The Eel River: A River of Opportunity with Implications Beyond its Basin

A Concurrent Session at the 39th Annual Salmonid Restoration Conference held in Fortuna, California from April 24–28, 2023

Session Coordinators:

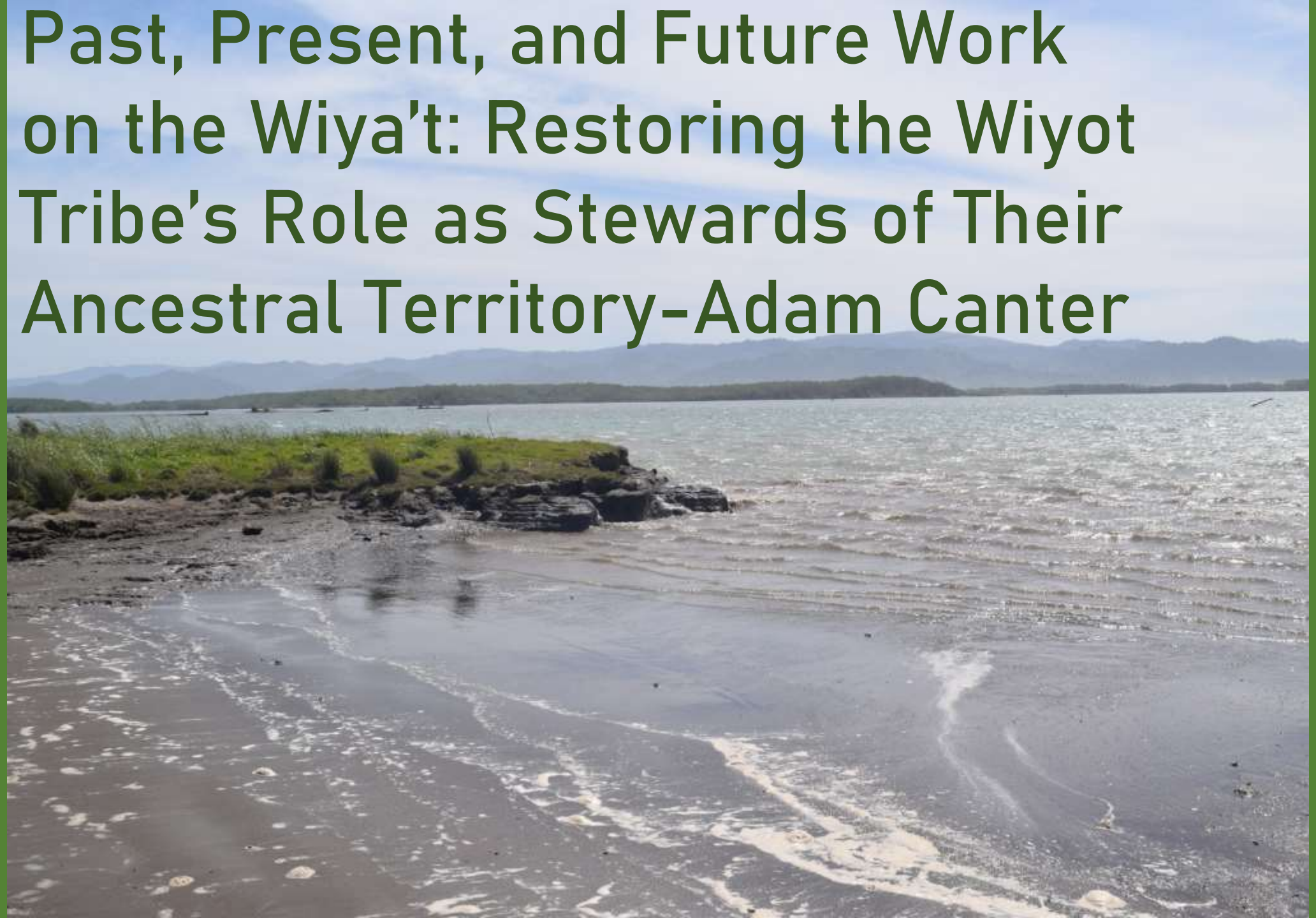
- Alicia Hamann, Friends of the Eel River

The Eel River is the third largest watershed in California and is home to several runs of native, wild salmonids and species of interest. The watershed holds unique opportunities in a variety of realms: for salmonid recovery, establishing legal precedent for enforcement of the Endangered Species Act, connecting communities and building a recreation economy, adapting a proactive approach to sea level rise, and so much more. This session will explore those opportunities, how a variety of organizations are working together to achieve them, and their implications within and beyond the Eel River basin.

Presentations

- Slide 4, **Past, Present, and Future Work on the Wiya't: Restoring the Wiyot Tribes' Role as Stewards of Their Ancestral Territory**, Adam Kanter, *Wiyot Tribe Natural Resource Department*
- Slide 40, **Monitoring Populations of Adult Salmonids in the Eel River Basin—Historical Context and Advancing Modern Abundance Estimates to Inform Recovery Targets and Recovery Efforts within the Basin**, David Kajtaniak, *CDFW*
- Slide 68, **Totally RAD Impassable Barriers: How Geologic Features Separate Summer and Winter-run Steelhead in the Eel River and Beyond**, Samantha Kannry, TRIB Research
- Slide 88, **Physical and Biological Constraints on the Capacity for Life-history Expression of Anadromous Salmonids: an Eel River, California, Case Study**, Alyssa M. FitzGerald, *UC Santa Cruz and Southwest Fisheries Science Center*
- Slide 118, **Advocacy on the Eel: How an Endangered Species Act Take Claims and Federal Energy Regulatory Commission Litigation Can Remove Barriers to Salmonid Recovery Nationwide**, Redgie Collins, Esq., *California Trout*

Past, Present, and Future Work on the Wiya't: Restoring the Wiyot Tribe's Role as Stewards of Their Ancestral Territory-Adam Canter

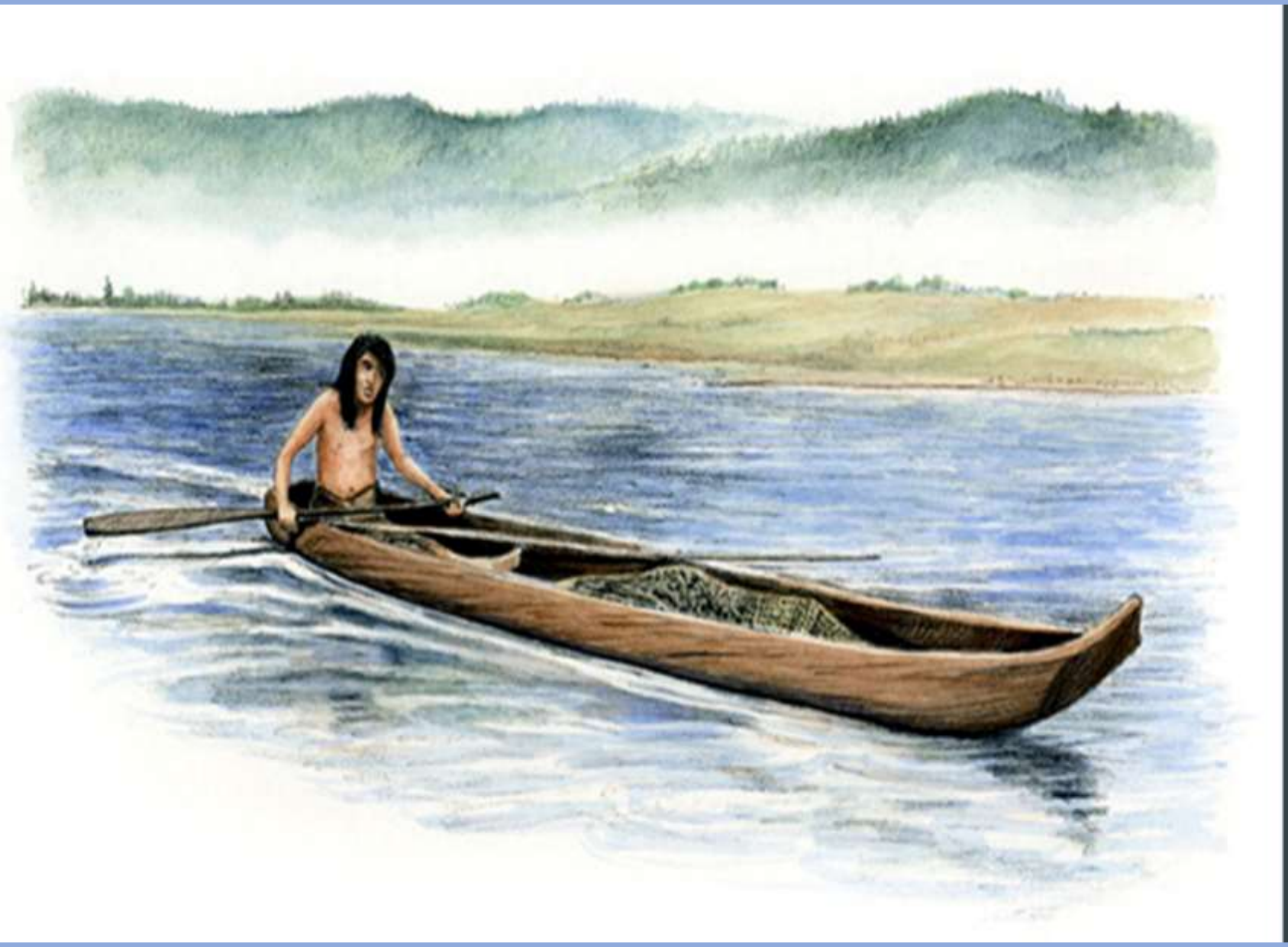



Extent of Map
CALIFORNIA
WIYOT
ANCESTRAL
TERRITORY
Arcata
Indian Island
PACIFIC
OCEAN
HUMBOLDT BAY
Eureka
Table Bluff Reservation
Old Wiyot Reservation
Cock Robin Island
EEL RIVER
0 1.5 3 6 9 12
Miles
Wiyot Tribe
Environmental Department


STOUFFER
Graphic Arts
T2115


STOUFFER


Have fun & respect
the Redwood Curtain



Wiyot man in a canoe.


Fortuna
Van Duzen
HUMBOLDT COUNTY
TRINITY COUNTY
Eel River
North Fork
South Fork
Middle Fork
Pacific Ocean
GLENN
MENDOCINO COUNTY
Fort Bragg
LAKE

Could California's Next Dam Removal Take Place on This Endangered River?

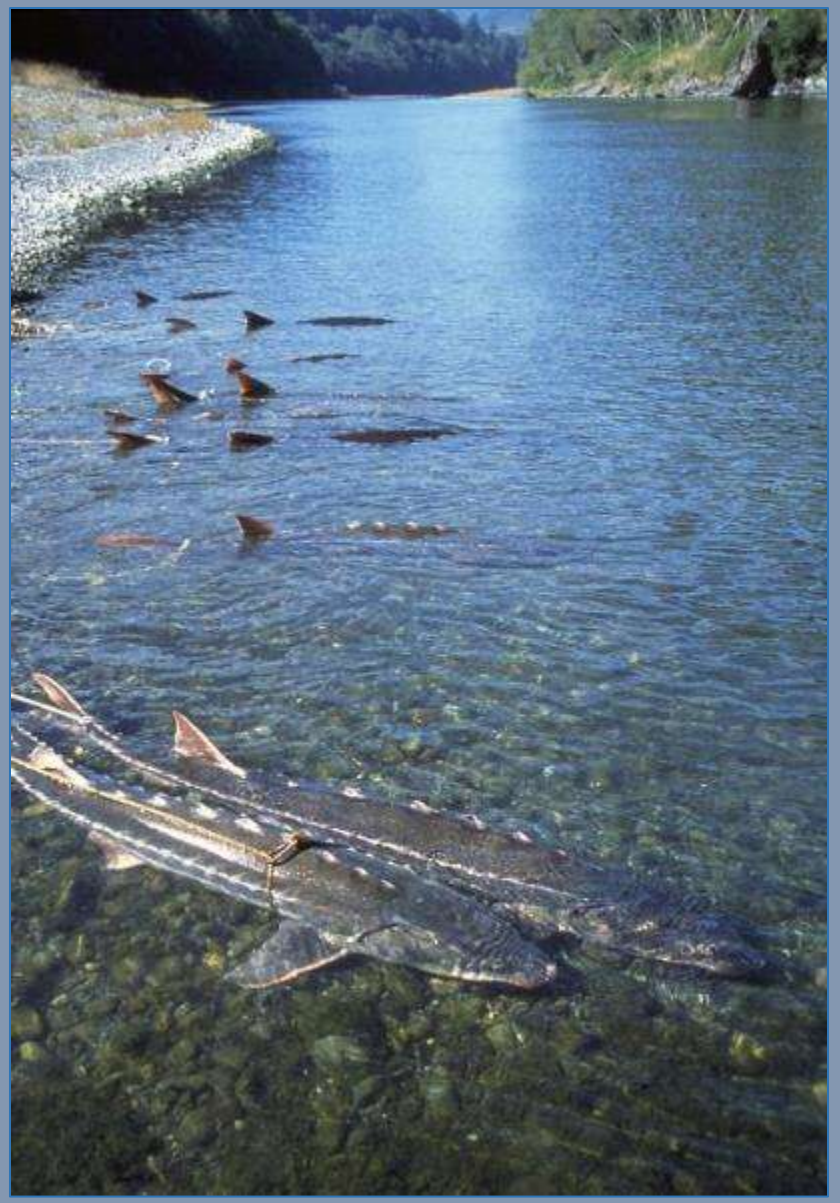

AMERICAN RIVERS
Life Depends on Rivers.℠
America's Most Endangered Rivers® of 2023
10 RIVERS. 10 THREATS. 10 SOLUTIONS.

American Rivers reviews nominations for the America's Most Endangered Rivers® report from river groups and concerned citizens across the country. Rivers are

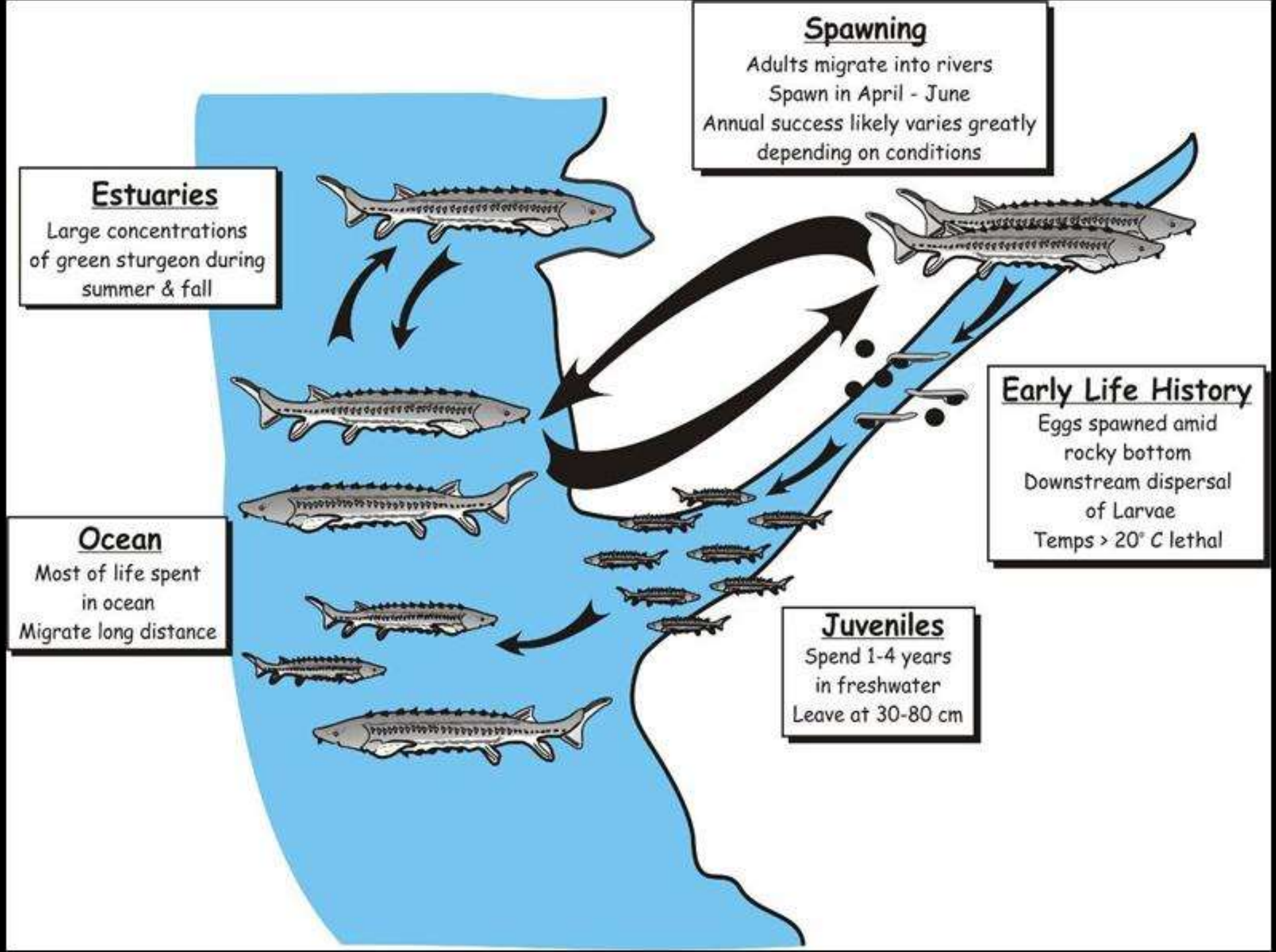
Modern Threats to Green Sturgeon

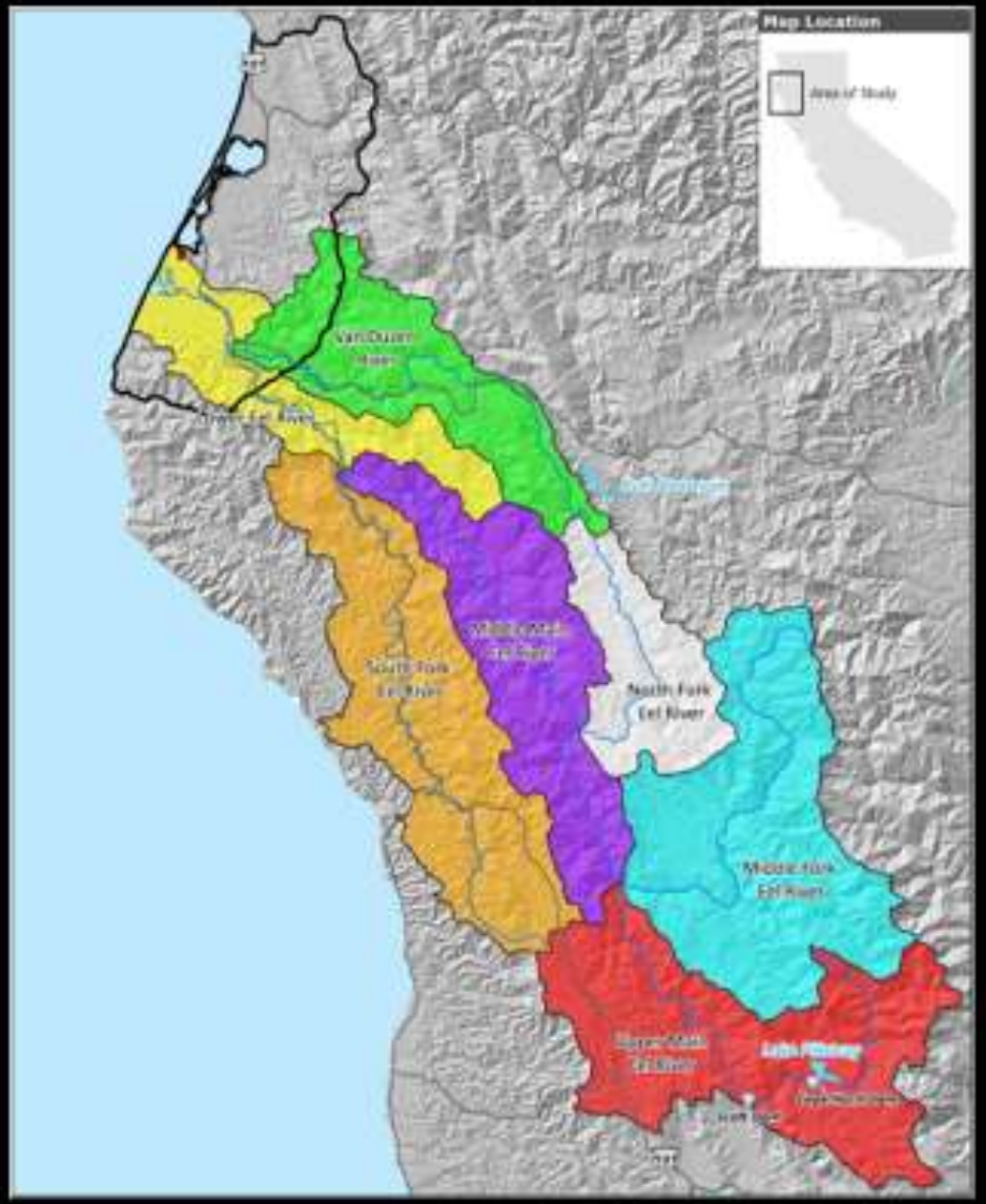
- insufficient freshwater flow rates in spawning
- contaminants (e.g., pesticides)
- bycatch of green sturgeon in fisheries
- potential poaching (e.g., for caviar)
- entrainment by water projects
- influence of exotic species
- small population size
- impassable barriers
- elevated water temperatures

- Eel River green sturgeon prominent data gap
- Large California river with historic run
- Official designations consider the spawning run lost
- Sightings occur annually




2015/05/19 20:21


Spawning
Adults migrate into rivers
Spawn in April - June
Annual success likely varies greatly depending on conditions
Estuaries
Large concentrations of green sturgeon during summer & fall
Early Life History
Eggs spawned amid rocky bottom
Downstream dispersal of Larvae
Temps > 20° C lethal
Ocean
Most of life spent in ocean
Migrate long distance
Juveniles
Spend 1-4 years in freshwater
Leave at 30-80 cm

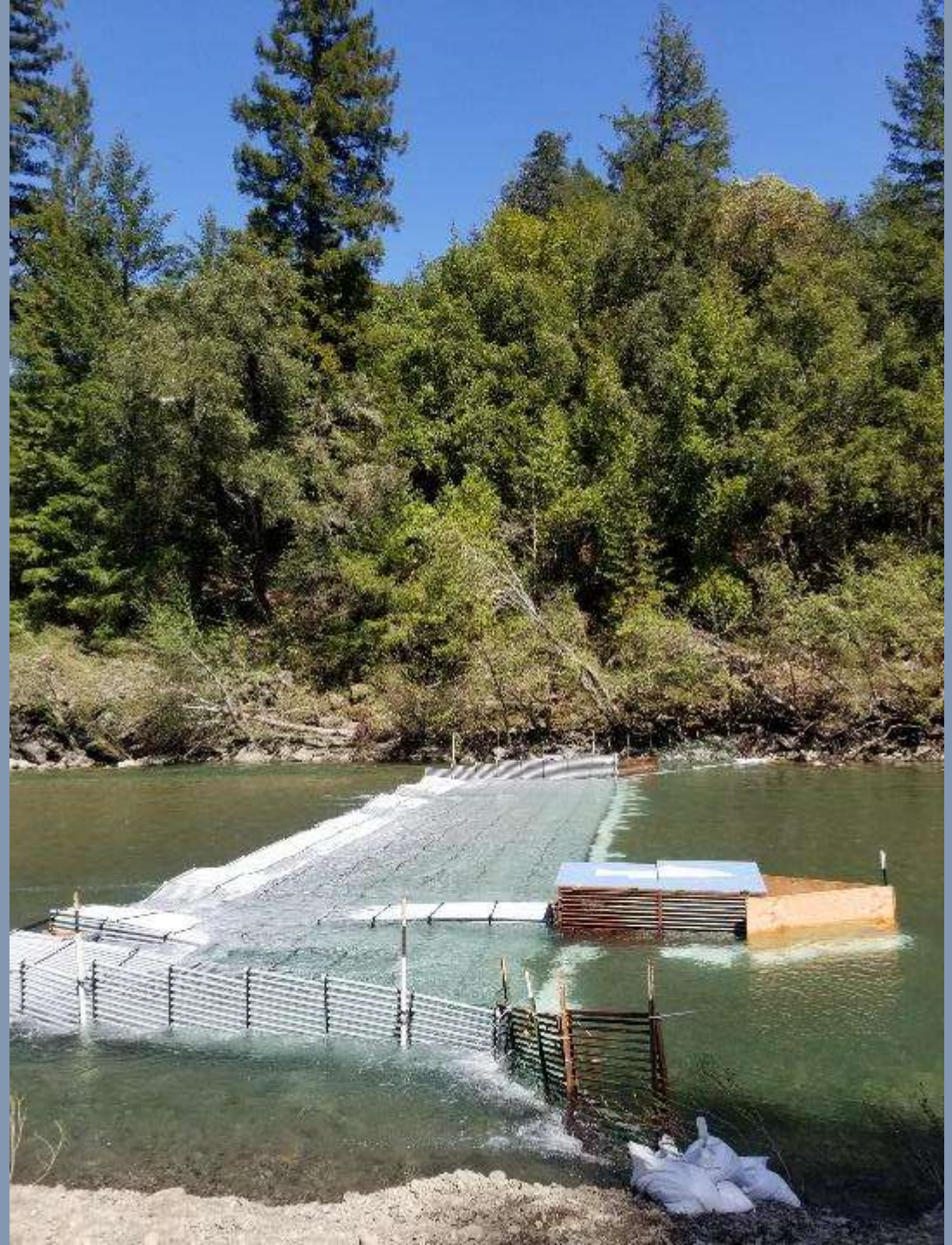


- Project area from confluence of Middle Fork and Mainstem (Dos Rios) to Pacific Ocean and nearshore marine portion of estuary
- Presence and enumeration survey using mobile DIDSON
- Assess habitat availability and limitations by cataloging pool depths and gathering water temp and flow data

Table 3-3. Mobile sonar survey results from the summer of 2015. Unit # corresponds to those in Appendix B. The number of sturgeon is an estimate with a range based on the level of certainty of observations.

Unit #	Location	Sturgeon	Max depth (m)	rkm
157	12th Street	2	4.9	19
155	Price Creek	0	4.6	23
153/154	Rio Dell	1–3	7.3	32
148	Stafford	0	5.5	42
147	Jordan Creek	2	7.9	45
139/140	Holmes	2	9.1	55
135	High Rock	0–3	10.4	62
131/132	SF Confluence	0	4.0	65
Total		**7–12**		


2




Thank You! Adam Canter, Wiyot NRD, adam@wiyot.us

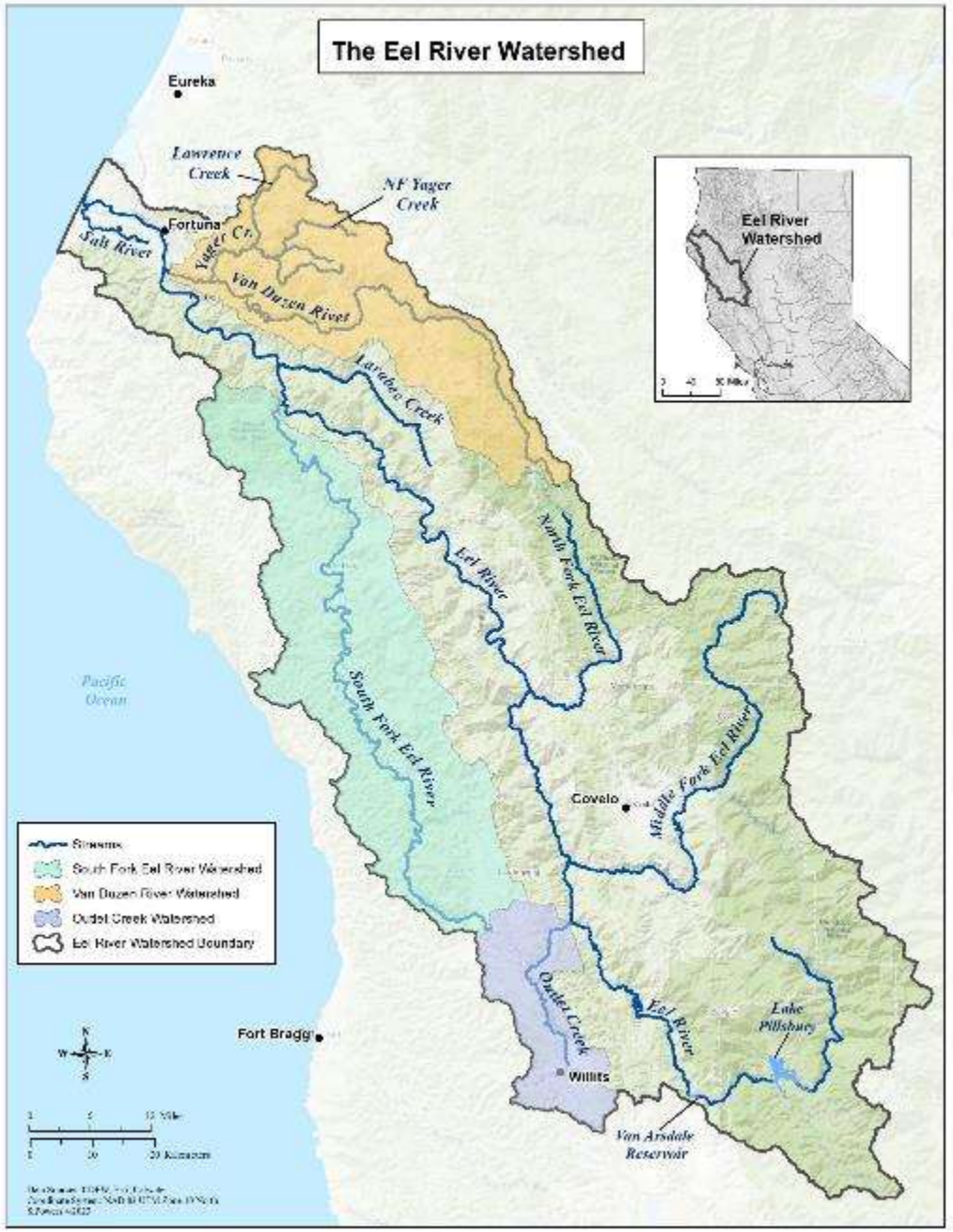
Monitoring Populations of Adult Salmonids in the Eel River Basin

Advancing modern abundance estimates to inform recovery targets and recovery efforts within the basin.

David Kajtaniak, Environmental Scientist, CDFW

Introduction

- Eel River, Wiyat, is the 3rd largest river entirely in California
- Mainstem is 197 miles in length with 832 perennial tributaries
- Historically it had the 3rd largest salmon run and likely the 2nd largest steelhead run in California
- Largest population of the Evolutionary Significant Unit (ESU) of California Coastal Chinook Salmon and a core population of Southern Oregon and Northern California Coho Salmon ESU.
- Significant population of Northern California (NC) Steelhead (Distinct Population Segment); and summer-run steelhead.
- Southern extent of the Coastal Cutthroat Trout.



Historic Abundance Estimates

Yoshiyama and Moyle (2010)

- “Historic runs of Chinook Salmon probably ranged between 100,000 and 800,000 fish per year, declining to roughly 50,000-100,000 fish per year in the first half of the 20th century”
- “Winter and summer steelhead run (combined) likely numbered between 100,00-150,000 adults per year during late 1800s and early 1900s.”
- “Coho Salmon were less than those of steelhead’ nonetheless, historic numbers probably ranged in the 50,000-100,000 fish per year.”

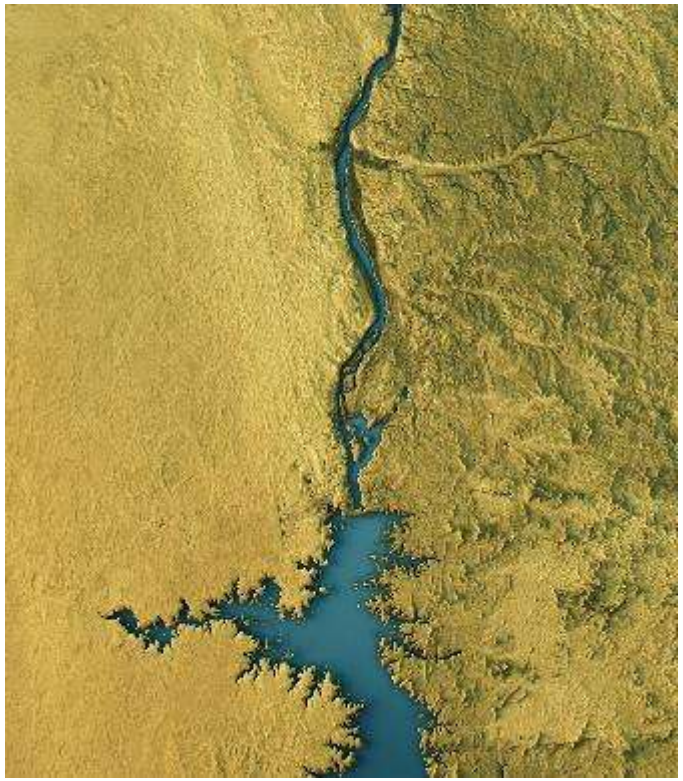
Historical Abundance Estimates Continued

- C+ = estimates used that had data to assist them, i.e. Benbow Dam counts on SF Eel

- C = Estimate made by people familiar with the stream and who made comparisons with better-studied streams

Spawning Escapement Estimates from CDFW Fish and Wildlife Plan 1965			
	Chinook Salmon	Coho	Steelhead
Total Eel River System	55,500	14,000	82,000
Van Duzen River	2,500 (C+)	500 (C+)	10,000 (C+)
South Fork Eel River	27,000 (C+)	13,000 (C+)	34,000 (C+)
North Fork Eel River	0	0	5,000 (C)
Middle Fork Eel River	13,000 (C)	0	23,000 (C)
Mainstem Eel River	13,000 (C)	500 (C)	10,000 (C)

Adult Salmonid Monitoring Efforts in the Eel River Watershed



Mainstem Eel River

- Van Arsdale Fish Station, at Cape Horn Dam, 1933 to present;
- Spawner surveys in Upper Eel mainstem and tributaries, below Cape Horn Dam, primarily from mid-1980s to present
- Citizen Science - Snorkel Dives in Lower Eel River holding pools, 2012 to 2018

While collecting valuable information, they all have significant limitations when determining accurate species abundance estimates.

Chinook salmon returns to VAFS 2005-2021

2005/06	**620**	2011/12	**2,436**	**DIDSON Operating Years**	
2006/07	**697**	2012/13	**3,466**	2018/19	**95**
2007/08	**478**	2013/14	**215**	2019/20	**156**
2008/09	**496**	2014/15	**583**	2020/21	**64**
2009/10	**518**	2015/16	**102**	2021/22	**457***
2010/11	**2,314**	2016/17	**436**	2022/23	**277***

PG&E. 2005-2021 Potter Valley Project, Annual Performance Report.
*Data not finalized by PG&E

Adult Salmonid Monitoring Efforts cont.

Van Duzen River

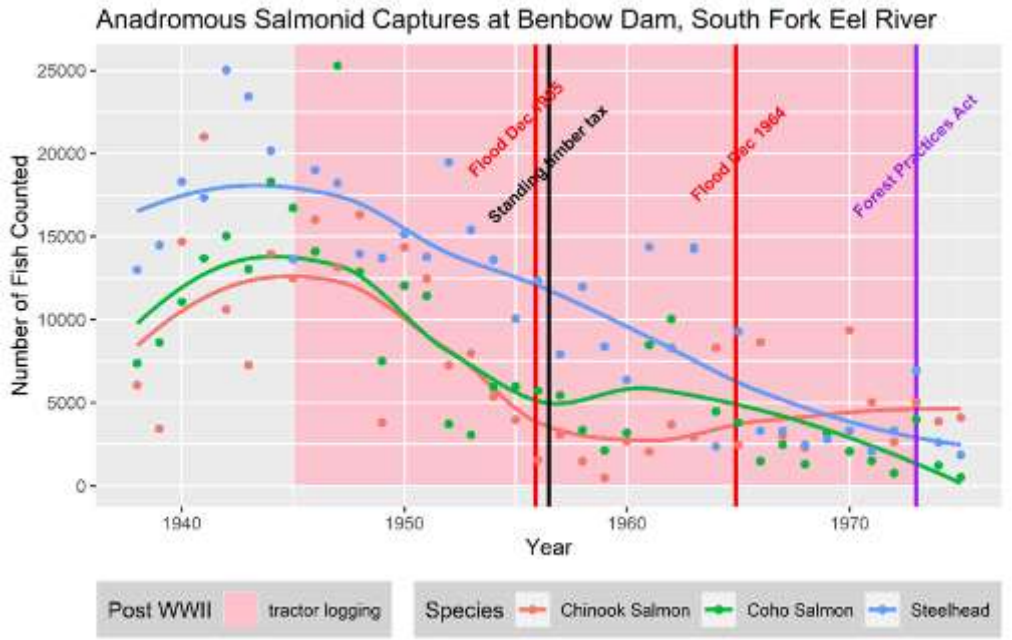
- CDFW Spawning Ground Index Surveys – late 1980s to 2015; 2017-18 Van Duzen and Lower Eel River Regional Spawning Grounds Survey Monitoring Project
- Citizen Science spawning ground survey efforts

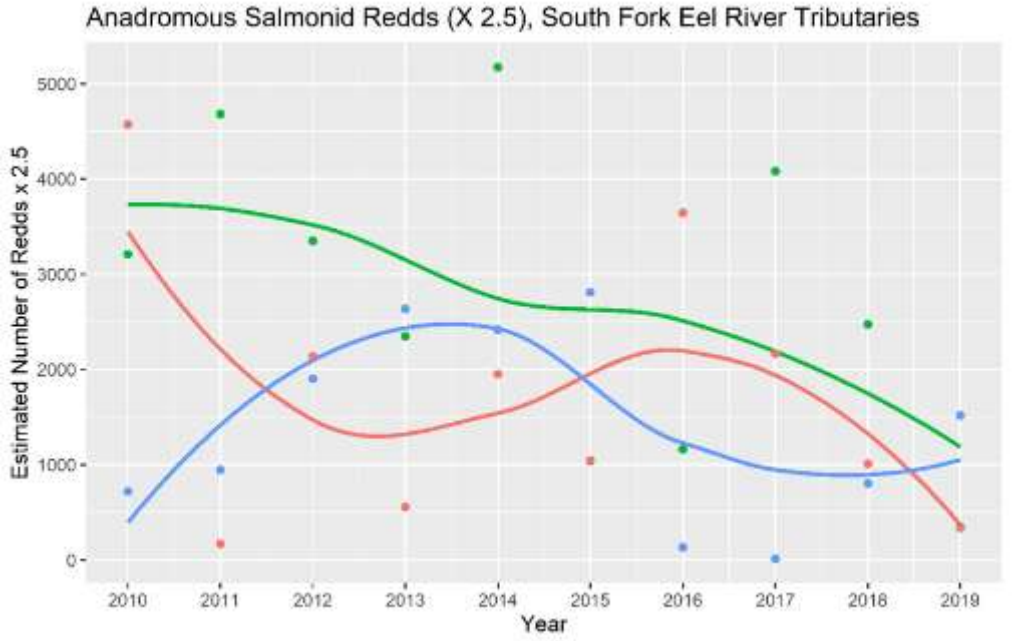
Middle Fork Eel

- Primarily limited to Summer Steelhead surveys. Little data for adult Chinook Salmon and winter-run steelhead

South Fork Eel

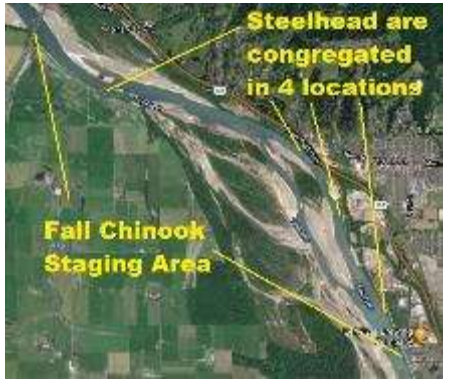
- Benbow Dam Counts -1938-1974
- CDFW Annual Spawning Ground Surveys 2010-Present (coho-focused)





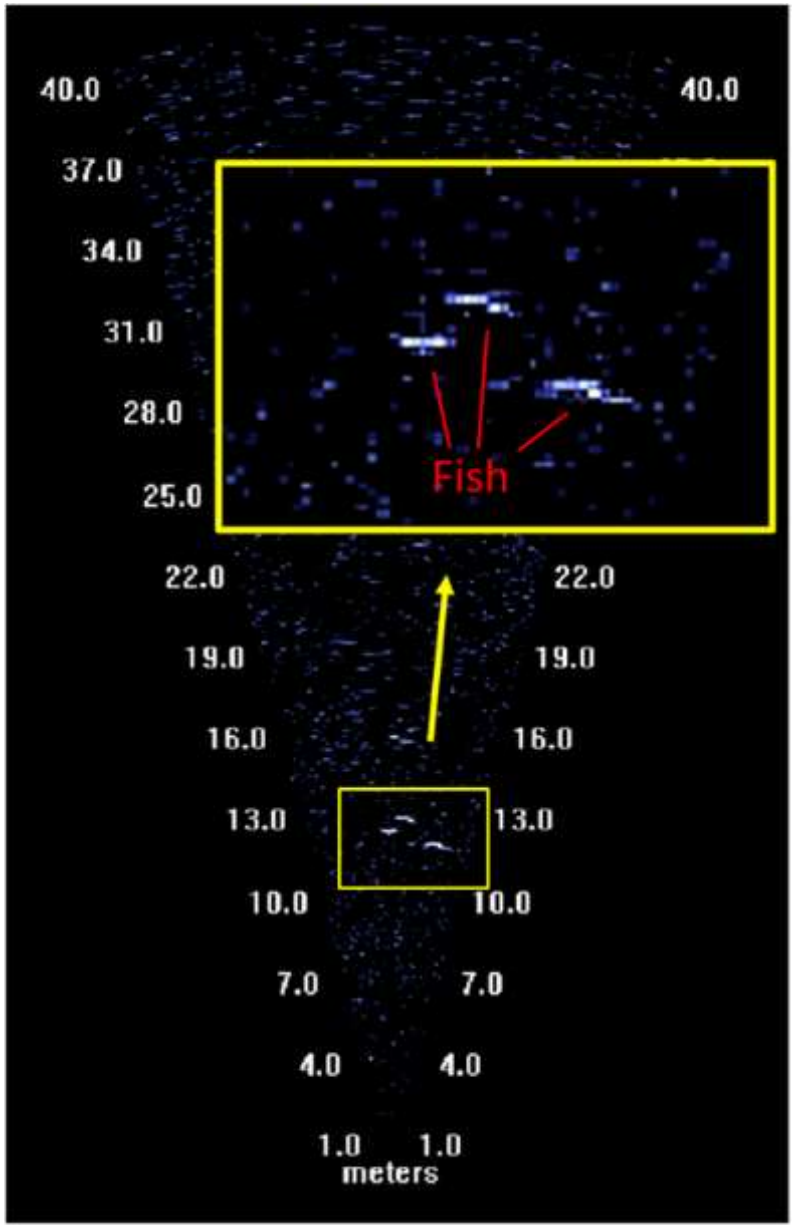
What’s New

Advancement with Lower Eel River Counts



Sonar Monitoring in the Eel River

DIDSON – **D**ual-frequency
IDentification **SON**ar camera



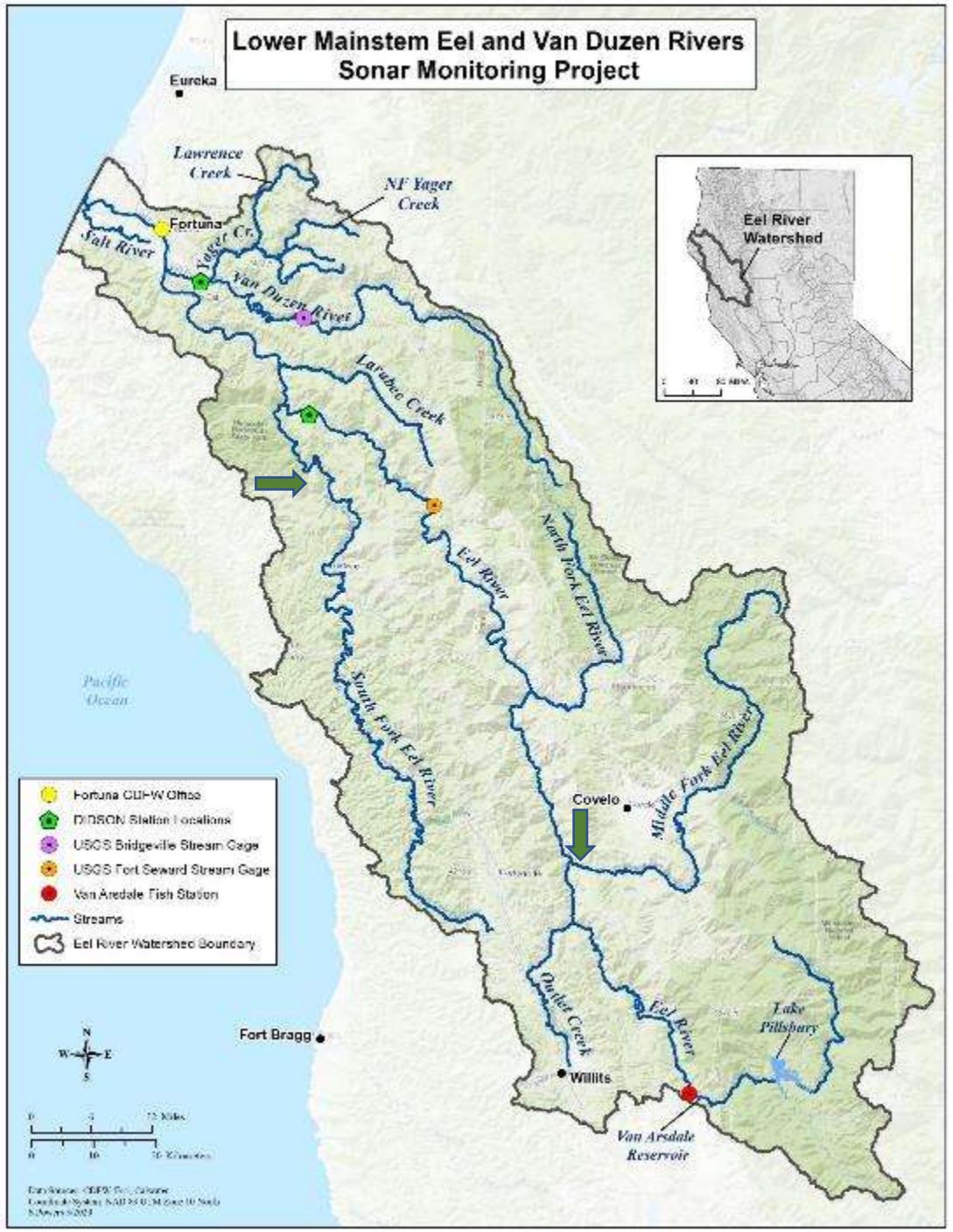
DIDSON Station Locations in the Eel River Watershed

CDFW operated 2 DIDSON Camera Locations in 2022-2023:

- Lower Van Duzen River *Pilot Year*
- Lower Mainstem Eel River Fall of 2018 to present

Additional DIDSON Camera Locations:

- Middle Fork Eel River (Round Valley Indian Tribes and McBain and Associates)
- South Fork Eel River (California Trout and UC Berkeley)



Sonar Field Setup and Operations

- Sites are located on large river bars without access to a power source. A temporarily placed structure (cargo trailer) houses the associated sonar equipment.
- Field equipment setup consists of a DIDSON camera inside a locked box, camera stand, an off grid power source, a laptop, and an external hard drive.
- Camera operate 24 hours/7 days a week, beginning with the initial onset of the migration season and is removed during high flow events.
- Camera is adjusted daily as the flows fluctuate.

Mainstem Eel River DIDSON Station

- Located 4 miles upstream the confluence with the South Fork Eel River on Humboldt Redwood Company property
- Began as a pilot project in fall of 2018 to collect information on the adult Chinook Salmon migration
- 5 years of operations 2018-2023, producing abundance estimates, run timing and additional species data
- Operates prior to the onset of fall rains (late Oct/November) till early spring (early April)

Van Duzen River DIDSON Station

- Located approximately 4 ½ miles upstream the confluence of the Eel River
- Fall 2022 Pilot-Year Project
- Operated October 31 to December 26, 2022
- Funding limited to Chinook Salmon Run

Drone Video at Van Duzen Site; Drone Video credit, David Sopjes

Species Apportionment

Generally, cannot identify fish to species during data file review

Mainstem Eel River has distinct, temporal migration patterns for each species.
Coho run in the range of 50-100 fish on Mainstem Eel

VAFS – Direct species ID

Direct Observations in Mainstem Eel

CDFW SF Eel Spawning Ground Surveys and Citizen Scientist survey observations

Opportunistic boat seining operations and mask and snorkel dives.

Additional Species Data Collected

Green Sturgeon (*Acipenser medirostris*)

- Historically spawned in the upper Eel River and should be still considered a spawning river used by Green Sturgeon (Stillwater Sciences and Wiyot 2017).
- Observations have occurred on DIDSON files in March of 2020 (1 adult) and February and March of 2022 (minimum of 2 and possibly up to 4 adults).
- Additional observations have occurred in the late summers of 2021 and 2022 in the lower river (Stockwell and Sopjes and CDFW).

Summer-run Steelhead

- Attempted in spring of 2021

Additional Species Data Collected cont.

Sacramento Pikeminnow (Ptychocheilus grandis)

- DIDSON data file review is allowing to capture important seasonal distribution information and general abundance numbers of size-class distribution.
- This data could be utilized for future suppression efforts.

South Fork Eel River Weir for Pikeminnow Suppression, April 25, 2023

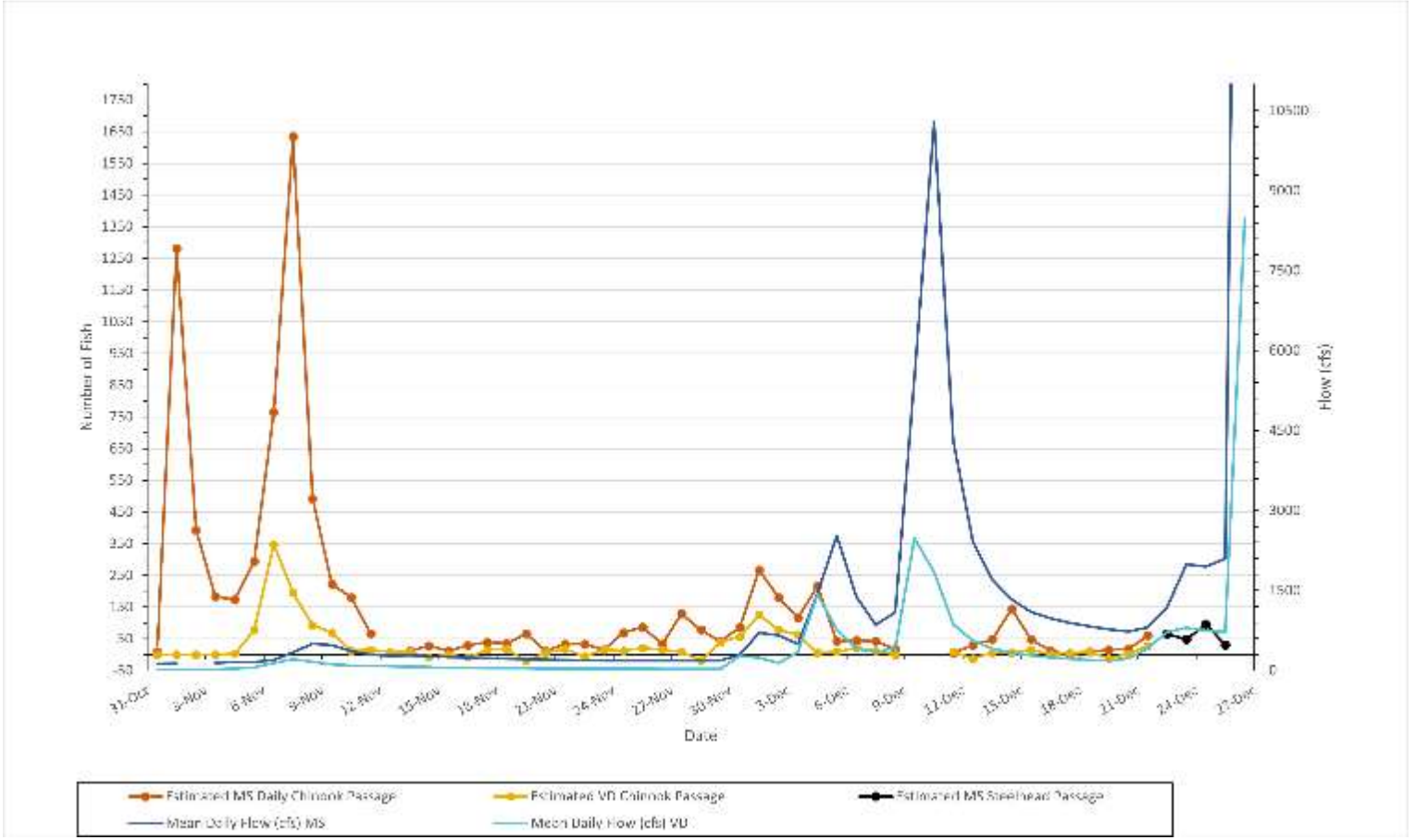
Results

2022-2023

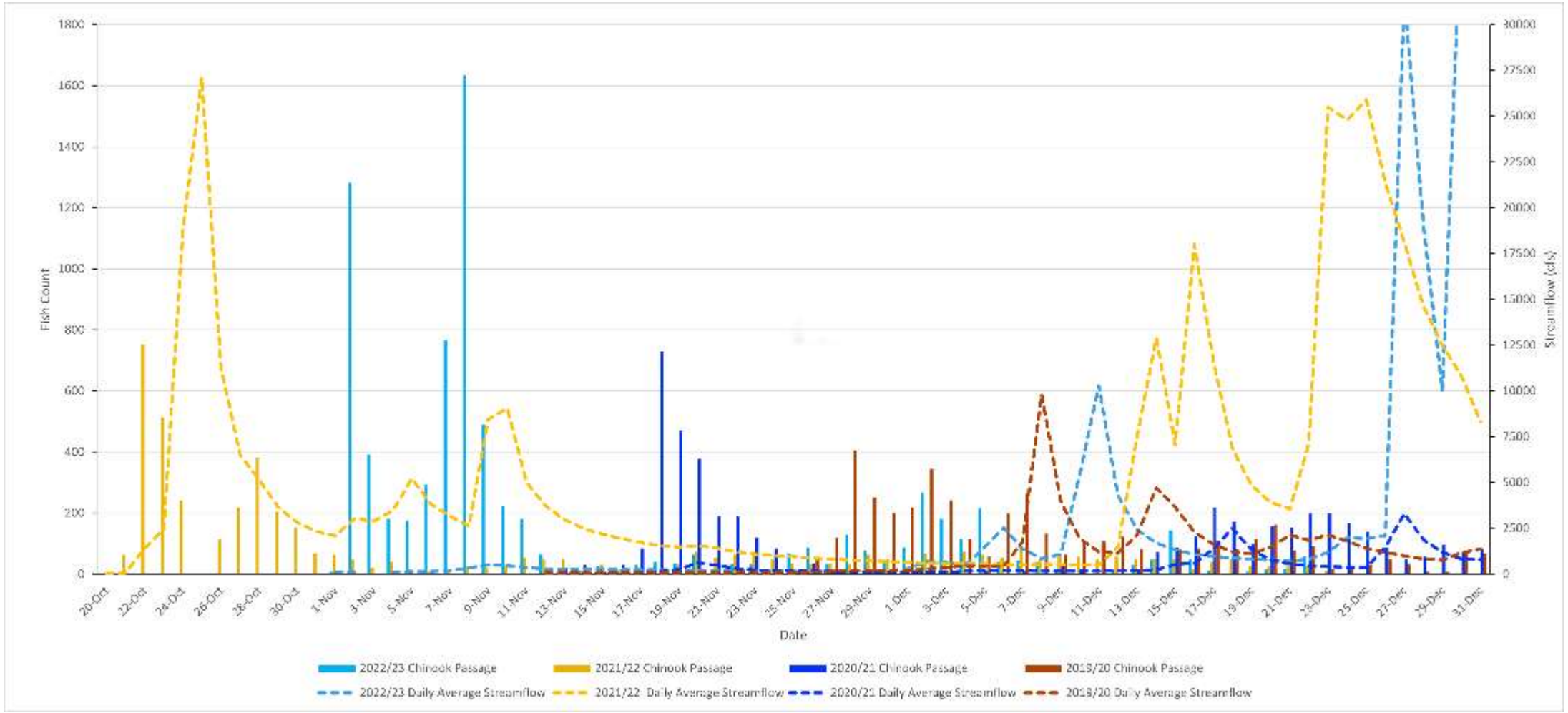
Daily Fish Passage vs Flows:

- Mainstem (MS) site observed very high passage rates during first 10 days of the season: highest counts recorded on 11/8 and 11/2 having 1,635 and 1,281 fish, respectively.
- MS Chinook Salmon Abundance Estimate: 8,250 (adult & jacks)
- Van Duzen (VD) experienced unsuitable fish passage flows initially; highest fish counts occurred on 11/7 and 11/8 with 330 and 219 fish, respectively.
- VD Chinook Salmon Abundance Estimate: 1,473 (adults and jacks)

Daily Fish (Chinook and Steelhead) Passage Counts at Mainstem (MS) and Van Duzen (VD) DIDSON Stations with Mean Daily Flows (cfs)



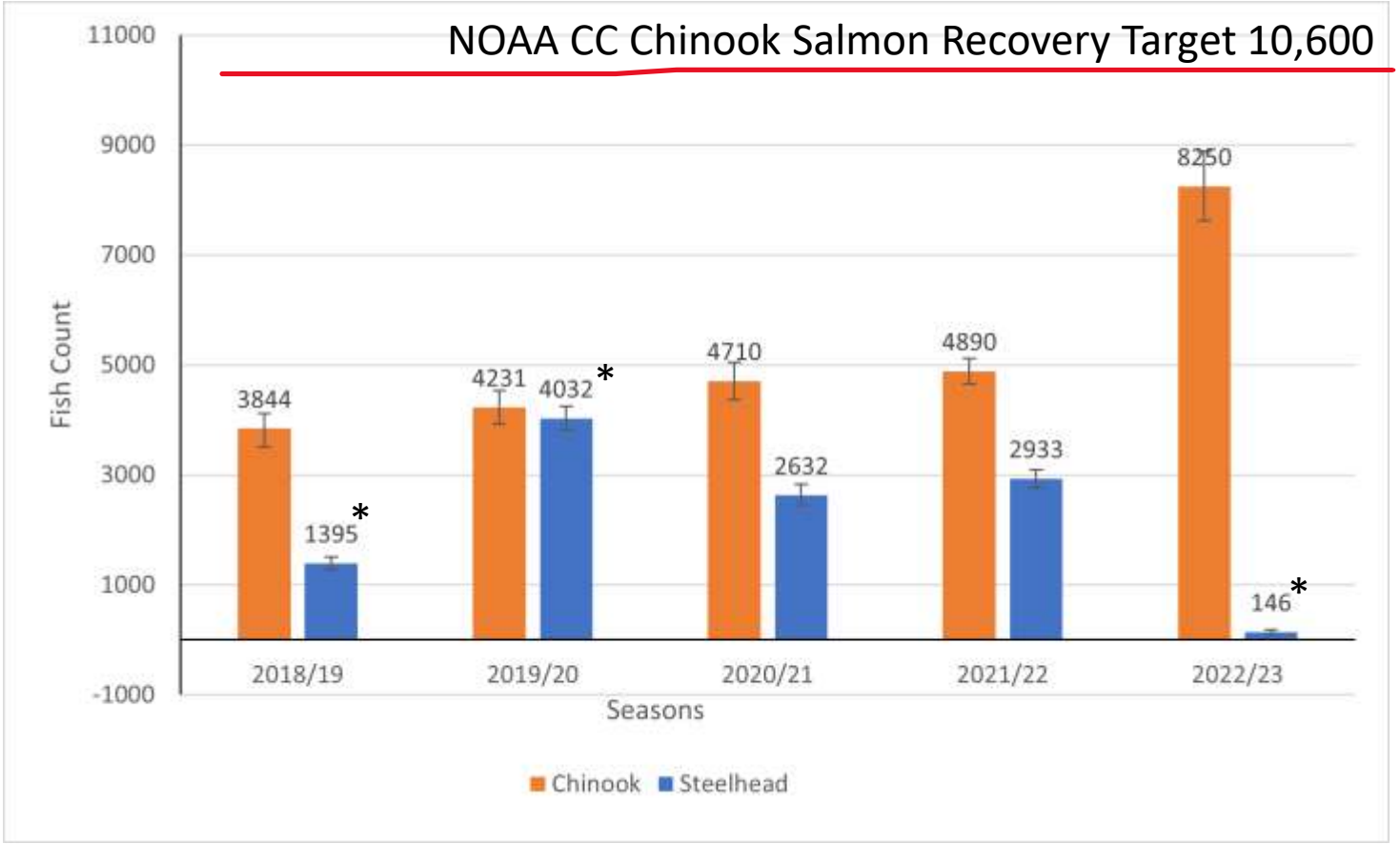
2019-2022 Mainstem Eel River Chinook Salmon daily counts with Average Streamflow



Results – 5-Year Project Summary
2018-2023

- Pilot-year's low counts can be partially attributed to learning curve, loss of experienced crew lead, and time camera was non-operational.
- Slight increase of Chinook Salmon counts each year of project with significant jump in 2022. Correlates to observations/counts in staging areas of Lower Eel River.
- Steelhead run coincides with higher flows and is twice as long as Chinook run, making it difficult to operate the camera as efficiently and challenges in producing yearly abundance estimates.
- Nonetheless, steelhead numbers are at an alarming low state!
- NOAA Recovery Target for Steelhead Mainstem with MF is 22,900.

Summary of Mainstem Eel River Escapement Yearly Estimates for adult/jack Chinook Salmon and Adult Winter-Run Steelhead 2018 - 2023

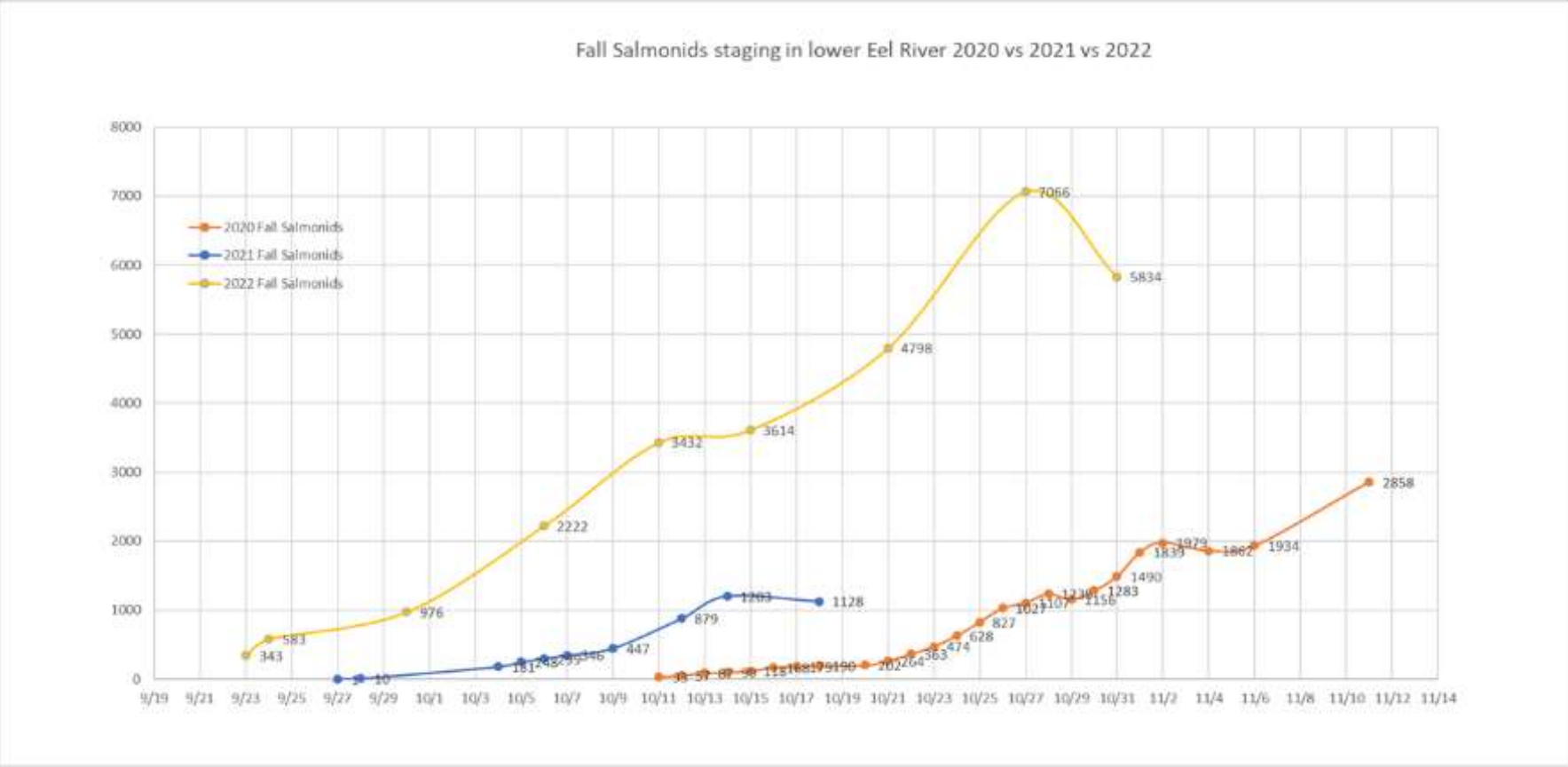


* Does not represent a full season of data collection for winter-run steelhead

Fall Salmonid Staging Counts in Lower Eel River

Sopjes and Stockwell Drone Counts 2020-2022:

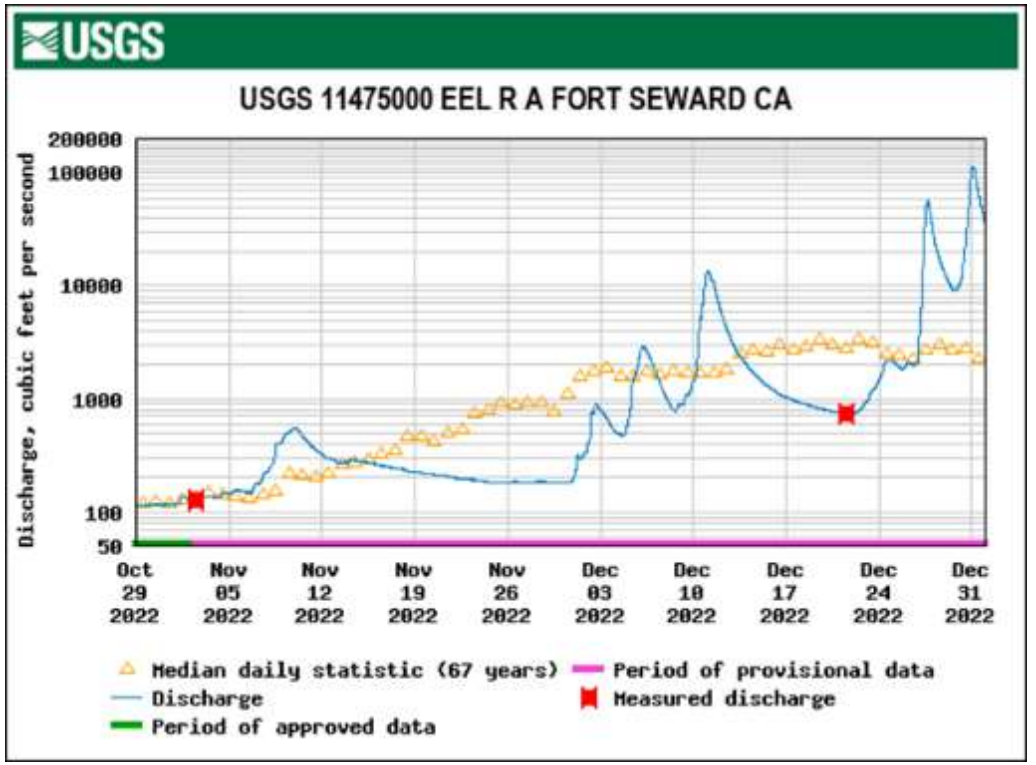
- Fall of 2022 was by far the highest counts of any year.
- Fall of 2020 and even to a greater degree in 2018 and 2019, low flow conditions prevented upstream migration; therefore, adult salmonids held in lower river until mid to late November



Camera Operations and River Flow Conditions

Chinook Salmon Run

- Generally, camera can operate in flows up to 7,000cfs @Fort Seward; Fall of 2022 -almost entire Chinook run experienced flows below 7,000cfs.



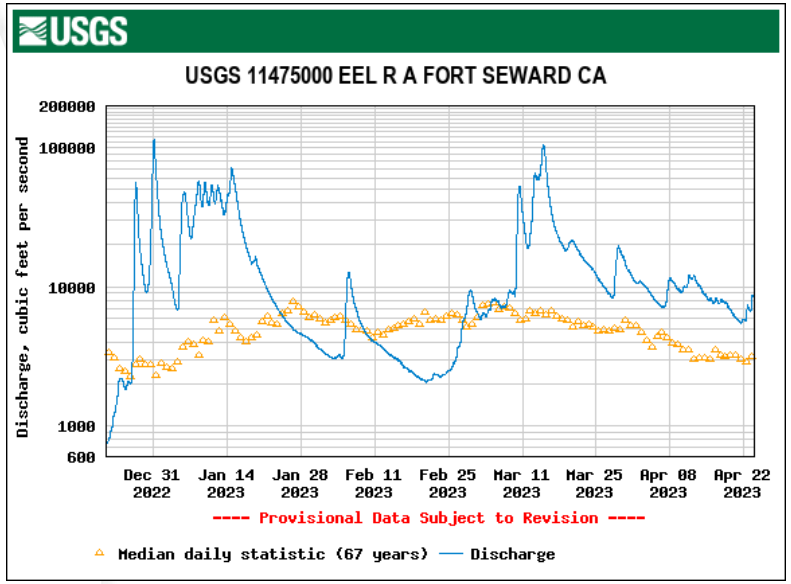
Chinook Salmon Season 2022 -2018

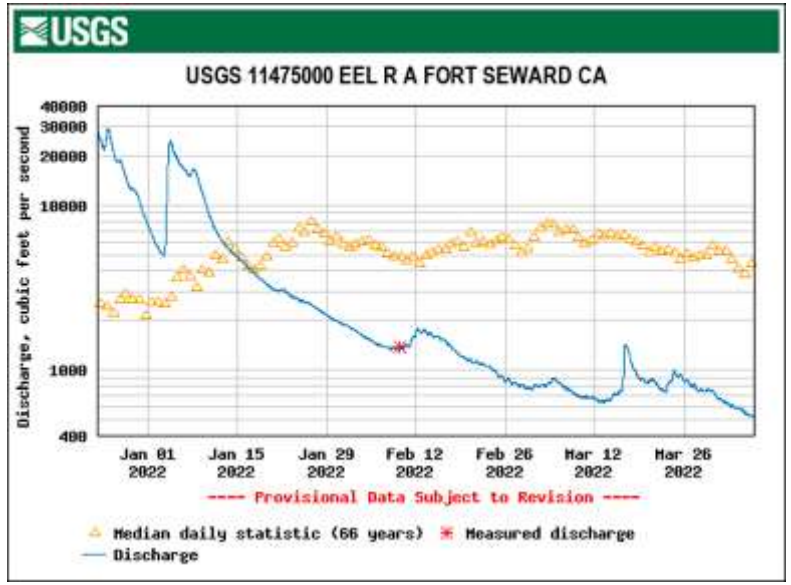
		Percent Time Sampled		Percent Time Not Sampled	
Project Year		Total % Sampled	# Hours Sampled	Total % Not Sampled	# Hours Not Sampled
Van Duzen 2022 Nov 1 – Dec 22		81%	1186	19%	278
2022	Nov 1 – Dec 22	90%	1115	10%	119
2021	Oct 31 - Dec 23	76%	1176	24%	371
2020	Nov 12 – Dec 31	98%	1162	2%	23
2019	Nov 25 – Dec 31	91%	799	9%	78
2018	Nov 15 – Dec 31	88%	1,058	9%	78

Camera Operations and River Flow Conditions

Winter-run Steelhead

During the 2022-23 Project Year, most of the winter-run steelhead season experience too high of flows to operate the camera (except month of February).





Steelhead Season 2023 – 2018

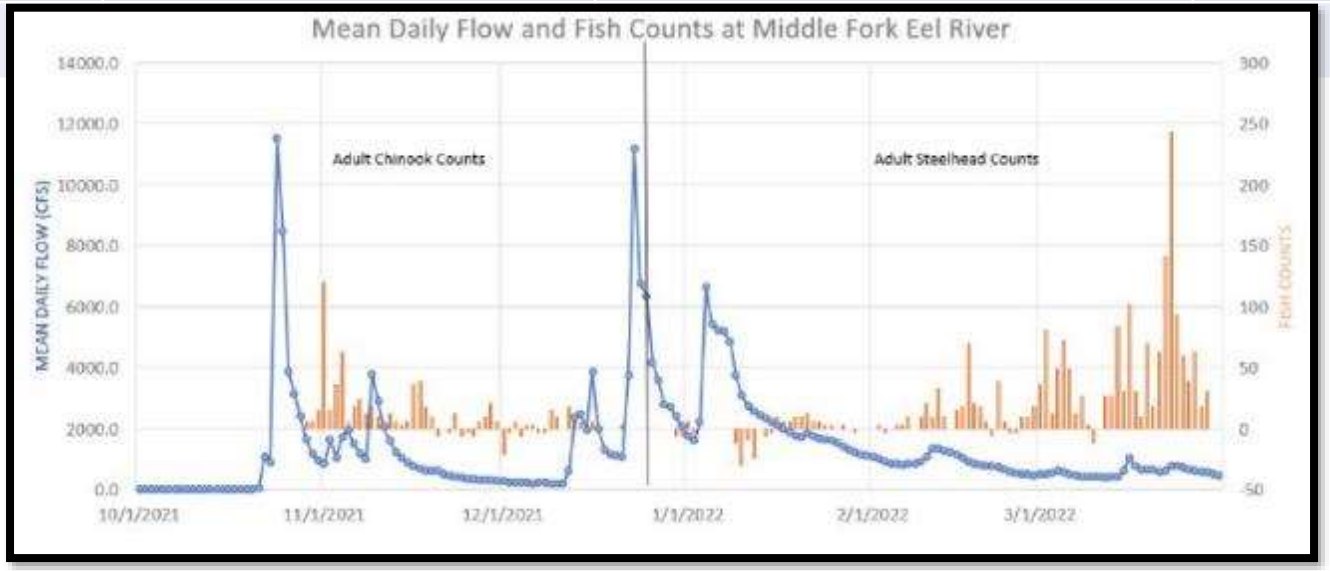
	Percent Time Sampled		Percent Time Not Sampled	
Project Year	Total % Sampled	# Hours Sampled	Total % Not Sampled	# Hours Not Sampled
2022-23 Dec 23 – Feb 28	47%	773	53%	859
2021-22 Dec 24 – Apr 5	82%	2031	11%	278
2020/21 Jan 1 - Apr 10	85%	2040	15%	359
2019/20 Jan 1 – Mar 20	95%	1815	5%	105
2018/19 Jan 1 – Feb 12	90%	N/A	N/A	N/A

Middle Fork Eel River DIDSON Monitoring

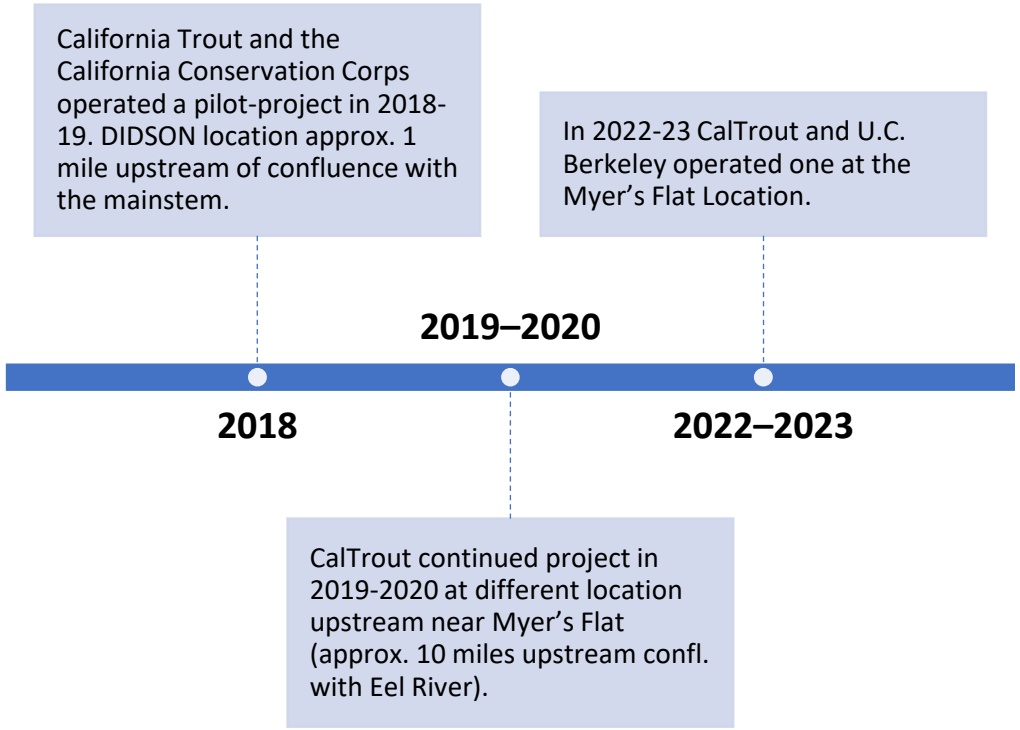
- Round Valley Indian Tribes and McBain and Associates began pilot- project began in fall of 2021
- Capturing data on the timing and duration of the fall Chinook Salmon run and winter-run steelhead and producing abundance estimates.
- Future funding includes continued operations and incorporating an ARIS camera.
- May expand future monitoring to North Fork Eel River

MF Eel Adult Salmonid Escapement 2022-2023

2021 Adult Chinook Salmon Return: October-December	2022 Adult steelhead Return: December- March	2022 Adult Chinook Salmon Return: October-December	2023 Adult steelhead Return: December- April
Adults (<65cm) **360 Fish**	Pilot Project- Did not separate size classes	Adults (<65cm) **348 Fish**	Adults (<65cm) **210 Fish**
Sub Adults- Jacks (35cm-64cm) **192 Fish**	Pilot Project- Did not separate size classes	Sub Adults- Jacks (35cm-64cm) **99 Fish**	Sub Adults- Jacks (35cm-64cm) **129 Fish**
Total= **552 Fish**	Total= **1,167 Fish**	Total= **447 Fish**	Total= **339 Fish**



South Fork Eel River DIDSON



South Fork Eel River population estimate for 3 salmonid species over 2 seasons of sonar operation. Coho estimates are derived From CDFW/PSMFC spawner surveys (Guczek et al. 2019, 20), where adults=*2.

Species	**2018-2019**	**2019-20**
Chinook Salmon	3,381	2,441
Coho Salmon	1,980	276
Steelhead	3,382	2,910

Conclusions

- Sonar projects have allowed for accurate abundance estimates of Chinook Salmon and during some project years winter-run steelhead.
- Projects expanding the knowledge on current run-timing of Chinook Salmon and Steelhead.
- With such a large percentage (40-60%) of the Chinook Salmon run confined to the first part of the run, lower Eel River holding areas and sufficient flows prior to onset of rain events are critical to the survival/success of CC Chinook in the Eel.
- Mainstem Eel has witnessed a rise in the Chinook Salmon abundance numbers; however, they still fall well below NOAA recovery targets (10,600) of this species. Will the uptick in numbers continue?
- Alarming low numbers of winter-run steelhead the past few years.
- Data collection of Sacramento Pikeminnow data could help with current and future suppression efforts.
- The Eel River watershed being an important producer of all three salmonid species, long-term funding should be committed to these monitoring projects.

Acknowledgements

- Funding for this year was provided by the U.S. Fish and Wildlife's Sport Fish Restoration Program, Pacific Coastal Salmon Recovery Fund, and additional funding from NOAA Fisheries West Coast Region and PG&E funding for the crew lead (fisheries biologist) position.
- We are very grateful for our project partners: Pacific States Marine Fisheries Commission, Stan Allen, who hired a fishery biologist to run field operations; PG&E and NOAA Fisheries West Coast Region, Josh Fuller, for additional funding and project support; Trout Unlimited, Charlie Schneider, for assistance with equipment purchasing, set-up, and technical support; CDFW Fisheries Branch for loaning the cameras, and The Nobles Family and Humboldt Redwood Company, including their fisheries biologist, Keith Lackey, for un-limited access to the sonar site location and additional security measures.
- PSMFC Fisheries Biologist, Karina Bencomo – helping oversee field operations, data review, qa/qc, data analysis
- CDFW field staff – Nathan Donatello, Stacy Giraldo, and Mario Minder
- AmeriCorps WSP members – Tiffany Douglas and Derek Masters
- Numerous additional folks that helped the initiation of this project (TU - Anna Halligan, Eric Young, Brian Johnson; CDFW Seth Ricker and Allan Renger; Nicholas Easterbrook, and Matt Matheny) and previous crew leads (Nicholas Easterbrook, Kori Roberts and Joshua Gruver) and field staff over the years.

Thank you!

Totally RAD Impassable Barriers: How Geologic Features Separate Summer and Winter-run Steelhead in the Eel River and Beyond

Samantha Kannry
TRIB Research and Native Fish Society

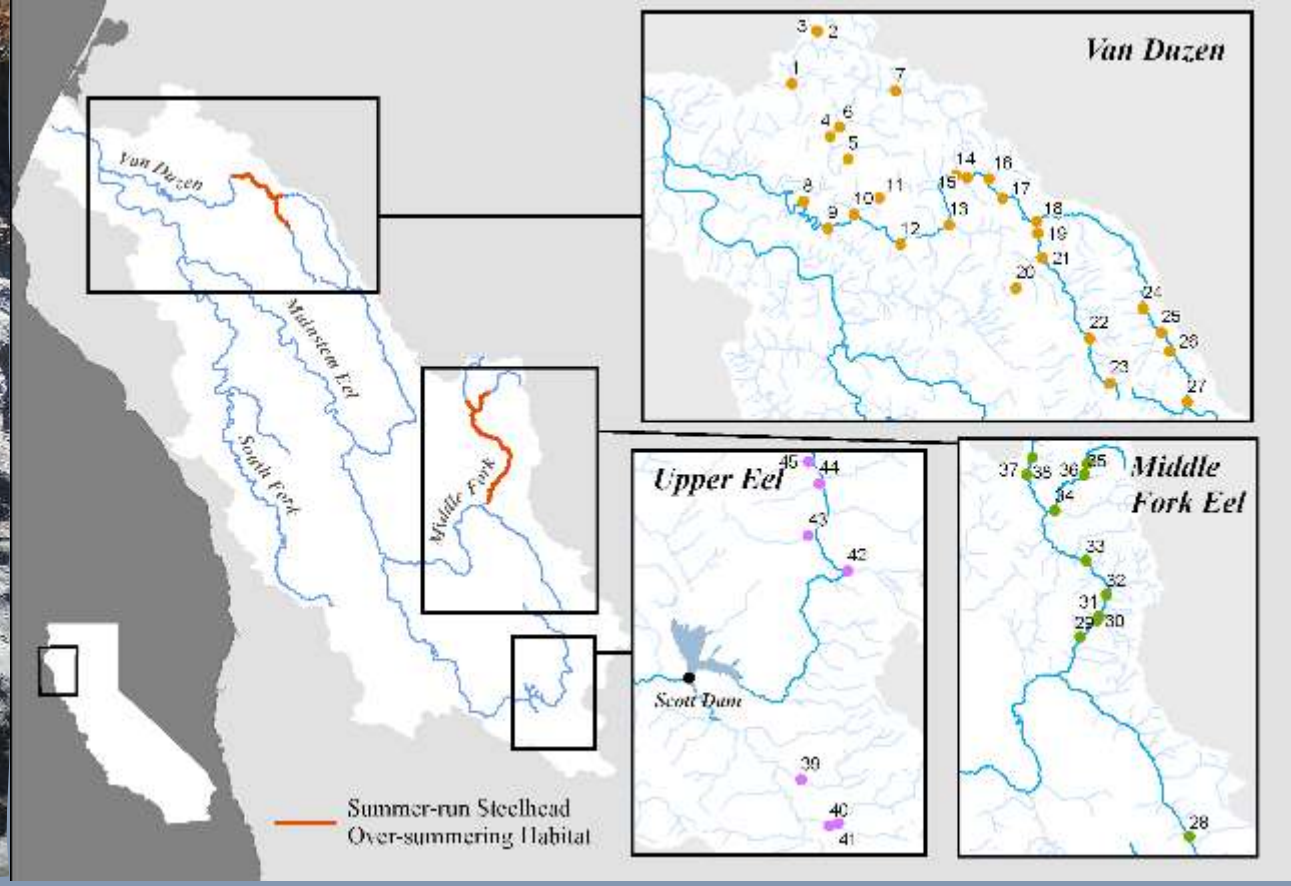
Summer-run have experienced a more precipitous decline

Summer steelhead in the Middle Fork Eel

Barriers in the Eel River are known as “roughs”

A number of questions existed regarding present and historical distribution of summer steelhead in the Eel

- Do summer and winter-run fish spawn and rear in different locations in the Eel?
- Are summer-run alleles present above Scott Dam?
- Are summer-run alleles being maintained as standing variation in the South Fork Eel River?
- Additional questions not covered in this talk



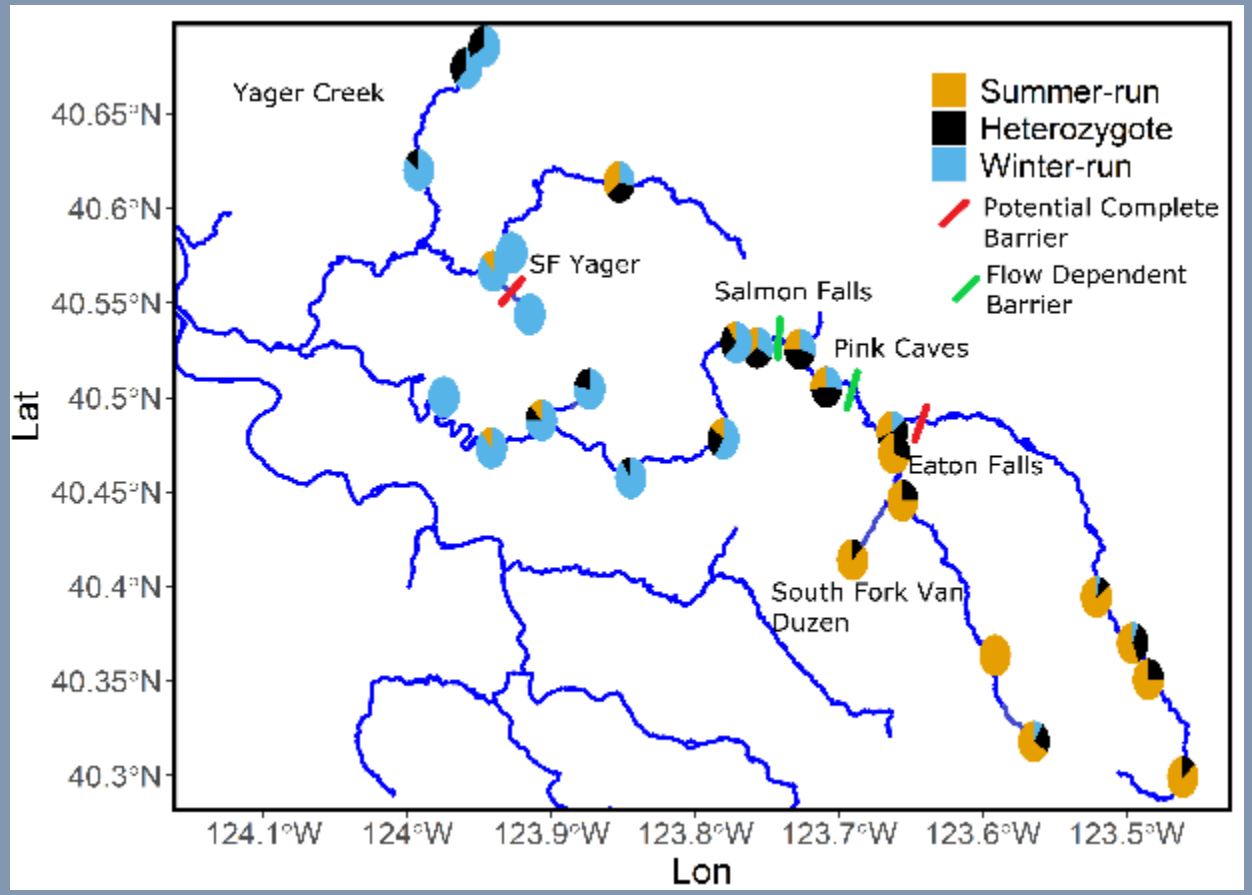
River backpacking (minking) combined with night sampling is the most efficient method for obtaining samples

- Spatial Distribution
- Young of the year sampling
- Lab work and analysis

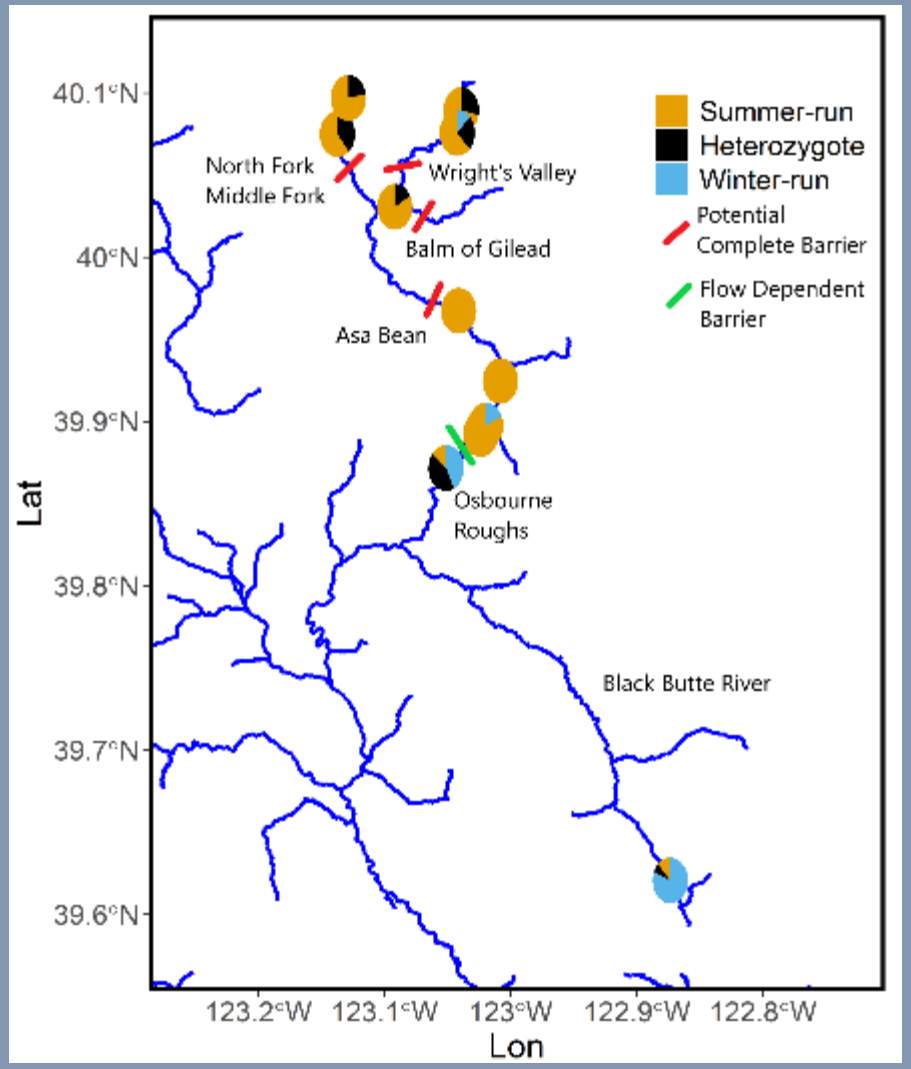
A number of questions existed regarding present and historical distribution of summer steelhead in the Eel

- Do summer and winter-run fish spawn and rear in different locations in the Eel?
- Are summer-run alleles present above Scott Dam?
- Are summer-run alleles being maintained as standing variation in the South Fork Eel River?

We observe distinct spatial segregation around the major Lost Duzen and Middle Fork Eel barriers at the GREB1L region.



Van Duzen River

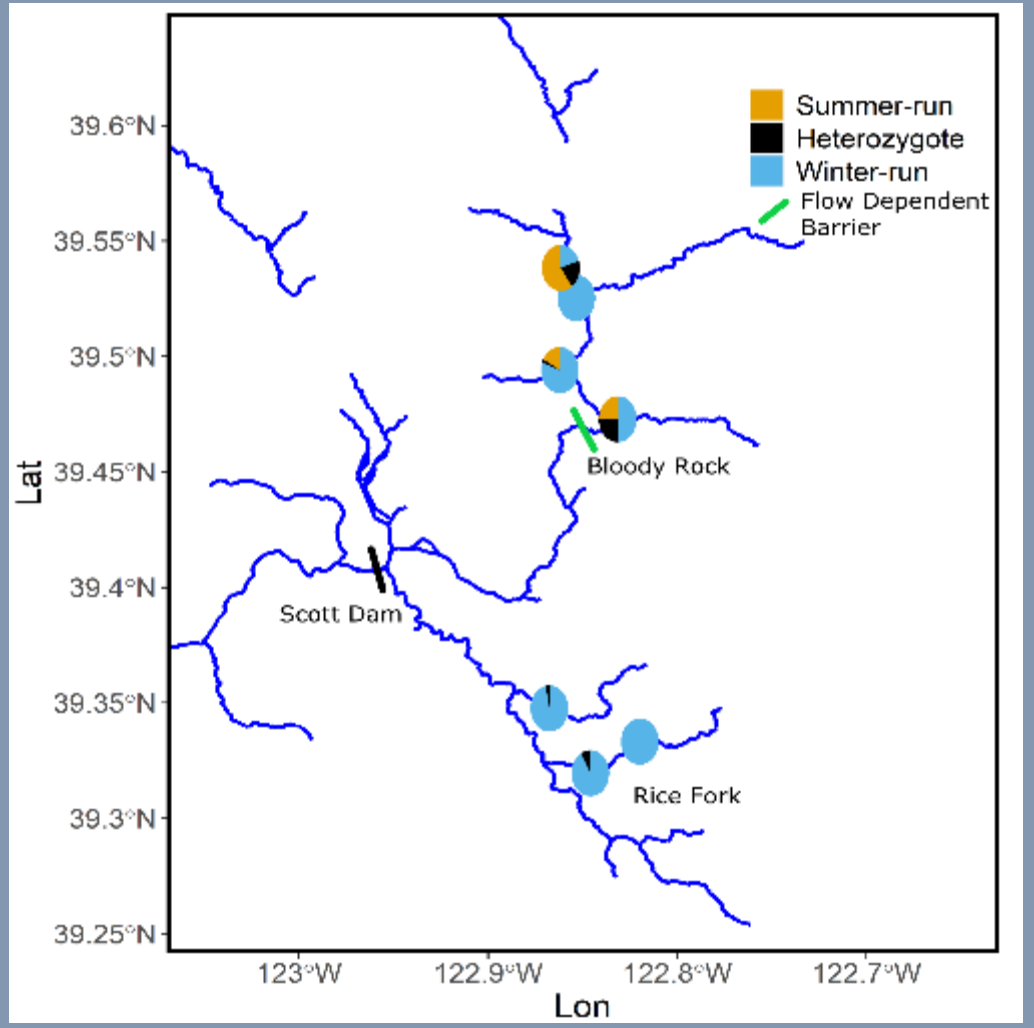


Middle Fork Eel River

A number of questions existed regarding present and historical distribution of summer steelhead in the Eel

- Do summer and winter-run fish spawn and rear in different locations in the Eel?
- Are summer-run alleles present above Scott Dam?
- Are summer-run alleles being maintained as standing variation in the South Fork Eel River?

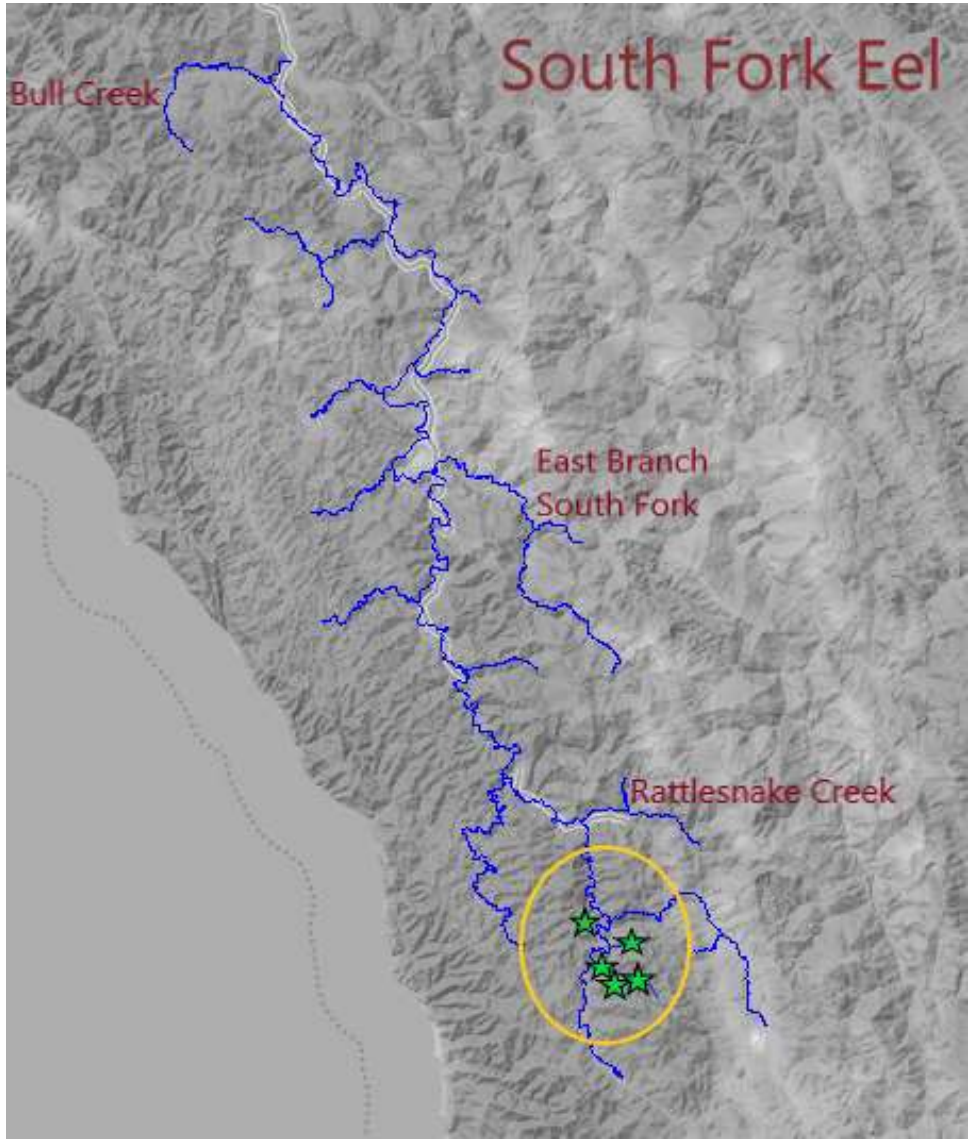
The summer-run allele is present in the resident trout population above Scott Dam



A number of questions existed regarding present and historical distribution of summer steelhead in the Eel

- Do summer and winter-run fish spawn and rear in different locations in the Eel?
- Are summer-run alleles present above Scott Dam?
- Are summer-run alleles being maintained as standing variation in the South Fork Eel River?

We do not detect the presence of summer-run alleles in nearly 1600 individuals sampled



Year	Homozygous winter	Heterozygous	Homozygous summer
2014	26	0	0
2015	550	0	0
2016	595	0	0
2017	422	0	0
Total	1593	0	0

Summer-run alleles are not being maintained as standing variation in the South Fork Eel winter-run population

“Thus, the premature migration (summer-run) allele does not appear to be masked in the heterozygous state and cannot be expected to be maintained as standing variation in populations that lack the premature migration phenotype”

-Prince et al., 2017

“As in the Hood River samples, heterozygotes in the BONAFF dataset exhibited Bonneville passage days that were often intermediate to either homozygote.”

-Willis et al., 2020

Conclusions from the Eel

- Summer and winter-run steelhead are reproductively isolated by distinct geographic barriers
- Summer-run steelhead inhabited the Upper Eel above Scott Dam prior to dam construction
- Loss of summer-run genotype= loss of summer-run phenotype
- Summer-run listed as Endangered under CESA

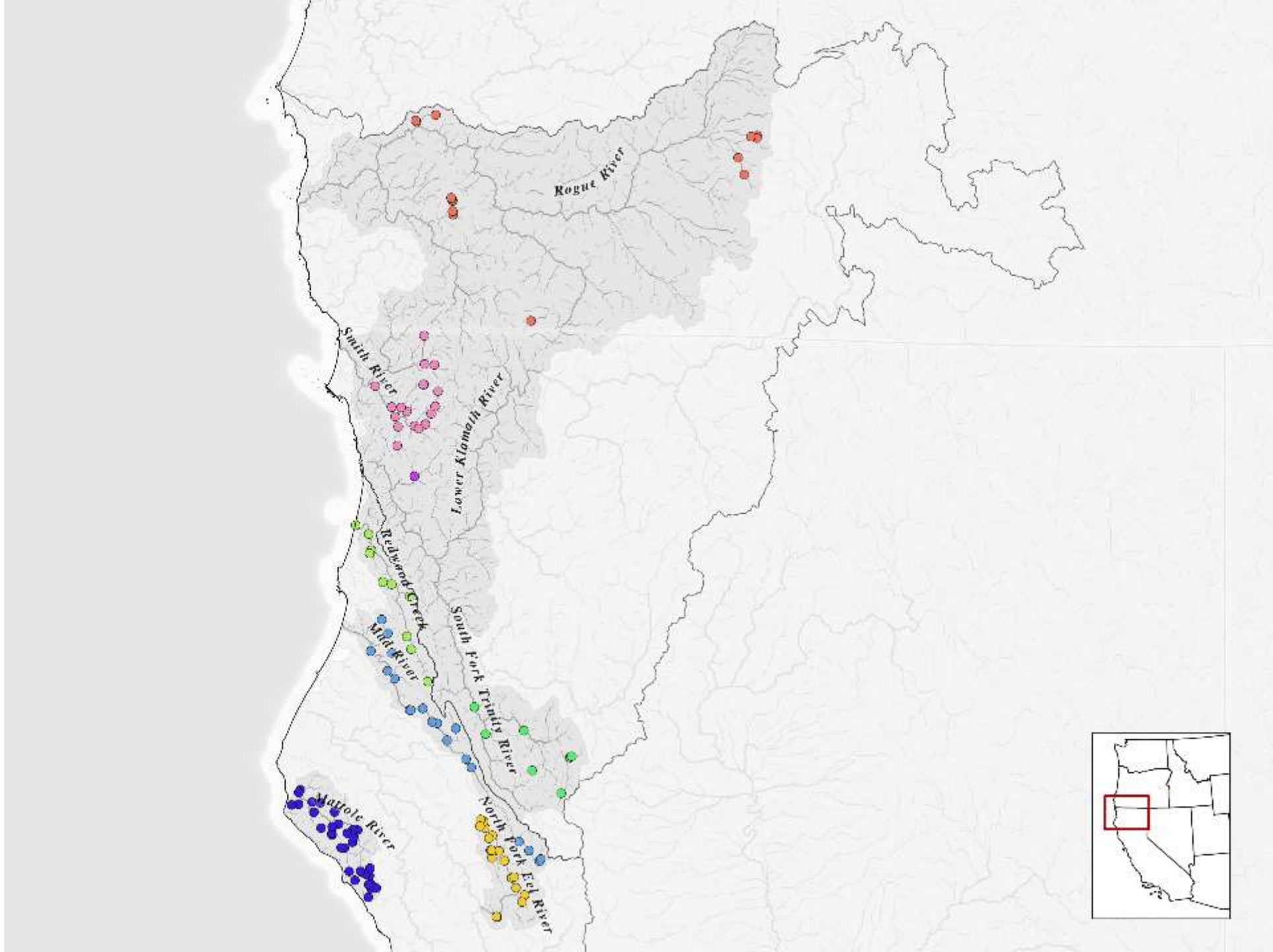
Additional questions about summer-run steelhead in the Eel River and beyond

- Is there genetic evidence of summer-run steelhead in the North Fork Eel and Mattole Rivers?
- What is the distribution of summer and winter-run alleles around barriers in Redwood Creek, the Mad, Smith, Trinity, Klamath and Rogue Rivers?
- Fall-run steelhead in the Eel, Klamath and Rogue Rivers.

Minking crosses state lines

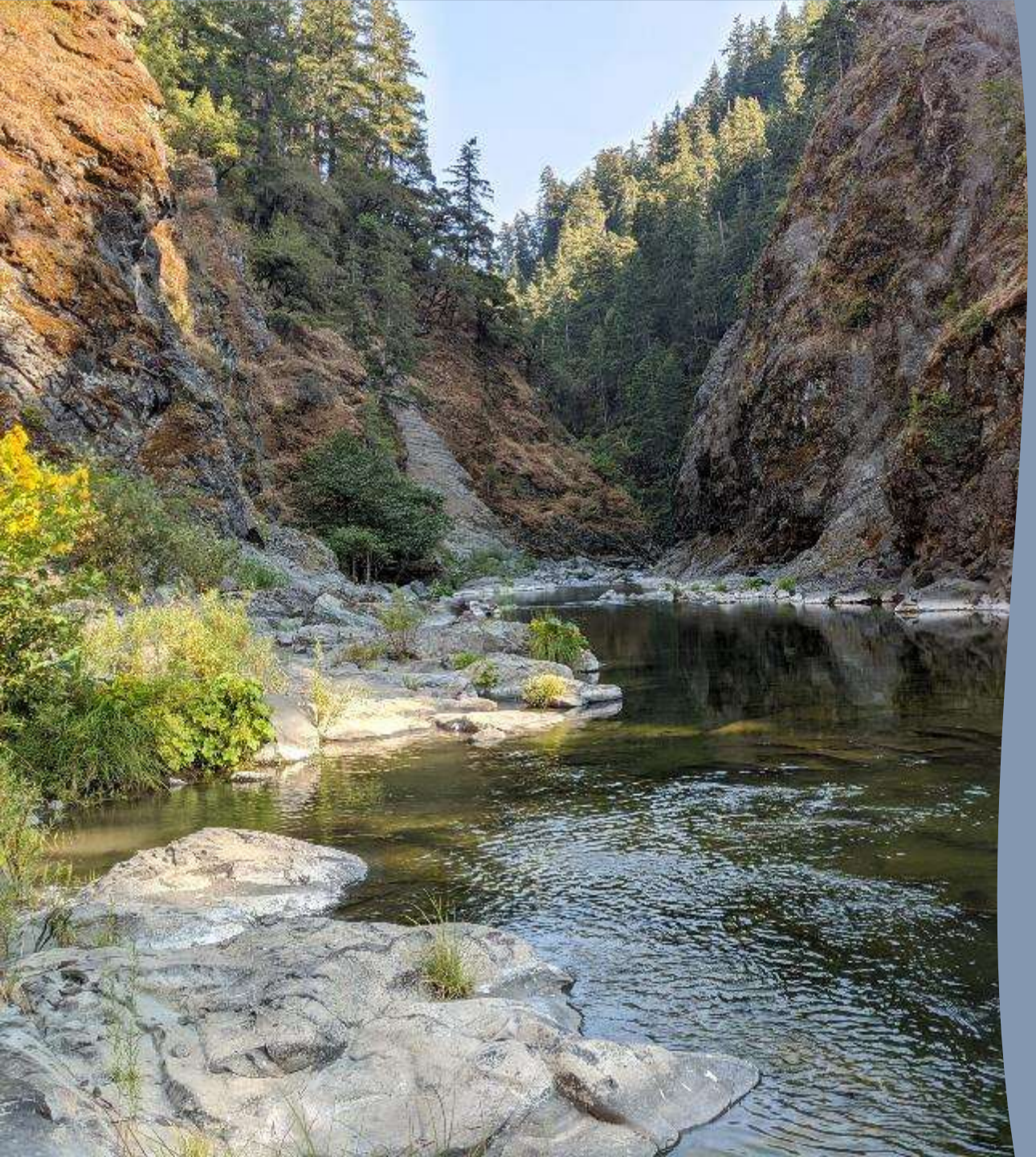
- River backpacking and nighttime dip netting are effective outside of the Eel
- Barriers come in many forms

Summer-run steelhead inhabit river systems with cooler upper reaches and seasonal barriers



Fall-run questions

- Refinement of the markers that explain run-timing in steelhead.
- Is the half-pounder life-history in the Eel, Klamath and Rogue associated with the fall-run marker?
- What is the distribution of fall and summer-run fish in the Klamath and Rogue?
- Are all the summer-run fish in the Rogue genetically fall-run?

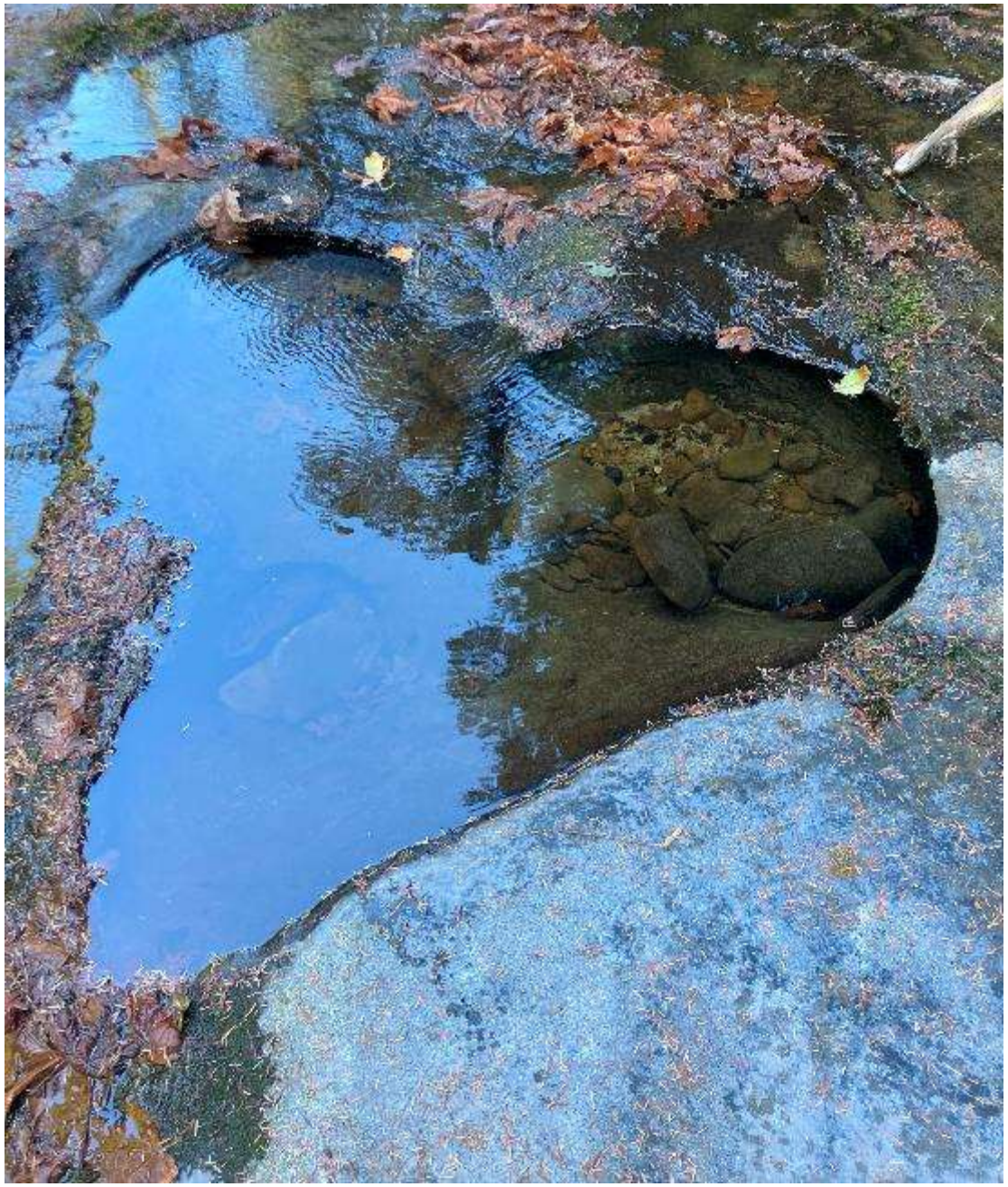


Conclusions from beyond the Eel

- Roughs are not the only geologic features separating winter and summer-run and minking is still great
- Look for more results from our extensive sampling in the next year

Suggestions to consider to improve heart, home and the world

- To heal our rivers, we must heal ourselves
- Treat your smartphone like a landline
- Find comfort in inconvenience
- Use muscle-energy
- Reconsider purchases and investments
- Cultivate mystery



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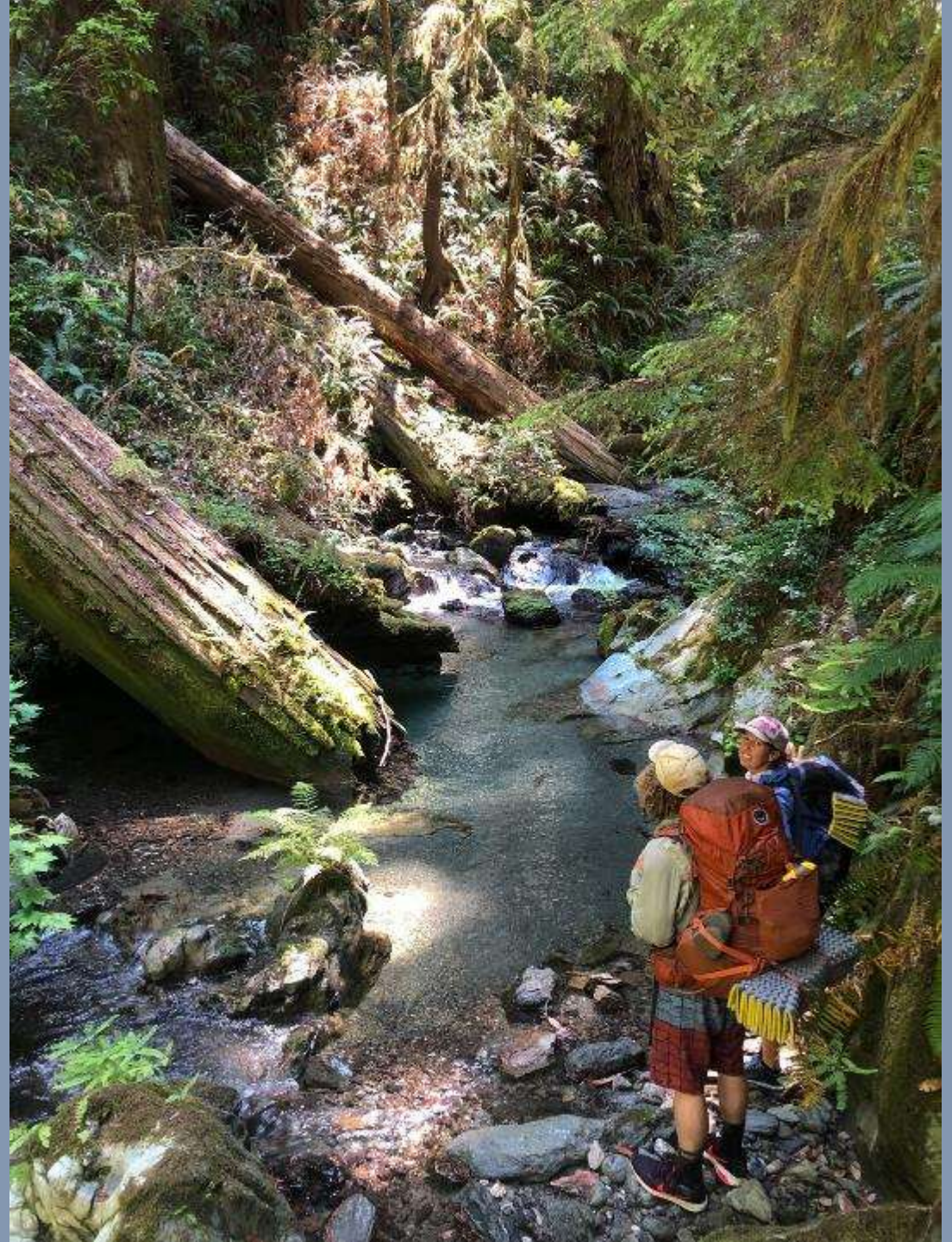
TRIB co-founder and night sampling's biggest fan: Sam Rizza



Physical and biological constraints on the capacity for life-history expression of anadromous salmonids: an Eel River, California, case study

Salmonid Restoration Federation - 28 April 2023

Alyssa FitzGerald*, David Boughton, Josh Fuller, Sara John, Ben Martin, Lee Harrison, & Nate Mantua

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Canadian Science Publishing

ARTICLE

Physical and biological constraints on the capacity for life-history expression of anadromous salmonids: an Eel River, California, case study

Alyssa M. FitzGerald, David A. Boughton, Joshua Fuller, Sara N. John, Benjamin T. Martin, Lee R. Harrison, and Nathan J. Mantua

Abstract: Recovery of anadromous salmonid populations is complicated by their complex life histories. We examined the spatiotemporal interplay of stream temperature, geomorphic features, and a species' thermal sensitivity mediated by biological interactions in a case study of steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*) in California's Eel River watershed. We estimated habitat suitability and fish capacity for each salmonid run and freshwater life stage during average, cool, and warm years in each of the watershed's subbasins, including a historically occupied high-elevation subbasin upstream of an impassable dam. Our estimates varied depending on whether we accounted for exposure to the Sacramento pikeminnow (*Ptychocheilus grandis*), an introduced predator and competitor. Our results indicate that the dammed subbasin has substantial salmonid capacity relative to the rest of the watershed and could provide an important cool-water refuge during warm years and from pikeminnow, potentially improving the productivity and resilience of multiple anadromous salmonid populations. Our approach can be applied in any setting where spatially explicit habitat metrics can be estimated and population-specific and life-stage-specific habitat criteria can be specified.

Résumé : La complexité des cycles biologiques des salmonidés anadromes complique le rétablissement de leurs populations. Nous examinons l'interaction spatiotemporelle de la température du cours d'eau, d'éléments géomorphologiques et de la sensibilité thermique des espèces modulée par les interactions biologiques dans une étude de cas de la truite arc-en-ciel anadrome (*Oncorhynchus mykiss*) et du saumon chinook (*Oncorhynchus tshawytscha*) dans le bassin versant de la rivière Eel, en Californie. Nous estimons la qualité des habitats et la capacité de charge de poissons pour les différentes étapes de migration et de vie en eau douce de ces salmonidés durant des années moyennes, froides et chaudes dans chacun des sous-bassins du bassin versant, dont un sous-bassin de haute altitude occupé par le passé situé en amont d'un barrage infranchissable. Nos estimations varient selon que nous tenons compte ou non de l'exposition à la saumagesse du Sacramento (*Ptychocheilus grandis*), un prédateur et concurrent introduit. Nos résultats indiquent que le sous-bassin endigué présente une capacité de charge de salmonidés considérable comparativement au reste du bassin versant et pourrait offrir un important refuge d'eau froide durant des années chaudes et contre la saumagesse, améliorant potentiellement la productivité et la résilience de plusieurs populations de salmonidés anadromes. Notre approche peut s'appliquer à tout contexte où des paramètres spatialement explicites de l'habitat peuvent être estimés et des critères relatifs à l'habitat peuvent être spécifiés pour des populations et étapes du cycle biologique précises. [Traduit par la Rédaction]

Introduction

Recovery of anadromous salmonid populations is complicated by the fact that these fish have complex life histories, exposing them to a variety of climatic, physical, and biological impacts throughout their life cycle. A useful framework for sorting through this complexity emphasizes how abundance and productivity (i.e., population growth rate), mediated by a population's interactions with habitat via spatial structure and diversity, impact a population's long-term viability (McElhany et al. 2000). Conceptually, the most straightforward way to apply these ideas has been through quantitative life-cycle models that estimate survival across successive life stages under various climatic and hydrologic conditions. But life-cycle models usually require detailed data on stage-specific survival and abundance over many years (e.g., Scheuerell et al. 2006; Zeug et al. 2012; Crozier et al. 2021), which tends to bias their application to highly impacted populations where collection of such data are mandated. To assess recovery scenarios for understudied or extirpated populations, an alternative approach is to

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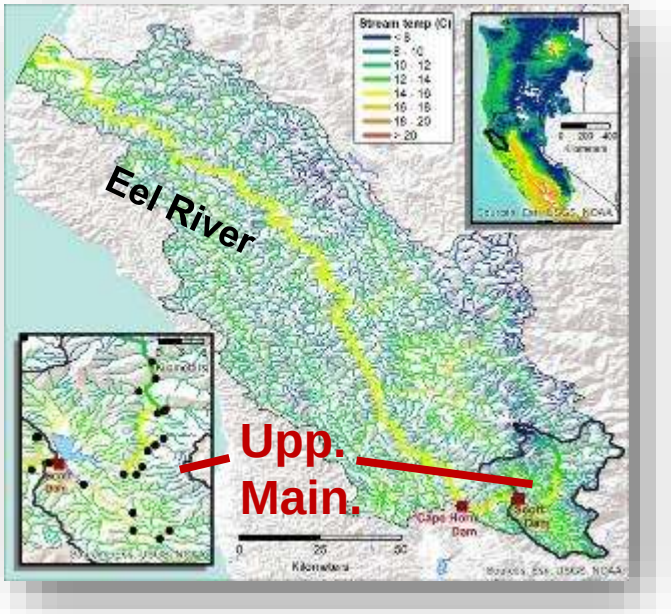
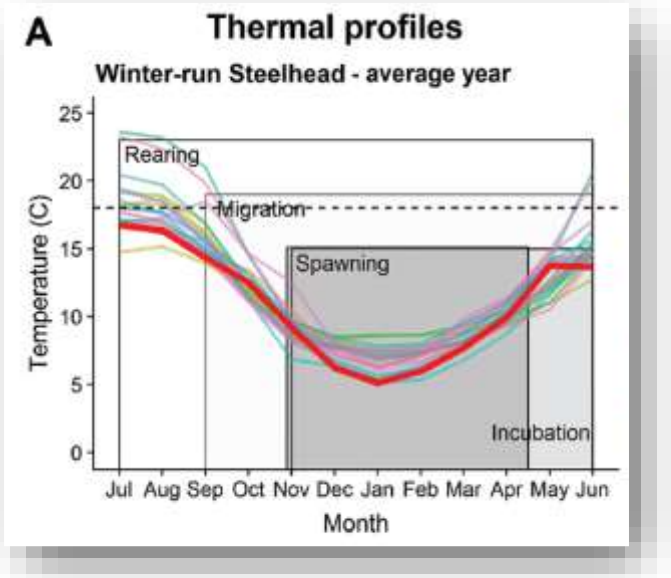
Dam blocks habitat in Eel River Basin

- Eel River Basin
  - Large, diverse stream system
    - ~10,000 river kilometers
    - Historically hosted robust run sizes (~1 million) of salmonids
      - Contains several threatened salmonid ESUs
    - 3rd largest salmonid watershed in CA
- Potter Valley hydroelectric project
  - Scott Dam (1922) blocks access to ~12% of river km in the Basin
- **Upp. Main.** is relatively cool





Approaches

Is the blocked Upper Mainstem Eel River subbasin important for salmonid recovery? How important?

1) Threshold approach
   - How much suitable habitat does the **Upp. Main.** have?
     - River km
     - Applied qualitative scores of channel type productivity and thermal conditions to estimate amount of suitable habitat

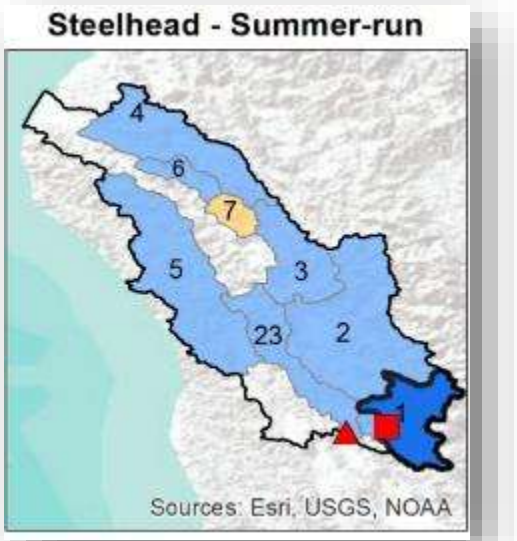
2) Capacity approach
   - How many parr and spawners can the **Upp. Main.** sustain?
     - Number
     - Applied Unit Characteristic Method, a capacity estimation statistical model

Methodological Approach 1

For each reach:

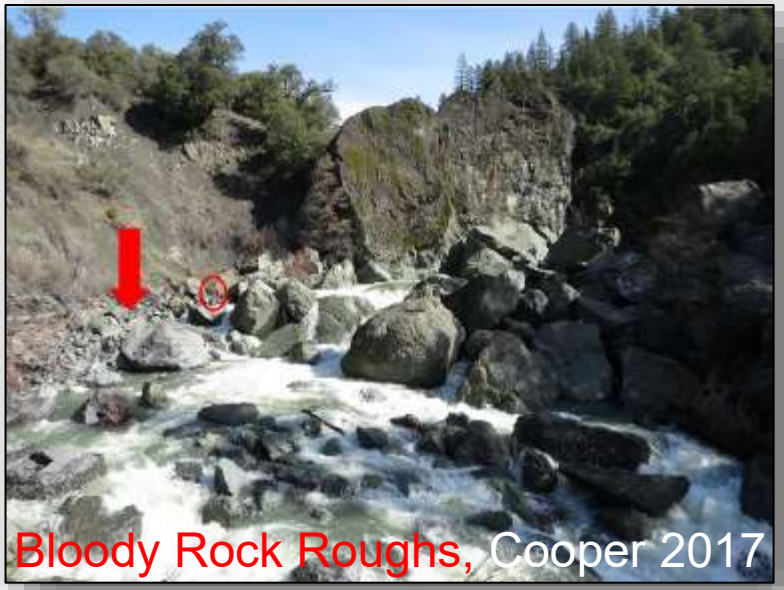
1) Accessible?
2) Productive habitat?
3) Thermally suitable?

- Assessed suitability for:
  - 3 ecotypes
  - 4 or 5 life stages (adult migration, pre-spawn holding, incubation, rearing, juvenile outmigration)
  - 3 year types (average, cool, warm)
  - Each subbasin
    - Subbasin: historical population boundaries defined from salmonid biogeographic breaks (Bjorkstedt et al. 2005, Spence et al. 2008)



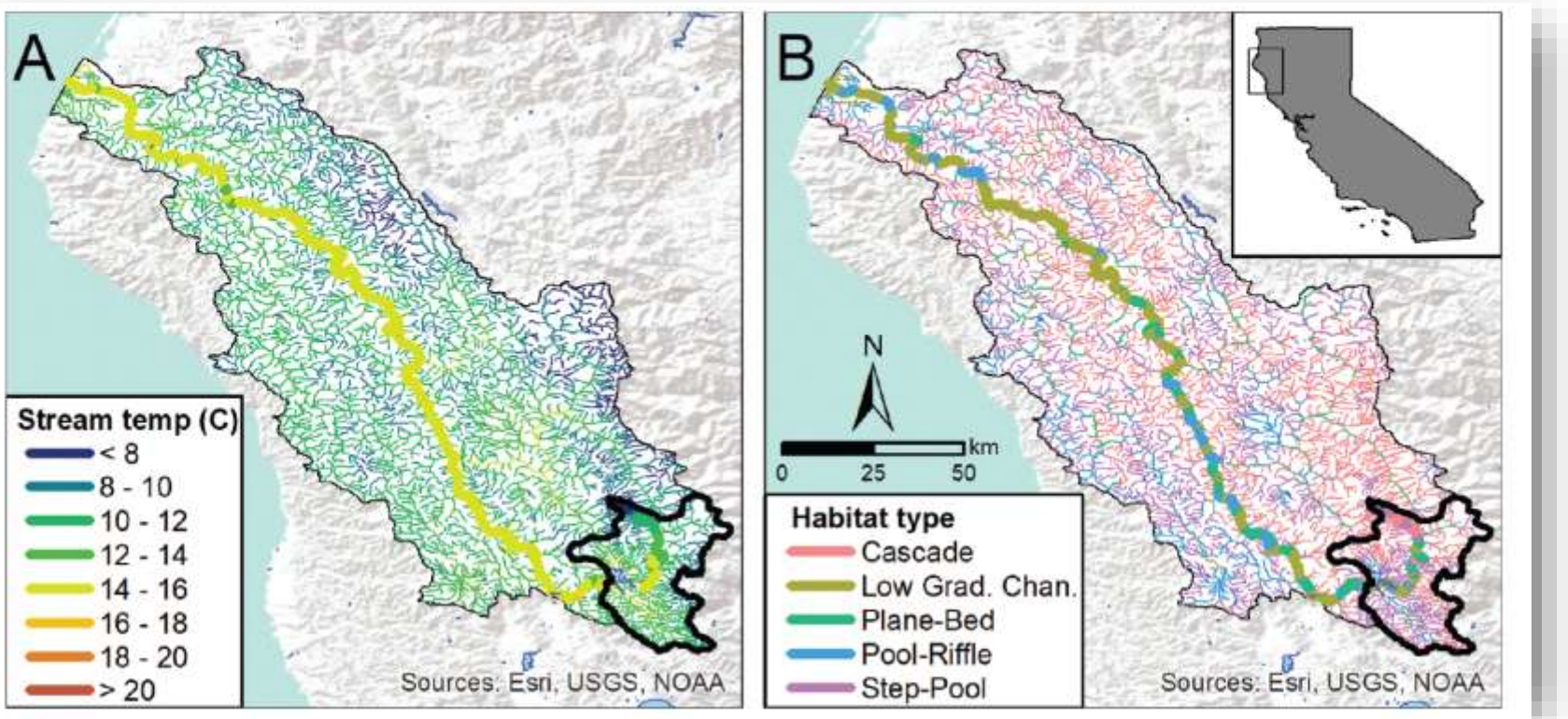
- Accessibility limits: upstream of physical impassable barriers (e.g., large waterfalls) or upstream of species-specific barriers inferred from stream gradient

- Steelhead
  - ~5,000 km potentially accessible
  - **584 km blocked in Upp. Main. (12%)**
- Chinook salmon
  - ~2,500 km potentially accessible
  - **144 km blocked in Upp. Main. (6%)**


Bloody Rock Roughs, Cooper 2017

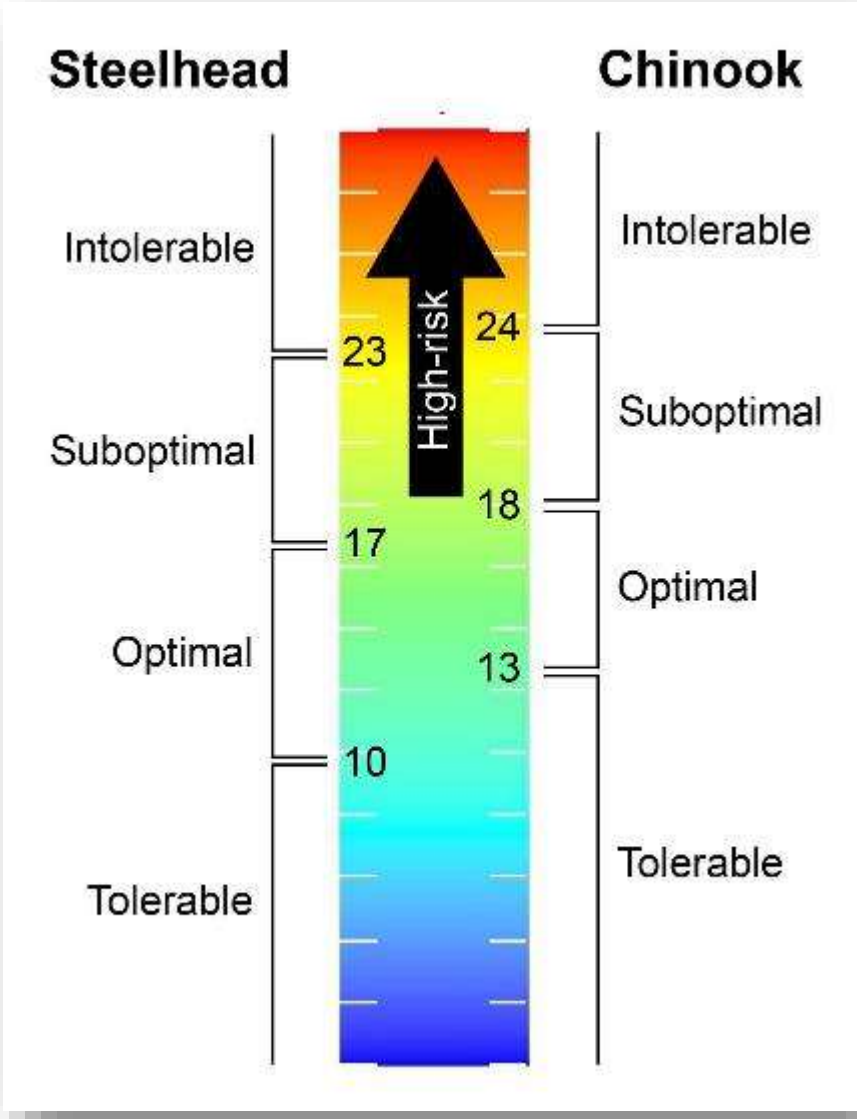

CalTrout

Accessible? | Productive habitat? | Thermally suitable?



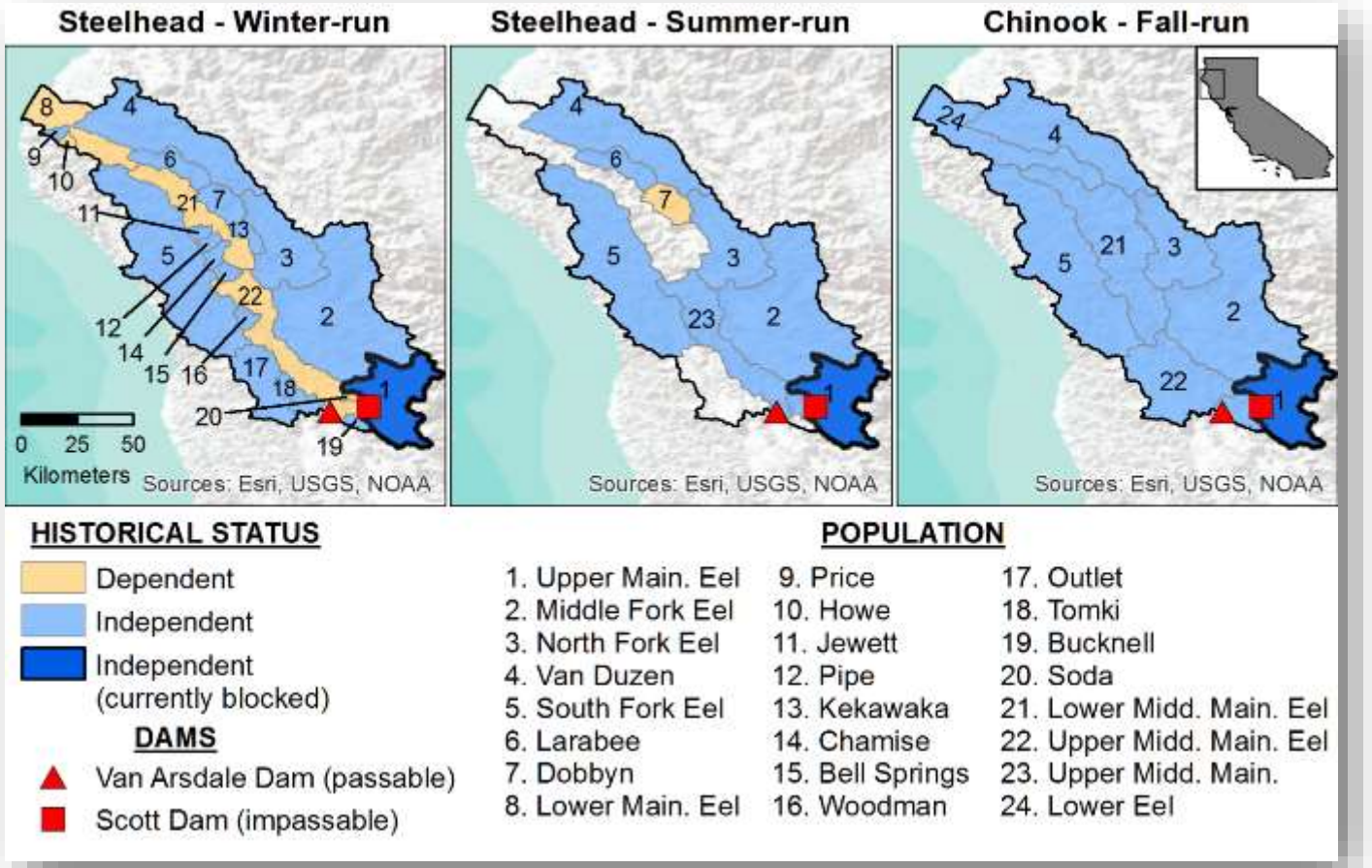
- Literature review to define productivity by geomorphic channel type and thermal tolerance
  - Per life stage
- Assigned productivity level and thermal suitability
  - Across year

- Additional thermal criteria needed for juveniles rearing
- Sacramento pikeminnow
  - Introduced species in Eel River Basin (ca. 1979)
  - Predator and competitor of juvenile salmonids
  - **Pikeminnow prefer temps ≥ 18°C**



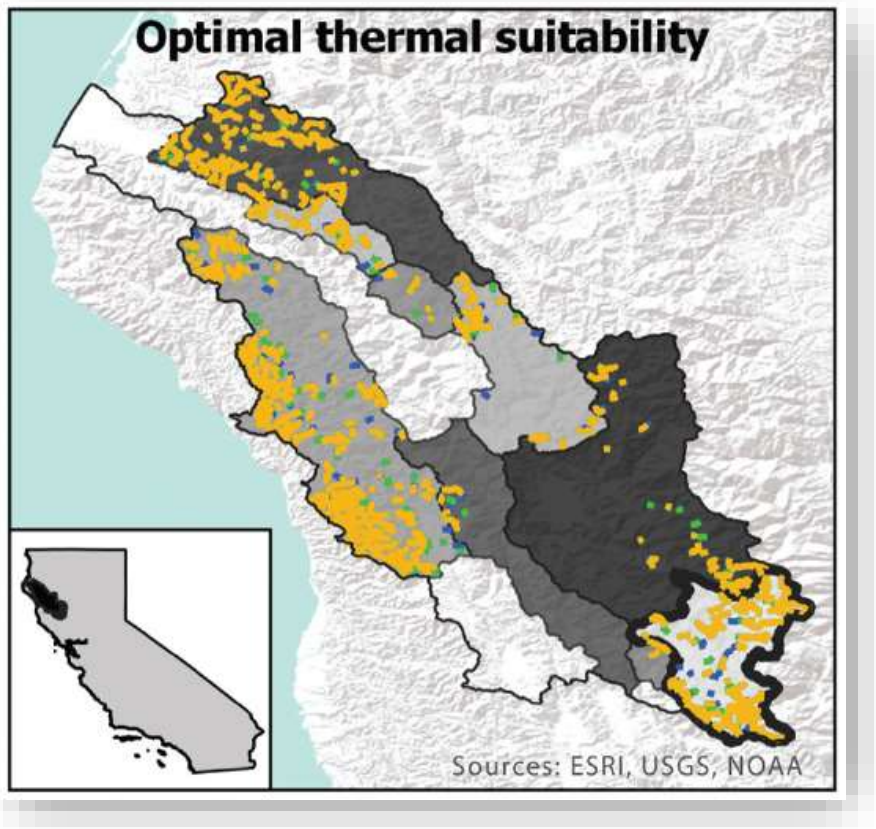
Approach 1: Results

How much suitable habitat does **Upp. Main.** have relative to other subbasins?



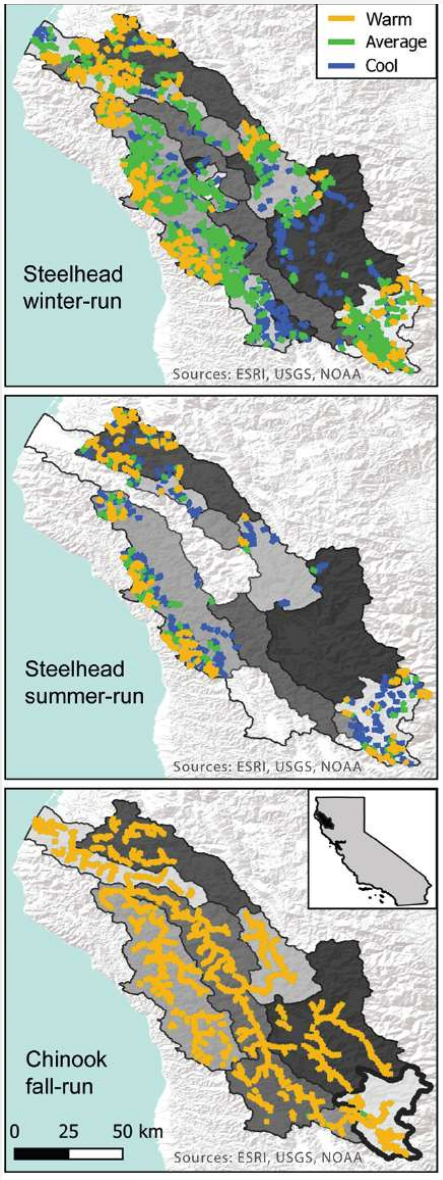
Results: Holding (STL summer only)

Figure 4. Reaches with optimal thermal suitability for holding summer-run steelhead trout in the month of August during warm years.



- Thermally optimal holding habitat present in June, greatly restricted during July and August, present in September
- Upp. Main., Van Duzen, Larabee, South Fork, had suitable cold-water habitat
- 216 km of optimal habitat in the Upp. Main., comparable to that of the Van Duzen (240 km)

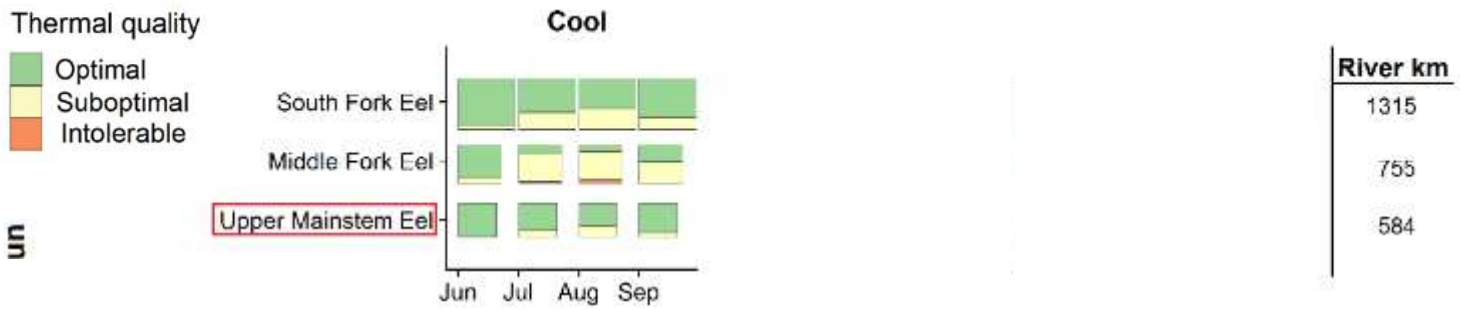
Results: Incubation



- Lots of suitable conditions during peak season (not shown)
  - **Upp. Main.** similar to Van Duzen during peak season
- Extended season – STL
  - During warm year (orange), much less suitable habitat
  - Successful spawning for fringe spawners may be precluded during drought years
- Extended season – CHK
  - Suitable throughout Basin

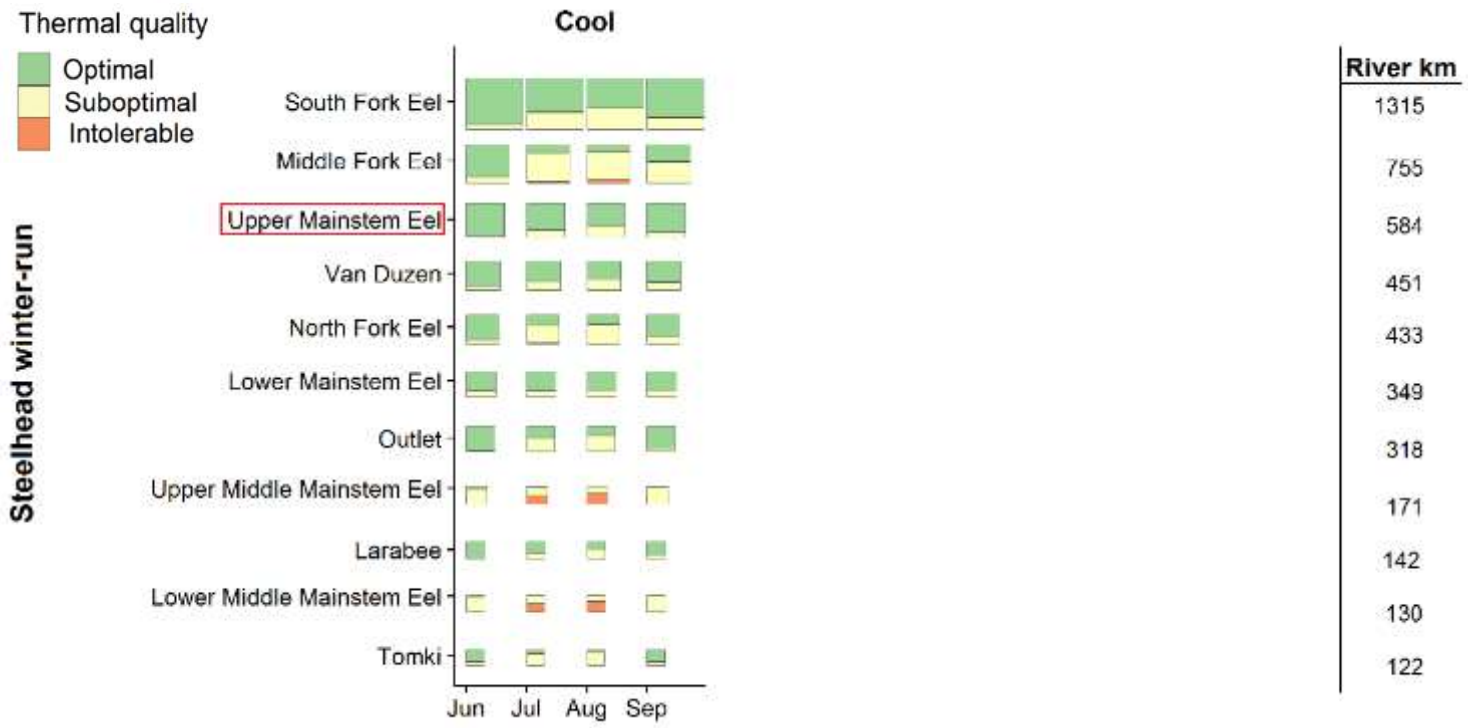
Figure 5. Suitable thermal refuges during the entire extended incubation season. Suitability is broken up by year type (colours in legend) and habitat type (left or right panels). In general, reaches suitable during the warm year were also suitable during the average year, and reaches suitable during the average year were also suitable during the cool year.

Results: Juvenile Rearing



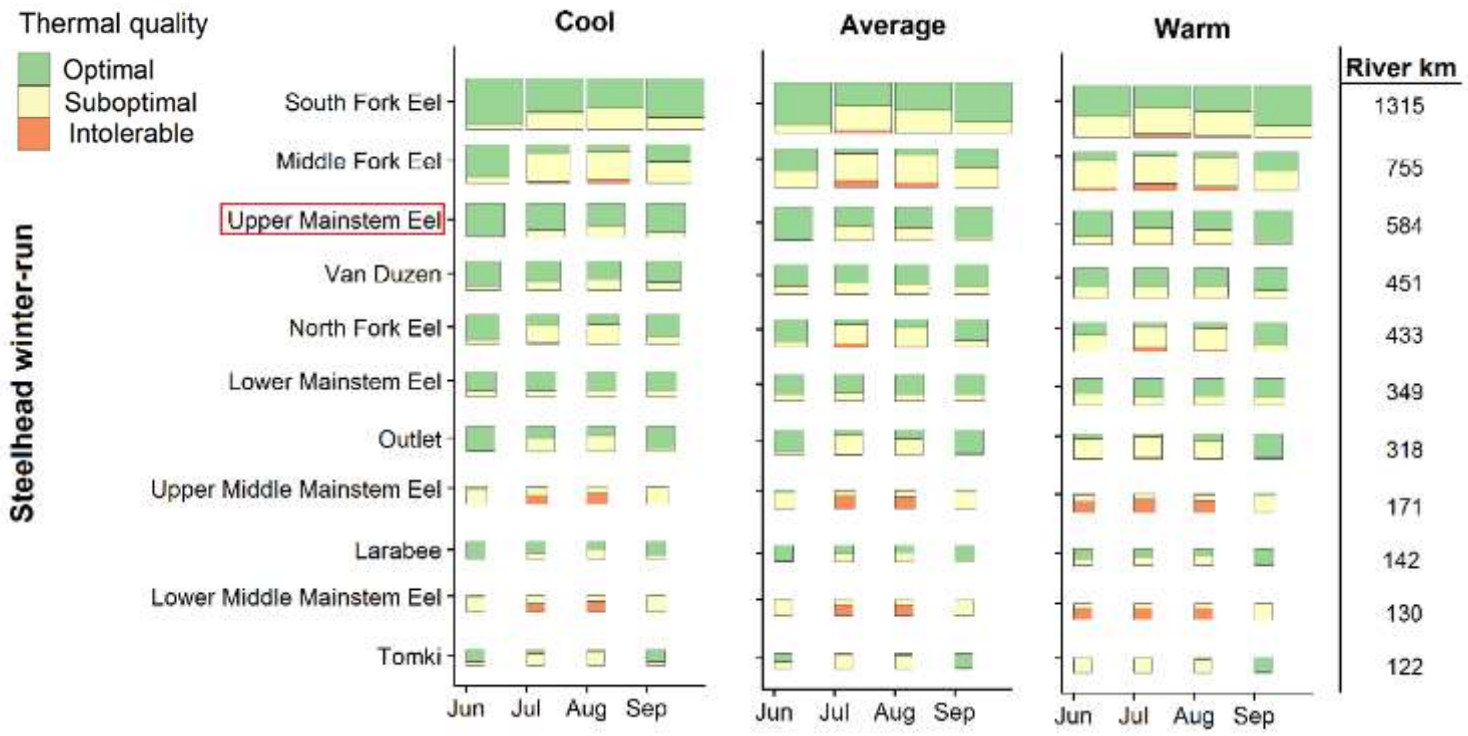
- Juveniles rear in a wide range of habitats, so temperature more restricting
- **Higher proportion green -> Good**
- Worse conditions in July & August
  - Chinook outmigrate by summer

Results: Juvenile Rearing



- Worse conditions in July & August
- Most reaches not lethal, many suboptimal -> Rearing squeezed in summer
- S. Fork had greatest amount of optimal space in July; **second was Upp. Main.**

Results: Juvenile Rearing



- Worse conditions in July & August
- Most reaches not lethal, many suboptimal -> Rearing squeezed in summer
- S. Fork had greatest amount of optimal space in July; **second was Upp. Main.**
- Better conditions in cool year, worse conditions in drought year
- **Upp. Main.** had no intolerable conditions

Summary: Approach 1

- Suitable habitat restricted during summer, warm year
  - Rearing juveniles were the most impacted, due to high temps and pikeminnow exposure
  - Late STL incubation
- **Upp. Main. had a similar or higher proportion of suitable habitat during all life stages relative to other subbasins**
  - Comparable to Van Duzen
  - STL: 169-467 km
  - CHK: 51-129 km

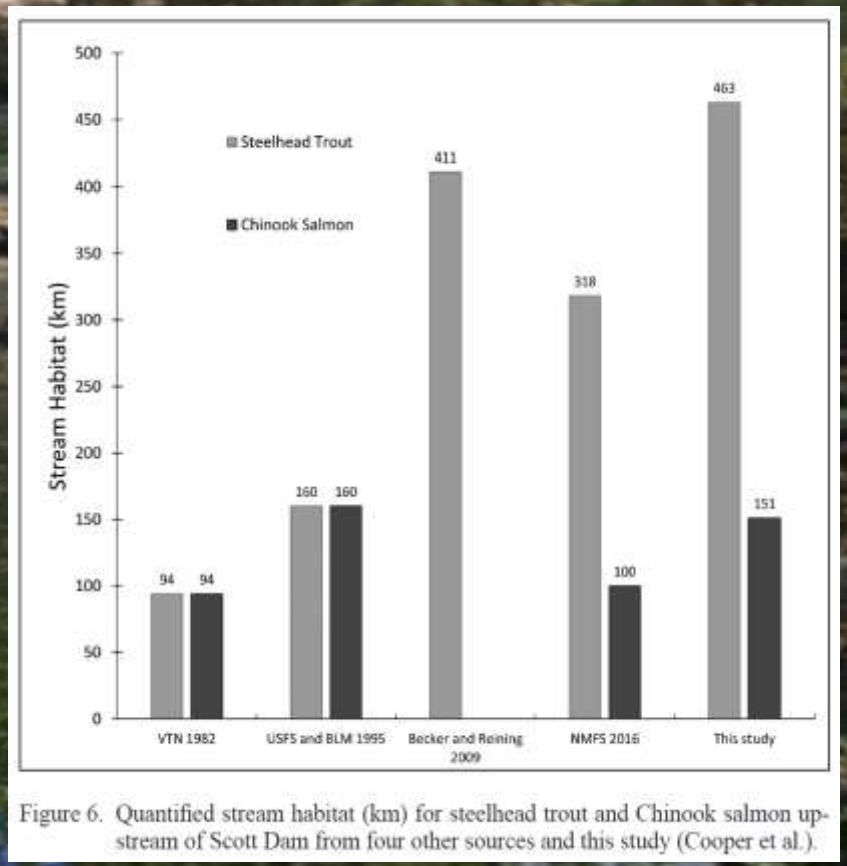


Figure 6. Quantified stream habitat (km) for steelhead trout and Chinook salmon upstream of Scott Dam from four other sources and this study (Cooper et al.).

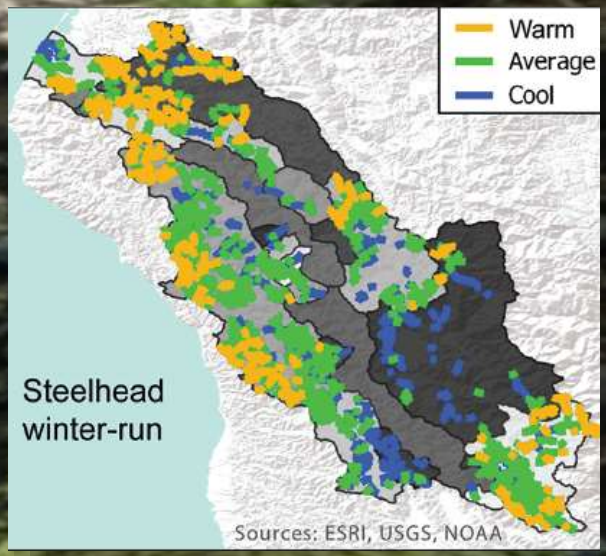
Figure 6 from Cooper et al. 2020

Bear Creek (upper) in Upp. Main. Cooper 2017

Summary: Approach 1

Opening access to **Upp. Main.** would be similar to adding a Van Duzen subbasin to Eel Basin

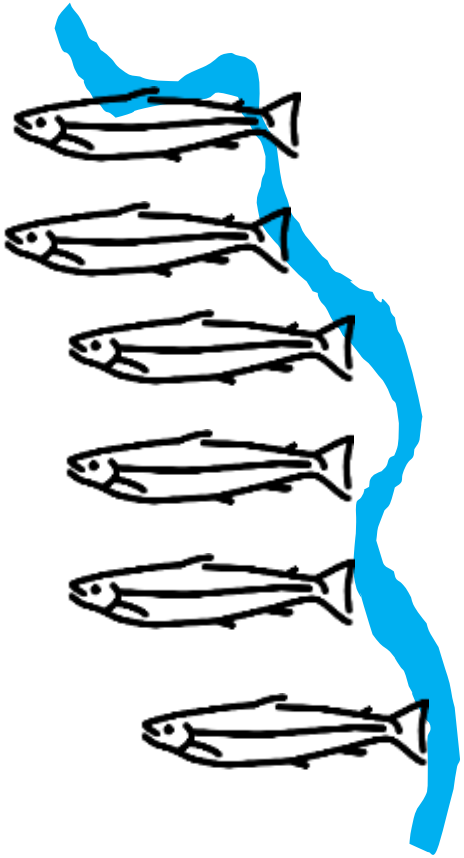
Upp. Main. could likely sustain anadromous populations, even during warm years



*How many fish could **Upp. Main.** sustain??*

Bear Creek (upper) in Upp. Main. Cooper 2017

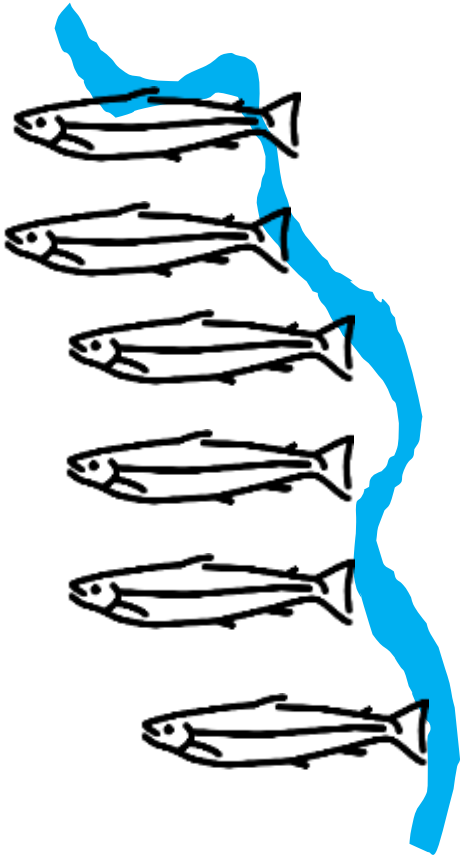
Methodological Approach 2



Baseline fish density

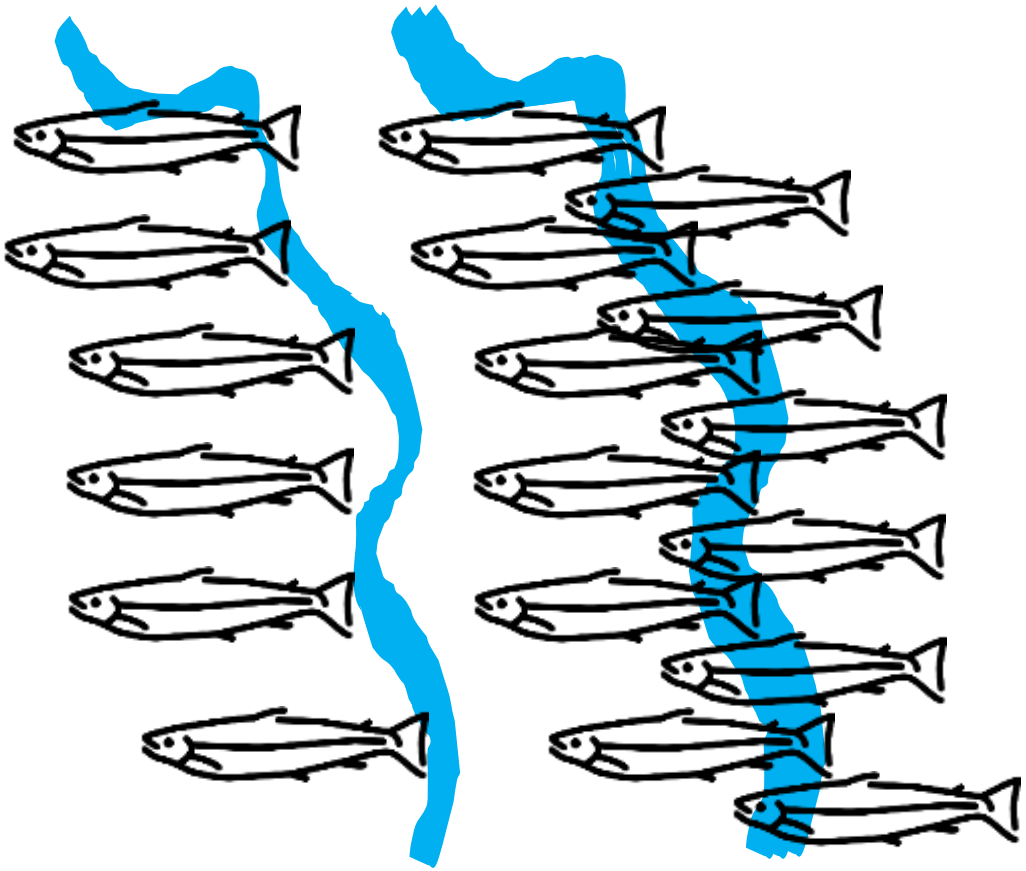
- Unit Characteristic Method (UCM) to estimate parr capacity (Cramer & Ackerman 2009)
- Multiplies baseline fish density by unit area, then adjusts the density by habitat scalar values based on parameters describing local conditions for each habitat type

Methodological Approach 2



Baseline fish density

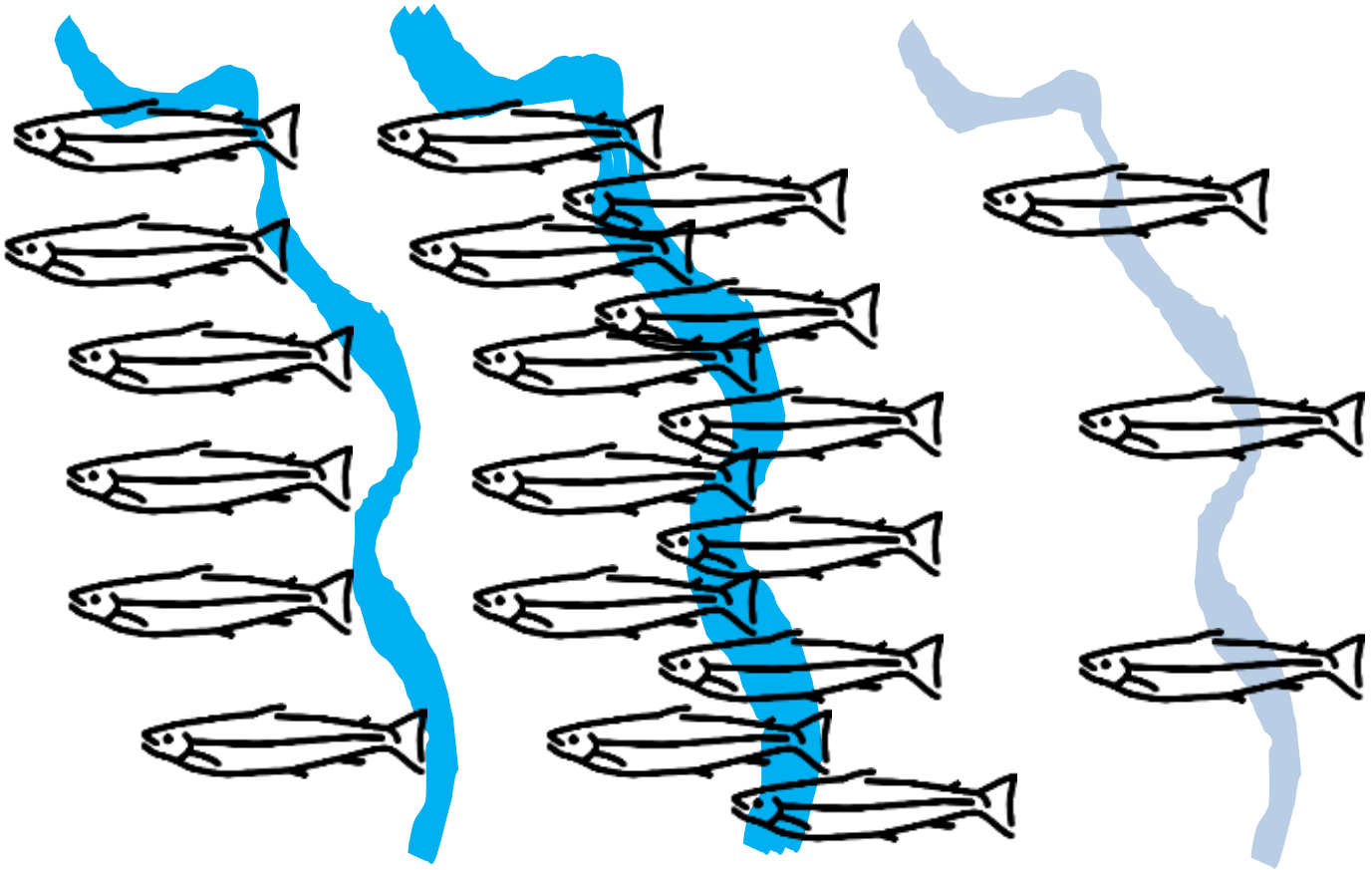
Methodological Approach 2



Baseline fish density

Larger area +
Same habitat ==
More fish

Methodological Approach 2

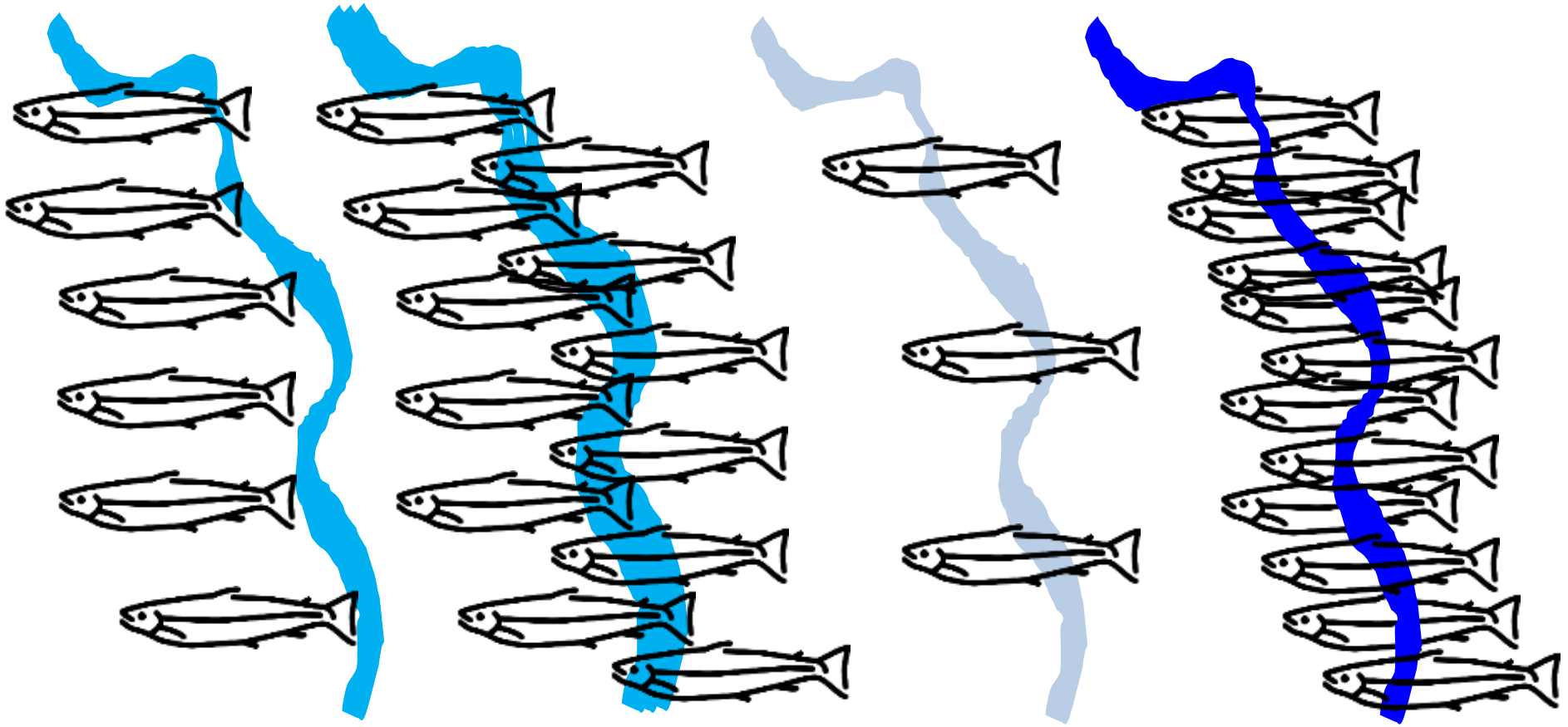


Baseline fish density

Larger area +
Same habitat ==
More fish

Equal area +
Worse habitat ==
Fewer Fish

Methodological Approach 2



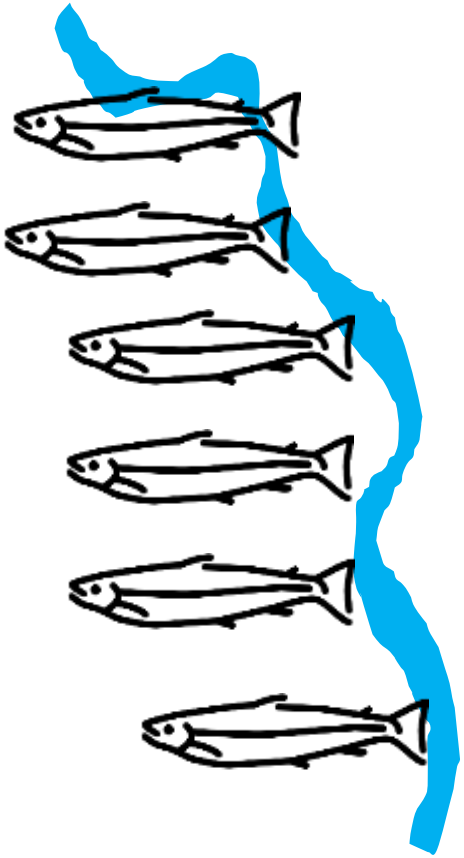
Baseline fish density

Larger area +
Same habitat ==
More fish

Equal area +
Worse habitat ==
Fewer Fish

Equal area +
Better habitat ==
More fish

Baseline Fish Density | Local Conditions | Reach Area



Baseline fish density

- Unit Characteristic Method (UCM) to estimate parr capacity (Cramer & Ackerman 2009)
- Multiplies baseline fish density by unit area, then adjusts the density by habitat scalar values based on parameters describing local conditions for each habitat type

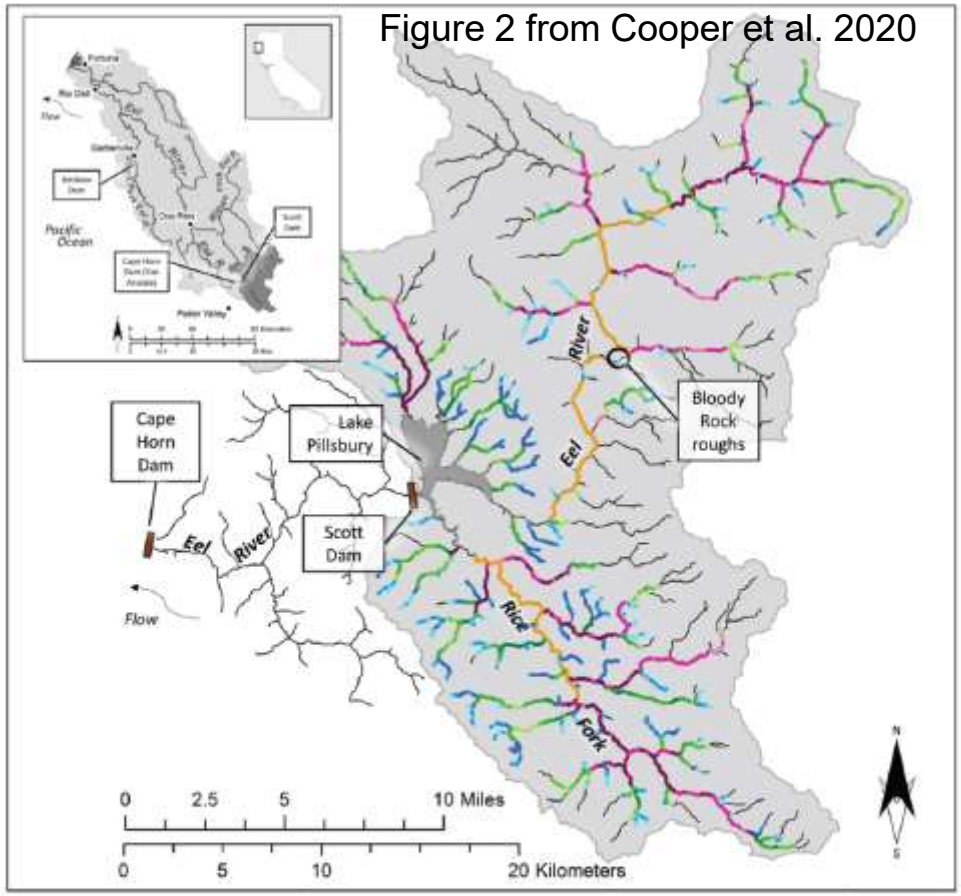
- Baseline fish density -> Oregon
- Reach area (length x width)
  - Modeled wetted width by month from flow gages
- Local conditions (e.g., habitat type, cover, depth, pH, % boulders, temperature)?

Baseline Fish Density

Local Conditions

Reach Area

Figure 2 from Cooper et al. 2020



Drainage Area	0 - 2 km²			2 - 10 km²				10 – 100 km²			> 100 km²
Slope	0 – 2%	2 – 7%	7 – 12%	0 – 2%	2 – 7%	7 – 12%	> 12%	0 – 2%	2 – 7%	7 – 12%	0 – 2%
RT	2.1	3.1	4.1	1.2	2.2	3.2	4.2	1.3	2.3	3.3	1.4

Figure 2. Study area streams were classified and coded into Reach Types (RT) by categories of drainage area (color) and slope (steeper slopes in lighter shades) for data collection and extrapolation. Bloody Rock roughs is a partial barrier and thin black streams upstream of Scott Dam are inaccessible to anadromous salmonids.

Salmonid Habitat and Population Capacity Estimates for Steelhead Trout and Chinook Salmon Upstream of Scott Dam in the Eel River, California

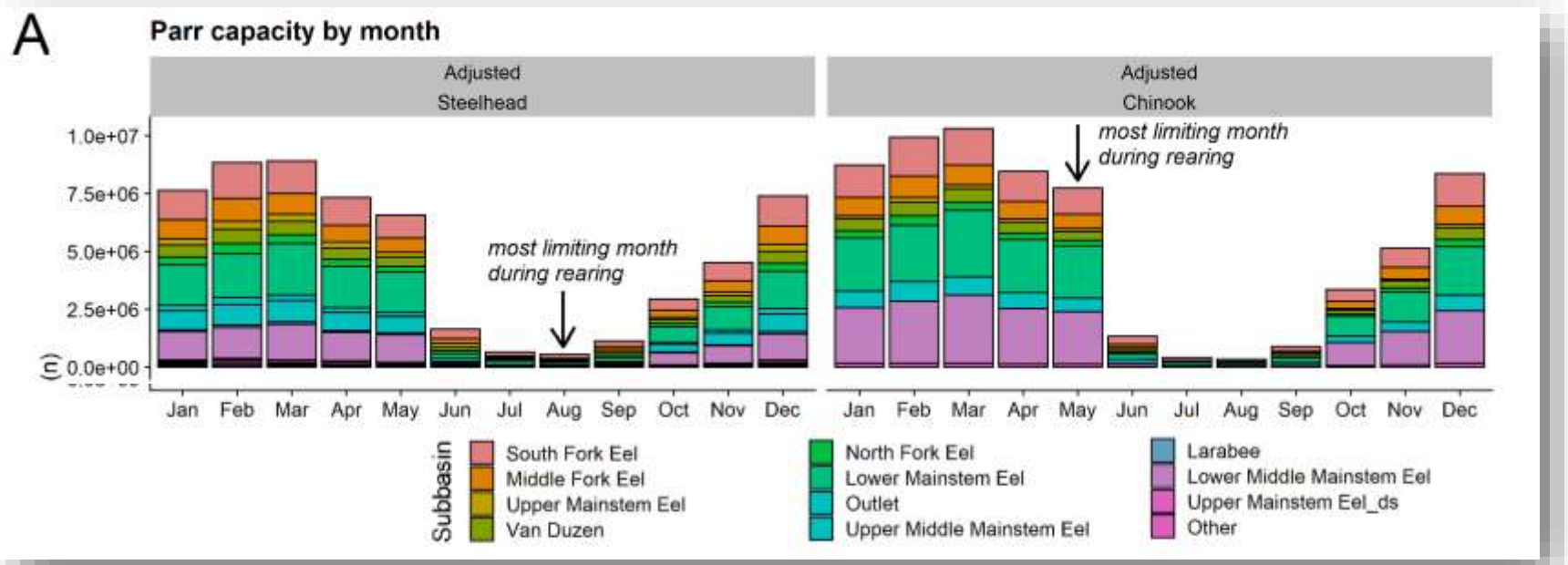
Emily J. Cooper, Alison P. O'Dowd, James J. Graham, Darren W. Milenz, William J. Trush, Ross Taylor

Author Affiliations ~

Northwest Science, 94(1):70-96 (2020). https://doi.org/10.3955/0346-094.0106

- Cooper (2017), Cooper et al. (2020)
- Extrapolated local conditions based on Reach Type
- **Assumed that local conditions in Upp. Main. are representative of other subbasins**

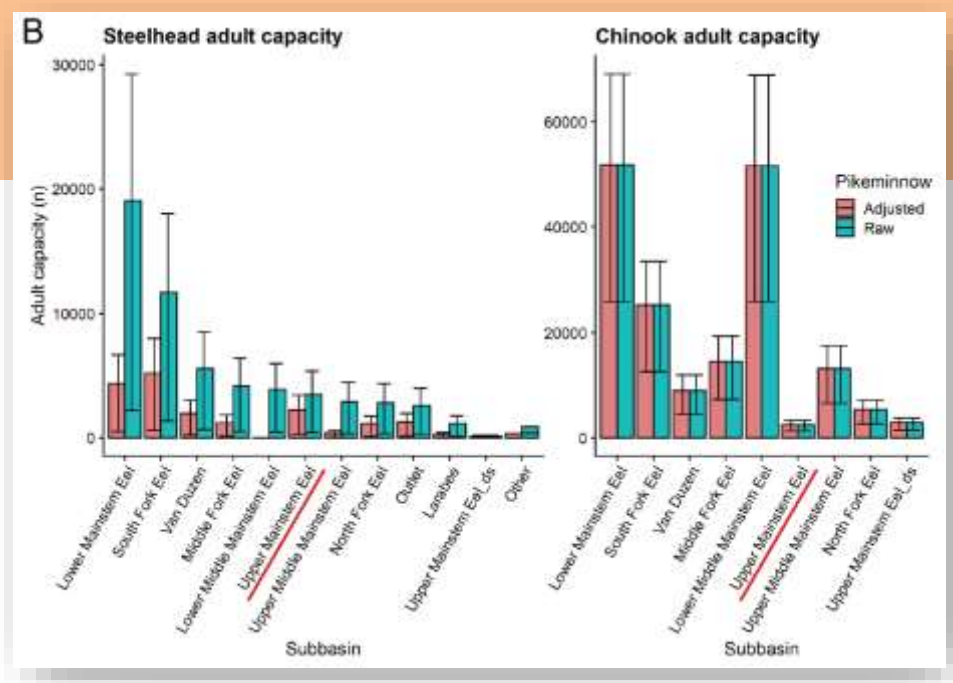
Results: Parr capacity by month



- **Steelhead**
  - 11.5% of the parr capacity in **Upp. Main.**
    - Similar to the Van Duzen
  - If unadjusted for pikeminnow, 5.8% of parr capacity in the **Upp. Main.**
- **Chinook salmon**
  - 1.4% of the parr capacity in **Upp. Main.**
  - Not adjusted for pikeminnow because temperature too cool in May

Results: Spawner capacity

- Converted parr to spawner capacity using parr-adult survival model and 3 different ocean survival models
- Large range in capacity estimates
  - STL: 256-5,370
  - CHK: 1,242-3,314
  - 3 different survival models
  - parr estimates were adjusted for pikeminnow exposure
- CHK capacity estimates overlap with previous estimates
- STL capacity estimates overlap when applying the moderate or high ocean survival model
  - Previous studies did not account for pikeminnow



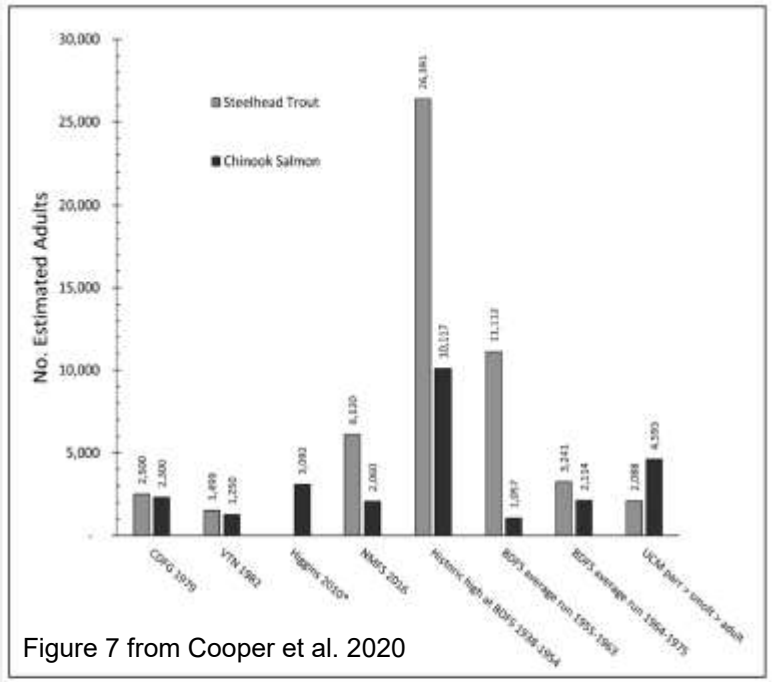


Figure 7 from Cooper et al. 2020

Alyssa.fitzgerald@noaa.gov

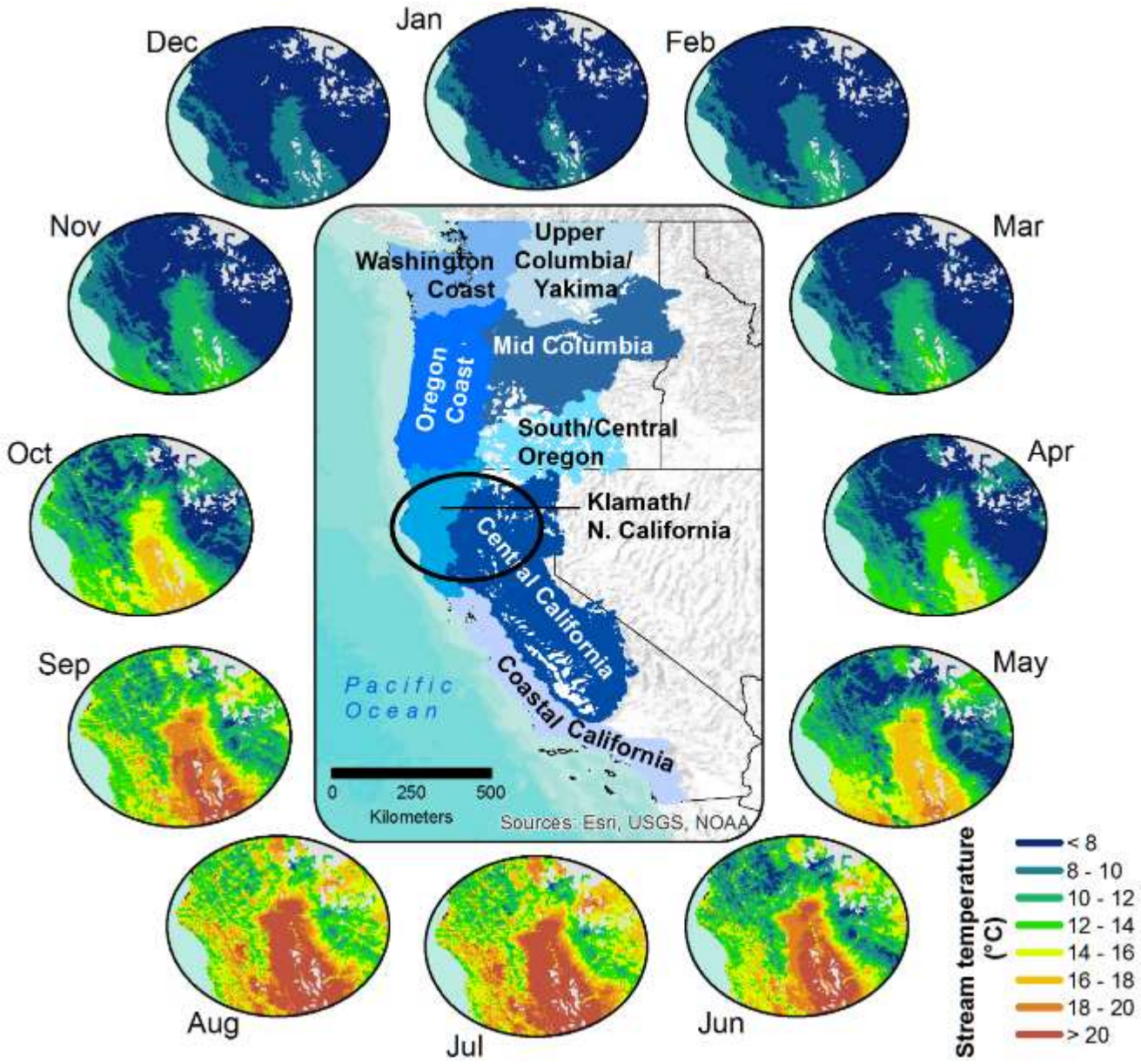
Conclusions

- Eel River Basin is particularly dynamic, with lots of spatial and temporal heterogeneity
- **Upp. Main.** harbors a large amount of thermally suitable, productive habitat types
  - Cool-water refuge during summer, warm years
  - **Upp. Main.** similar to Van Duzen
- Capacity estimates are wide, but generally overlap with other estimates
- **Upp. Main.** could sustain populations of anadromous salmonids

Cooper 2016

EXTRA

Accessibility | Channel productivity | Thermal suitability

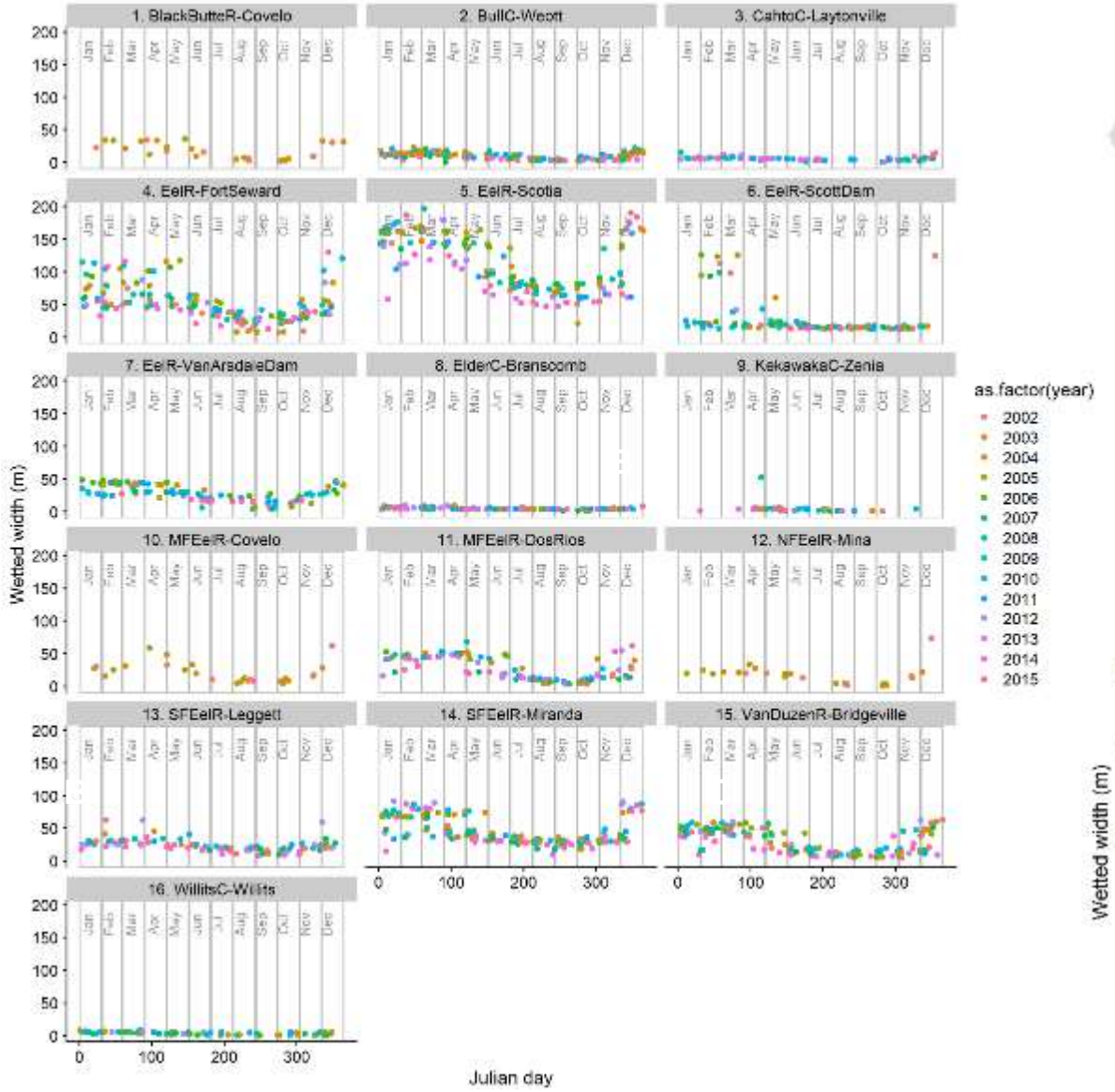


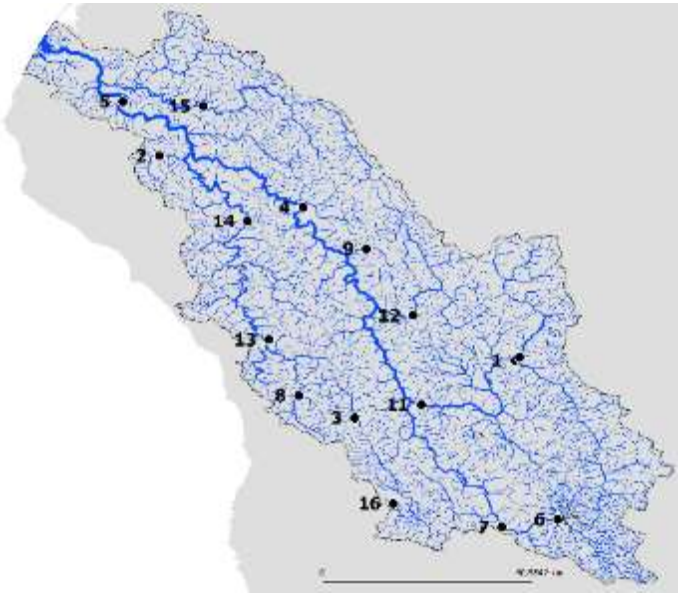
- Expanded a pre-existing spatial stream network (SSN) model
  - https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html
- Mean monthly stream temperature predictions for ~380,000 stream km in western U.S., across 8 major watershed units
- $r^2 = 0.925$
- Error ~ 1°C

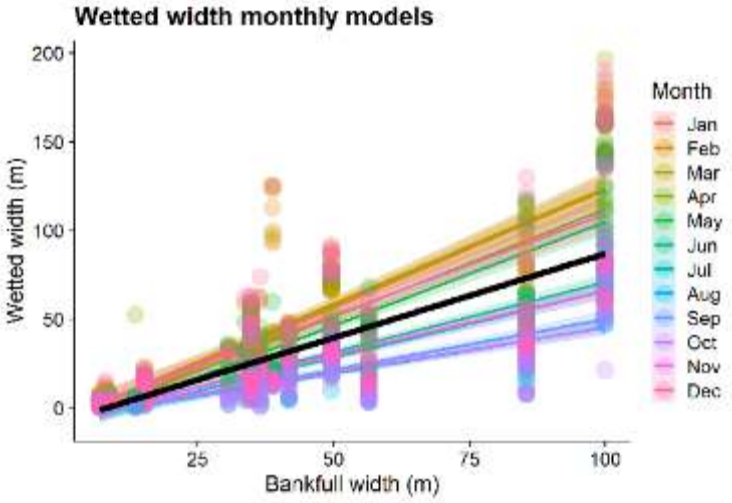
Baseline Fish Density

Local Conditions

Reach Area







Results: Spawner capacity

- To convert from parr to spawner capacity:

- **Steelhead**
- Parr-adult survival model
  - 28% survival
- Ocean survival models
  - 1.5%
  - 13%
  - 20%

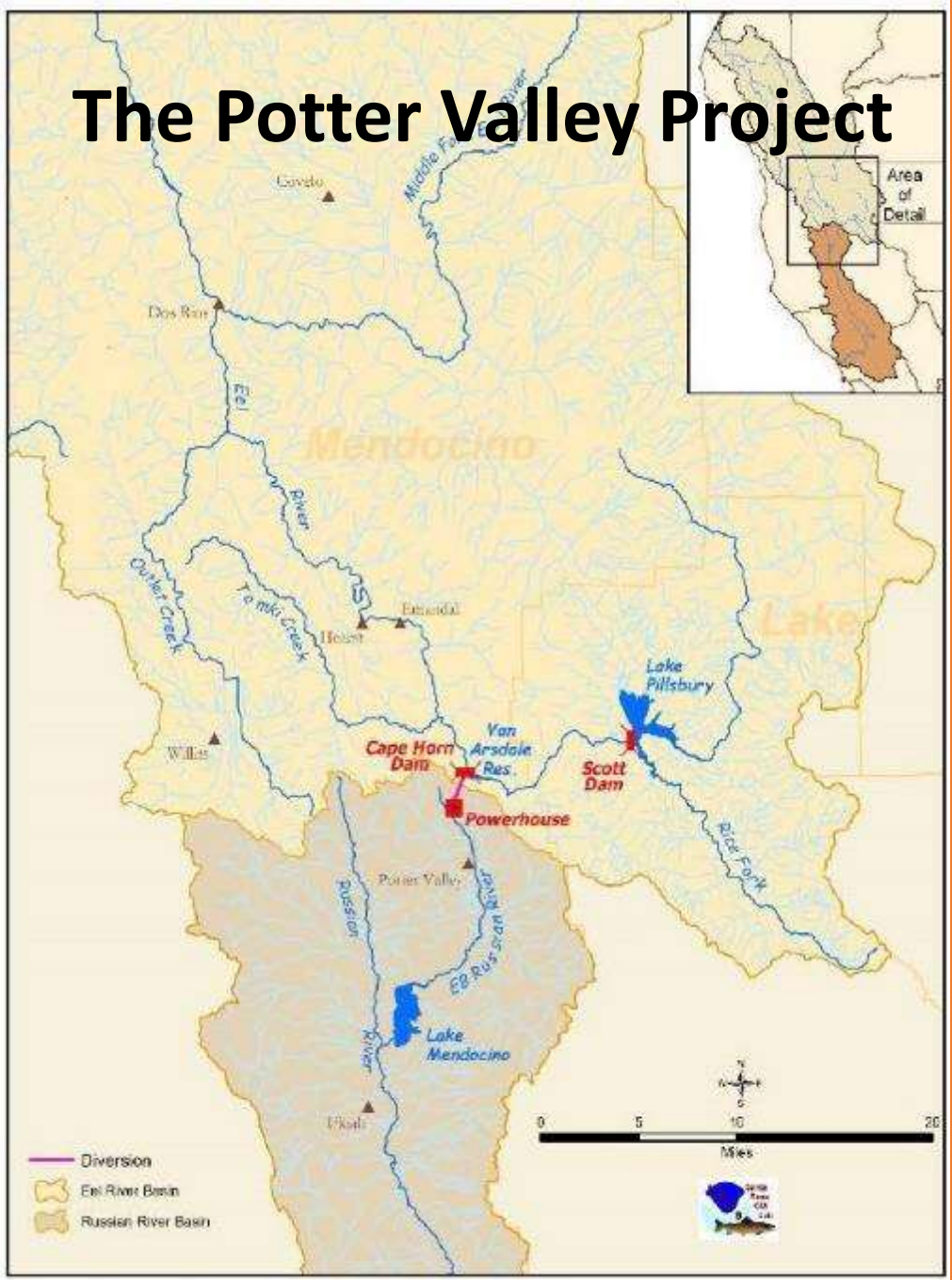
- **Chinook salmon**
- Parr-adult survival model
  - 76% survival
- Ocean survival models
  - 1.5%
  - 3.0%
  - 4.0%

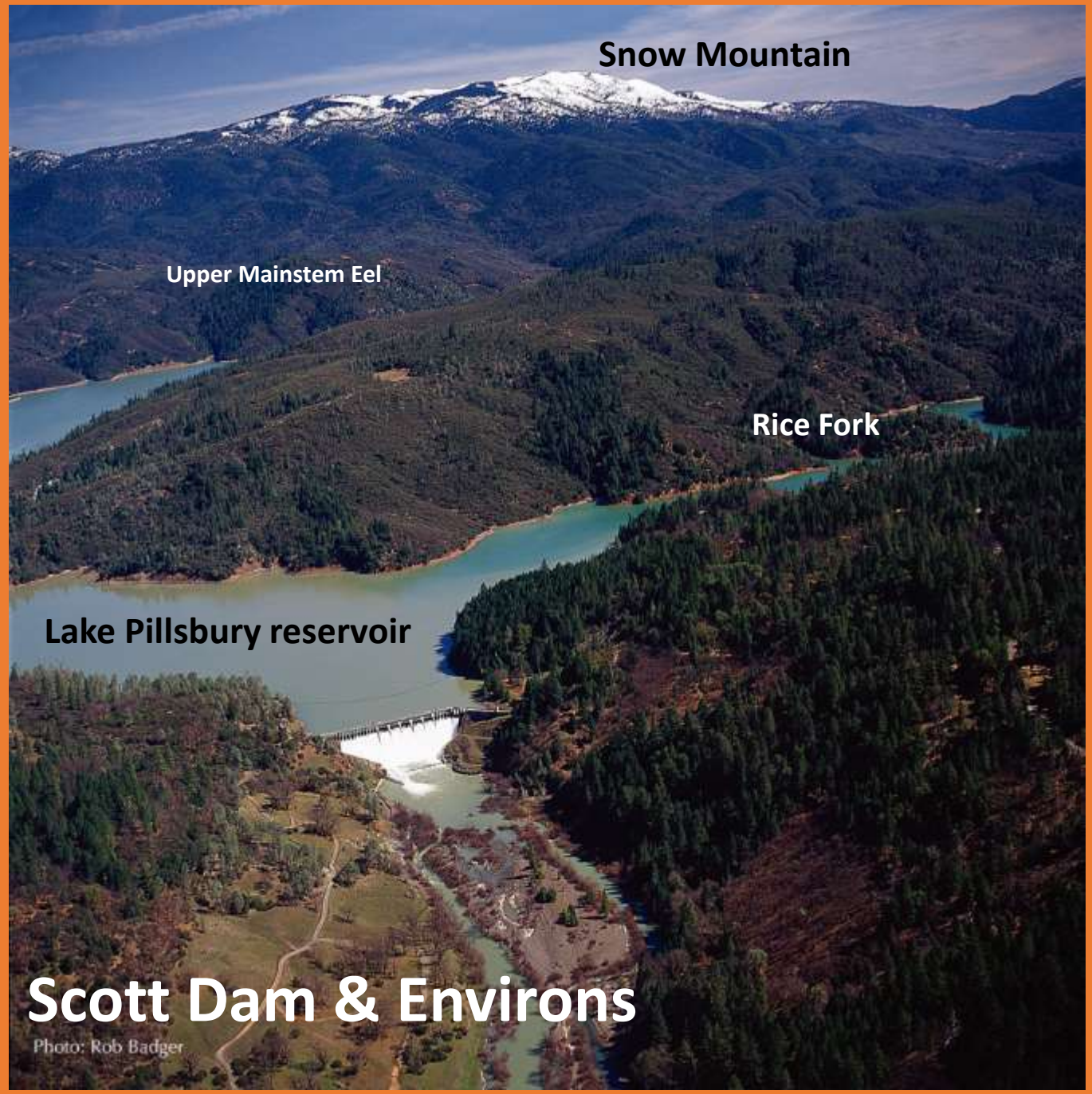
Scott Greacen
Conservation Director
Friends of the Eel River

ESA Advocacy on the Eel

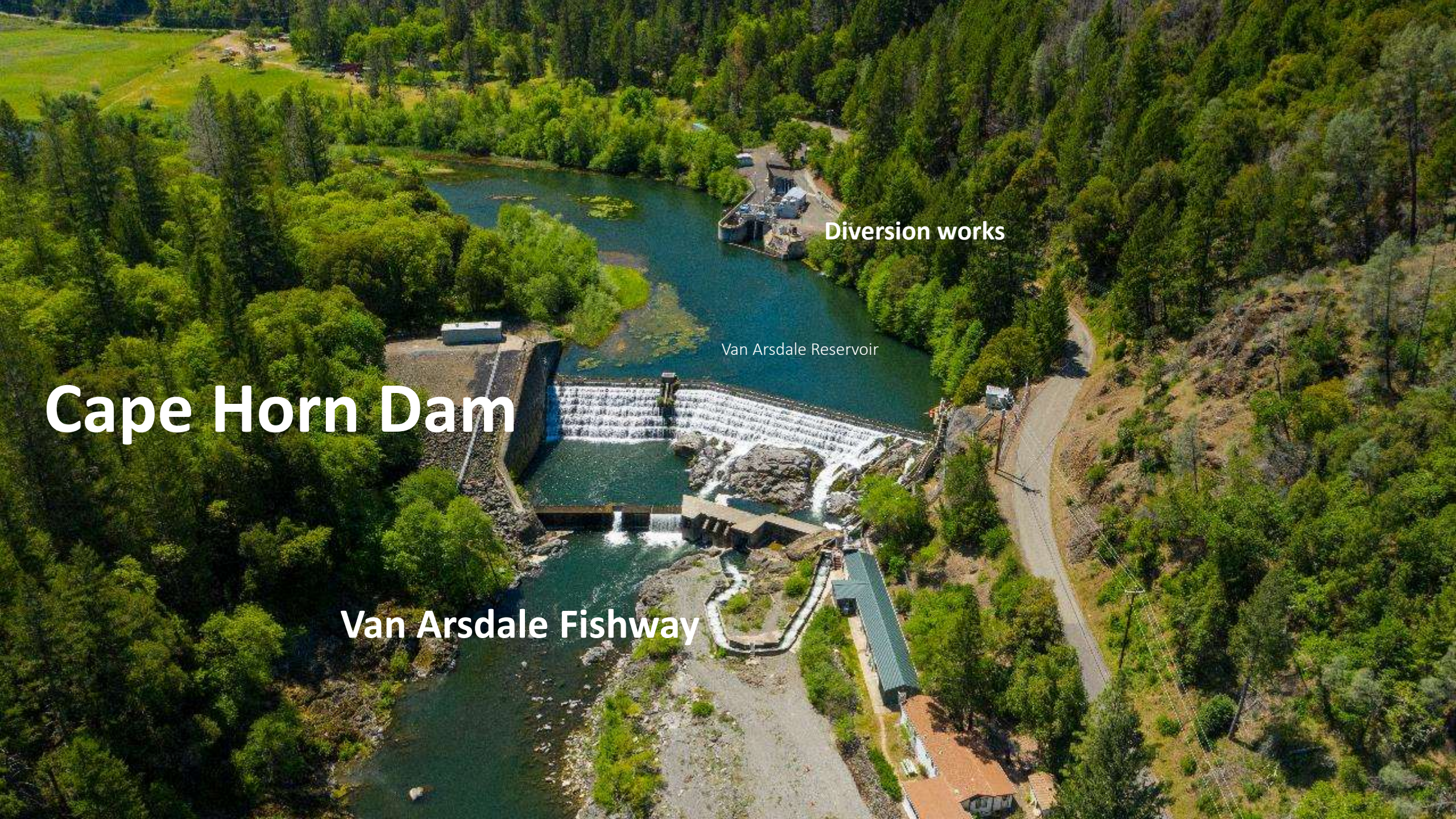
Citizen Enforcement of the Endangered Species Act and Removing Barriers to Salmonid Recovery

The Potter Valley Project






Scott Dam
More Gates
Gates
Gates
The Knocker
The Only Low-Elevation Outlet



Cape Horn Dam

Van Arsdale Fishway

Take (and its consequences) under the ESA

Take

The ESA defines "*take*" as:

"*harass*, *harm*, **pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."**

- Department of Commerce regulations define "*harm*" as "An act which actually kills or injures fish or wildlife," including "significant habitat modification or degradation which actually kills or injures fish or wildlife by *significantly impairing essential behavioral patterns*, including breeding, spawning, rearing, migrating, feeding or sheltering."
- DoC guidance defines "*harass*" as "Creat[ing] the likelihood of injury to wildlife by annoying it to such an extent as to *significantly disrupt normal behavioral patterns* which include, but are not limited to, breeding, feeding, or sheltering."

ESA Section 7

Requires federal agencies to:

- Aid in the conservation of listed species, and
- Ensure their activities are *not likely to jeopardize* the continued existence of listed species or destroy or adversely modify designated critical habitats.
- Consult with NMFS/FWS where actions "*may affect*" listed species or their habitat.

ESA Section 9

(and Dept of Commerce regs) make it *unlawful* for any person to "take" federally listed fish species within the United States without a permit from NMFS/USFWS.

FERC Licensing

- All hydropower dams must have a license from the Federal Energy Regulatory Commission (FERC)
- Long-term licenses (25-50 years)
- Compliance with all other laws (ESA, CWA, etc.) wrapped into relicensing
- Potter Valley Project was relicensed in 1977
- Chinook and steelhead listed under ESA (1999, 2000)
- 2003 NMFS Biological Opinion finds PG&E operations of Potter Valley Project under FERC license *jeopardize* ESA listed Eel River Chinook and steelhead

Jeopardy and its consequences

NMFS' 2003 Biological Opinion (BiOP)

- **Jeopardy determination**

  Jeopardize the continued existence of = engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02)

- **Running the PVP for maximum power production risks driving Eel River salmon and steelhead extinct in the Upper Mainstem**
- **Reasonable and Prudent Alternative (RPA)** = alternative methods of project implementation to avoid jeopardy
- Jeopardy finding forces FERC to amend the PVP license to adopt the RPA, changing PG&E's instructions

PG&E has operated PVP under RPA since 2003

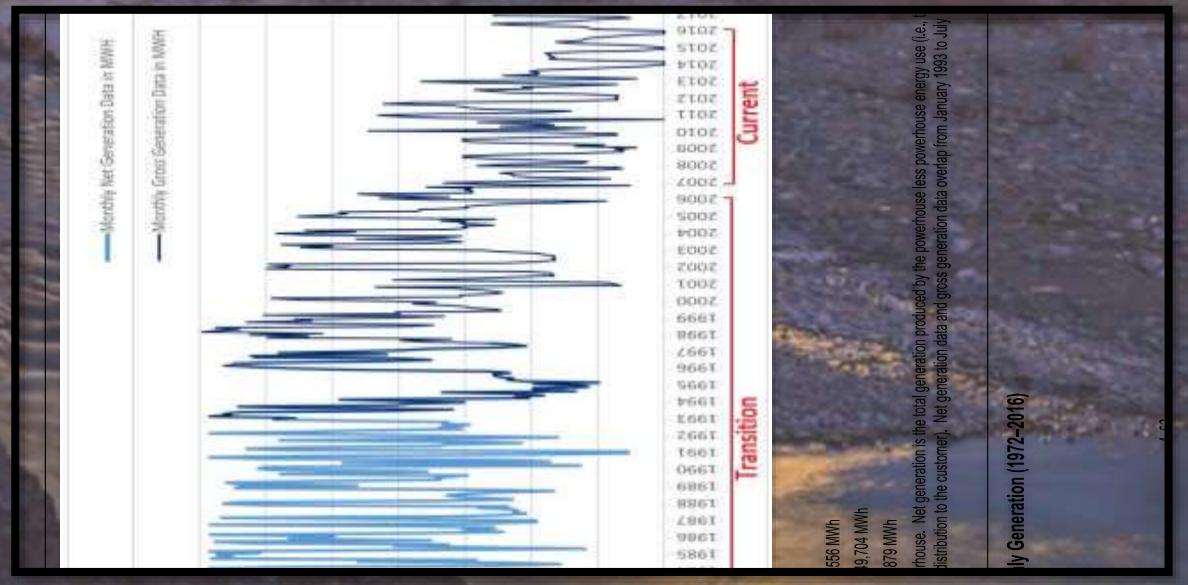
RPA flow schedule approximates natural flow regime

Changes utility of PVP as hydropower asset

- PVP was tiny to begin with – 9.2 MW nominal capacity
- Unspecified flows stay in the Eel – PG&E and PVID can't just take any excess as they did before

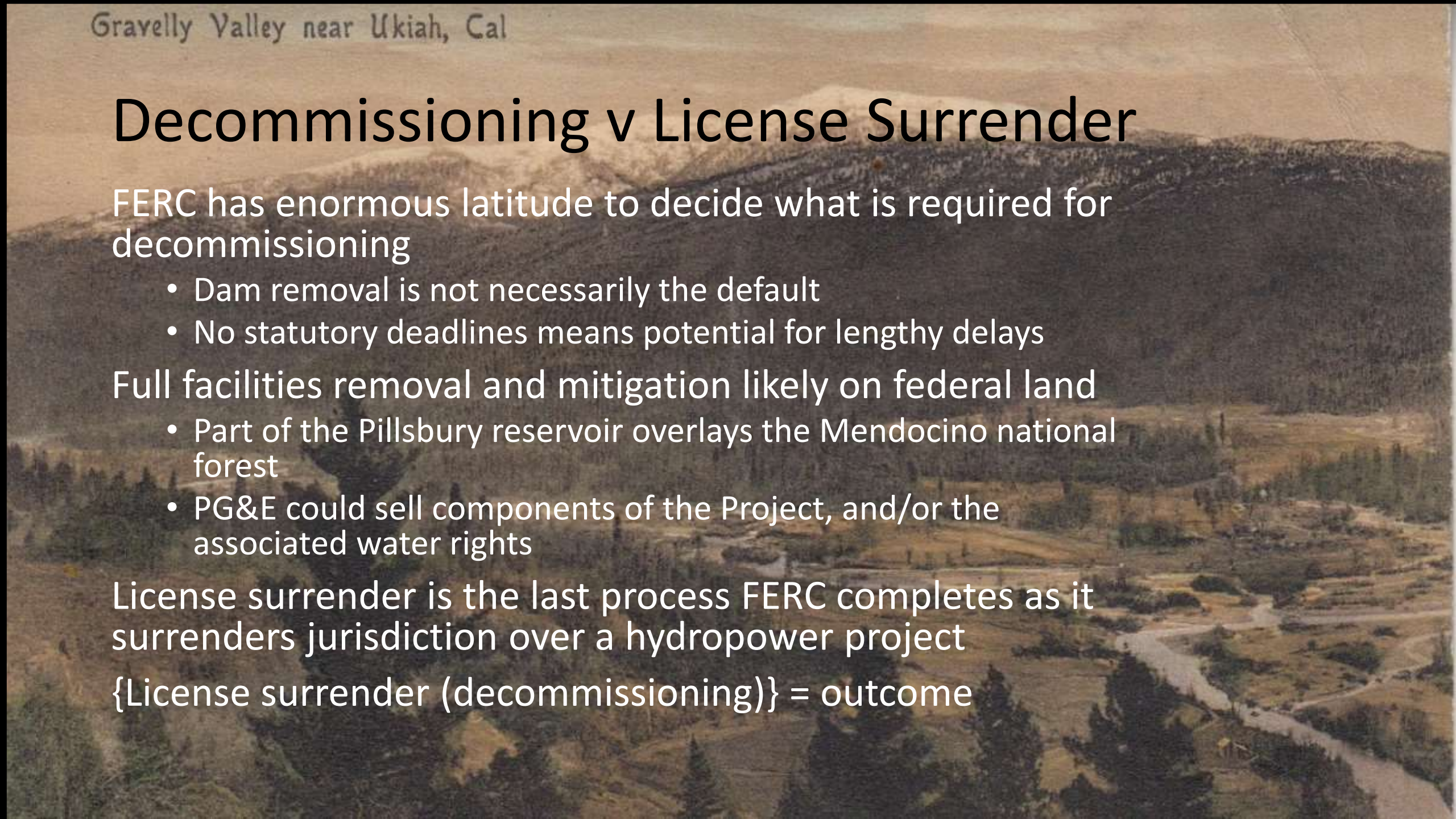
RPA has broken down over 20 years of implementation.

Variances more common than not.



From relicensing to decommissioning

- **2017 PG&E proposes to relicense the Potter Valley Project**
- **2018 offers to auction PVP during relicensing**
  - Auction spiked after Camp Fire
  - PG&E retreat to bankruptcy to protect shareholder$ from fire victims
- **January 2019 PG&E withdraws relicensing application**
  - Cannot license PVP again
- **June 2019 Two Basin Solution group formed to attempt relicensing**
  - 2022 relicensing effort fails
  - Because PG&E refused to fund it
  - Closes the door to any future relicensing of PVP as a hydroelectric facility
- **April 15, 2022 PVP license expired**
- **April 21, 2022 FERC issues Annual License to PG&E**
  - Will remain in effect through decommissioning, until license surrender
  - Same terms as previous license, including RPA
- **PG&E decommissioning plan now due late 2023**



Decommissioning v License Surrender

FERC has enormous latitude to decide what is required for decommissioning

- Dam removal is not necessarily the default
- No statutory deadlines means potential for lengthy delays

Full facilities removal and mitigation likely on federal land

- Part of the Pillsbury reservoir overlays the Mendocino national forest
- PG&E could sell components of the Project, and/or the associated water rights

License surrender is the last process FERC completes as it surrenders jurisdiction over a hydropower project

{License surrender (decommissioning)} = outcome

Meanwhile, take continues at PVP

NMFS to FERC: *March 17, 2022*

The 20-year duration of the proposed action is a central component of the Opinion. We relied upon this set duration to: (1) assess the effects of the proposed action; (2) develop the RPAs necessary to avoid jeopardy and the destruction or adverse modification of critical habitat; and (3) evaluate the effectiveness of the RPAs over the expected life of the proposed action.

Based on information currently available, we conclude that the Project is causing take of ESA-listed salmonids in a manner not anticipated in the Opinion and from activities not described in the Opinion.

- BiOp expires with PVP license April 15, 2022
- Incidental Take Statement (ITS) exceeded
- Cape Horn Dam and fishway never covered by ITS
- RPA is failing to provide for Chinook and steelhead production & recovery
- Interim Protective Measures required pending decommissioning

Causes of take include:

At Cape Horn

- Closures & blockages in higher flows
- Predation in the ladder
- Predation on downstream migrants above the ladder
- Downstream migrants killed & injured passing down the dam

Interdam reach

- Pikeminnow
- Temperature

Below Cape Horn

- Predation on upstream migrants
- Temperature

FERC's ESA liability for allowing take at PVP

Section 7(a)(1)

- failing to ensure operation of the Project is consistent with the conservation of listed species

Section 7(a)(2)

- failing to ensure operation of the Project is not likely to jeopardize the continued existence of these listed species or destroy or adversely modify their critical habitat.
- issuing the Annual License without initiating or reinitiating consultation with the National Marine Fisheries Service ("NMFS") regarding the Project's effects on the listed species and their designated critical habitat

Section 9(a)(1)(B)

- authorizing an activity that harms, kills, and otherwise causes take of the listed species

Addressing FERC's role in take at the PVP

May 20, 2022 filing with FERC challenging issuance of an "annual license" to PG&E:

MOTION TO INTERVENE AND REQUEST AND PETITION FOR REHEARING, RECONSIDERATION, AND/OR DISCRETIONARY ACTION

- Seeking FERC move to amend PVP Annual License to comply with ESA
- Denied by operation of law

Ninth Circuit petition for review filed August 15, 2022

- Plaintiffs: PCFFA/IFR, Trout Unlimited, CalTrout & FOER
- Now under abeyance

FERC now considering whether to open a proceeding to amend the PVP license to impose the Interim Protective Measures NMFS has specified.

PG&E's potential liability for take at the PVP

Our November 14, 2022 60-day notice letter

PG&E is committing illegal, ongoing take of Chinook salmon and steelhead, in violation of ESA section 9, by continually harming and harassing these fish.

Elevated temperatures harm steelhead, reduce production, increase pikeminnow predation

- **In *nine of the last eleven years*, Scott Dam releases have exceeded 20.0^{O}C; temperatures have exceeded the "intolerable" and "potentially lethal" level of 23.0^{O}C in five of those years.**

Cape Horn Dam harms downmigrating juveniles & kelts, subjects adults and juveniles to predation in fishway

- **Predators observed feeding in or from the fishway include Sacramento Pikeminnow, Smallmouth Bass, Otter, Bald Eagle, Raccoon, and Black Bear.**

Blocking habitat & impeding migration

- **Scott Dam has no fish passage**
- **Cape Horn impairs migration**

Per NMFS, *none of this take is permitted*

- **BiOp & ITS are expired**
- **ITS exceeded**
- **Cape Horn never covered**

Dam Safety questions loom over the PVP

Physical structure of PVP is not sustainable

- Sediment buildup risks only low water outlet
- Reservoir can't be lowered too fast or too far

PG&E's March 16 statement on seismic issues

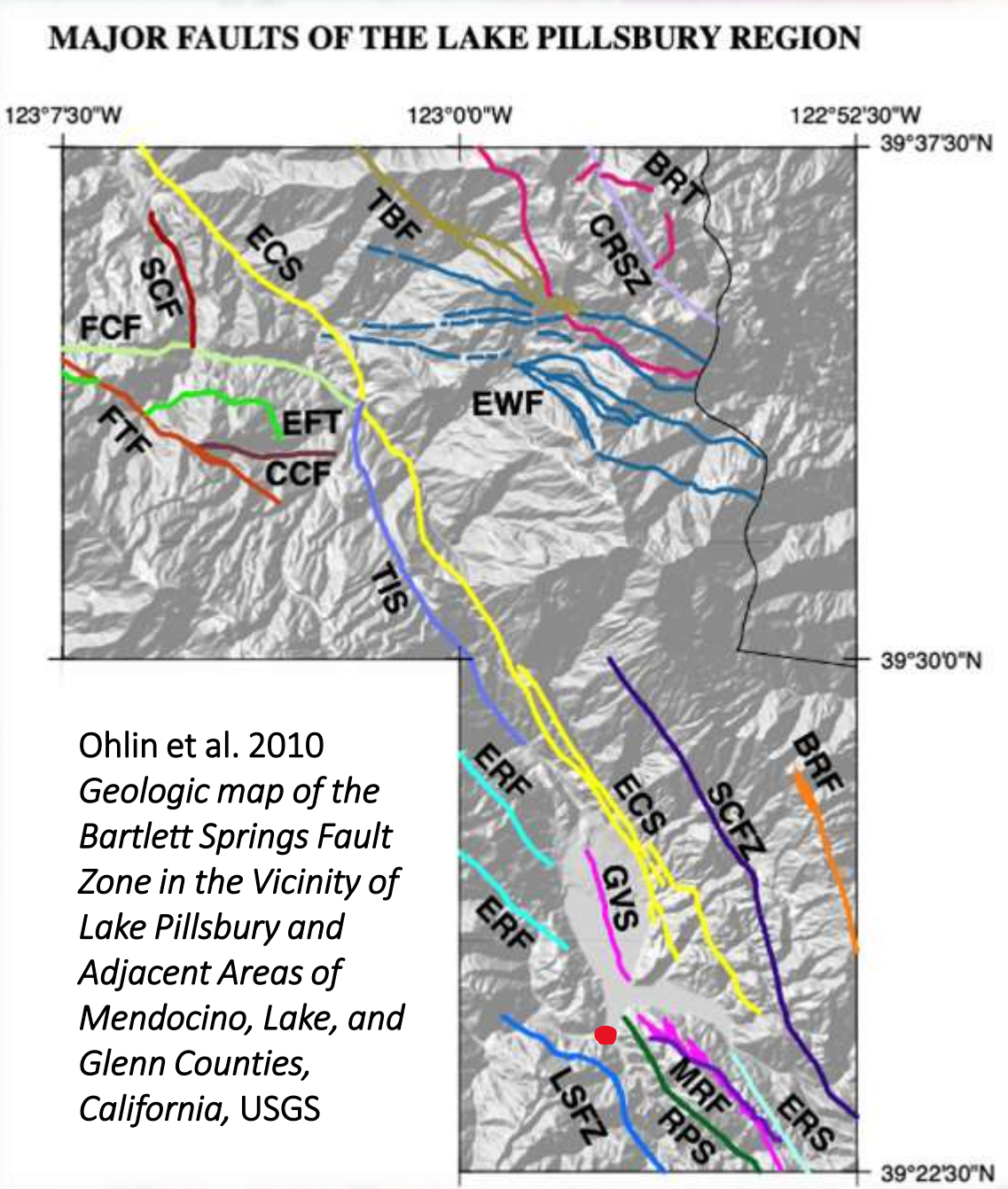
- Raises prospect of 'expedited dam removal'
- Meanwhile Scott Dam's gates will not be raised again
- Capacity of reservoir reduced by about 20K AF

A surprise?

- FERC doesn't consider dam safety an issue for relicensing.
- Lozos et al 2015 **Dynamic rupture models of earthquakes on the Bartlett Springs Fault, Northern California:** *"… ground motions generated by a BSF earthquake may be sizeable… Our models produce a wide magnitude range: from M6.32 to M7.24."*

A Game Changer?

- Dam safety could move the PVP from FERC's free form decommissioning process to a more rapid exercise of the Commission's broad authority to protect public safety.



Ohlin et al. 2010 *Geologic map of the Bartlett Springs Fault Zone in the Vicinity of Lake Pillsbury and Adjacent Areas of Mendocino, Lake, and Glenn Counties, California,* USGS

Oh and no more electricity.
So not so much water to divert either.

PG&E will not replace failed transformer at PVP powerhouse.

- So no more hydropower.
- No more “abandoned” water in East Branch Russian River or Lake Mendocino reservoir.
- Only diversions to Potter Valley Irrigation District under their contract with PG&E will continue.

Decommissioning is not without risks

- Decommissioning ultimately means whatever FERC says it does
- FERC doesn't have statutory deadlines to complete decommissioning
- Potential for decommissioning to be stalled

HOWEVER …


PG&E will propose full facilities removal in its Decommissioning Plan for the Potter Valley Project.
M. Wier

The current is with us

Removal of the Potter Valley Project dams will be a key step toward salmonid recovery in the Eel River.

What are the barriers?

- **Scott and Cape Horn Dams**
- **PG&E**
- **FERC**
- **Dam removal opponents**