



Impacts of Nonnative Fish on Salmon Recovery

Lessons Learned from Long-Term Predation Studies in the San Joaquin Basin

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Co-Authors: Tyler Pilger, Matt Peterson, and Andrea Fuller

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Today's Talk

- Fish impact water management
- Burden placed on water users
- Mechanisms behind flow benefits poorly understood
- Lessons learned from predation research
- Benefits of long-term CV-wide nonnative predator monitoring





What Drives Fish and Water Management in Central Valley?

- Numerous agencies, laws, policies, and plans
- ESA, BiOps, and SWRCB most impactful
 - Minimum flows
 - Delta exports curtailed
 - OMR management
 - X2 (salinity)
 - Temperature objectives
 - Restoration
- Nearly all actions are focused on providing ***additional flow for fish***
- Resulted in little success and most species remain imperiled



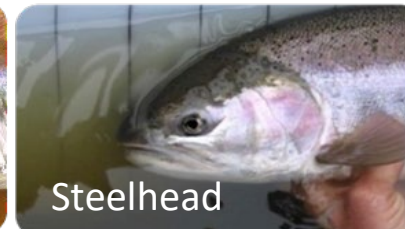
Green Sturgeon



Longfin Smelt



Delta Smelt



Steelhead



Chinook Salmon



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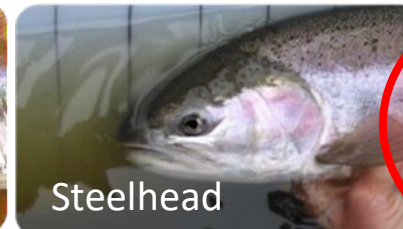
Green Sturgeon



Longfin Smelt



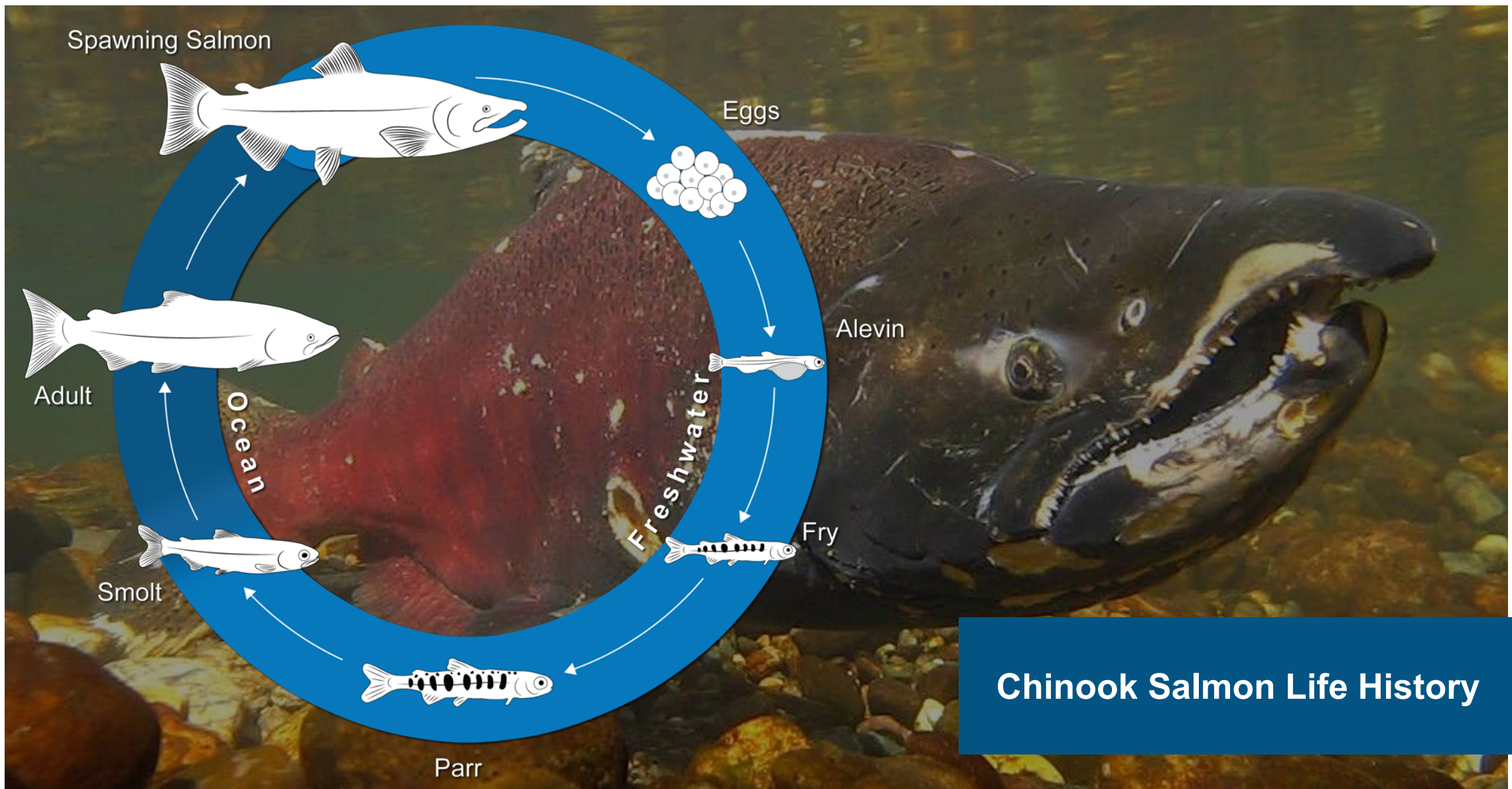
Delta Smelt



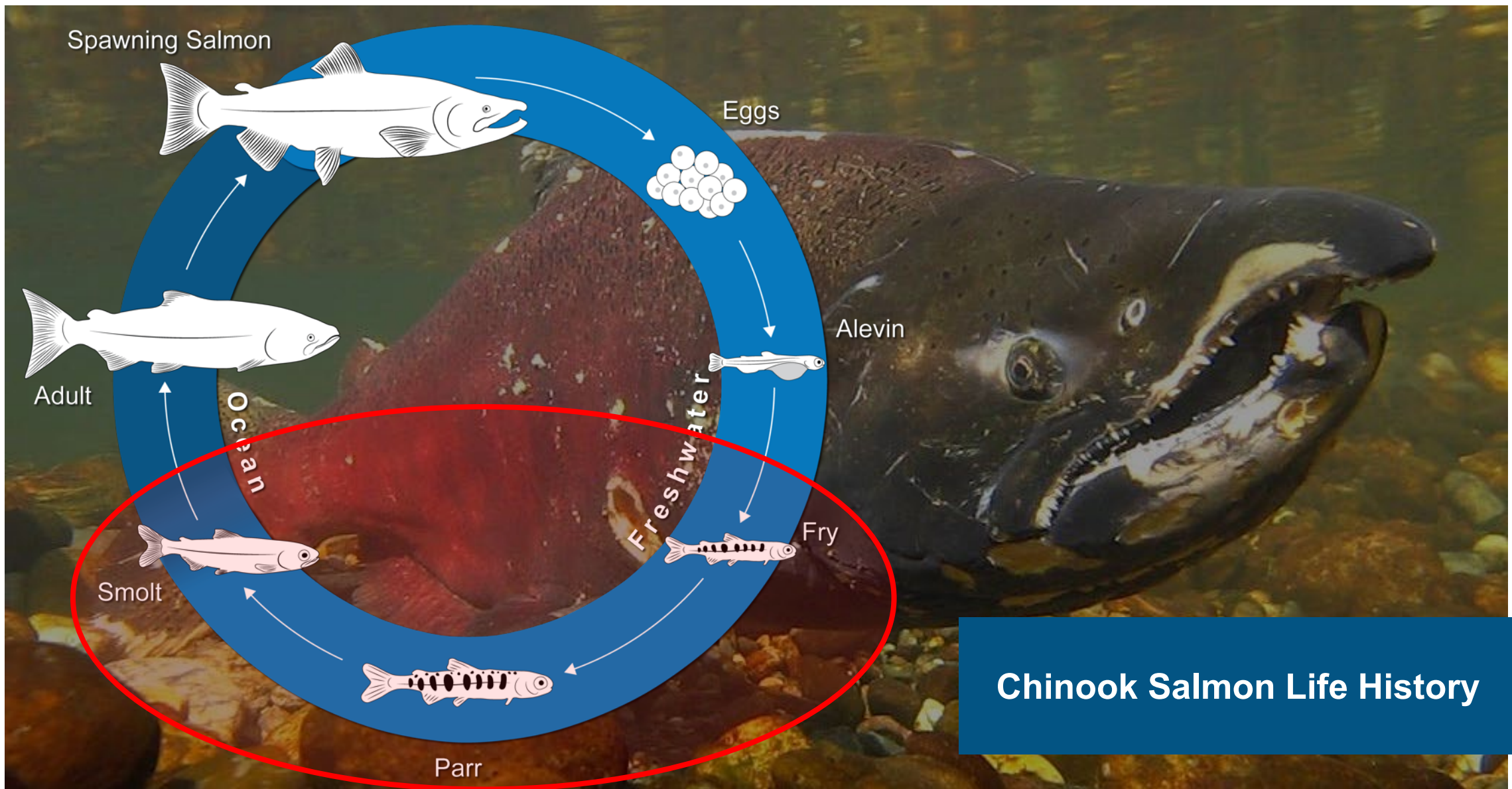
Steelhead



Chinook Salmon



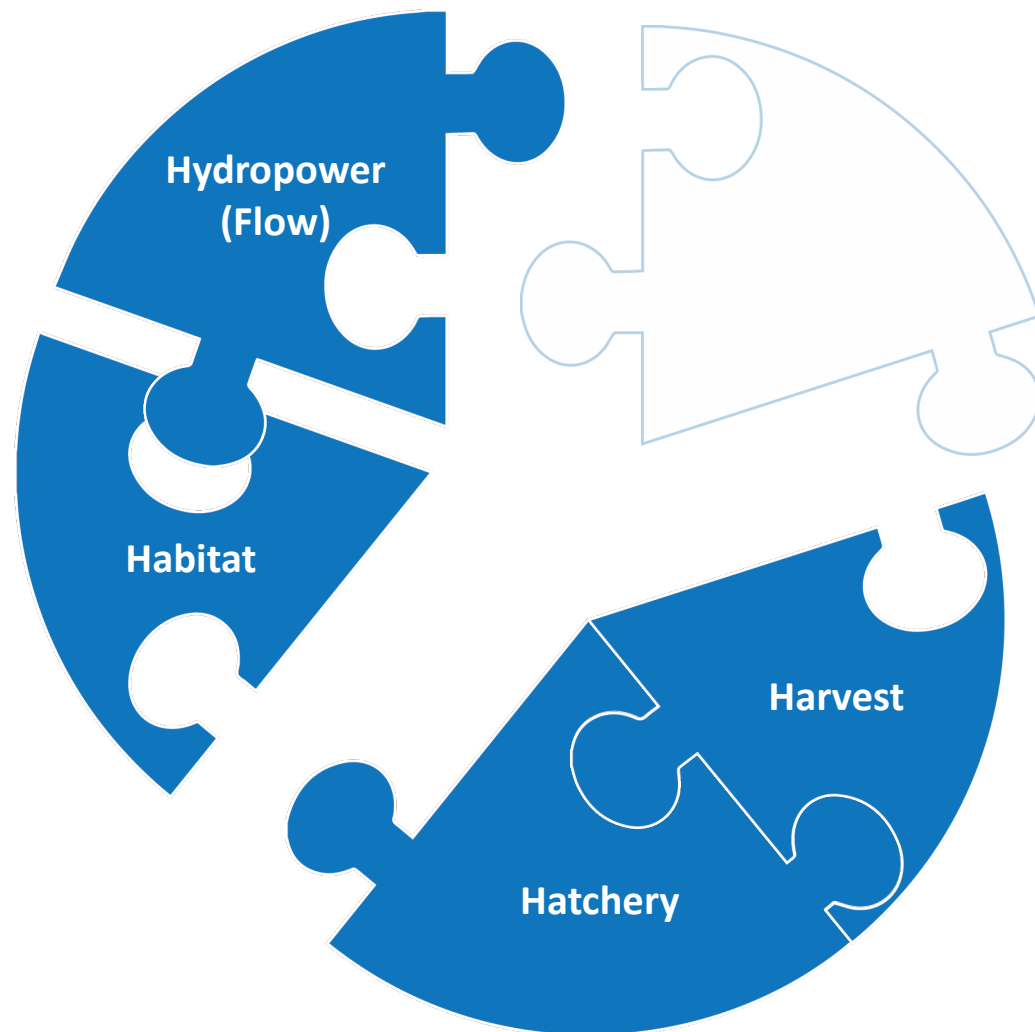
Chinook Salmon Life History



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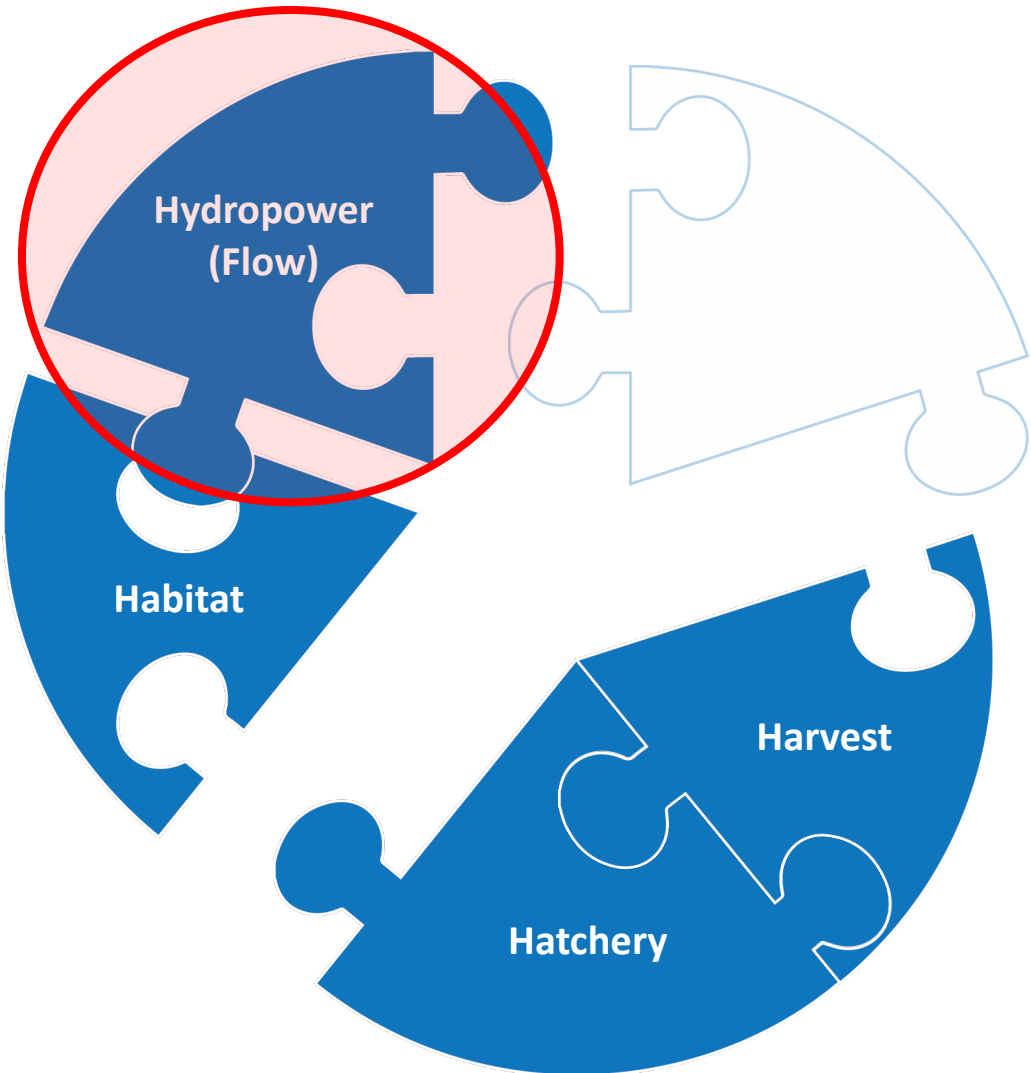


Central Valley Salmon Management Puzzle





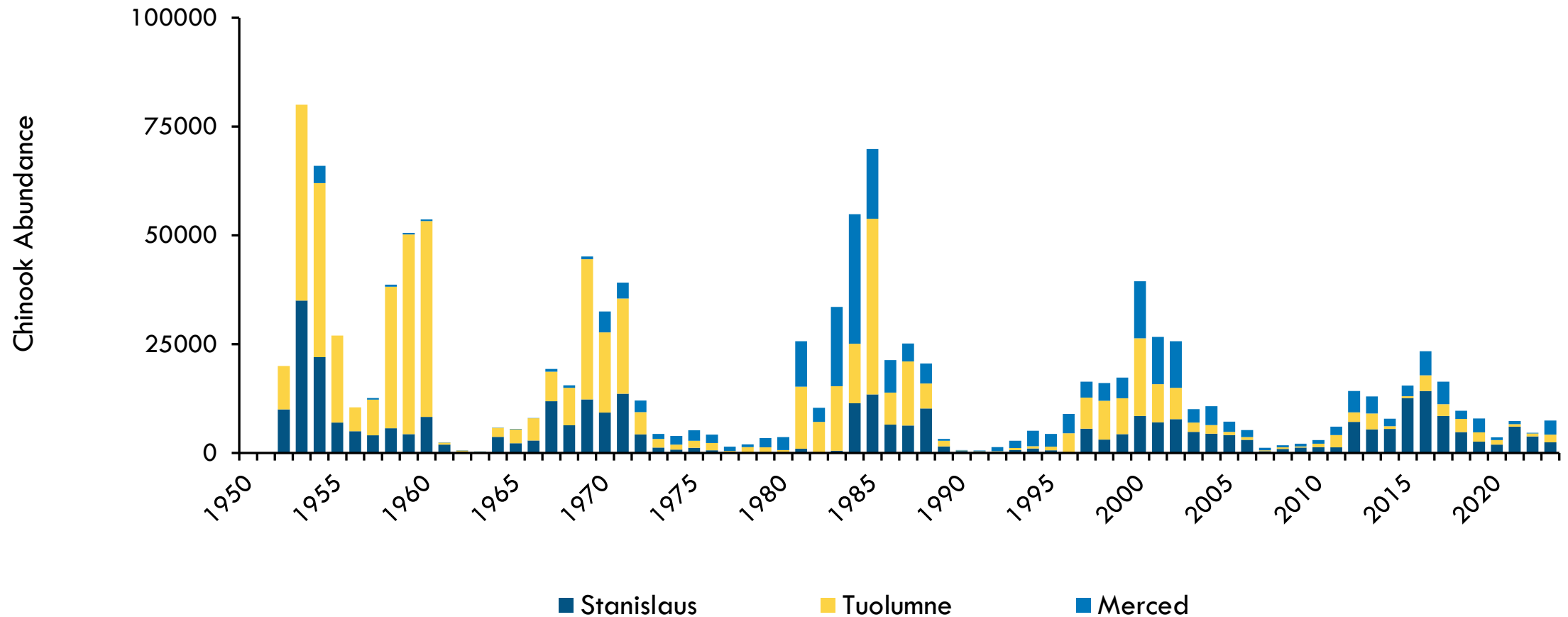
Central Valley Salmon Management Puzzle





What drives salmon abundance?

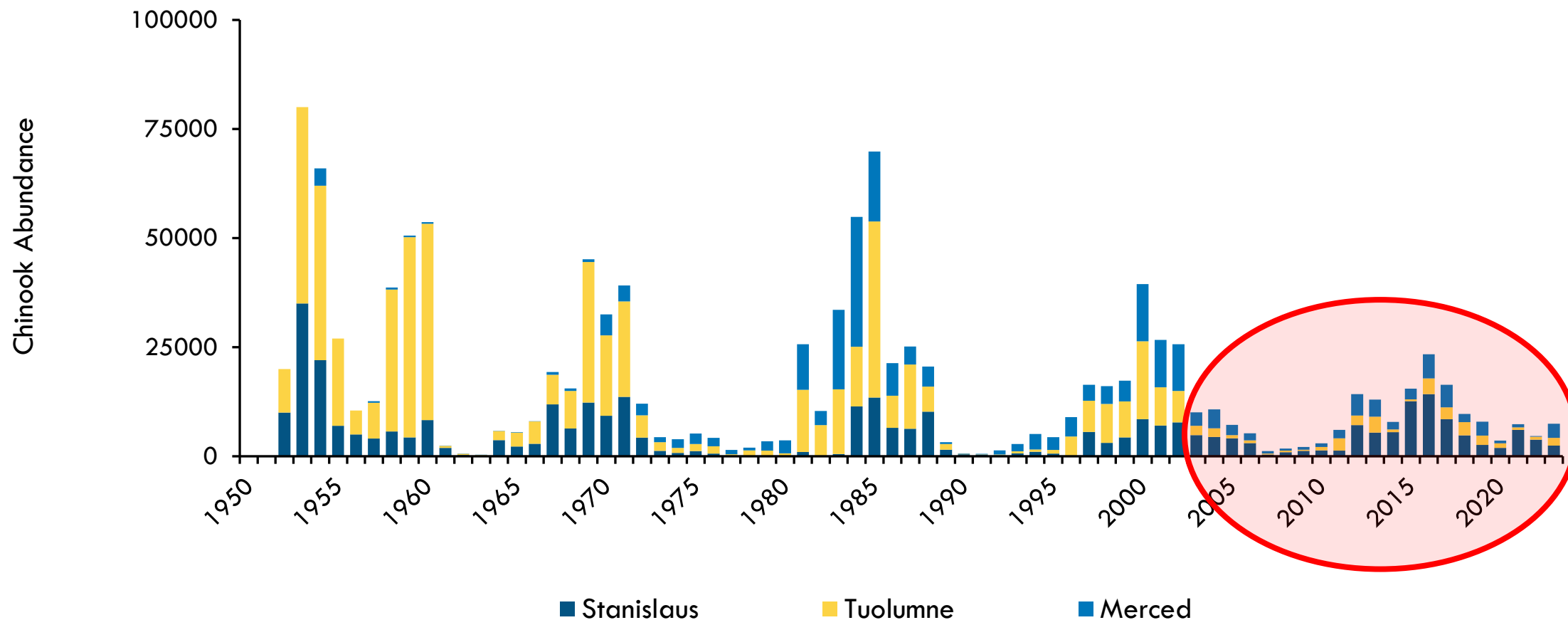
San Joaquin Fall-run Chinook Abundance 1952-2023





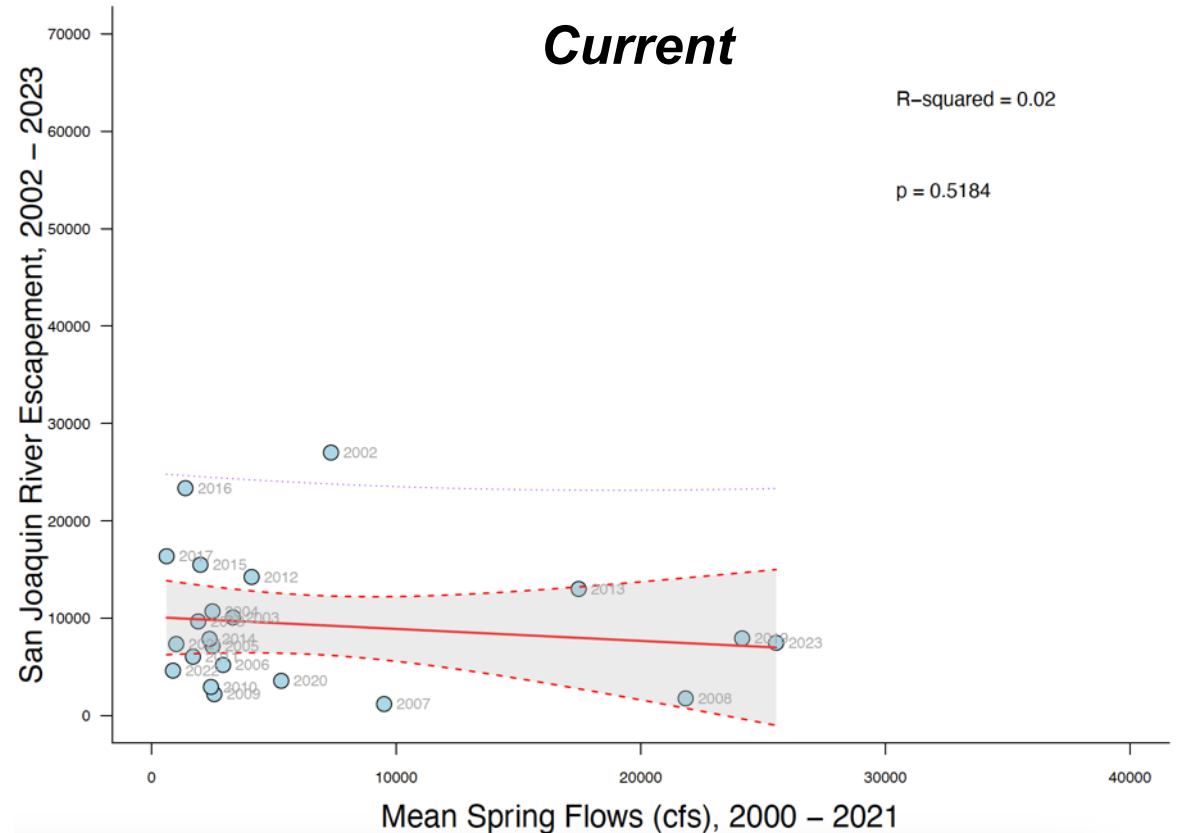
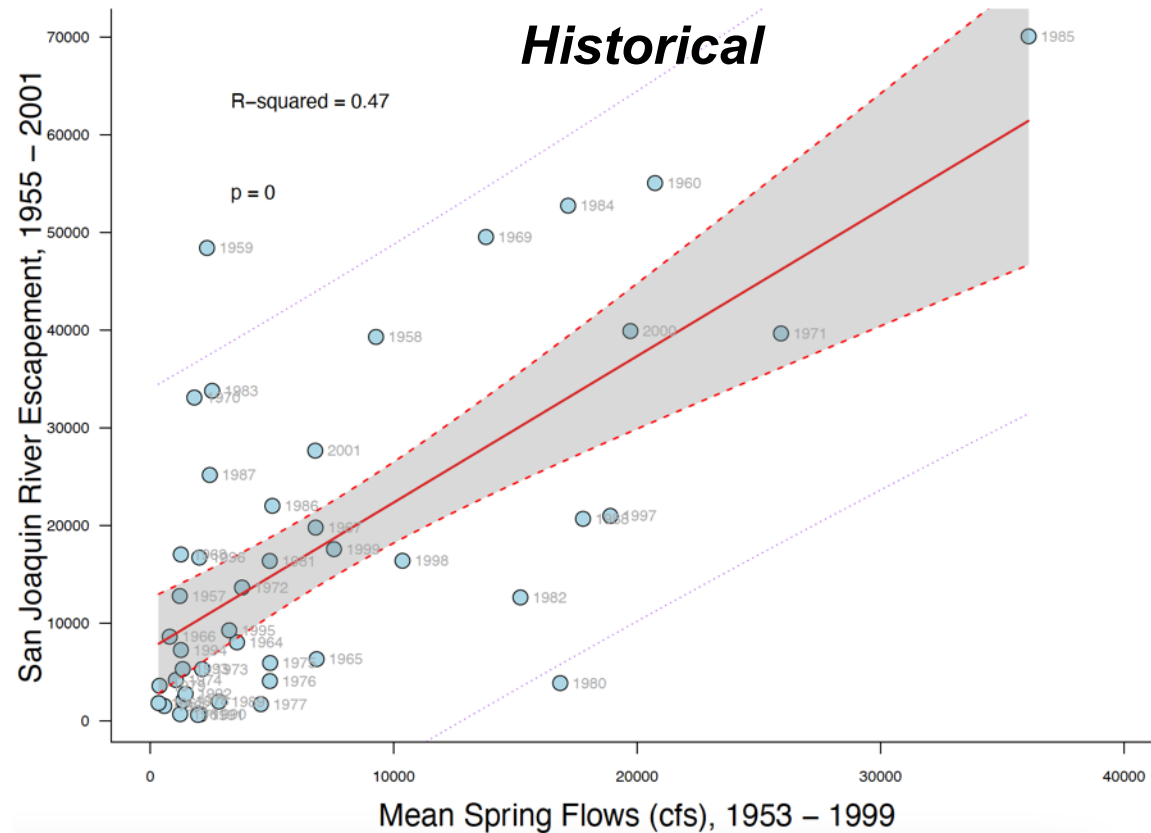
What drives salmon abundance?

San Joaquin Fall-run Chinook Abundance 1952-2023





Salmon Abundance and Flow



- Higher flows no longer leading to increased abundance
- Other limiting factors acting on the population



Poor Outmigration Survival across the Central Valley

3-16% survival

Michel et al. (2015)

<1% survival

Notch (2017)

0-5% survival

Brandes et al. (2018)

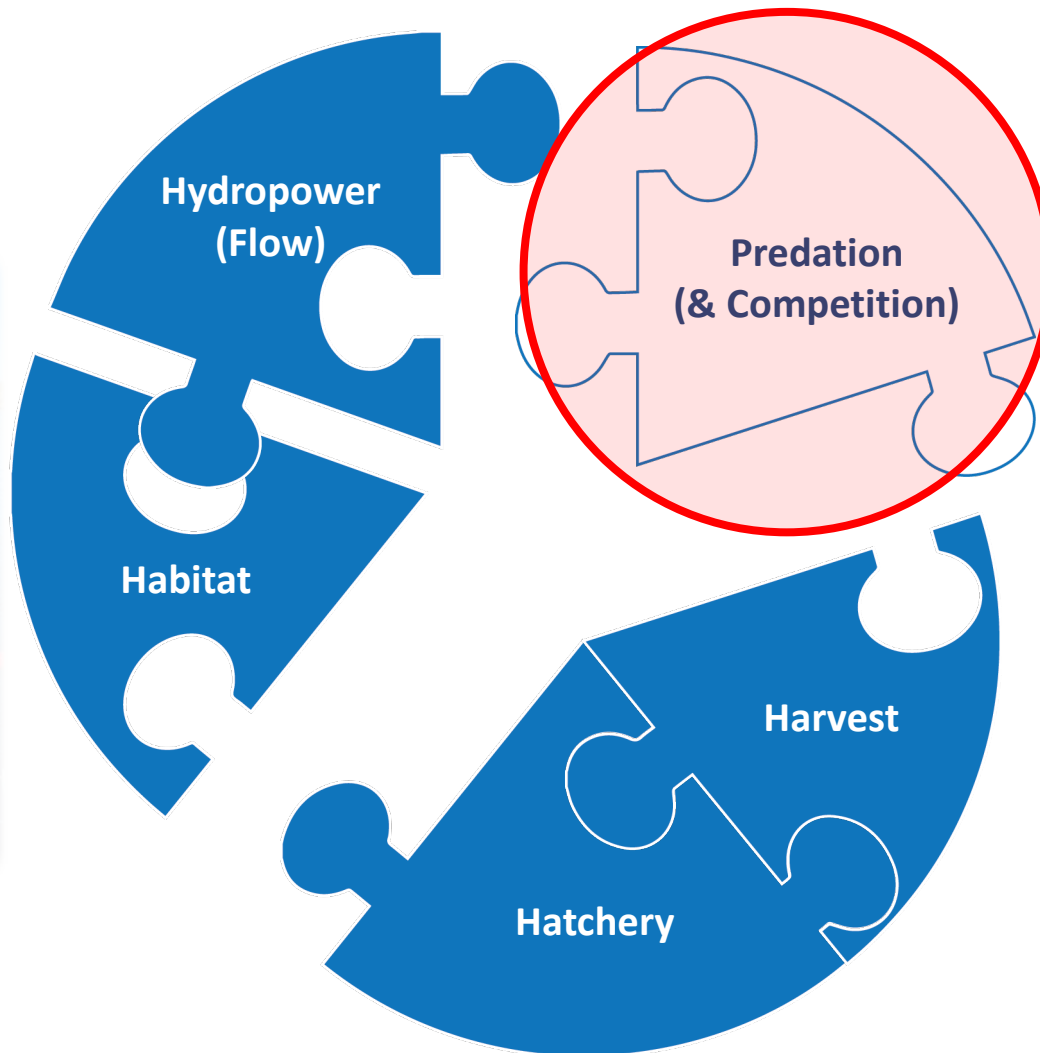
7-25% survival

Zeug et al. (2016)

- Salmon populations heavily impacted by poor survival during outmigration
- Juvenile survival generally increases during high flow years
- Survival in other Pacific Coast rivers often exceeds 50% (e.g., Columbia River; Rechisky et al. 2013)

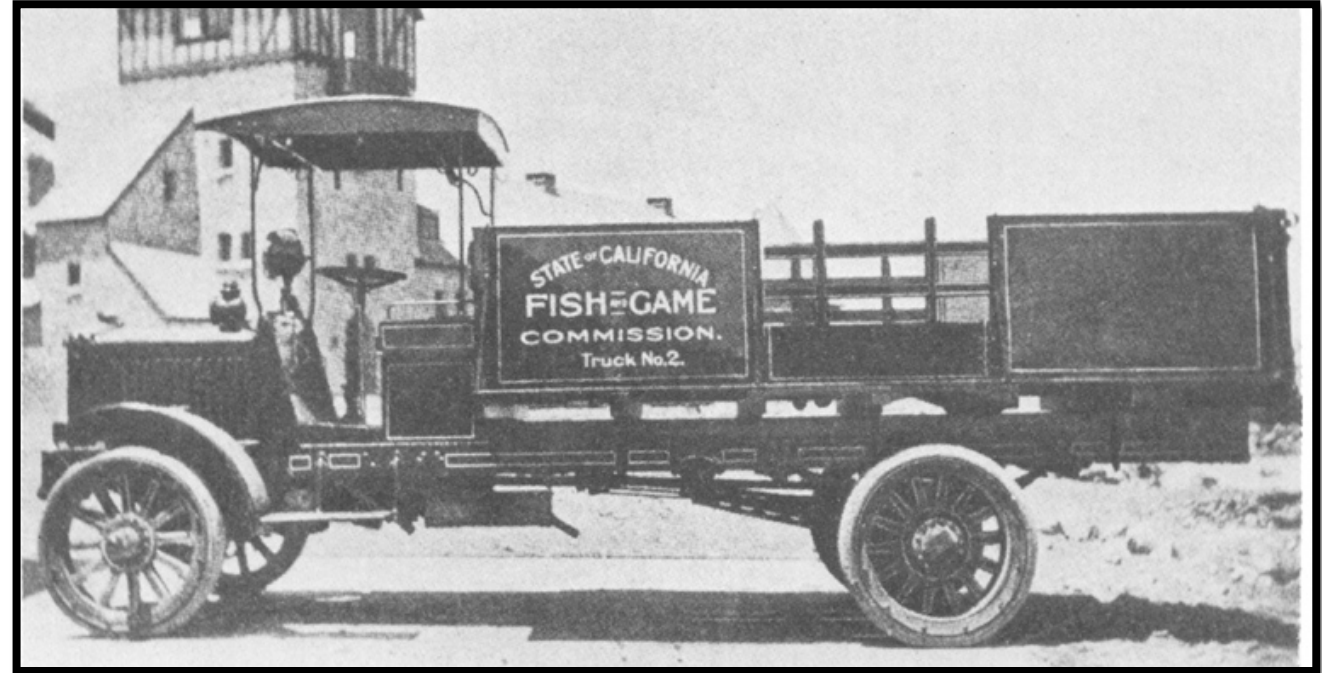


Central Valley Salmon Management Puzzle: Nonnative Species

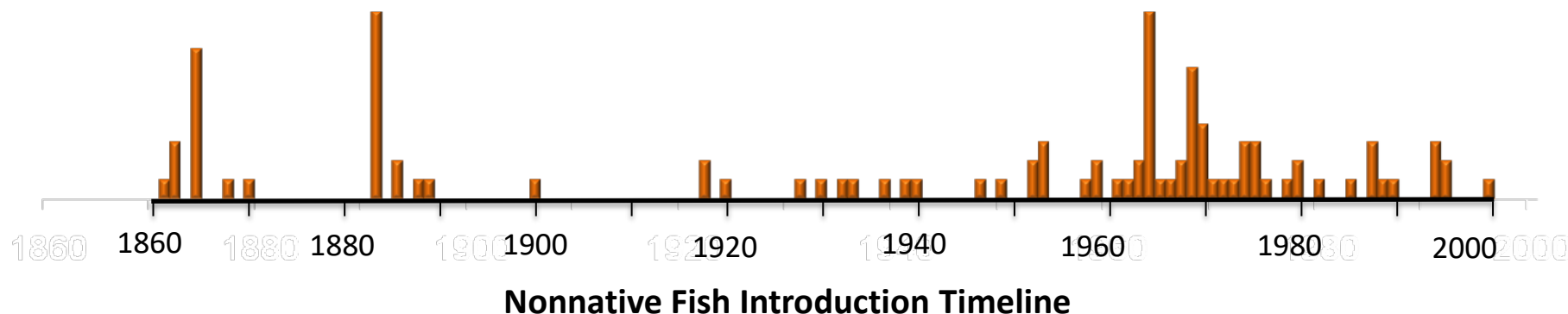


How Did All the Predators Get Here?

- The majority (69%) of California fish introductions were made by the California Fish and Game Commission and CDFW.
- Management of nonnative species to support sportfishing



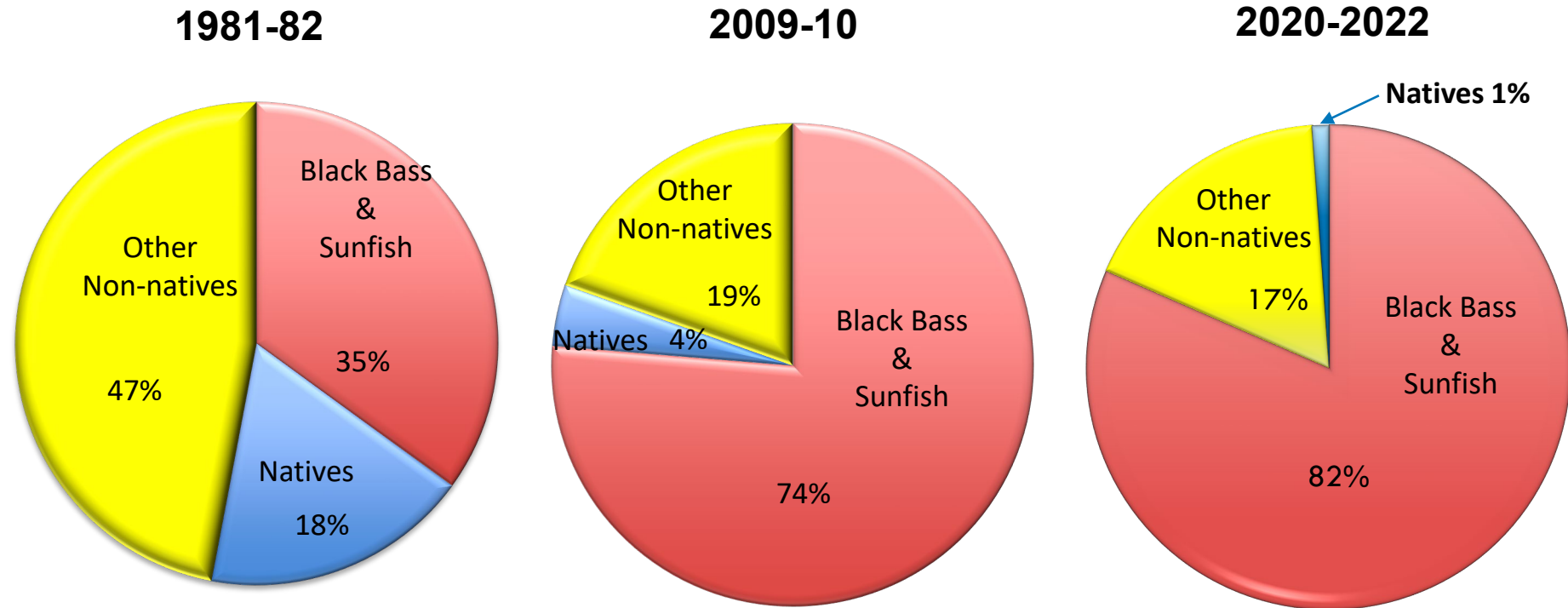
CA archive image



Data from Cohen and Moyle 2004



Native Fish are Becoming Rarer in the Delta



Conrad et al. 2010. More big bass: Understanding the role of largemouth bass as top predators in the littoral zone. Delta Science Council Conference Sacramento, California September 2010



Increasing Evidence of Impacts

2012 Tuolumne River Predation Study

- Only 4% Chinook estimated to have survived the 25-mile migration
- Predator abundance and predation rates indicate potential for 96% loss due to predation



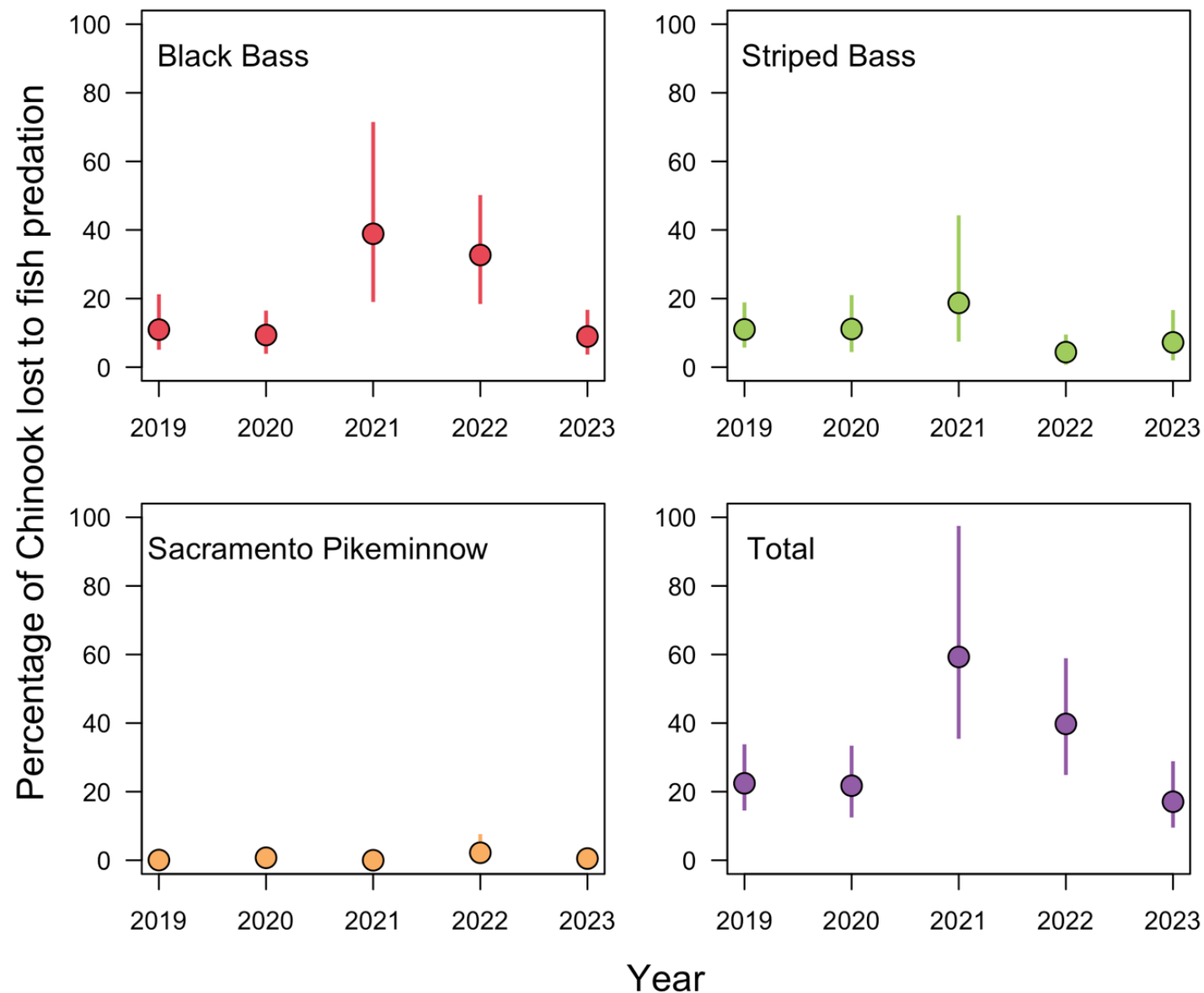
Juvenile salmon pumped from striped bass stomach

- **Chinook Salmon Recovery Plan (2009):** Reduce abundance of striped bass to *“prevent extinction or to prevent the species from declining irreversibly”*
- **Loboschfsky et al. (2012):** Striped bass consume 55,000,000 lbs of fish per year. *Eating every single juvenile salmon would still only be 2% of their annual diet.*
- **Sabal et al. (2016):** Striped bass predation on juvenile Chinook had *population-level impacts of up to 29%* at a single spot in the Mokelumne River

Stanislaus Predation Research

- First proposed in 2009, required Congressional Act to obtain permits
- Project Goals:
 - Estimate abundance of nonnative predators
 - Estimate total salmon lost to predation





Chinook Salmon Predation Observed in Stanislaus River across range of conditions





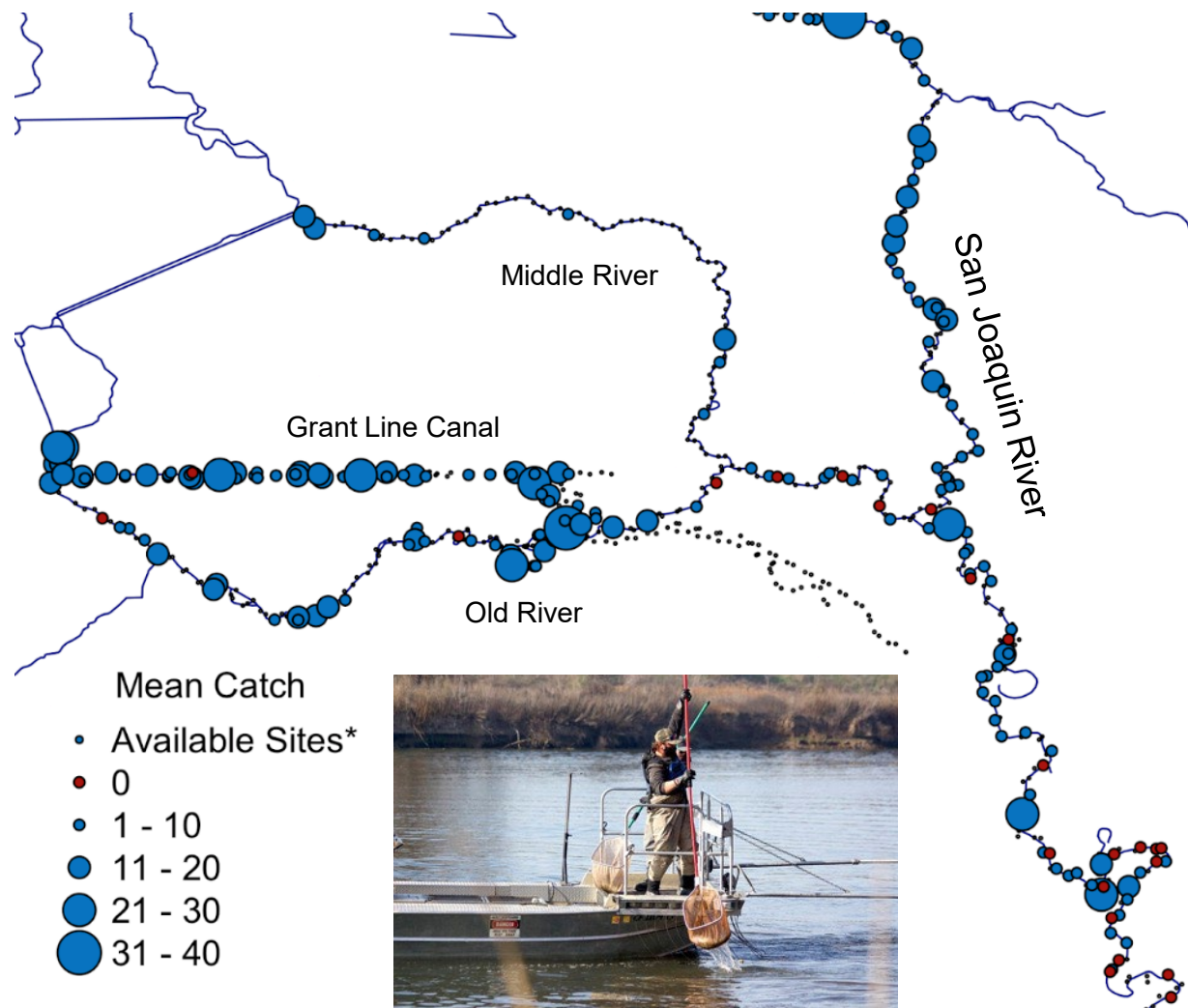
SJR and South Delta Research

- Electrofishing began in 2020
- Project Goals:
 - Estimate abundance of nonnative predators
 - Assess movement patterns of predators in the south Delta
 - Assess population-level impacts of predation



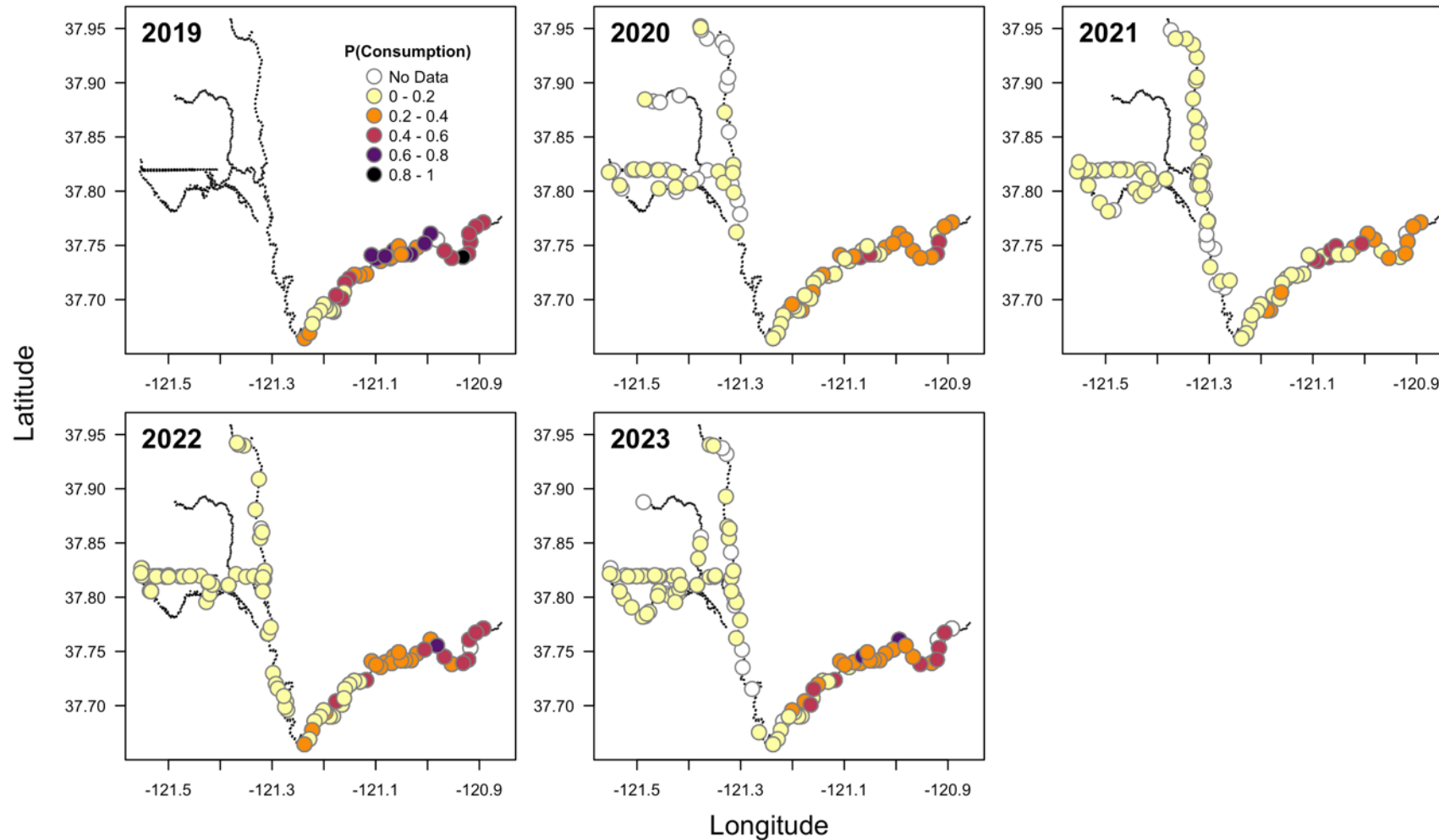
Bass are Everywhere in the Delta - What about the Salmon?

- Bass observed at 85% of all sampled units since 2020
- In 5 years, only 9 live salmon captured in the South Delta
- >100x more predators captured than Chinook!
- Only 4 salmon found in predator stomachs in the Delta since 2020





Where are the Salmon Being Consumed?



Predator Abundance

X

Salmon Consumption Rate

=

salmon eaten



What do we know about the impacts of predation?

- Significant effort over to collect data on predator populations, consumption rates, and salmon abundance



Predator Abundance

X

Salmon Consumption Rate

=

salmon eaten

salmon eaten

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salmon available

Predation impact

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Predator Abundance

X

Salmon Consumption Rate

=

salmon eaten

salmon eaten

salmon available

=

Predation impact



**What do we know
about the impacts
of predation?**

- Data from a small portion of the San Joaquin Basin suggests that predation is a major factor precluding recovery of salmonids



Predator Abundance

X

Salmon Consumption Rate

=

salmon eaten

salmon eaten

salmon available

=

Predation Impact

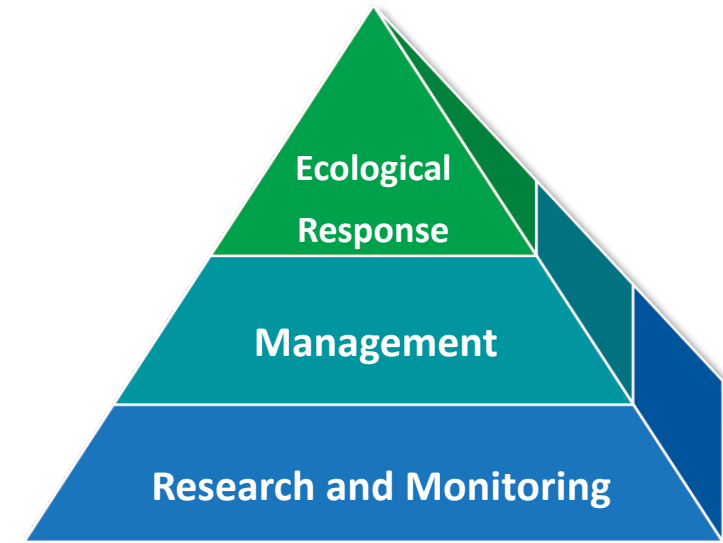
- Data needed from the wider Central Valley to understand complete picture of predation impacts
- Sacramento Basin contains majority of listed species driving water operations
- Eradication not possible, but predator management is achievable

What do we know about the impacts of predation?



Take Home Messages

- Multiple factors influencing salmon abundance
- Management solutions focused primarily on flow and habitat
- Flow alone is not enough to recover listed species
- Nonnative fish have substantial impacts to native species survival
- Coordinated long-term data collection needed across Central Valley
- Overall goal is recovery of salmonids and other native fish
- Management of nonnative species necessary to prevent extinction





Questions?



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Funding Provided By:





Acknowledgements

Water Infrastructure and Improvement for the Nation [WIIN] Act of 2016, Sec. 4010 (d))

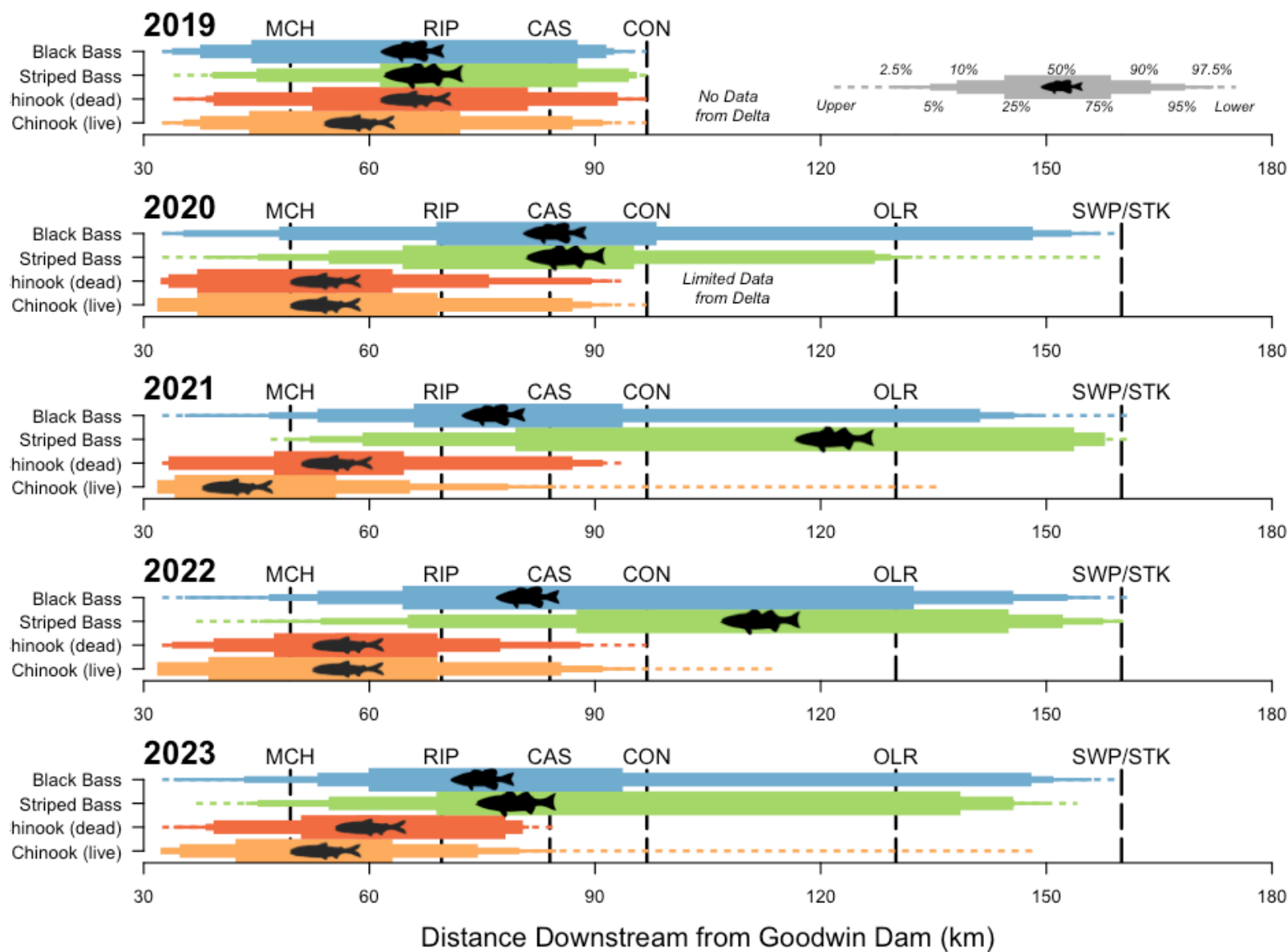
Agency partners: **NMFS** – Barbara Byrne, Amanda Cranford, Cyril Michel, Monica Gutierrez, Meiling Colombano, Andrew Hein, Maria Rea, Charlotte Ambrose, Steve Lindley, Eric Danner, Erin Strange; **CDFW** – Rob Titus, Steve Tsao, Ryan Kok, Ryon Kurth, Jonathon Nelson, and Leslie Alber

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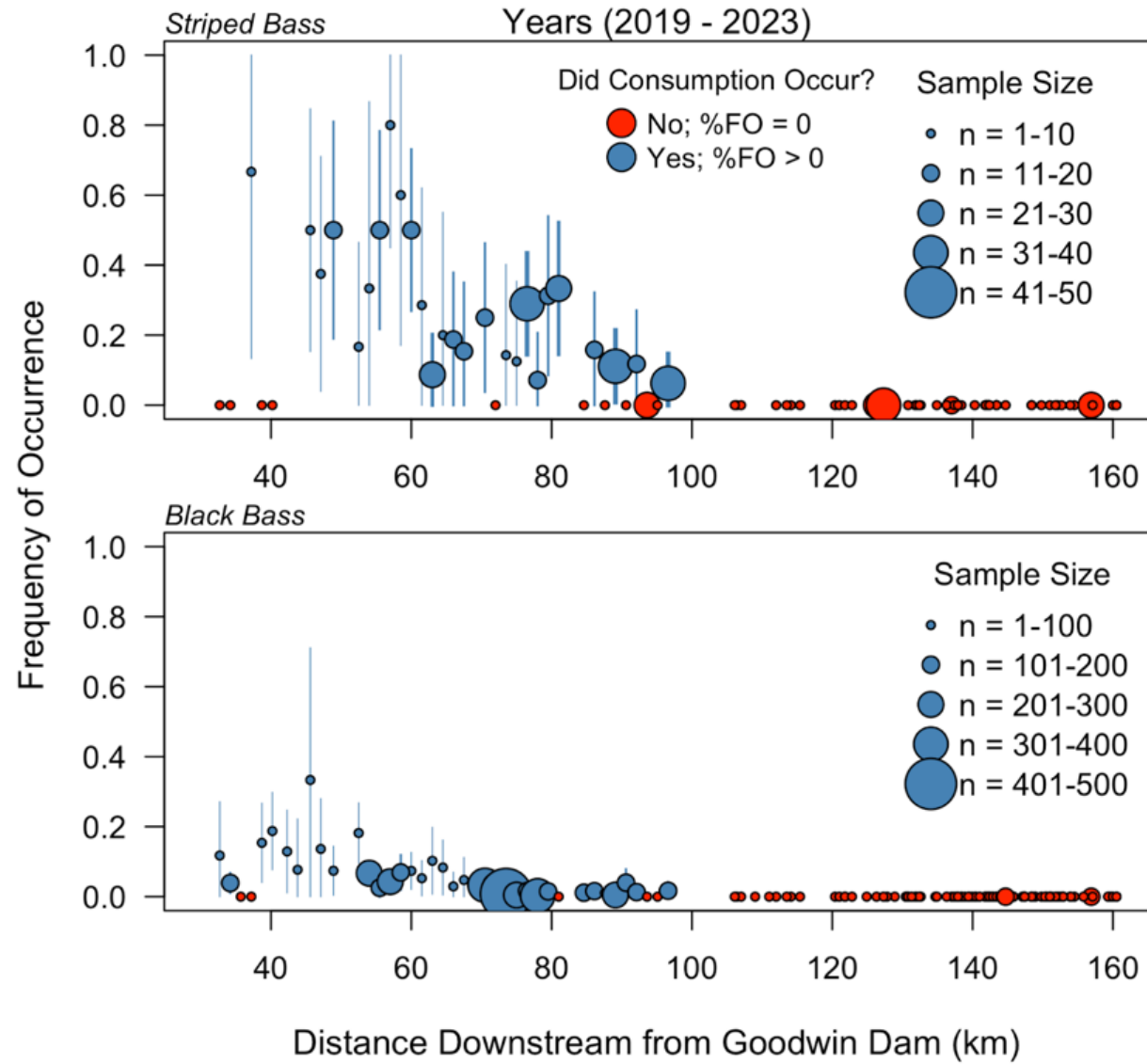
River access: Two Rivers RV Park, Caswell Memorial State Park, City of Ripon, Salida Sanitary District, Zolezzi Ranch, City of Riverbank, and US Army Corps of Engineers

Funding: Stanislaus River - Oakdale and South San Joaquin Irrigation Districts; San Joaquin River – Patterson ID, Banta Carbona ID, West Stanislaus ID, and San Luis Water District





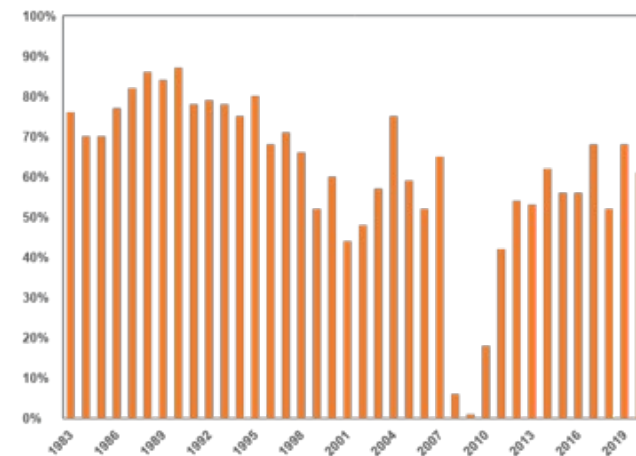
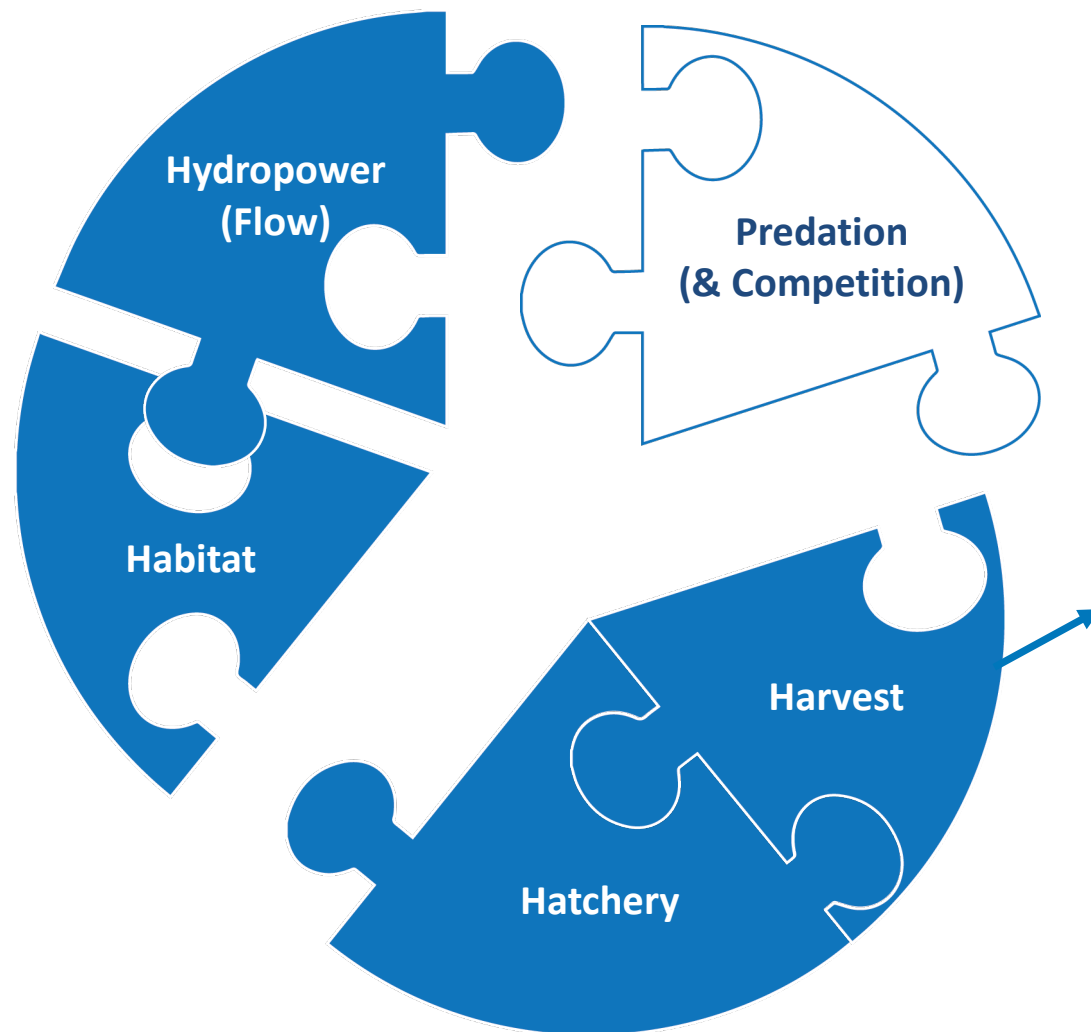
Distribution of Predators and Prey



Salmon Abundance and Flow

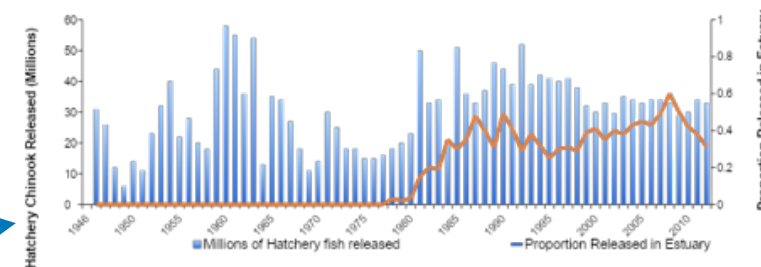
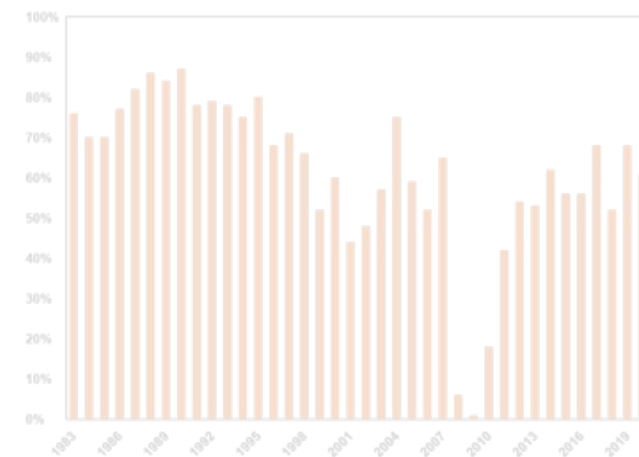
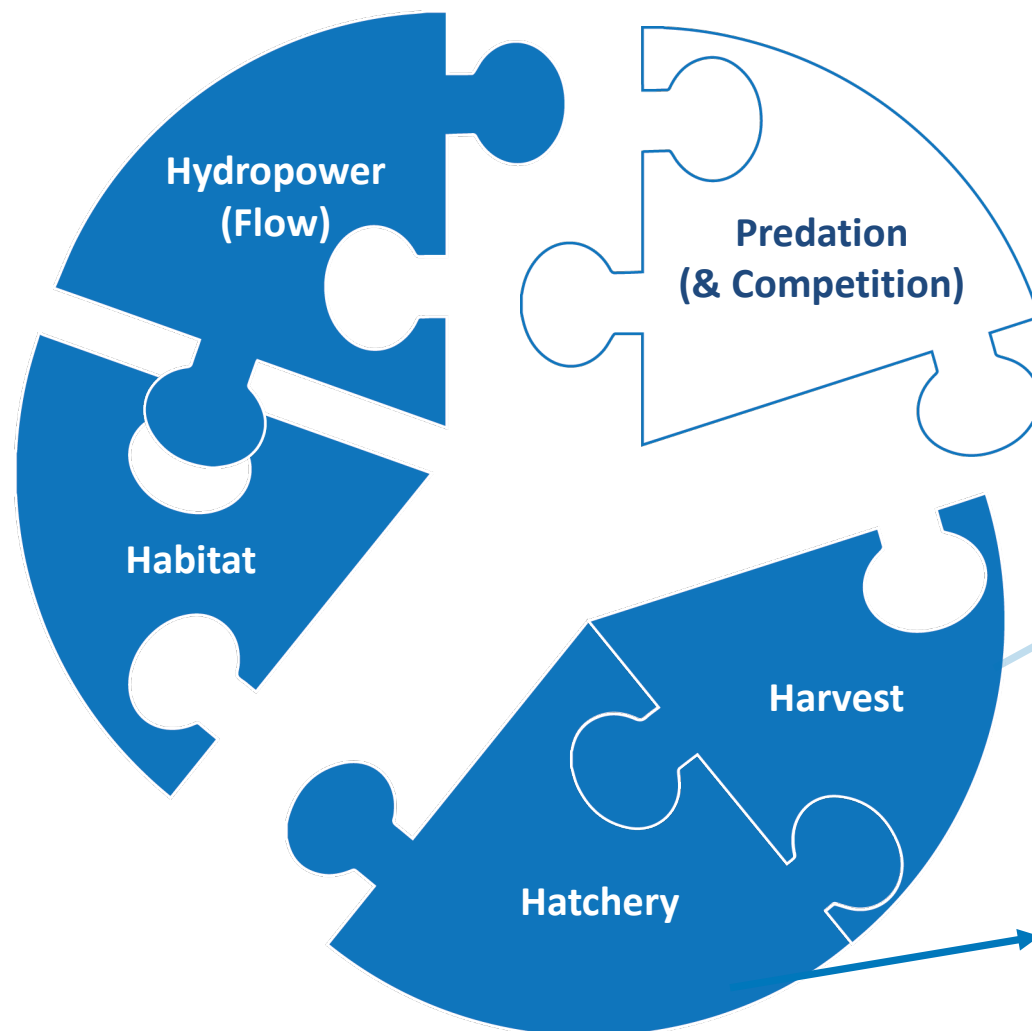


Central Valley Salmon Management Puzzle: Harvest





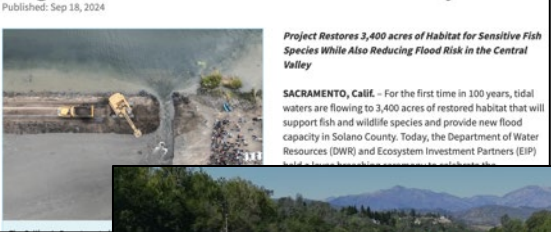
Central Valley Salmon Management Puzzle: Hatcheries





Central Valley Salmon Management Puzzle: Habitat

Levee Breach Marks Completion of the Delta's Largest-ever Tidal Wetland Restoration Project



Project Restores 3,400 acres of Habitat for Sensitive Fish Species While Also Reducing Flood Risk in the Central Valley

SACRAMENTO, Calif. – For the first time in 100 years, tidal waters are flowing to 3,400 acres of restored habitat that will support fish and wildlife species and provide new flood capacity in Solano County. Today, the Department of Water Resources (DWR) and Ecosystem Investment Partners (EIP) announced the completion of the Delta's largest-ever tidal wetland restoration project.



DWR: Upper Sacramento River restoration project provides habitat for juvenile salmon

Department of Water Resources (DWR) | Delta Science | Science | July 19, 2024 | 105

Healthy Rivers and Landscapes

Area	Total Acres ¹
San Joaquin Basin – Tuolumne ²	77 (rearing/floodplain), >21.35 (spawning gravel)
Sacramento Basin – Sacramento	137.5 (instream), 113.5 (spawning)
Sacramento Basin – Sutter Bypass, Butte Sink, and Colusa Basin	20,000 (floodplain) ³ , 20,000 (fish food production) ⁴
Sacramento Basin – Feather	15 (spawning), 5.25 (instream), 1,655 (floodplain) ⁵
Sacramento Basin – Yuba ⁶	50 (instream), 100 (floodplain)
Sacramento Basin – American	25 (spawning), 75 (rearing)
Sacramento Basin – Mokelumne	1 (instream), 25 (floodplain)
Sacramento Basin – Putah	1.4 (spawning)
North Delta Arc and Suisun Marsh	5,227.5 ⁷

Progress Towards Restoration Targets

