governance in a basin with many overlapping tribal, municipal, state, and regional jurisdictions
- Building relationships and coalitions throughout the basin to drive forward water quality goals

Dam Removal 2023-2024

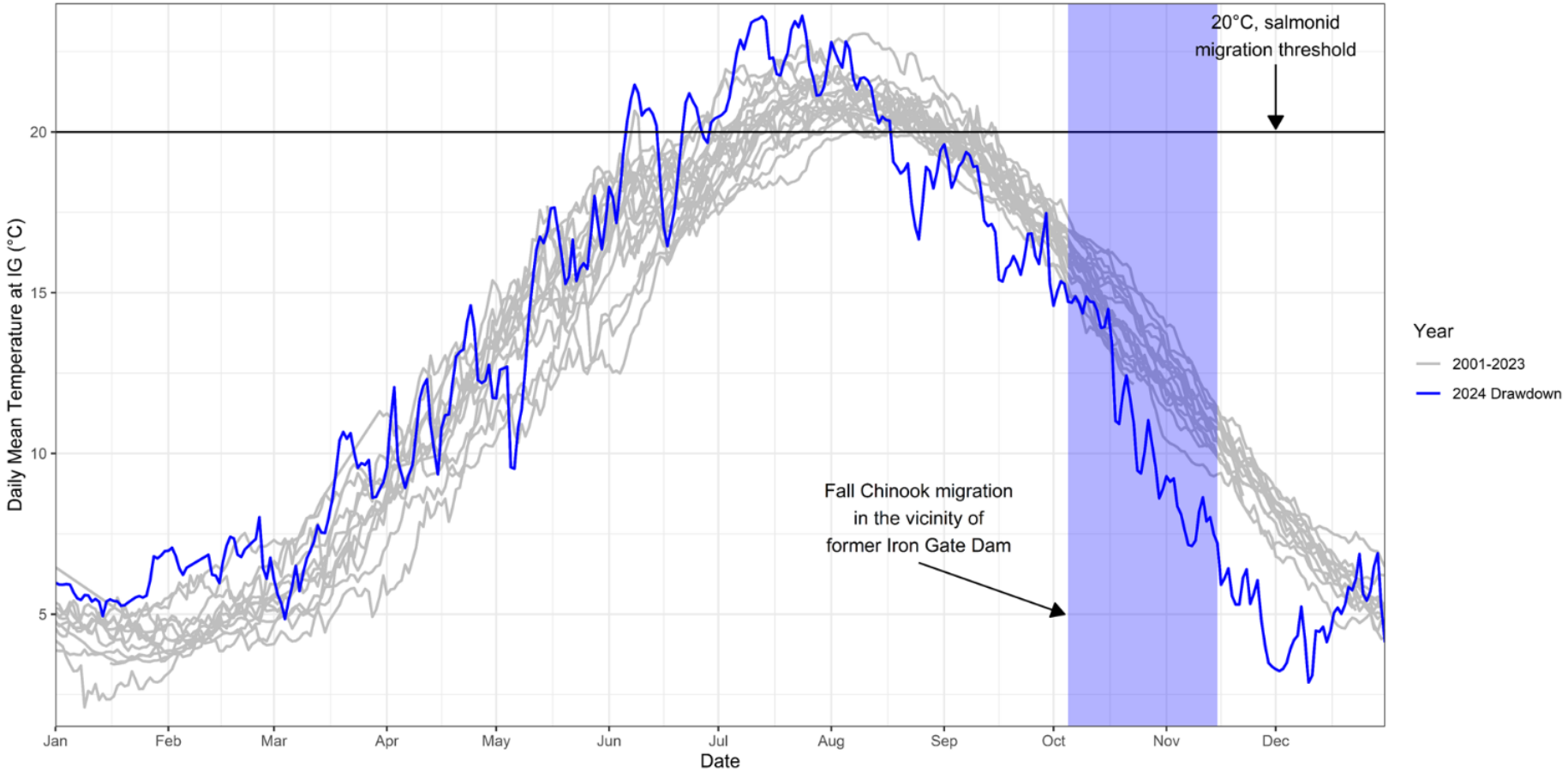
Dam Removal Monitoring: real time at waterquality.karuk.us



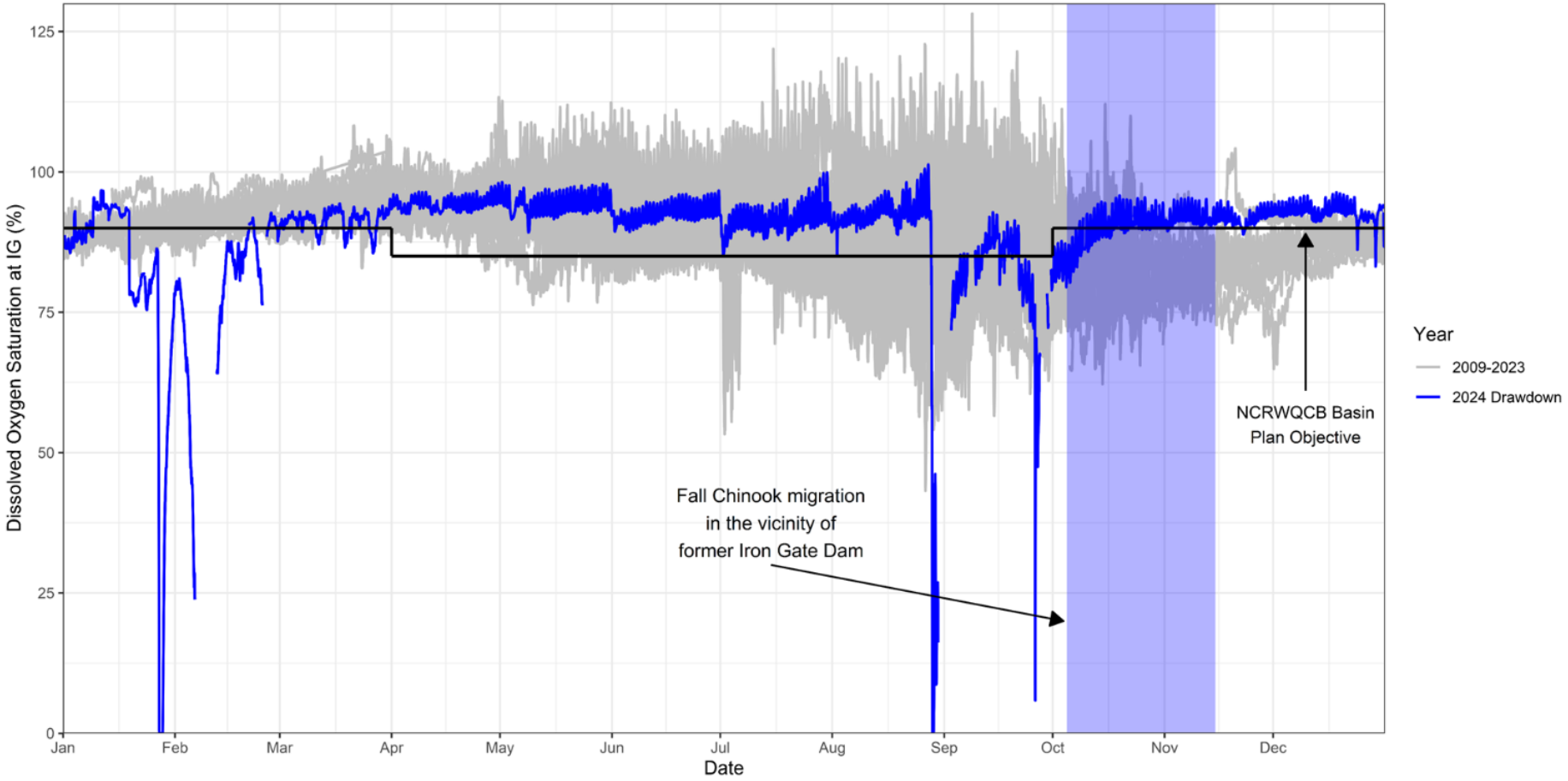
Modeled Expectations vs. Measured Results

Parameter	Modeled	Actual
Maximum SSC (mg/L)	15,000-30,000	**7,290**
Days above 1,000 mg/L SSC	56	**52**
Days above 5,000 mg/L SSC	14	**4.3**
Days below 7 mg/L DO	53	**6.2**
Days below 5 mg/L DO	12	**3.6**

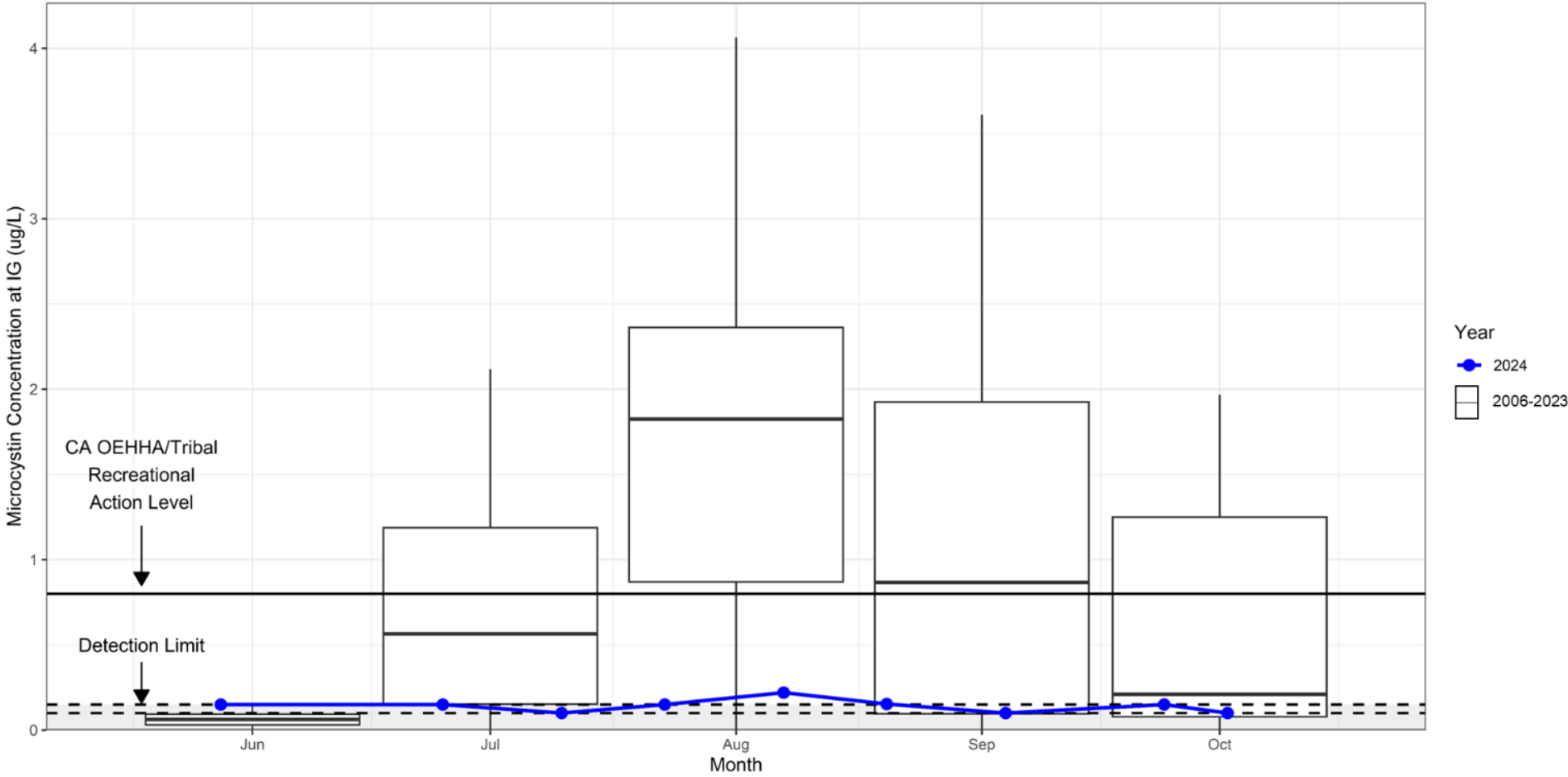
Temperature Improvement



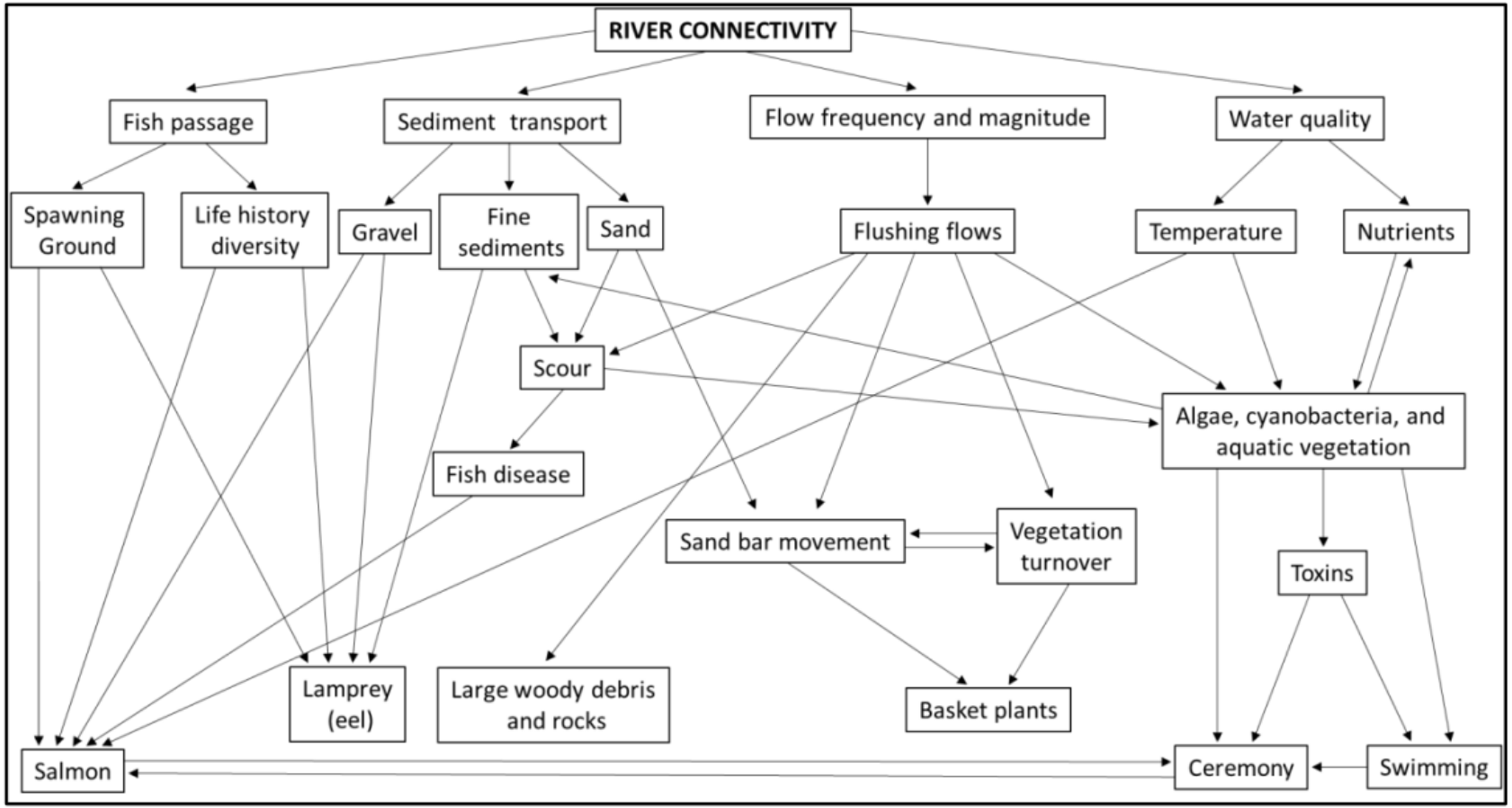
Dissolved Oxygen Improvements



Microcystin Improvements



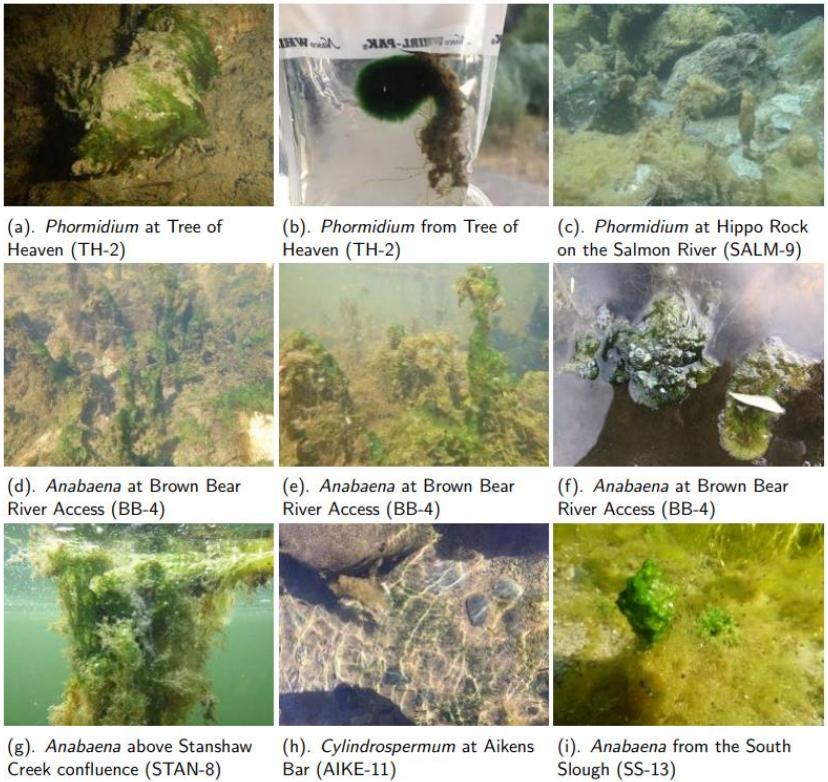
Social Impact Assessment: Interlinked River and Tribal Health



Tributary Monitoring

- Crucial gap not covered by dam removal that EPA fills
- Spawning and rearing habitat, cold clean water
- Water security for Tribal Communities
- Wild and scenic rivers

Benthic Cyanobacteria



(a). *Phormidium* at Tree of Heaven (TH-2)

(b). *Phormidium* from Tree of Heaven (TH-2)

(c). *Phormidium* at Hippo Rock on the Salmon River (SALM-9)

(d). *Anabaena* at Brown Bear River Access (BB-4)

(e). *Anabaena* at Brown Bear River Access (BB-4)

(f). *Anabaena* at Brown Bear River Access (BB-4)

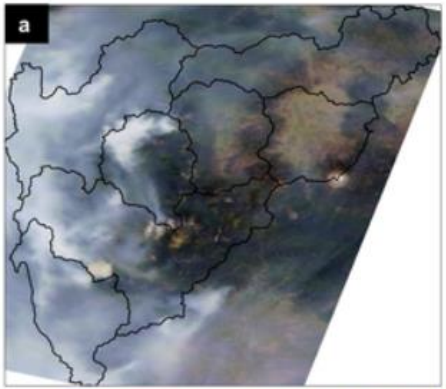
(g). *Anabaena* above Stanshaw Creek confluence (STAN-8)

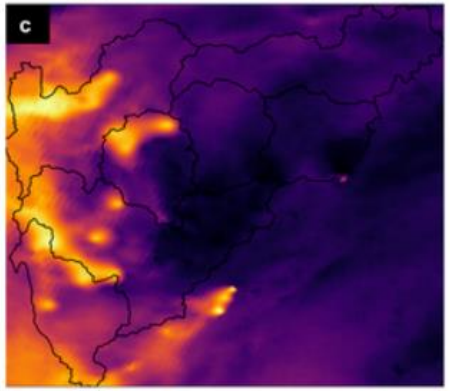
(h). *Cylindrospermum* at Aikens Bar (AIKE-11)

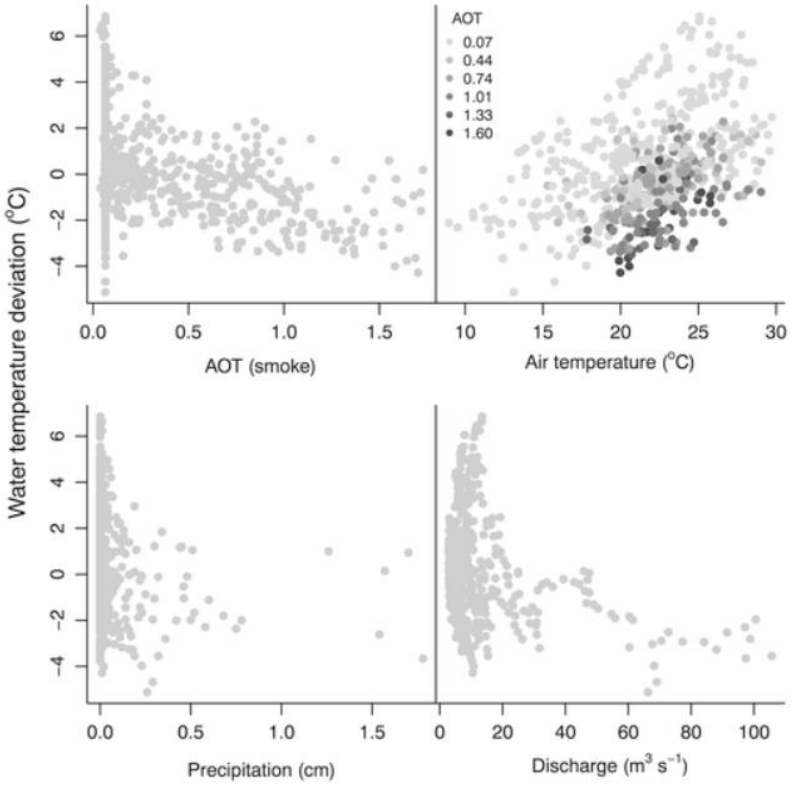
(i). *Anabaena* from the South Slough (SS-13)

- Developing methods for detecting and monitoring anatoxins
- Emerging understanding of public health threat
- Study in tributaries as well as mainstem

Smoke & Traditional Upslope Management

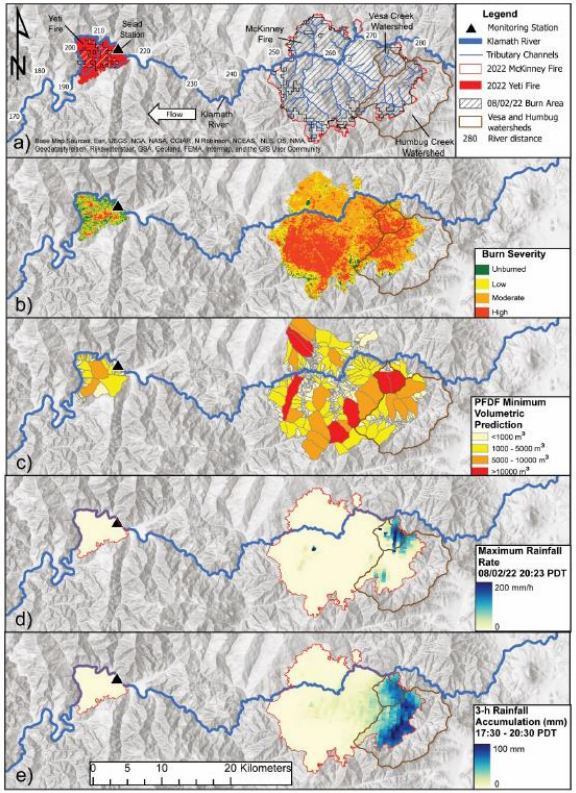






- Smoke cools water temperature for migrating salmonids during hottest days
- Traditional landscape scale management using fire

Catastrophic Wildfire and Water Quality



- McKinney Fire in 2022 destroyed the town of Klamath River and killed two people
- Sediments, structural contaminants, dissolved oxygen sags, and fish kills can result from rain-on-fire events
- Continuous monitoring allowed us to capture unique data about this emerging threat


WARREN BUFFET'S
DAMS KILL
SALMON, JOBS, COMMUNITIES

Yôotva ~ Wok-hlew’

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