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RECLAMATION

Old and Middle River (OMR) Management and Monitoring



Brian Mahardja, Catarina Pien

2/29/2024

Regulatory Context

- Reclamation's 2019 Proposed Action for the Central Valley Project
- USFWS 2019 Biological Opinion (Delta Smelt)
- NMFS 2019 Biological Opinion (Salmonids and Sturgeon)
- Incidental Take Permit for SWP Operations (ITP)
- Interim Operations Plan (IOP)
- Guidance Documents:
 - [20210706 DCC OPS Fall Winter Guidance Document Final.pdf](#)
 - [OMR Management Guidance Document December 2020.pdf](#)

Federal

State



Listed species relevant for OMR management

- Delta Smelt
- Longfin Smelt
- Winter-run Chinook Salmon
- Spring-run Chinook Salmon
- Central Valley Steelhead
- Green Sturgeon*



Photo Credit: Dave Giordano
Ecositemedia.com



Teams

Team

Product/Outcome



**NOAA
FISHERIES**



Salmon Monitoring Team (SaMT)
Chinook Salmon, Steelhead, Green Sturgeon

Biologists, operators

Smelt Monitoring Team (SMT)
Delta Smelt, Longfin Smelt

Biologists, operators

Delta Monitoring Workgroup (DMW)

Water contractors, Stakeholders

Water Operations Management Team (WOMT)

Regulatory agency managers, operators

Operations **Outlook** (Summary of Water Operations)

Federal and State Risk **Assessments**
(Assessment of potential risk to species based on available weekly and historical data)

Provide recommendations and advice to management in terms of OMR Index

Provide input on risk assessment

Operations decision



Salmon and Smelt Monitoring Teams

- Review hydrologic, operational, water quality, and fishery data on a weekly basis (December-June)
- Provide opportunities for engagement and discussion among biologists and operators on relevant information and issues
- Provide input on the Proposed Action Assessment and advice on the ITP Risk Assessment for WOMT
- The results of the Teams discussions will be captured in Assessments and meeting notes for consideration by WOMT



- **Weekly Fish and Water Operations Outlook (Outlook Document)**
 - Anticipated operations, fish conditions, current conditions (including status of surveys)
 - Input from water operators, tributary group members

Weekly Fish and Water Operations Outlook

12/6/2022 – 12/12/2022

FORECASTED WEATHER: Showers and a few thunderstorms on Monday, tapering off on Tuesday, and dry at mid-week. Precipitation returns at the end of the week.

Table 1: Anticipated weekly operational ranges by tributary. Environmental and fish conditions updated by respective watershed groups at varying intervals that may not coincide with the weekly range of Water Operations

Tributary/Division	Anticipated Weekly Ranges	Related Environmental and Fish Conditions
Clear Creek	• Current Release: 200 cfs • Anticipated Weekly Range of Releases: 200 cfs	• Spring-run Chinook salmon eggs are incubating in gravel. Fry are starting to emerge. • Fall-run Chinook Salmon eggs are incubating in the gravel. • Late fall-run Chinook Salmon are entering and will begin spawning soon. • <i>O. mykiss</i> adults are migrating and holding in Clear Creek. Last year's juvenile <i>O. mykiss</i> are present. (updated 12/5/22)
Sacramento River	• Shasta Storage: 1,406 MAF • Current Release: 3,250 cfs • Anticipated Weekly Range of Releases: 3,250 cfs	• Spring-run Chinook salmon fry are emerging from redds into the river. Final redd emergence will be in late December. • Winter-run Chinook juvenile salmon have all emerged from redds and are migrating downstream. • Winter-run and Spring-run Chinook salmon (length-at-date) juveniles are being caught in low numbers.



Weekly Assessment on ESA-listed Species (Assessment Document) and Risk Assessments

- Summary of relevant data
- Assessment of species status or risk based on data and evaluation from team members
- Recommendations/Advice to WOMT

State Water Project Incidental Take Permit Risk Assessment for Delta Smelt and Longfin Smelt

Section 1: Overview

Date: 02/20/2024

Life Stages Present:

Delta Smelt (DS): Larvae, Sub-Adults, and Adults

Longfin Smelt (LFS): Larvae, Sub-Adults, and Adults

Advice to Water Operations Management Team (WOMT):

Smelt Monitoring Team (SMT) continues to recommend Old and Middle River Index (OMRI) be limited to no more negative than -3,500 cfs on a 7-day average under Condition Of Approval (COA) 8.5.2, until the average Secchi depth in the Central and South Delta is greater than 1m as measured by the next Smelt Larva Survey (SLS).

Risk Assessment:

Weekly Assessment of CVP and SWP Delta Operations on ESA-listed Species

Executive Summary

a. Operational Conditions

See Weekly Fish and Water Operation Outlook document for June 27 – July 3 which includes the initial CVP and SWP operational intent and biological justification for the next seven days. Any recommended changes or alternatives to those operations made by either monitoring team is captured herein.

b. Winter-run Chinook Salmon

Loss of natural winter-run Chinook Salmon (by length at date, LAD) has not occurred in the past week at the State and Federal fish salvage facilities (WY 2023 total loss = 109.88 fish, as of 6/26/2023). Loss of natural winter-run Chinook Salmon at the Central Valley Project (CVP) and State Water Project (SWP) fish collection facilities is unlikely to occur over the next week. 0% of juvenile natural winter-run Chinook Salmon from brood year (BY) 2022 are estimated to be present in the Delta.

c. Spring-run Chinook salmon

Loss of natural spring-run Chinook Salmon (by length at date, LAD) has occurred in the past week at the State or Federal fish salvage facilities (WY 2023 total loss = 10,151.50 fish as of 6/26/2023). Loss of spring-run Chinook salmon at the CVP and SWP fish collection facilities is less likely to occur over the next week. 0% of juvenile natural spring-run Chinook Salmon from brood year (BY) 2022 are estimated to be present in the Delta. The genetic data from salvage for WY 2023 indicates majority LAD spring-run Chinook are fall-run Chinook.

d. Central Valley Steelhead

Loss of natural California Central Valley (CCV) steelhead has not occurred in the past week at the State and Federal fish salvage facilities (WY 2023 December 1 – March 31 total loss = 1015.16 fish).



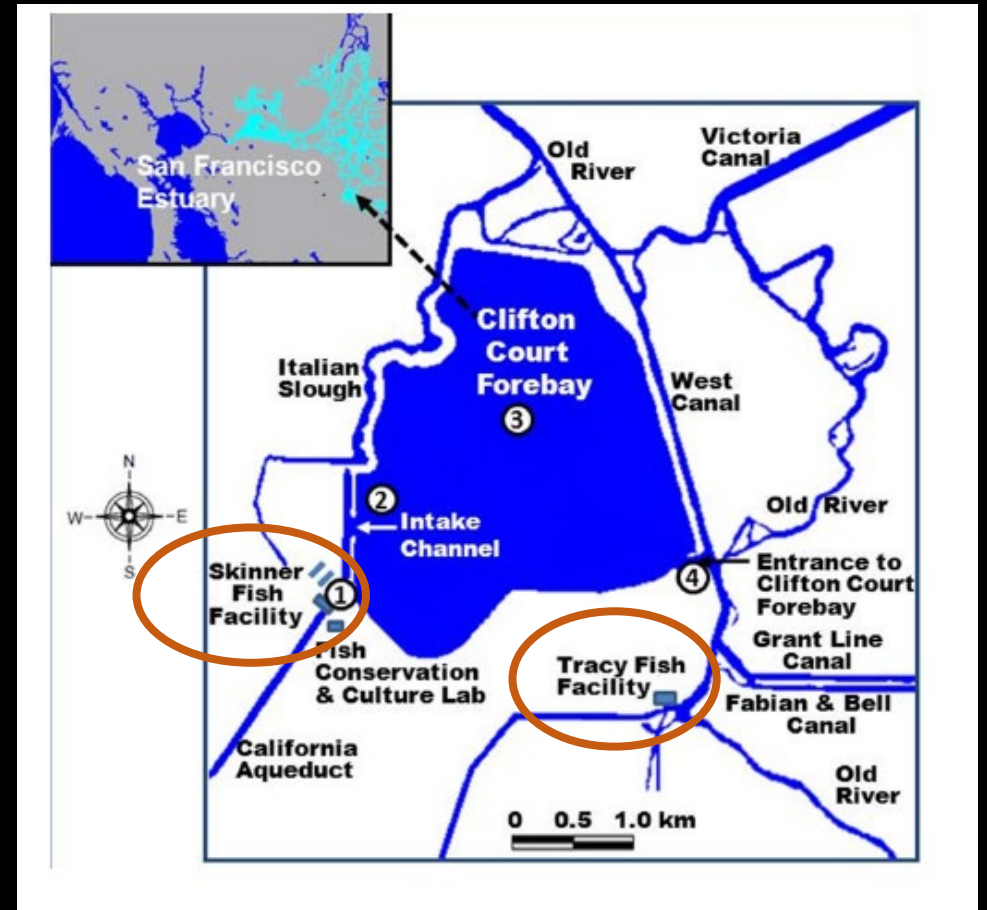
Monitoring Data and Their Uses

OMR Management Phase	Smelt	Salmon
Onset	Flow and Turbidity	Salmonid presence in the Delta
Export Reduction	Turbidity Presence and spatial distribution of fish Flow metrics, water temperature, Secchi depth	Salmonid daily and cumulative loss
Offramp	Water temperature	Water temperature Salmonid presence in the Delta



Fish Salvage Facilities

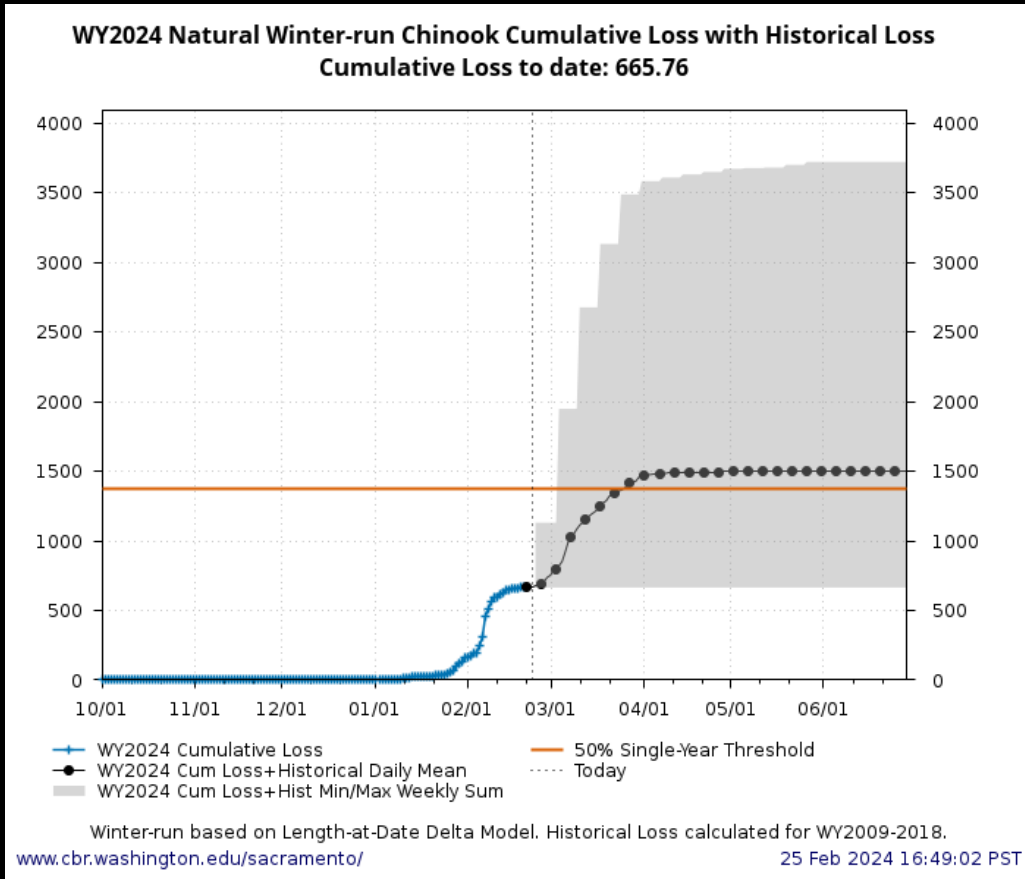
- Central Valley Project (Tracy Fish Collection Facility) & State Water Project (Skinner Delta Fish Protective Facility)
- Salvage (fish observed in salvage sampling)
- Entrainment (incorporates pre-screen loss and screen efficiency)
- Live release estimation (handling and truck loss)
- $\text{Loss} = \text{Entrainment} - \text{Release}$
- Calculation details:
filelib.wildlife.ca.gov - /Public/salvage/



Castillo et al. 2012

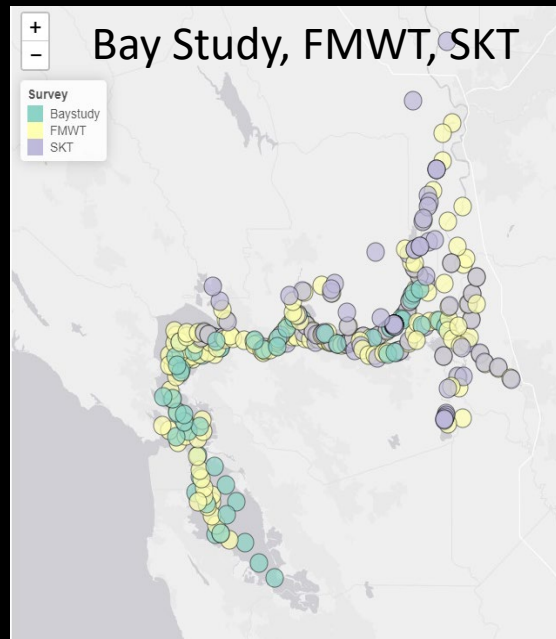


Take limit set based on population size



- Based off annual Juvenile Production Estimate (JPE)
 - Currently implemented only for Winter-Run Chinook
 - JPE in development for other salmonids
- Smelt usage of Fall Midwater Trawl Survey Smelt Abundance Index
 - Movement towards environmental surrogates
- Export reductions taken when loss exceeds thresholds





<https://deltascience.shinyapps.io/monitoring/>

Adult Smelt Detections

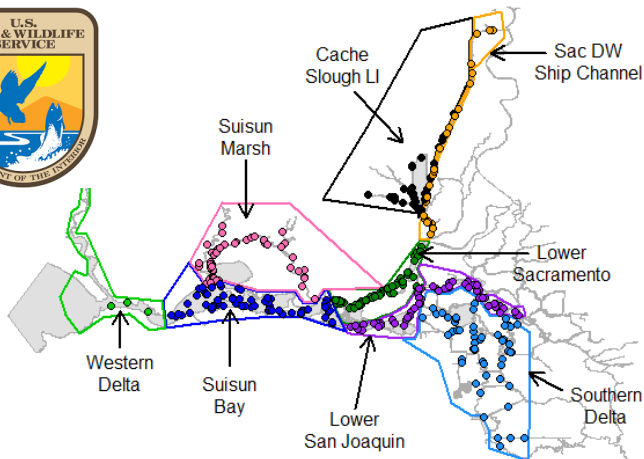
- Spring Kodiak Trawl (SKT) (2002-2023; Jan-May; monthly) – Delta Smelt Index
- Fall Midwater Trawl (FMWT) (1967-present; Sept-Dec; monthly) – Delta Smelt Index
- Bay Study (1980-present; year-round; monthly)
- Enhanced Delta Smelt Monitoring (EDSM) (2016-present; year-round; weekly) – Delta Smelt Abundance Index

Photo credit: USFWS

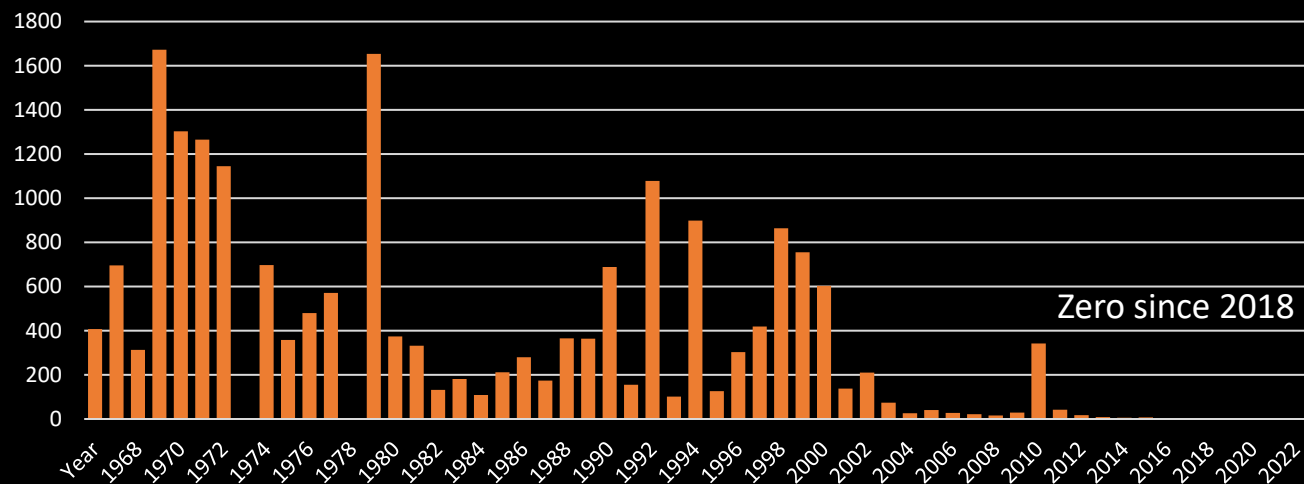


EDSM

All Sampling Locations To Date



Fall Midwater Trawl Survey Delta Smelt Index, 1968-2023



Zero since 2018



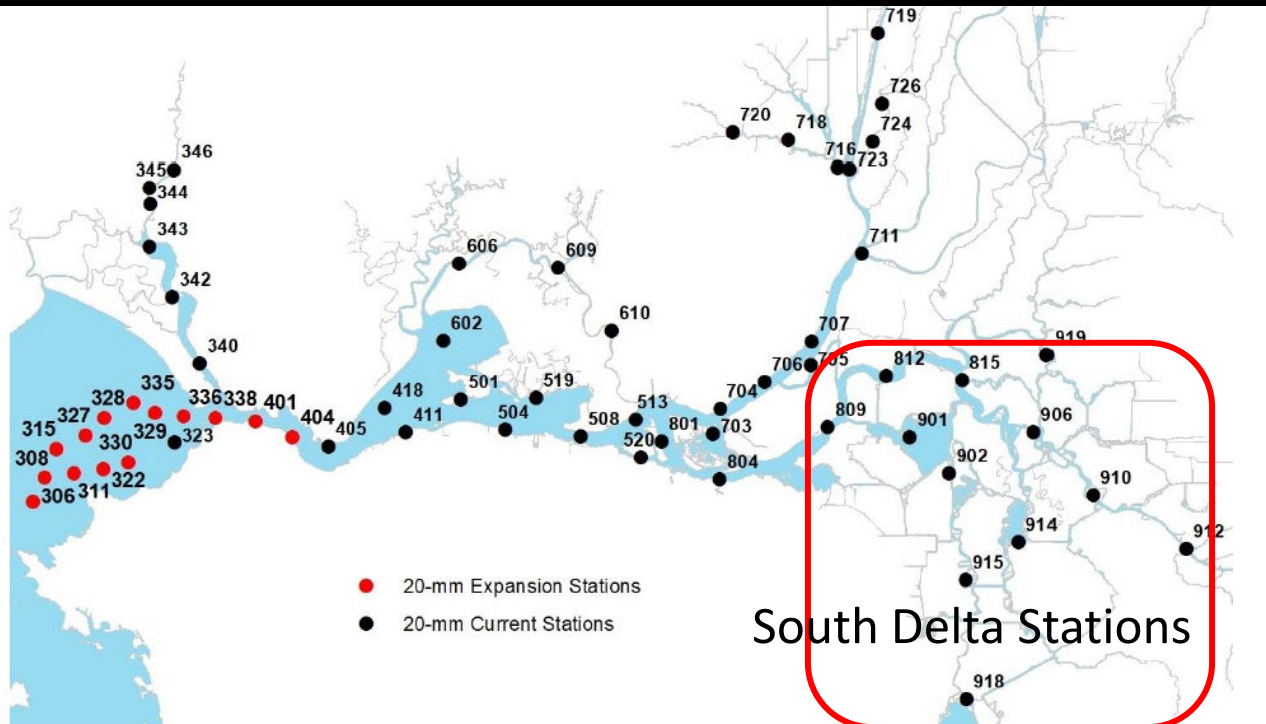


Photo credit: CDFW



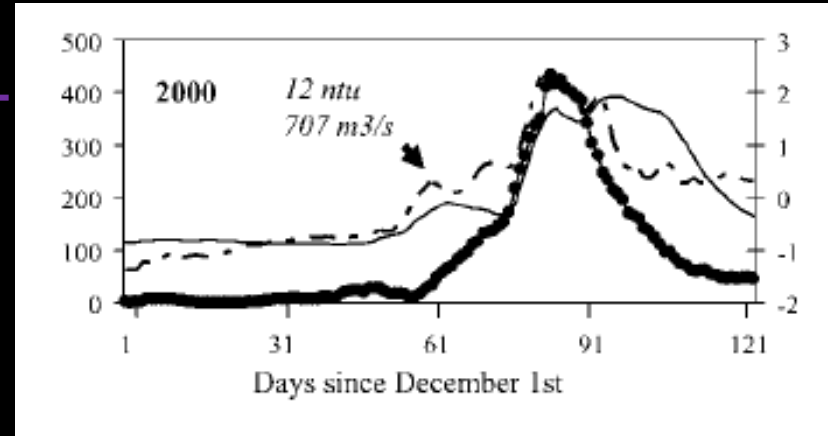
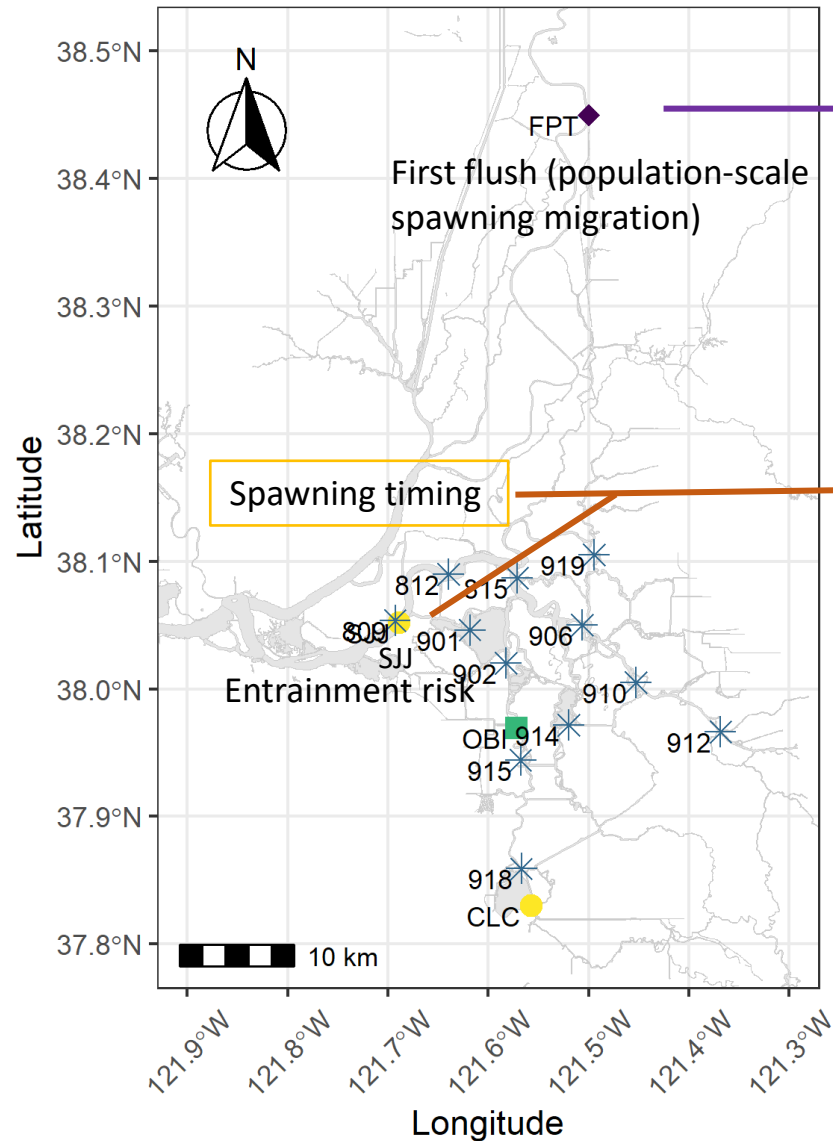
Larval and Juvenile Smelt detections

- Smelt Larva Survey (2009-present; biweekly)
- 20mm Survey (1995-present; biweekly)
- Enhanced Delta Smelt Survey
- Detection of larval and juvenile smelt in the Central and South Delta can trigger actions

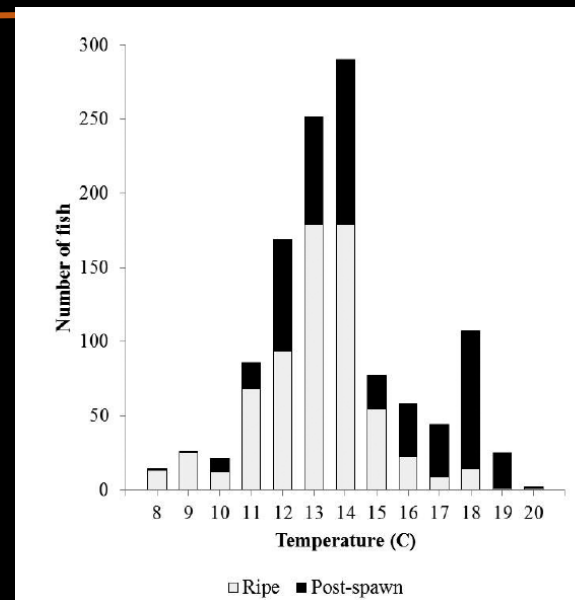


Environmental surrogates

- ◆ Flow, Turbidity
- ★ Secchi depth
- Turbidity
- Water temperature



Grimaldo et al. 2009

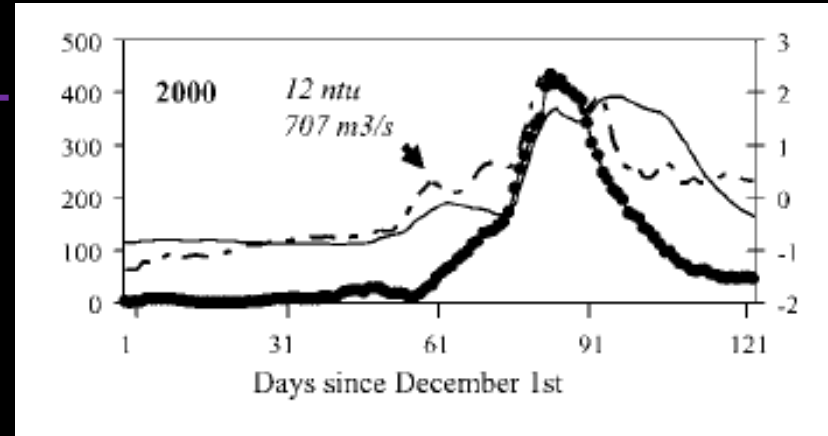
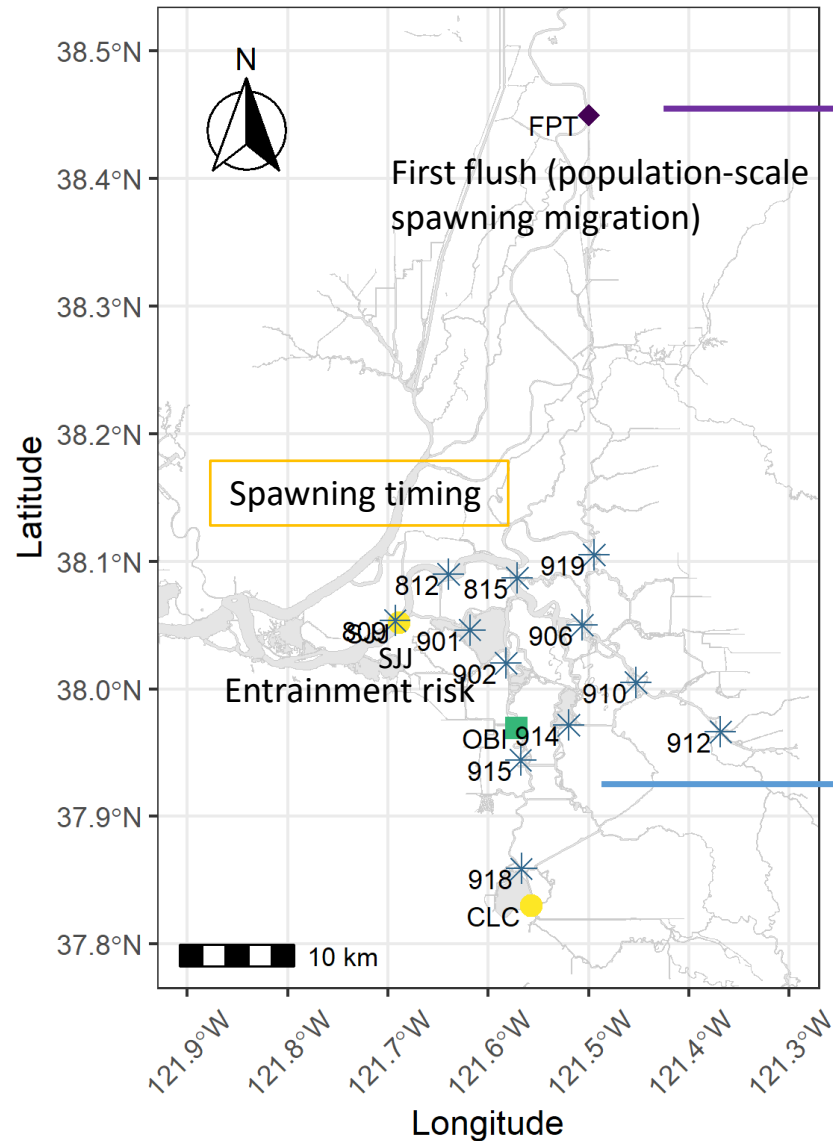


Damon et al. 2016



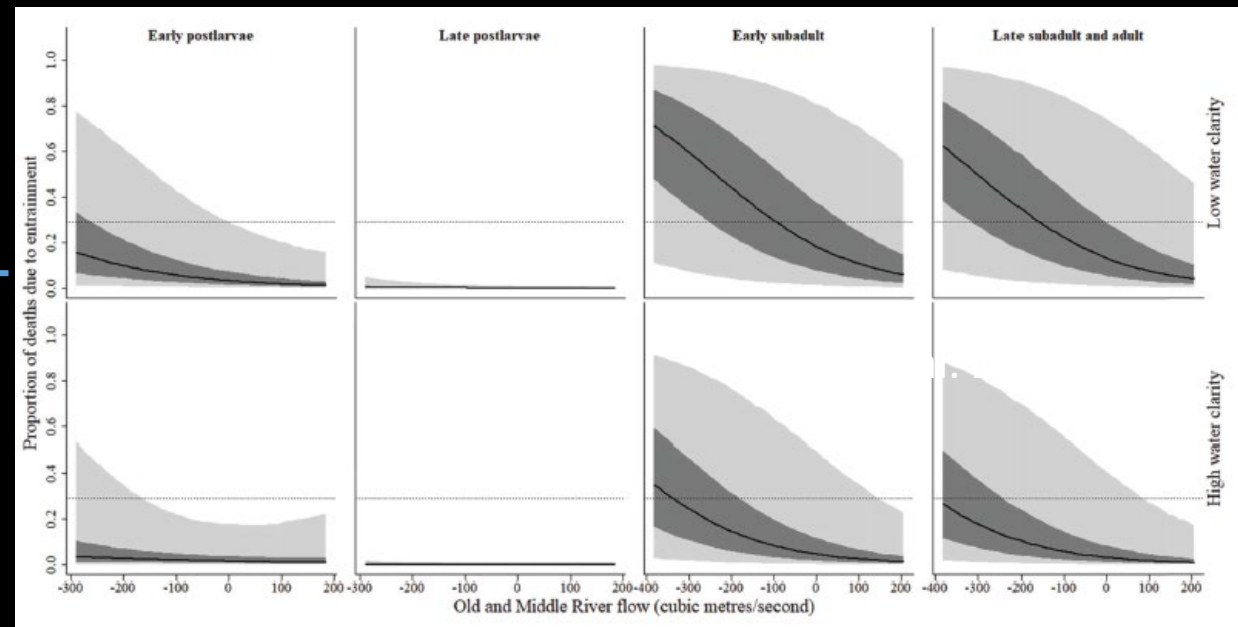
Environmental surrogates

- ◆ Flow, Turbidity
- ★ Secchi depth
- Turbidity
- Water temperature



Grimaldo et al. 2009

Smith et al. 2021



Longfin Smelt

- State protections, federal listing pending
- 2-year cycle instead of annual cycle
- Distributed further west to the ocean – recent expansion of survey
- Similar fish data sources as Delta Smelt
- Environmental/Hydrologic information:
 - High flows on Sacramento or San Joaquin River
 - Water Year Type
 - Flow metrics (outflow, QWEST)

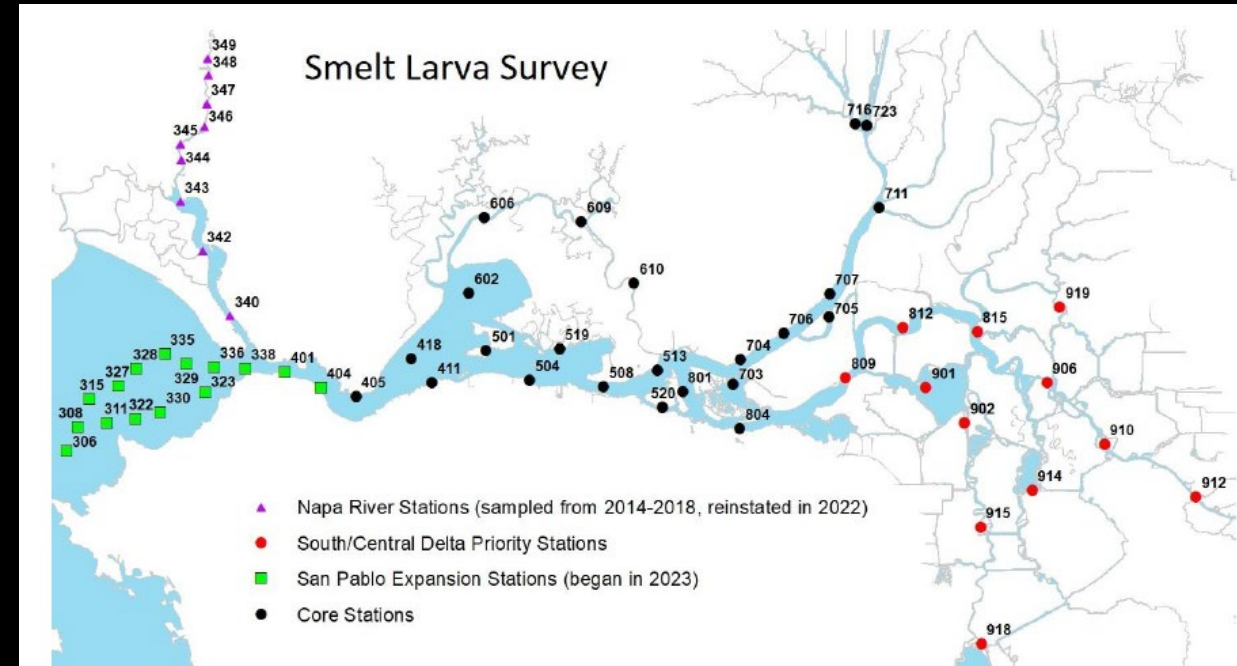
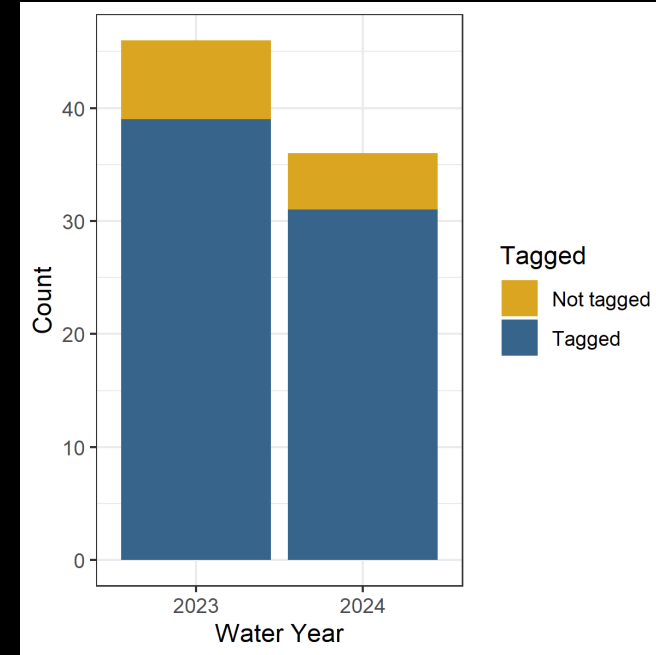


Photo by R. Reyes



How smelt data are used to inform water operations today

- Current distribution of fish, including salvage
 - Recent Delta Smelt detections are mostly supplementation fish
- Historical distribution of fish (salvage and centroid)
- Environmental data to inform fish distribution
- Hydrologic data and modeling (see next presentation)
- Weekly determination of risk (ITP), assessments, recommendations



Section 1-B: Central Delta

Risk of entrainment into the export facilities for Delta Smelt in the Central Delta:

Species and life stage	Risk type	Risk level	Rationale (turbidity, exports, OMR level, X2, Q west, temperature, distribution etc.)
DS sub-adults and adults	Exposure Risk (Hydrology)	Moderate	Ten marked DS were detected in salvage (pre-expansion) since 02/01/24. Three marked adult DS were detected at Prisoner's Point by EDSM, one 02/13/24, one on 02/08/24 and one on 01/31/24. Water temperatures reached 12°C at Jersey Point on 01/31/24, but have decreased to below 12°C starting 02/08/24. While turbidity remains low between Holland Tract and Victoria Canal, turbidity remains high in rest of the Delta.
DS larvae	Exposure Risk (Hydrology)	Moderate	The average Secchi depth in the Central and South Delta, as measured by SLS 3, is less than 1m.



Winter-run Chinook Salmon

- Likely the most well-studied of the listed anadromous fish species
- Serve as a good example of a more well-established OMR management for salmonids



Forecasting the number of juvenile winter-run Chinook Salmon expected to enter the Delta

- Migration to the Delta takes ~6 months
- Use monitoring upstream to estimate number of fish entering the Delta
- Referred to as “juvenile production estimate” or JPE
- Estimated by the following:
 - Number of winter-run fry equivalents passing Red Bluff Diversion Dam
 - Survival rate of natural-origin fry to smolts
 - Survival rate of smolts from Red Bluff Diversion Dam to Delta entry

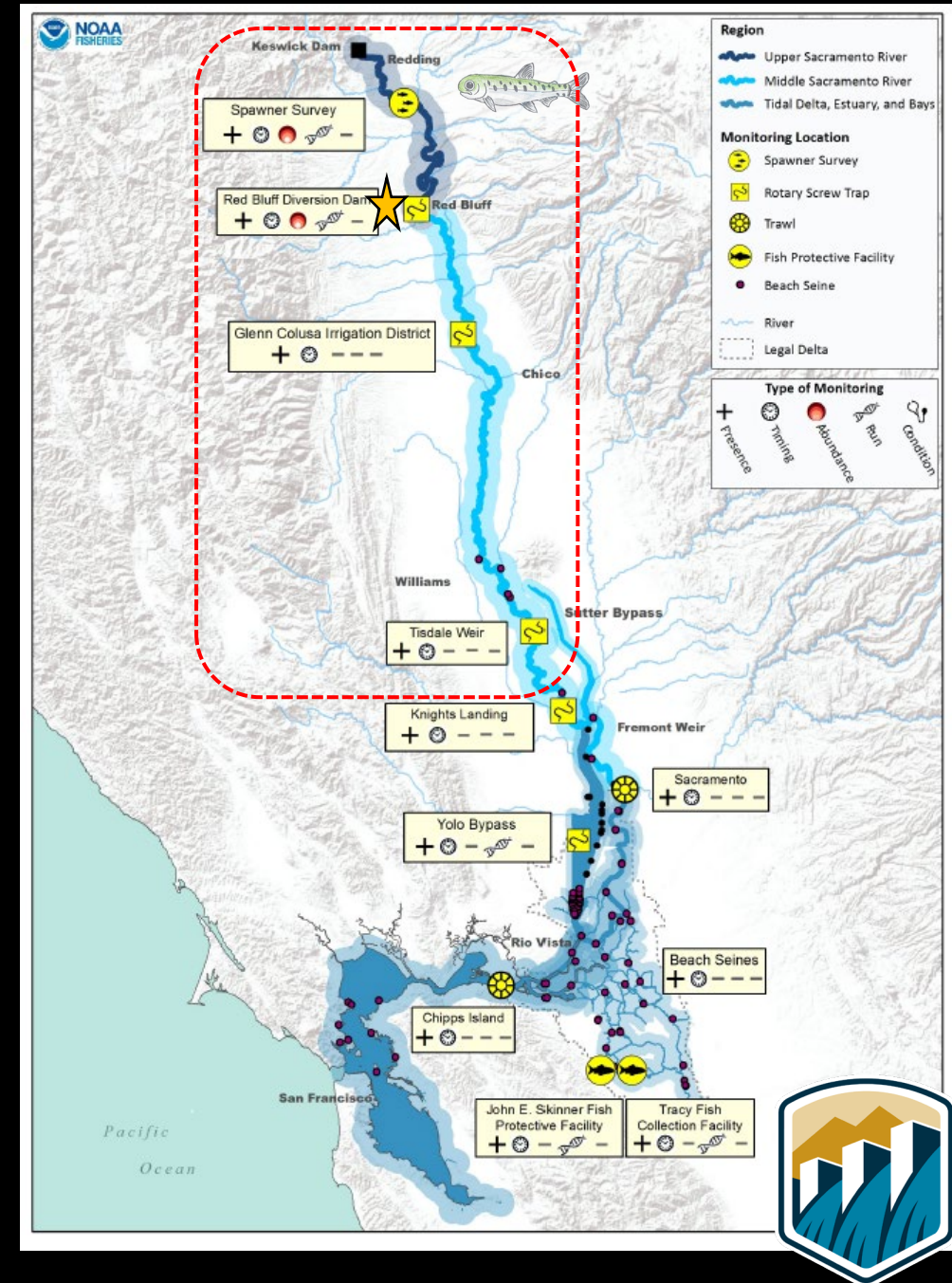


Figure from [Johnson et al. 2017](#)

Delta Monitoring for salmonids

- For understanding timing and numbers of fish entering & exiting the Delta
- Examples:
 - Knights Landing Rotary Screw Trap
 - Delta Juvenile Fish Monitoring Program (DJFMP)
 - Trawl (labeled as Sacramento and Chipps Island on figure), beach seines, boat electrofishing

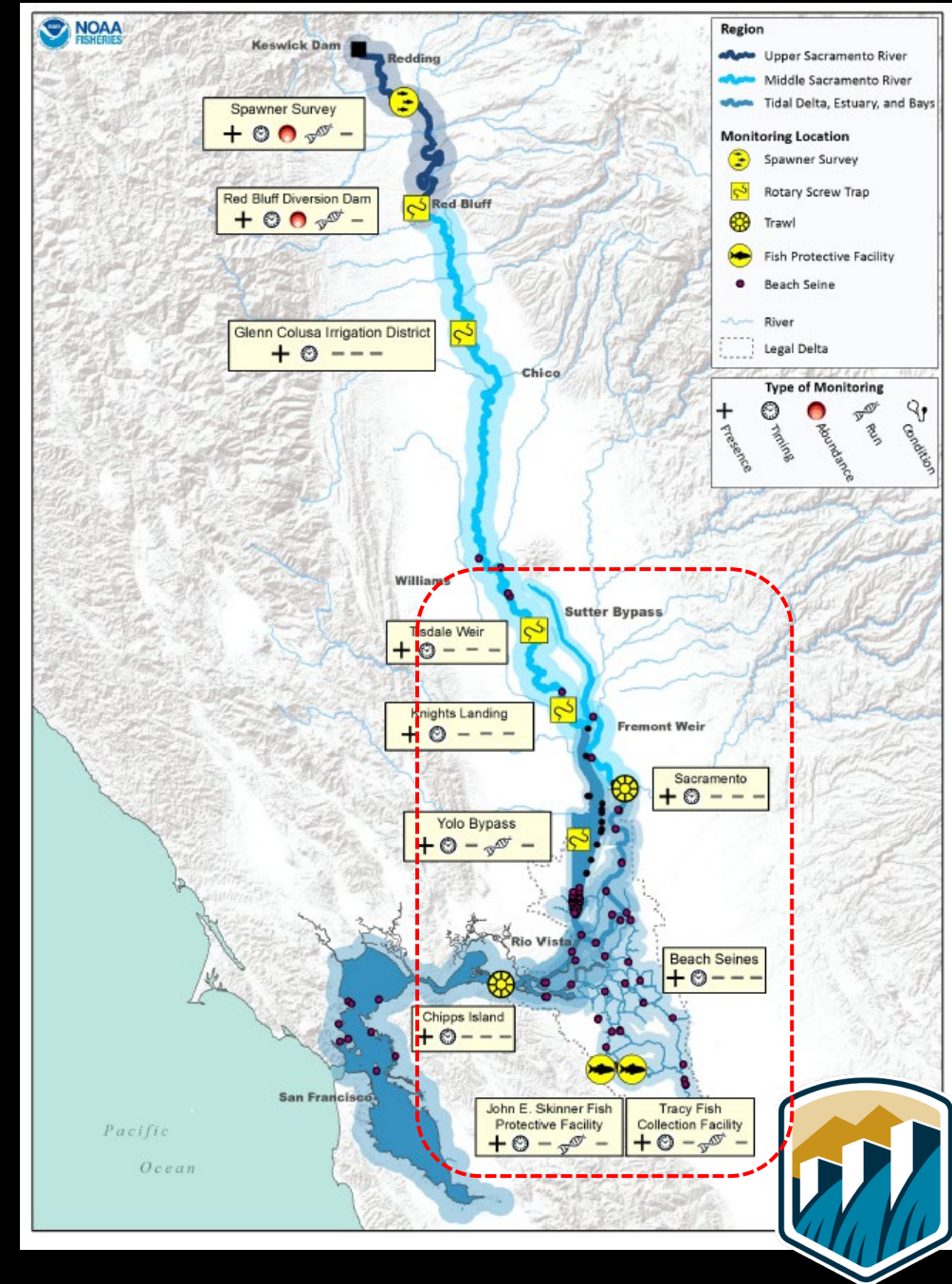


Figure from [Johnson et al. 2017](#)

Acoustic Telemetry

- Allow estimation of movement and survival for salmonids
- Studies found low survival in the interior Delta and that routing can be affected by hydrology
- Can be tracked in real-time:
<https://oceanview.pfeg.noaa.gov/CalFisHTrack/index.html>

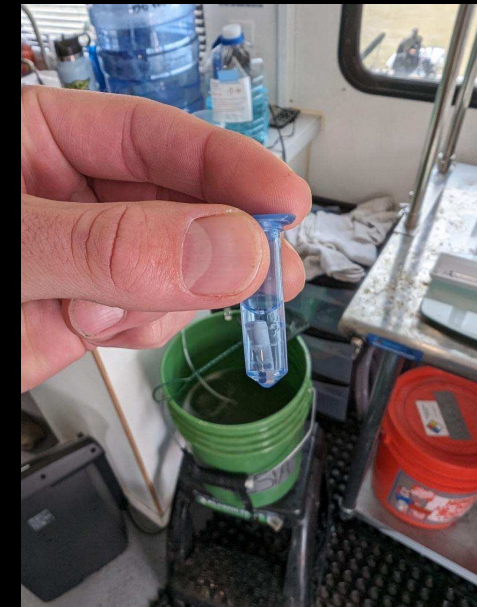
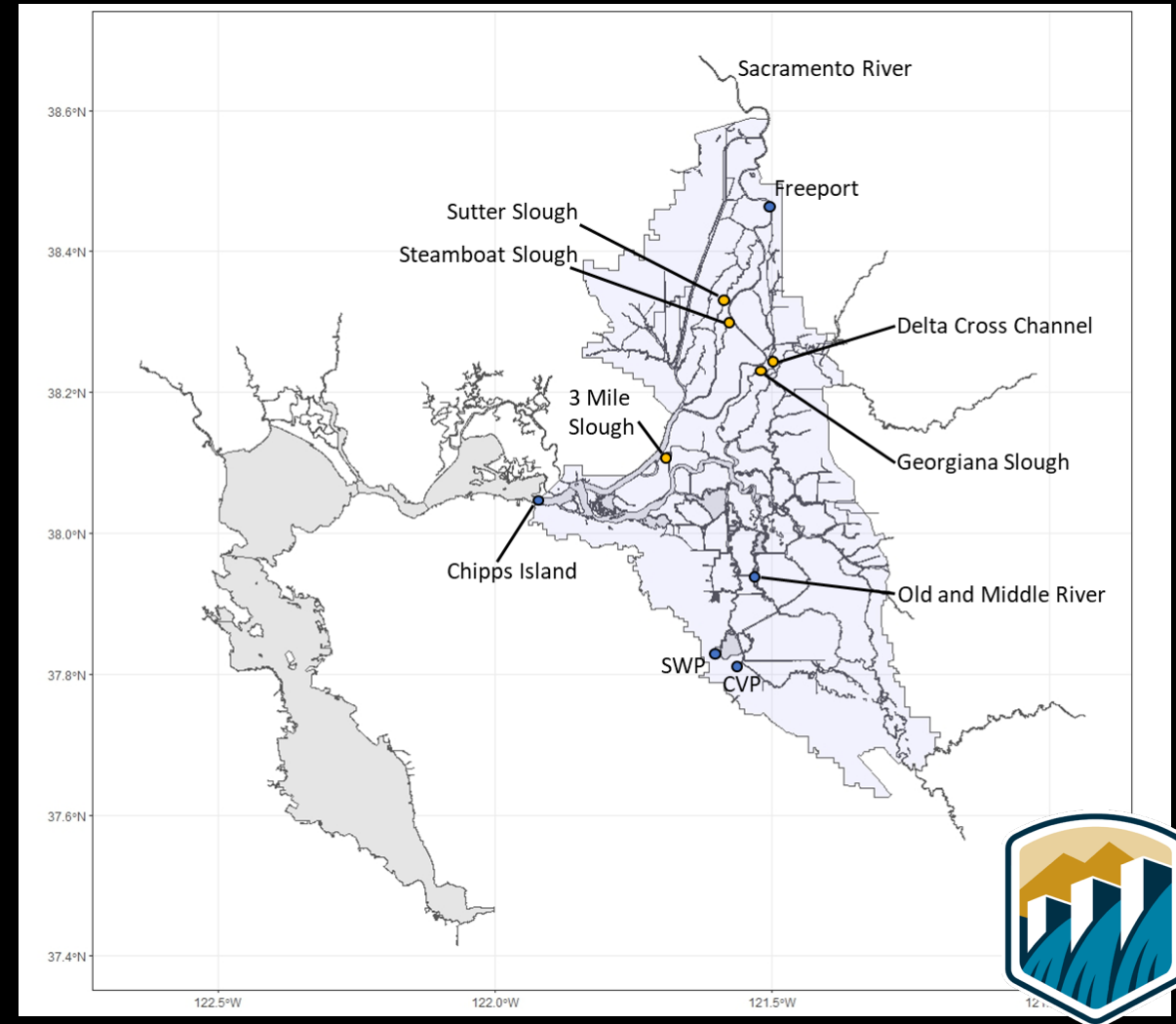


Photo credit: Alexander Vaisvil

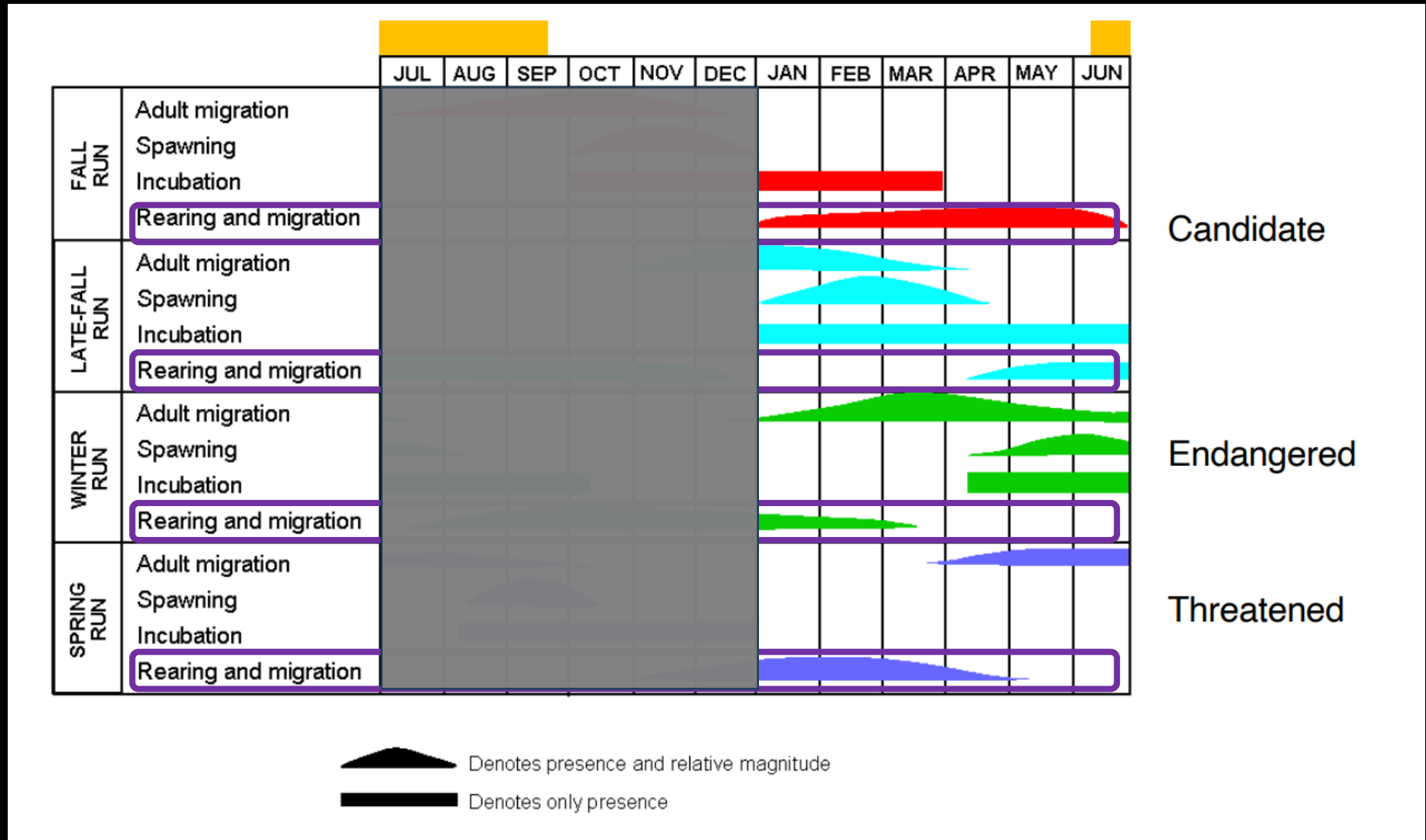


Physical and non-physical barriers are put in place to steer winter-run towards routes with higher survival

- Delta Cross Channel Gate Operations
 - Gate effectively closed during peak outmigration period for salmonids
- Georgiana Slough non-physical barrier



Identifying listed salmon runs can be difficult



Length-at-date criteria used to assign salmon run for practical purposes

- Fast, cheap, and easy
- Results in a lot of misclassifications
- Error rate varies by year

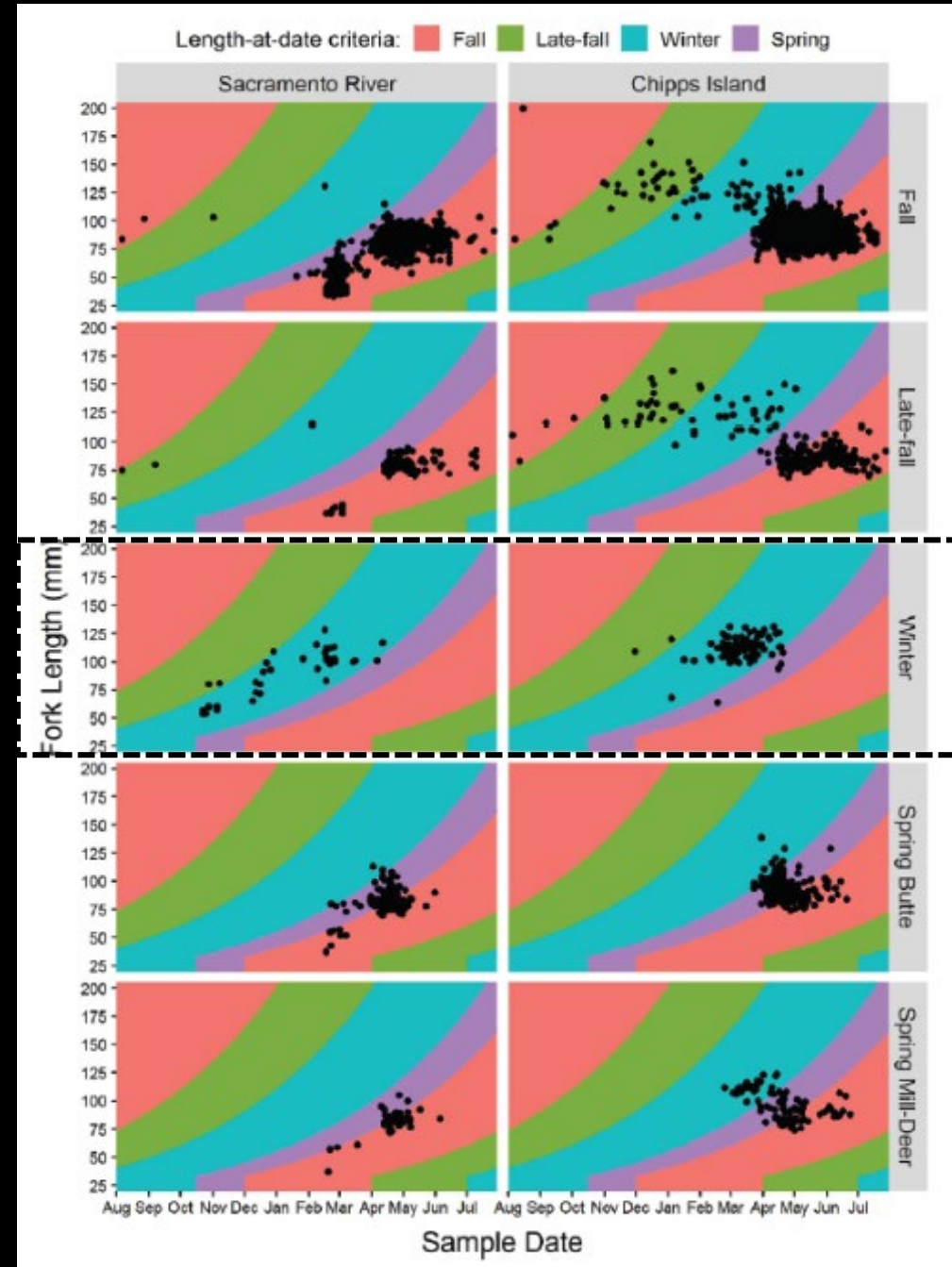


Figure from Brandes et al. [2021](#)



Correction using Genetic Assignment



- Genetic analysis with high-throughput sequencing (GTSeq; Campbell et al. 2014)
- Single nucleotide polymorphism (SNP) panel by Clemento et al. (2011)
- Rapid processing can occur and results can be provided within 48 hours



Spring-run Chinook Salmon

- No daily, weekly, or annual loss thresholds for young-of-year
- Use of surrogate for yearling through late-fall hatchery fish release
- Key issues:
 - Hybridization with fall-run (in parts due to hatchery practices)
 - No JPE established, but CDFW and DWR are working on this



Central Valley Steelhead

- Annual loss threshold
 - Based on greatest loss from 2010-2018
- No population estimates or JPE
 - However, a draft framework exists
- Contribution from Sacramento vs. San Joaquin basin unknown
- Little known about what drives anadromy/life history expression
- Low gear efficiency for many existing monitoring in the Delta

A Framework for Evaluating *O. mykiss* Juvenile Production and Factors Affecting Anadromy



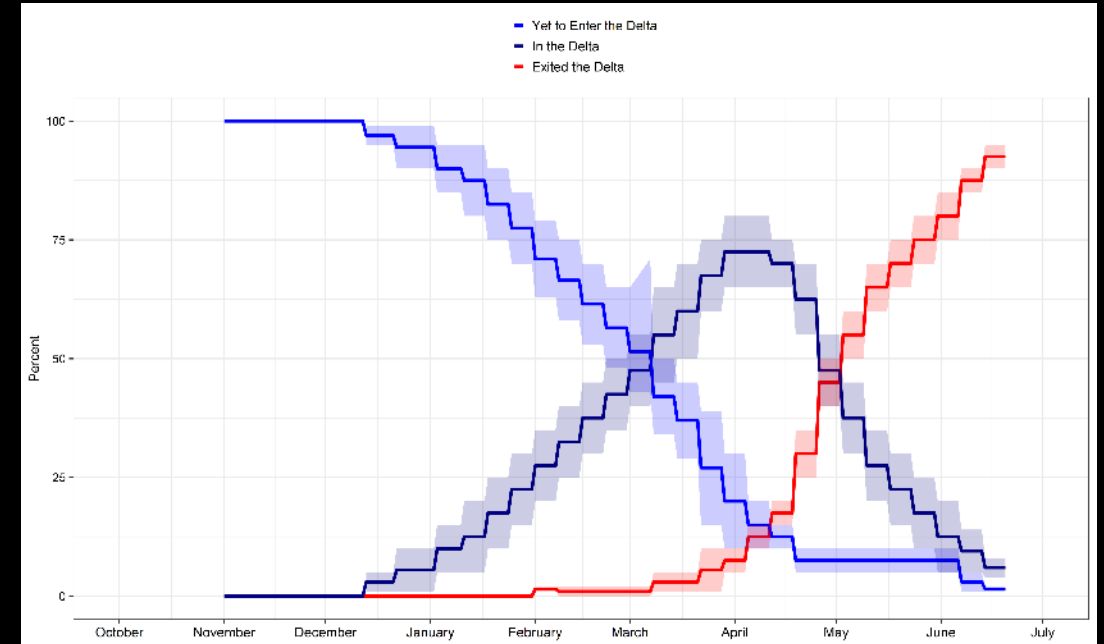
Suggested Citation

Beakes, M. P., Bilski, R., Brown, H., Collins, A., Ehlo, C., Ferguson, E., Ferguson, J., Goertler, P. A.L., Green, E., Gutierrez, M., Israel, J., Jensen, A., Kurth, R., Mahardja, B., Mathias, B., Nelson, J., Pien, C., Spear, K., and Vick, P. 2023. A Framework for Evaluating *O. mykiss* Juvenile Production and Factors Affecting Anadromy (xx pp.).



How salmonid data are used to inform water operations today

- Distribution Estimates based on monitoring and historical data or other information
 - Used to on-ramp and off-ramp OMR restrictions for salmonids
- Meant to reflect actual listed runs (e.g., genetic winter-run and not length-at-date winter-run)
- Determination of Risk (ITP)

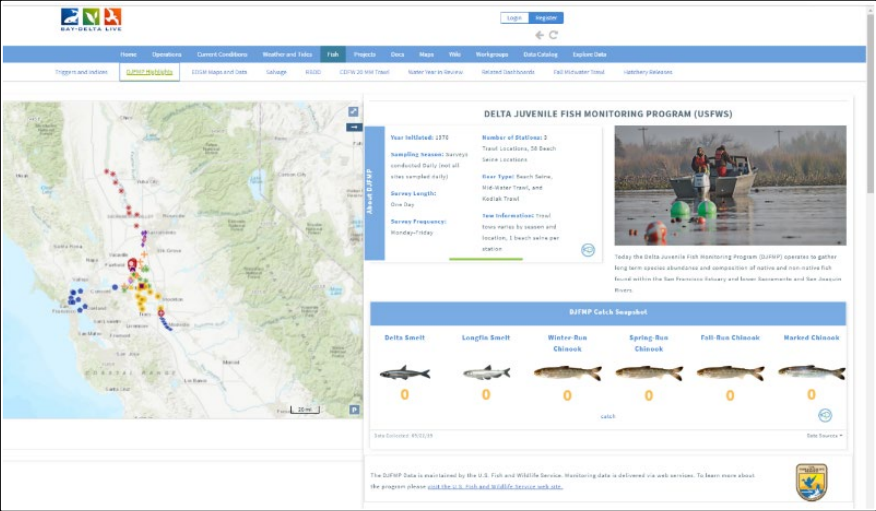


Location	Yet to Enter Delta	In the Delta	Exited the Delta
Young-of-year (YOY) winter-run Chinook salmon	Current: 5-10% Last week: 5-15%	Current: 70-90% Last week: 70-90%	Current: 5-20% Last week: 5-15%
YOY spring-run Chinook salmon	Current: 34-50% Last week: 43-60%	Current: 45-65% Last week: 40-55%	Current: 1-5% Last week: 0-2%
YOY hatchery winter-run Chinook salmon	Current: 85-95% Last week: 90-95%	Current: 5-15% Last week: 5-10%	Current: 0% Last week: 0%
Natural origin steelhead	Current: 30-70% Last week: 50-65%	Current: 20-50% Last week: 15-40%	Current: 10-20% Last week: 10-20%



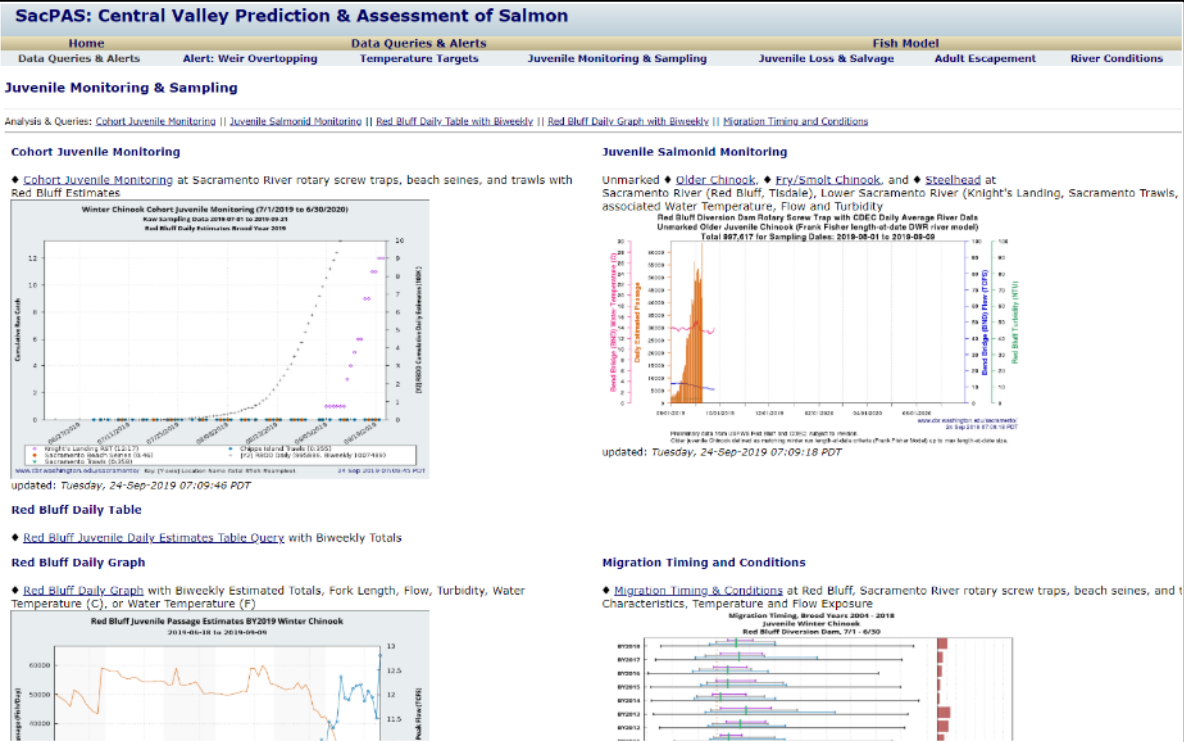
Many data and tools can be accessed in real-time online

Baydeltalive



Historical datasets published on the Environmental Data Initiative

SacPAS: Central Valley Prediction and Assessment of Salmon



Advancements in Monitoring and Emerging Technologies for OMR management



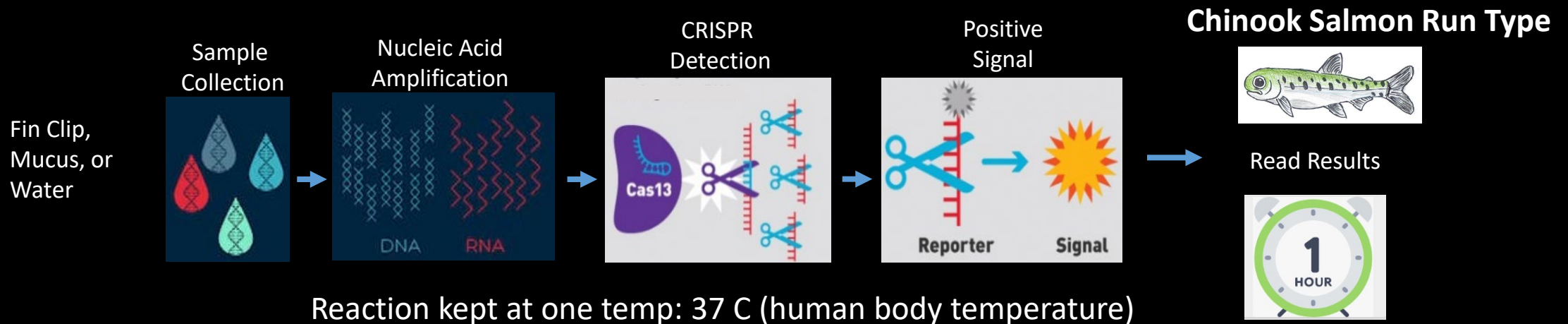
- Spring-run JPE: Additional genetic and field monitoring, modeling for spring-run
- Stanislaus River monitoring as a foundation for Central Valley Steelhead life-cycle monitoring and potentially JPE
- Longfin Smelt Science Plan
 - Work towards a life cycle model
- Acoustic and VIE tagging of Delta Smelt
- Predictive tools/models
 - Will be covered in next session
- New genetic tools (Parentage-based tagging, SHERLOCK)



SHERLOCK

Specific High-Sensitivity Enzymatic Reporter unLOCKing (Gootenberg et al., 2017 & 2018, Science)

- Originally developed for human pathogen detection
- Key attributes: specific, sensitive, rapid, low cost, easy to use, minimal equipment



Smelt Species: [Baerwald et al. 2020](#)
Chinook ESUs: [Baerwald et al. 2023](#)



For more information: Melinda Baerwald
(melinda.baerwald@water.ca.gov)

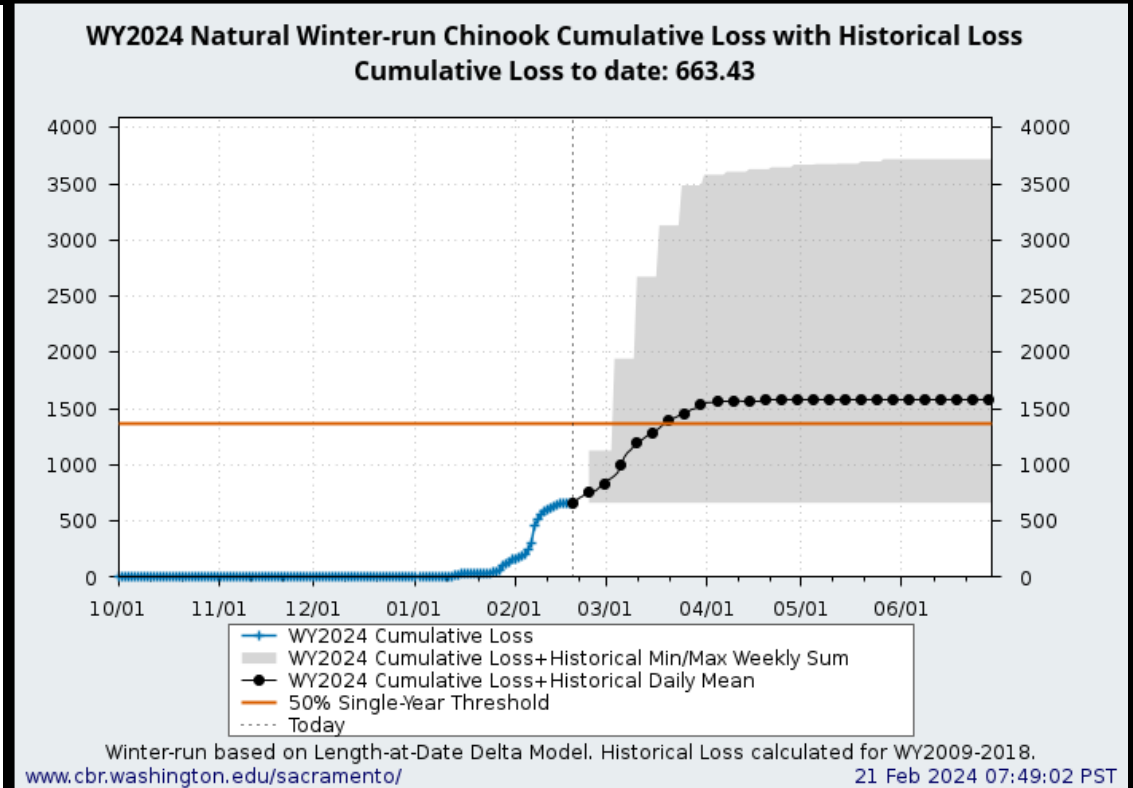
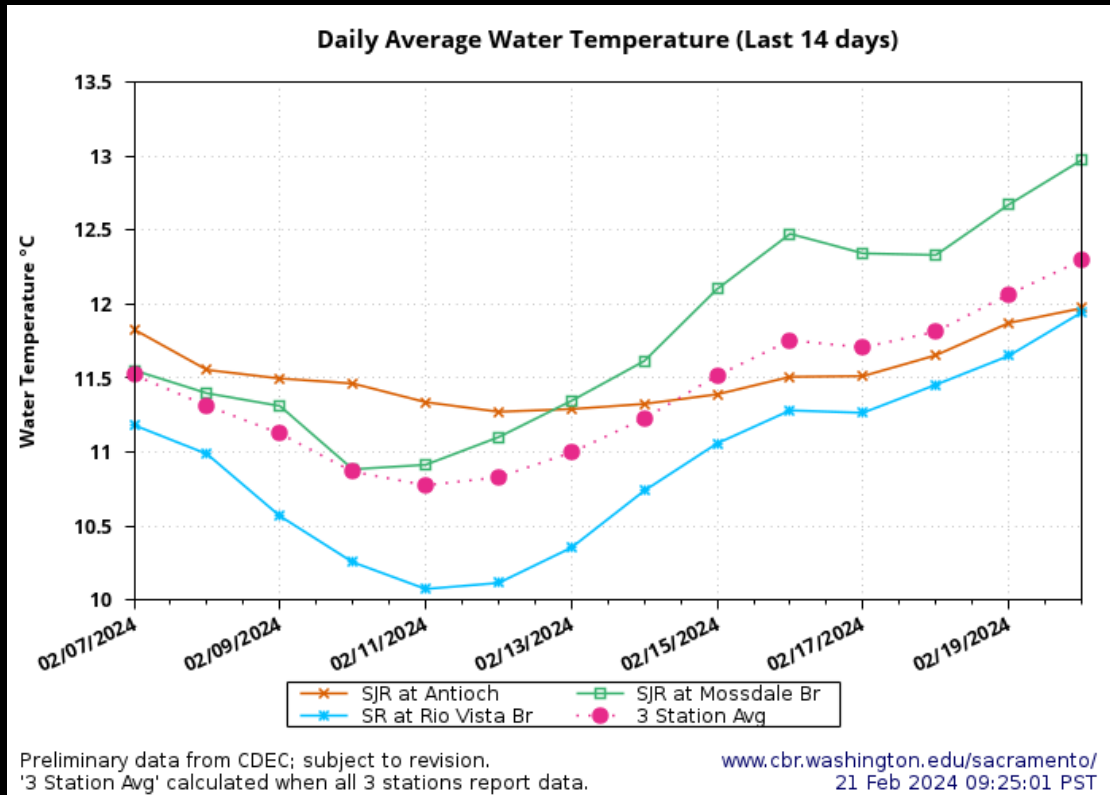


How do we evaluate our actions?

- In real-time (during the OMR management season; January-June)
- At the end of the season/year
- For long-term planning



- In real-time (during the OMR management season; January-June):
 - Combination of salvage data, fish survey data, expert opinion, and modeling tools
 - See weekly outlook and assessment documents, ITP risk assessment
 - <https://www.usbr.gov/mp/bdo/delta-monitoring-work-group.html>
 - <https://www.usbr.gov/mp/bdo/salmon-monitoring-team.html>
 - <https://www.usbr.gov/mp/bdo/smelt-monitoring-team.html>



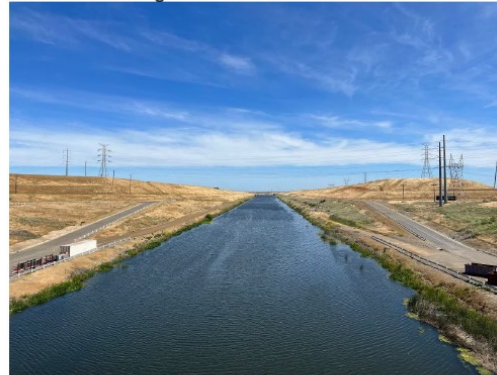
- At the end of the season/year
 - By salvage/loss numbers, whether or not we exceeded thresholds and trigger restrictions (see OMR seasonal reports)
 - May be viewed through the lens of population size (e.g., % of winter-run JPE)



— BUREAU OF —
RECLAMATION

Water Year 2022 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California
California-Great Basin Region



Cover Photo: View from Bill Jones Pumping Plant - Bureau of Reclamation

U.S. Department of the Interior

August 2022



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Water Year 2023 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California
California-Great Basin Region



Cover Photo: Delta Cross Channel Gates - Bureau of Reclamation

U.S. Department of the Interior

August 2023



- For long-term planning:
 - Life cycle models to put OMR management in context of population growth
 - Delta Smelt Life Cycle Model with Entrainment (LCME) ([Polansky et al. 2021](#), [Smith et al. 2021](#))
 - Maunder and Deriso's ([2011](#)) Life Cycle Model
 - Central Valley Project Improvement Act (CVPIA) Science Integration Team (SIT) decision support model for Chinook Salmon ([Peterson and Duarte 2020](#))



Key uncertainties surrounding OMR management

- Winter-run Chinook Salmon
 - What is the right target (i.e., % JPE) for OMR management?
- Spring-run Chinook Salmon
 - The number of juveniles entering the Delta, similar to winter-run regarding % JPE
- Central Valley Steelhead
 - Number of juvenile steelhead entering the Delta
 - Proportion of Sacramento vs. San Joaquin population
 - Factors driving anadromy
 - How OMR entrainment affects the anadromous population



Key uncertainties surrounding OMR management

- Delta Smelt
 - How well environmental surrogates represent Delta Smelt
 - Behavioral, physiological differences between supplemental and “wild” fish
- Longfin Smelt
 - Role of OMR management in Longfin Smelt life cycle (see [Longfin Smelt Science Plan](#))



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