



# Overview of SacPAS:

## Central Valley Prediction & Assessment of Salmon and other fishes



Jennifer L. Gosselin, Susannah Iltis, and W. Nicholas Beer



SCHOOL OF  
AQUATIC AND FISHERY SCIENCES

COLLEGE OF THE ENVIRONMENT  
UNIVERSITY OF WASHINGTON



COLUMBIA BASIN RESEARCH

# Presentation Goals



**AWARENESS**  
of **SacPAS tools**  
available



**APPROACH**  
of how we provide  
**SERVICE**



**Kickstart at**  
**workshop**  
for  
**FEEDBACK**  
and  
**COLLABORATION**

# Outline



- CBR History & Philosophy
- Sneak peak of new SacPAS website



## I. Data Queries & Alerts

## II. Work Groups & Teams

## III. Models: survival, migration, etc.



- Recap of presentation to setup for:
  - Open Discussion
  - Office Hours

# History & Philosophy of CBR

- Three decades ago, Prof. Anderson and Skalski started Columbia Basin Research
- Provide practitioners easy access to data, info, and analytical methods, for in-season fish & river management meetings.
- That is what we continue to strive to provide:
  - access to data,
  - value-added visualizations,
  - statistical & modeling tools customized to the needs of the users.



JAMES J. ANDERSON  
CBR Co-Founder

Anderson /  
Gosselin Lab



JOHN R. SKALSKI  
CBR Co-Founder

Skalski /  
Buchanan Lab

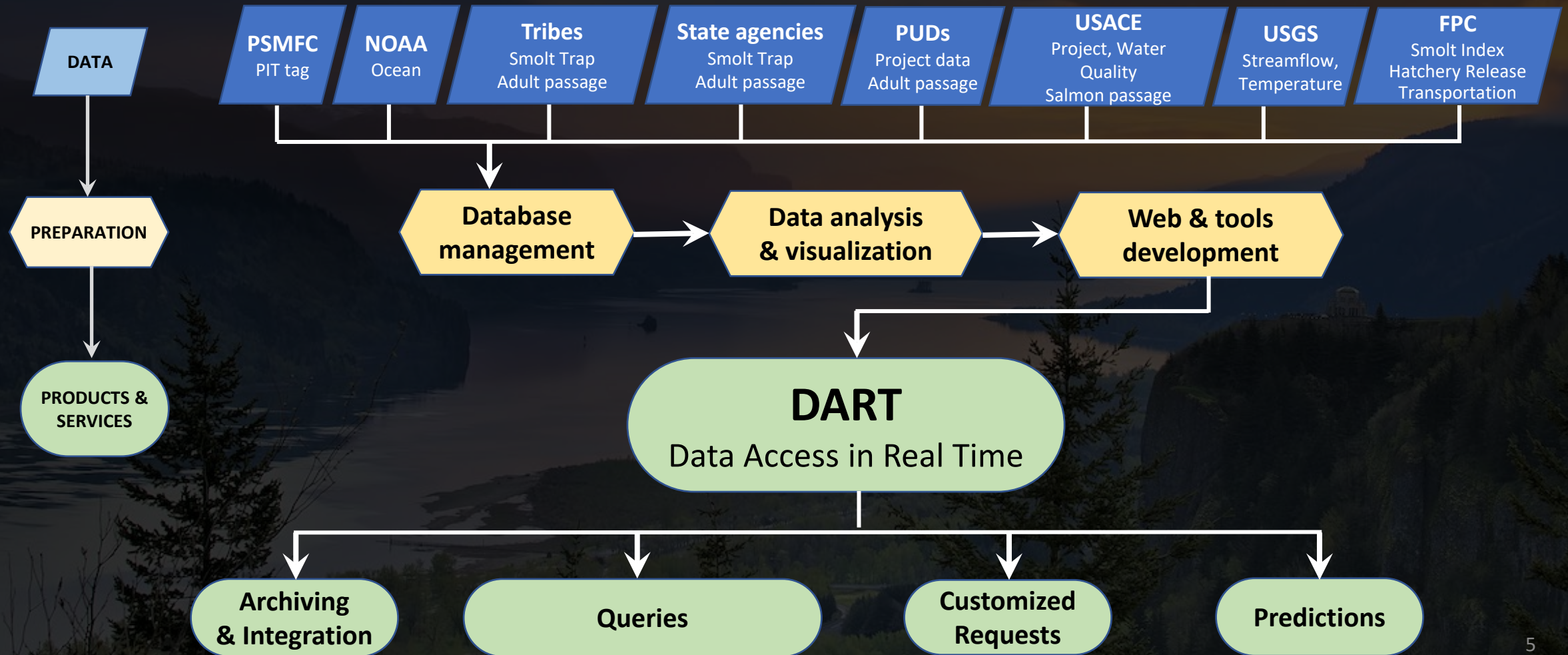


JENNIFER L. GOSSELIN  
CBR Co-Director



REBECCA A. BUCHANAN  
CBR Co-Director

# DART: SECONDARY DATA REPOSITORY, CENTRALIZED AND INTEGRATED DATA SETS





Providing data and analytical tools for science-based decision making and management of regulated rivers and fishes

FACILITATING ACCESS

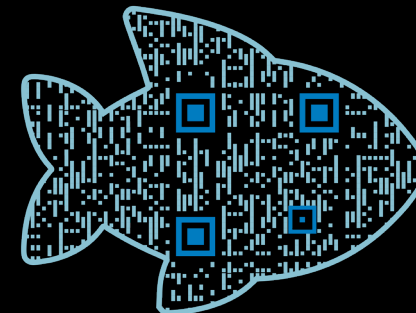
Data on fishes and conditions, and tools for visualizations and predictions

CONDUCTING RESEARCH

Fish and river models, statistical packages, presentations and publications

MAKING CONNECTIONS

Collaborators, practitioners, stakeholders, students, data, knowledge, and experiences



<https://www.cbr.washington.edu/>

COLUMBIA RIVER DART

- ESU/DPS
- Adult Passage Counts
- Adult Passage Quick Look
- Juvenile Passage
- Transportation
- SAR Estimates

- Columbia Basin Conditions
- River Conditions
- Streamflow & Temperature
- Water Quality Hourly
- Pacific Ocean Coastal Upwelling
- Ocean Moored Buoys

Overview  
DART News & Announcements

PREDICTIONS

- Snake River Smolt Passage
- Chelan Smolt Passage
- Adult Passage
- Water Quality

TRENDS

- Columbia Basin Annual Trends
- ROSTER Results

- Dam Conditions
- Reservoir Conditions

TOOLS

- ATLAS
- Basin TribPit
- Branch
- failCompare
- PitPro
- ROSTER
- SampleSize
- SURPH
- USER

- COMPASS Model
- Vitality Model

SACPAS

- Data Queries & Alerts
- Weir Overtopping Alert
- Temperature Thresholds
- Juvenile Monitoring & Sampling
- Juvenile Salvage & Loss

- Smelt Monitoring Team
- Salmon Monitoring Team
- Stanislaus Monitoring Team

- Fish Model
- Model Support Tools
- Delta STARS
- Loss and Salvage Predictor



**SacPAS website updates in progress...**

# SACPAS: CENTRAL VALLEY PREDICTION AND ASSESSMENT OF SALMON

UNIVERSITY of WASHINGTON  
Columbia Basin Research

Data & Alerts ▾

Workgroups & Teams ▾

Tools & Models ▾

4th Dimension ▾

About ▾



Providing data and analytical tools for science-based decision making and management of regulated rivers and fishes



SACRAMENTO RIVER  
**FISH MODEL**



CENTRAL VALLEY  
**TOOL 2**



Data & Alerts

Workgroups & Teams

Tools & Models

4th Dimension

About

## DATA & ALERTS

Publicly accessible, web-based query and reporting system of historical and current fish, environmental, and hydrologic information, vital to year-round planning and adaptive management of the Central Valley Project and State Water Project. Data uploads provide the most up-to-date data as it is made available, whether it be daily, biweekly, monthly or annually.

Basic conditions, performance measures, and threshold-based alerts are available through data aggregation and analysis of environmental conditions.

## RESOURCES

- [Overview of Data&Alerts](#)
- [Access all Data&Alerts tools](#)
- [Metadata and Glossaries](#)
- [Data Inventory](#)
- [Data Site Maps](#)
- [News and Announcements](#)
- [Data Feedback](#)

## RIVER CONDITIONS

- [River Graph&Text](#)
- [Daily River Table](#)
- [All Years Graph](#)
- [Basin Conditions](#)
- [Exposure Index](#)
- [more](#)

## JUVENILE MONITORING & SAMPLING

- [Cohort Juvenile Monitoring](#)
- [Current Catch](#)
- [Juvenile Salmonid Monitoring](#)
- [Red Bluff Daily Table](#)
- [Red Bluff Daily Graph](#)
- [Cohort Migration Timing](#)
- [more](#)

## TEMPERATURE THRESHOLDS

- [Clear Creek](#)
- [Lower American](#)
- [Sacramento](#)
- [Stanislaus Flow&Temp](#)

## JUVENILE SALVAGE & LOSS

- [Salvage and Loss Summary](#)
- [Delta Loss Graphs](#)
- [Delta Salvage Graphs](#)
- [Salvage Timing](#)
- [Hatchery Chinook Loss Tables](#)
- [Salvage and Loss Detail](#)
- [more](#)

## ALERTS

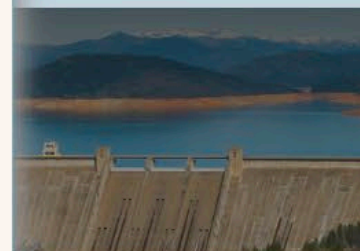
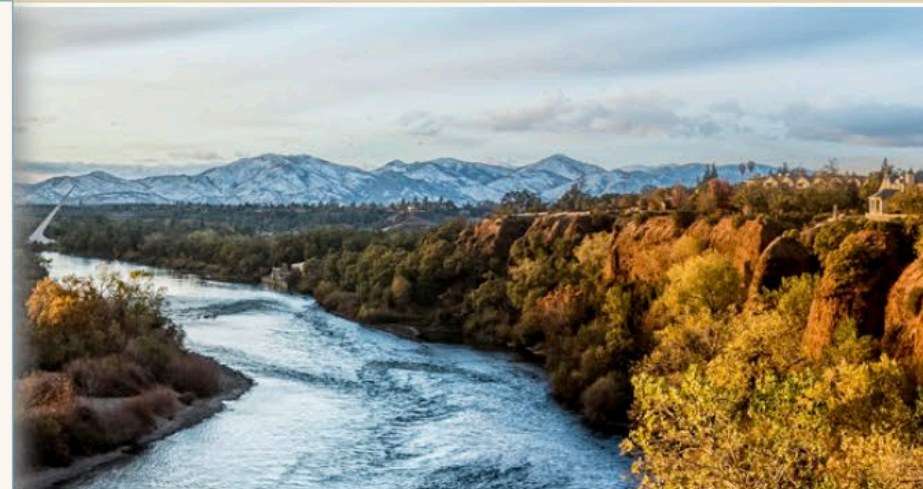
- [Weir Overtopping](#)

## SMOLT-TO-ADULT RETURN

- [CWT SAR Survival](#)

## ADULT ESCAPEMENT

- [CDFW GrandTab](#)



## SACPAS

- [Data Queries & Alerts](#)
- [Temperature Thresholds](#)
- [Juvenile Monitoring & Sampling](#)

Data & Alerts ▾

Workgroups & Teams ▾

Tools & Models ▾

4th Dimension ▾

About ▾

## WORKGROUPS & TEAMS

*Customized data visualizations, critical limits, and data tables of current conditions in real-time to facilitate monitoring and management by Central Valley Work Groups and Monitoring Teams.*

### RESOURCES

[Water Operations and Watershed Monitoring Technical Teams](#), BDO, BOR

#### SALMON MONITORING TEAM (SAMT)

[DCC Operations](#)

[Alerts for flow](#)

[Juvenile Sampling Summary](#)

[Migration Pattern for "Today"](#)

[Species Distribution Estimates](#)

[Loss&Salvage Predictor Est.](#)

[Delta STARS Estimates](#)

[Single-Year Loss Thresholds](#)

[more ↷](#)

#### SMELT MONITORING TEAM (SMT)

[Delta Smelt Current](#)

[Water Temperature](#)

[Onset of OMR Management](#)

[Turbidity Bridge Avoidance](#)

[Larval&Juv. Delta Smelt Protect.](#)

[End of OMR Management](#)

[Operations and Hydrology](#)

[Chippis Island Detail](#)

[EDSM Detail](#)

[Daily & Hourly Data](#)

[more ↷](#)

#### STANISLAUS WATERSHED TEAM (SWT)

[Temperature and Flow](#)

[Juvenile Sampling Summary](#)

[Current River Conditions](#)

[Water Temp. Min, Max, Avg](#)

[Water Temperature Historical](#)

[Dissolved Oxygen](#)

[Goodwin Dam Discharge](#)

[Data Locations Map](#)

[more ↷](#)

#### SAN JOAQUIN RIVER RESTORATION PROGRAM (SJRRP)

[Allocation Inventory](#)

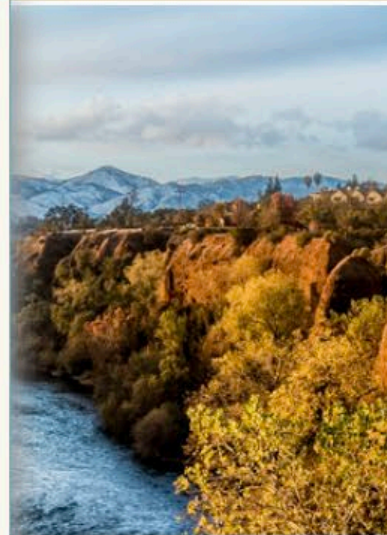
[Restoration Flow Released](#)

[Allocation Management](#)

[Flow Hydrograph](#)

[Flow Snapshot](#)

[more ↷](#)



Data & Alerts ▾

Workgroups & Teams ▾

Tools & Models ▾

4th Dimension ▾

About ▾

## TOOLS & MODELS

*Interactive statistical software and models for prediction of loss/salvage and analysis of fish growth. Shiny Apps developed by SacPAS in support of various tools and models.*

*Includes implementation of 3rd Party Tools.*

### FISH MODEL

[Egg-to-Fry model](#)

[Migration models](#)

[more ↷](#)

### 3RD PARTY TOOLS

[Delta STARS](#)

[Loss & Salvage Predictor](#)

[WRCLM](#)

### SUPPORTIVE TOOLS

[Egg Growth Model](#)

[EGGGROWTEMPPS Shiny app](#)

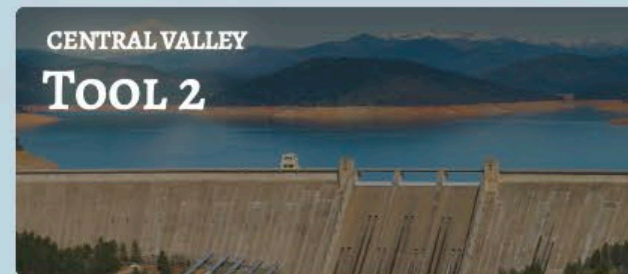
[EGG\\_SURV Shiny app](#)

[SURVDEMO Shiny app](#)

[MIGR\\_DISTRIB Shiny app](#)

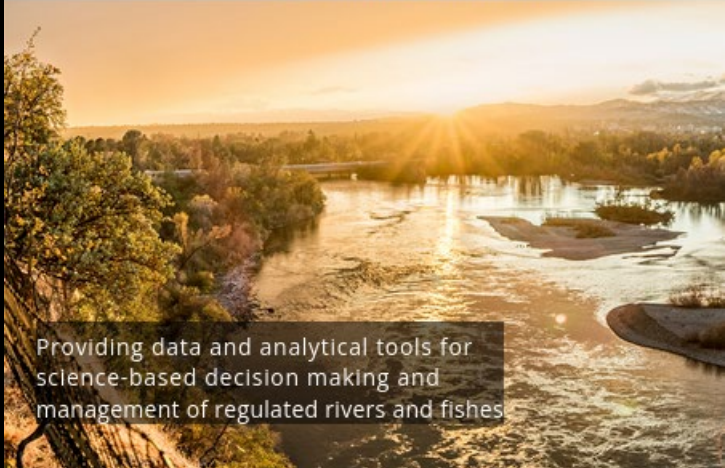
[TEMPMAKER Shiny app](#)

Providing  
science-based  
management






☰ SACPAS: CENTRAL VALLEY PREDICTION AND ASSESSMENT OF SALMON




Providing data and analytical tools for science-based decision making and management of regulated rivers and fishes.

SACRAMENTO RIVER  
**FISH MODEL**



CENTRAL VALLEY  
**TOOL 2**



# Mobile version

*in development*



## SACPAS: CENTRAL VALLEY PREDICTION AND ASSESSMENT OF SALMON

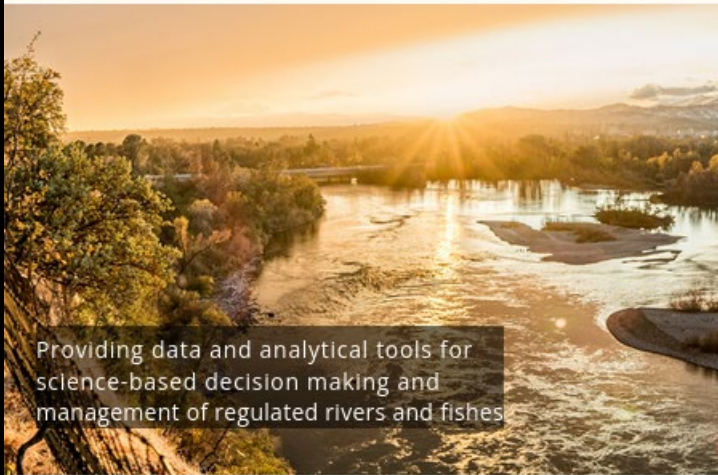
Data & Alerts

Workgroups & Teams

Tools & Models

4th Dimension

About



Providing data and analytical tools for science-based decision making and management of regulated rivers and fishes





## SACPAS: CENTRAL VALLEY PREDICTION AND ASSESSMENT OF SALMON

### Data & Alerts >

#### Data & Alerts

River Conditions >

Temperature Thresholds >

Alerts >

Juvenile Monitoring & Sampling >

Juvenile Salvage & Loss >

Smolt-to-Adult Return >

Adult Escapement >

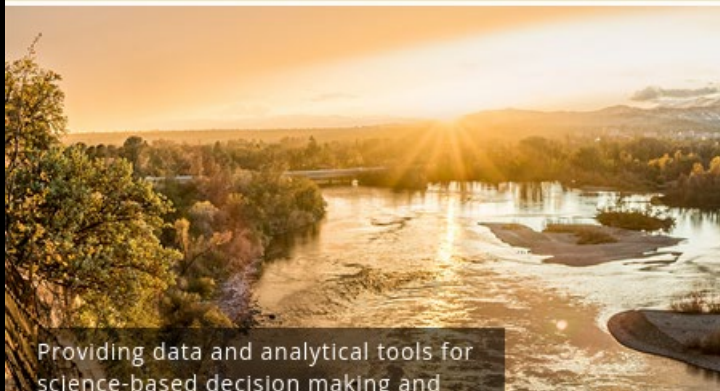
Resources >

#### Workgroups & Teams

Tools & Models

4th Dimension

About



Providing data and analytical tools for science-based decision making and



## SACPAS: CENTRAL VALLEY PREDICTION AND ASSESSMENT OF SALMON

Data & Alerts

Workgroups & Teams >

### Workgroups & Teams

Salmon Monitoring Team (SaMT) >

Smelt Monitoring Team (SMT) >

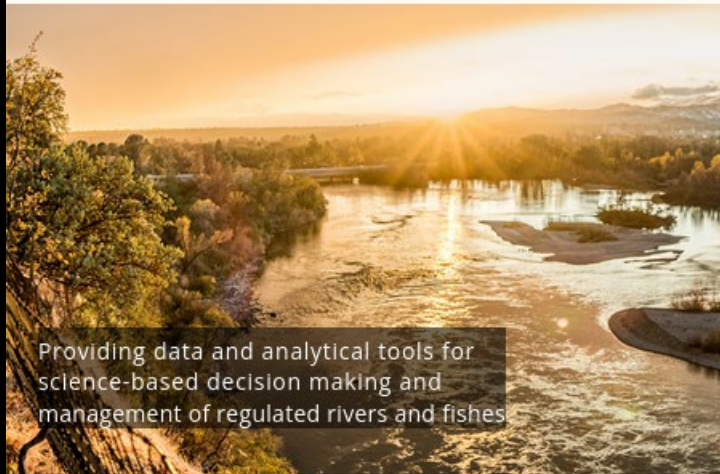
Stanislaus Watershed Team (SWT) >

San Joaquin River Restoration Program (SJRRP) >

Tools & Models

4th Dimension

About



Providing data and analytical tools for science-based decision making and management of regulated rivers and fishes

SACRAMENTO RIVER

# Assistance in accessing data and addressing knowledge-action gaps

• Data collection → Data Access → Knowledge • Actions • Goals



# Developing with Design Thinking & Human-Centered Design in mind

1. Understand & empathize

2. Explore & Ideate

3. Test & Implement

Values  
Context  
Culture  
Worldviews

Goals  
Objectives

Ideas  
Concepts

Conceptual  
prototypes

Functional  
prototypes  
Feedback  
Revisions

Implemented  
Online Tool  
Updates

# SacPAS tools



**I. Data Queries & Alerts**

II. Work Groups & Teams

III. Models: survival, migration, etc.



# I. SacPAS Data Queries & Alerts

## What

- SacPAS provides users:
  - Access to data and visualizations
  - Data downloads
  - Summaries of relevant metrics
  - Customized query interfaces & user-centered tools

## How

- SacPAS does so with:
  - Attribution to data owners
  - Transparency of methods
  - Value-added services
  - Human centered design

# I. SacPAS Data Queries & Alerts

1. Juvenile Monitoring & Sampling



2. Juvenile Salvage & Loss



3. Adult Escapement



4. Temperature Thresholds



5. River Conditions



6. Exposure Index



# Common Elements of SacPAS Query Interface

Query Title / Type

Data Attribution

Topic Area Queries

Output Formats

Selections:  
customized to data  
and query

Submit button

Query Notes &  
Resources

**CDFW GrandTab, California Central Valley Chinook Population Database**

Data Courtesy of [CDFW via CalFish](#)

Adult Analysis & Queries: **GrandTab** || [CWT\\_SAR](#)

**Select Output Format**

Barchart w/Table  Download CSV Only  Download Graph Only [PNG]

**Select Species-Run, Spawning Type**

Chinook, Winter	In-River
Chinook, Spring	Hatchery
Chinook, Fall	All
Chinook, Late-Fall	

**Select Spawning Location**

Spawning Location by Water Body Area  Spawning Locations by Diversity Group [Map]

Battle Creek - Upstream of CNFH, Sacramento

**Options**

Rolling 3 Year Geometric Mean  
 Color Vision Deficiency (CVD) colors

Generate Query Result Link Only

**Query Notes & Resources**

- As of 20 July 2023: Data presented through this query is based on GrandTab 2023.06.26. [California Central Valley Chinook Population Database Report "GrandTab"](#), CDFW via CalFish

Generate re-usable  
query URL for automated retrieval  
e.g., for "Download CSV Only" option, in Rscript  

```
mydata <- read.csv(queryURL)
```

# 1. Juvenile Monitoring & Sampling



Cohort Juvenile Monitoring

**SacPAS: Central Valley Prediction & Assessment of Salmon** UW\_Columbia\_Basin\_Research

Home | Data Queries & Alerts | Work Groups & Teams | Fish Model | Tools | Contact

Data Queries & Alerts | Alert: Weir Overtopping | Temperature Thresholds | Juvenile Monitoring & Sampling | Juvenile Salvage & Loss | Adult Escapement | River Conditions | Exposure Index | Data Sites & Inventory

**Juvenile Monitoring & Sampling**

Analysis & Queries: Cohort Juvenile Monitoring | Current Catch | Juvenile Salmonid Monitoring | Red Bluff Daily Table with Biweekly | Red Bluff Daily Graph with Biweekly | Migration Timing and Conditions

**Cohort Juvenile Monitoring**

◆ Cohort Juvenile Monitoring at Sacramento River rotary screw traps, beach seines, and trawls with Red Bluff Estimates

Winter Chinook Cohort Juvenile Monitoring (07/1/2023 to 6/30/2024)  
Raw Sampling Data 2023-07-03 to 2023-11-17  
Red Bluff Daily Estimates Brood Year 2023

updated: Wednesday, 22-Nov-2023 08:16:02 PST

**Juvenile Salmonid Monitoring**

Unmarked ◆ Older Chinook, ◆ Fry/Smolt Chinook, and ◆ Steelhead at Sacramento River (Red Bluff, Tisdale), Lower Sacramento River (Knights Landing, Sacramento Trawls, Chipps Island) and San Joaquin (Mossdale) with associated Water Temperature, Flow and Turbidity

Red Bluff Diversion Dam Rotary Screw Trap with CDEC Daily Average River Data  
Unmarked Older Juvenile Chinook (Fork Length-at-Date QWS) (over model)  
Total 729,176 for Sampling Dates: 2023-08-01 to 2023-11-18

updated: Wednesday, 22-Nov-2023 08:16:01 PST

**Red Bluff Daily Table**

◆ Red Bluff Juvenile Daily Estimates Table Query with Biweekly Totals

**Red Bluff Daily Graph**

◆ Red Bluff Daily Graph with Biweekly Estimated Totals, Fork Length, Flow, Turbidity, Water Temperature (C), or Water Temperature (F)

Red Bluff Juvenile Passage Estimates BY2023 Winter Chinook  
2023-06-18 to 2023-11-18

updated: Wednesday, 22-Nov-2023 08:16:01 PST

**Current Catch**

Unmarked ◆ Winter Chinook, ◆ Spring, ◆ Fall, ◆ Late Fall, and ◆ Steelhead at Sacramento River (Red Bluff) and Lower Sacramento River (Knights Landing, Sacramento Trawls, Chipps Island) monitoring locations

Current Catch Juvenile Uncipped Winter Chinook  
By Nov 20 | Annual Total | 2023 Predicted

updated: Tuesday, 21-Nov-2023 08:49:10 PST

**Migration Timing and Conditions**

◆ Migration Timing & Conditions at Red Bluff, Sacramento River rotary screw traps, beach seines, and trawls Cumulative Passage, Migration Timing Characteristics, Temperature and Flow Exposure

Migration Timing, Brood Year 2008 - 2023  
Juvenile Uncipped Winter Chinook  
Red Bluff Diversion Dam, 711 - 6r30

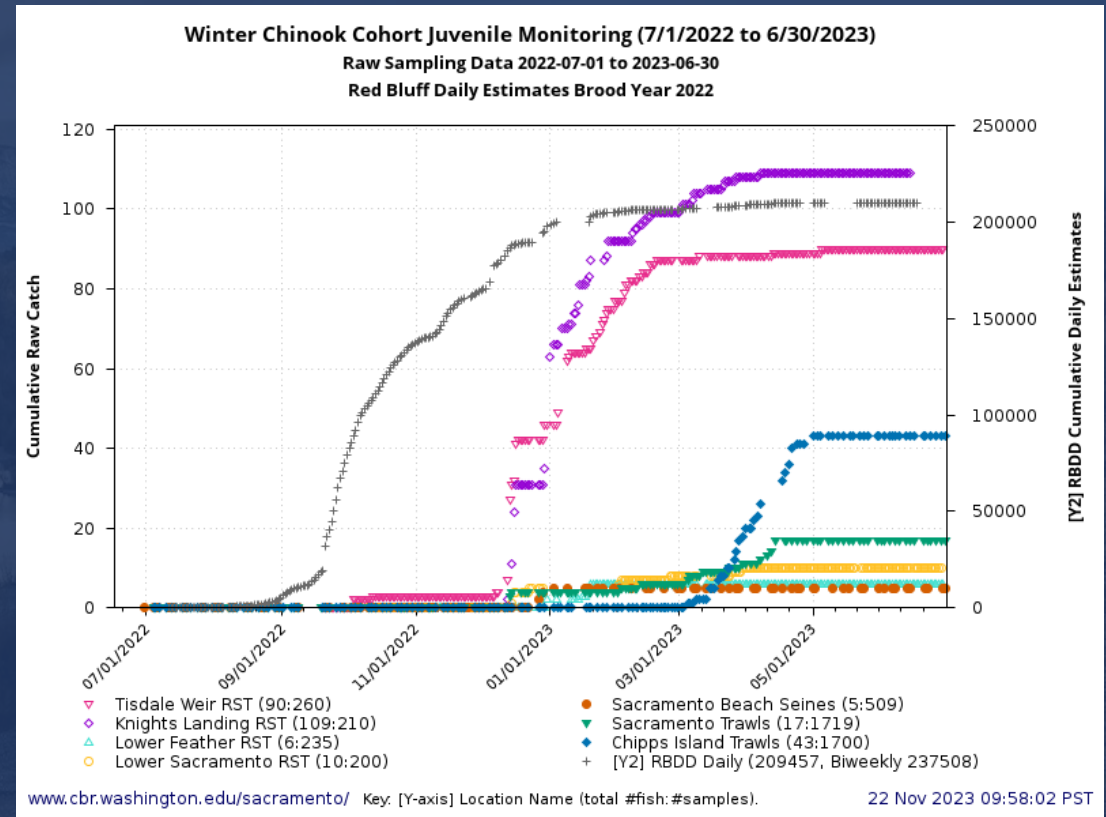
updated: Wednesday, 22-Nov-2023 08:16:00 PST

Current Catch

Migration Timing and Conditions

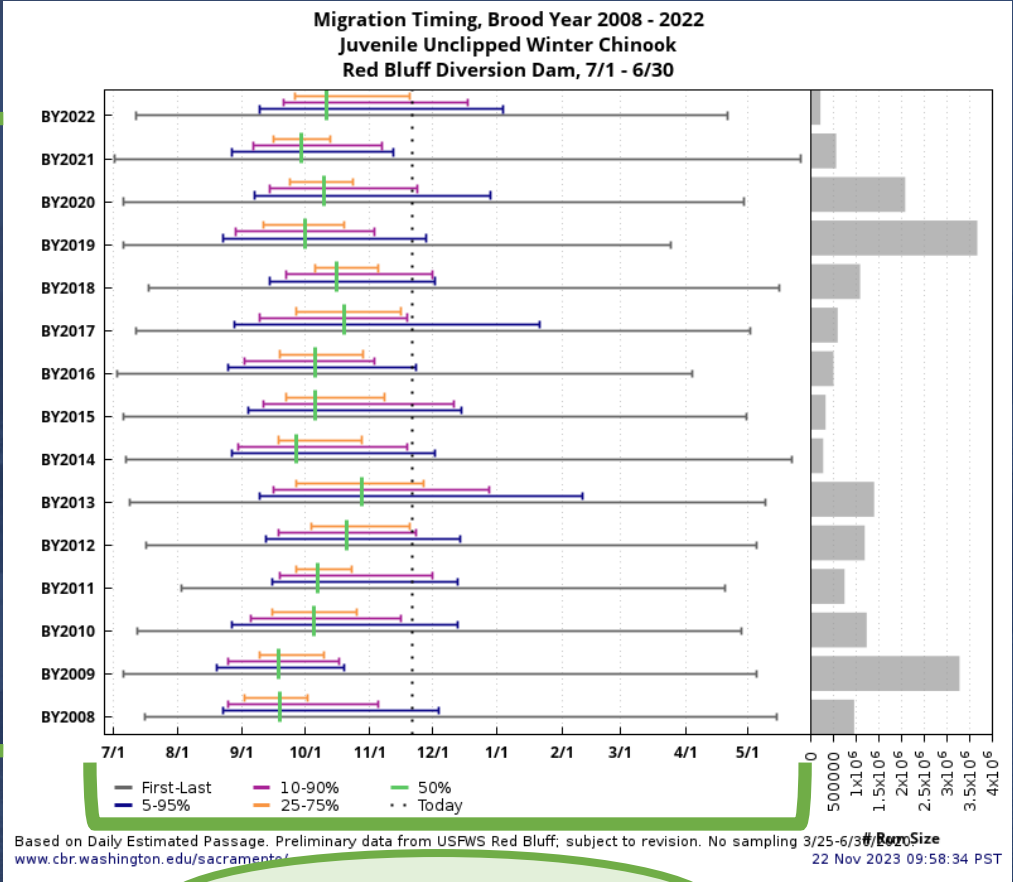
# Juvenile Monitoring & Sampling – Single Brood Year, Multiple Locations

- Rotary Screw Traps, Beach Seines, Trawls, and Red Bluff Diversion Dam catch
- Single point query access
- Brood Year cohorts
  - Red Bluff Diversion Dam
  - Length-at-Date model run assignments
- Tracking migration downstream



# Juvenile Monitoring & Sampling – Multiple Brood Years, Single Location

Brood Years



Total Passage Estimates or Catch

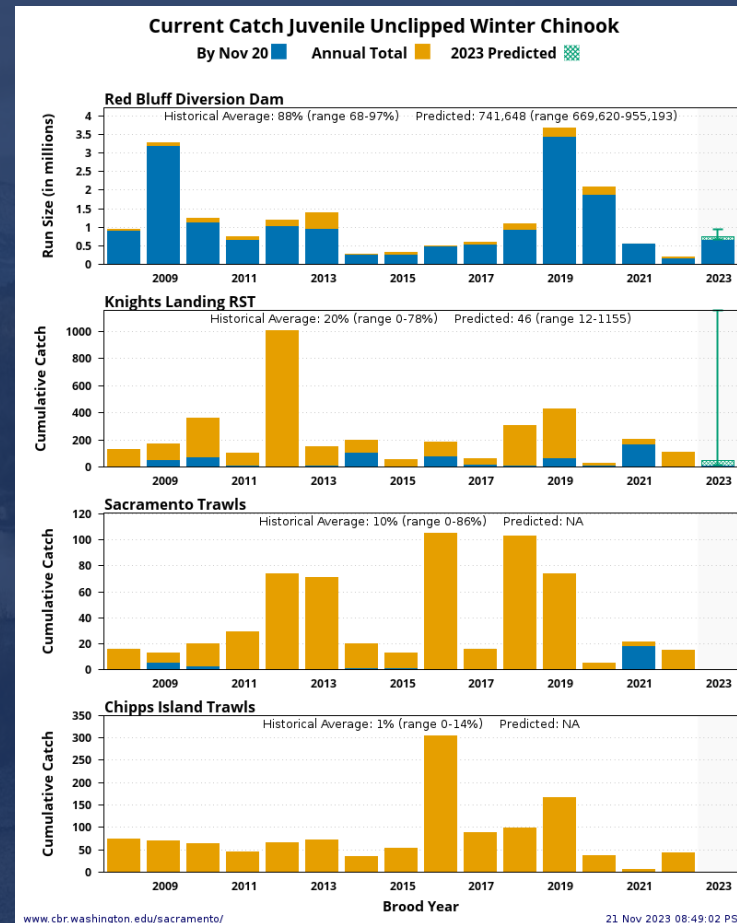
Date Range period



# Juvenile Monitoring & Sampling –

## Multiple Brood Years, Multiple Locations

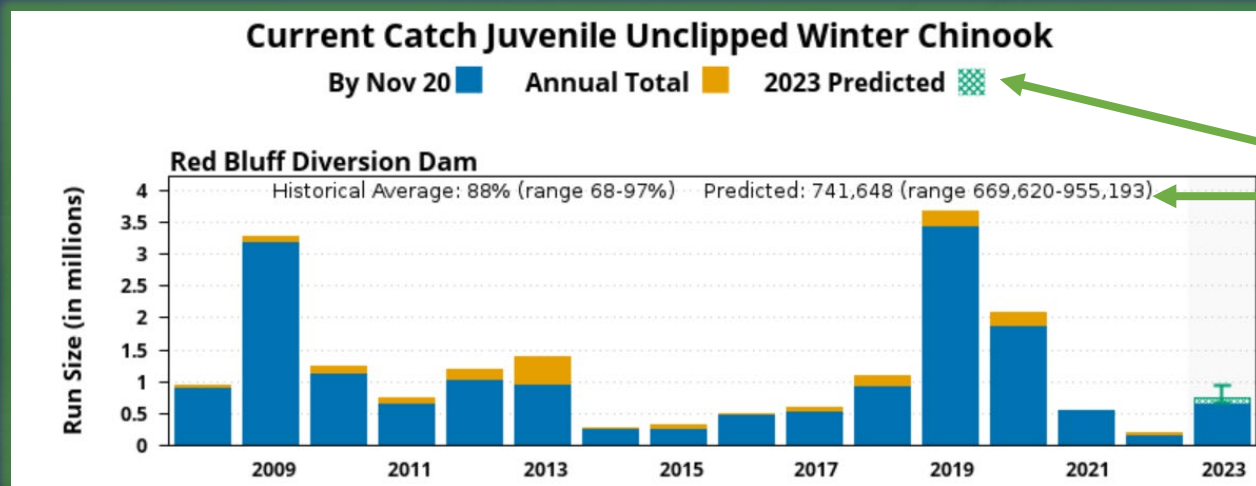
### Simple “Prediction” based on Historical & Current Years



“Current Catch” [cbr.washington.edu/sacramento/data/currcatch.html](http://cbr.washington.edu/sacramento/data/currcatch.html)

# Juvenile Monitoring & Sampling –

Multiple Brood Years, Multiple Locations  
Simple “Prediction” based on Historical & Current Years



November 20<sup>th</sup>,  
Winter Chinook  
Red Bluff BY2023  
Prediction

### 3. Adult Escapement

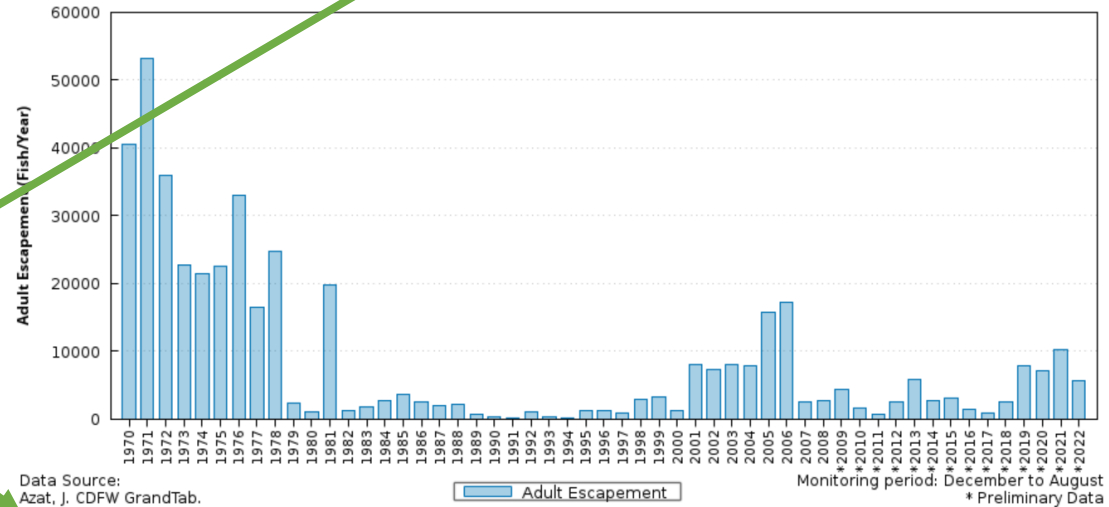


Detailed title and footnote included in the figure for transparency

#### CDFW GrandTab Adult Escapement Graph

[< browser back](#) [<< return to query page](#) [download CSV](#)

**California Central Valley Chinook Population Database Report CDFW GrandTab Adult Escapement**  
Basalt and Porous Lava Diversity Group  
In-River Winter Chinook  
Spawn Years 1970-2022  
2 Sub Populations  
Battle Creek - Upstream of CNFH, Mainstem - Upstream of RBDD  
3 GrandTab Data Notes exist for dataset



Data Source:  
Azat, J. CDFW GrandTab.  
2023.06.27  
<http://www.calfish.org/ProgramsData/Species/CDFWANadromousResourceAssessment.aspx>

Monitoring period: December to August  
\* Preliminary Data  
[www.cbr.washington.edu/sacramento/](http://www.cbr.washington.edu/sacramento/)  
22 Nov 2023 09:32:48 PST

#### GrandTab Data Notes

1. Winter In-River Battle Creek - Upstream of CNFH: Fish passed upstream of Coleman Weir.
2. Winter In-River Mainstem - Upstream of RBDD: Upstream mainstem in-river estimates prior to 2001 were based on RBDD counts. Subsequent estimates are based on carcass surveys. Numbers using RBDD data are adjusted for angler harvest.
3. \* Indicates annual escapement and mean are not final, data is Preliminary status.

#### Query Notes

1. To each population in the GrandTab report, CBR assigned a Diversity Group as outlined by NOAA Fisheries in [California Central Valley Salmon & Steelhead Recovery Plan](https://www.cbr.washington.edu/sacramento/data/query_adult_grandtab.html).

# Adult Escapement

## CDFW GrandTab, California Central Valley Chinook Population Database

Data Courtesy of [CDFW via CalFish](#)

Adult Analysis & Queries: **GrandTab** || [CWT SAR](#)

### Select Output Format

Barchart w/Table  Download CSV Only  Download Graph Only [PNG]

### Select Species-Run, Spawning Type

Chinook, Winter	In-River
Chinook, Spring	Hatchery
Chinook, Fall	
Chinook, Late-Fall	

### Select Spawning Location

Spawning Location by Water Body Area  Spawning Locations by Diversity Group [\[Map\]](#)

Basalt and Porous Lava DG

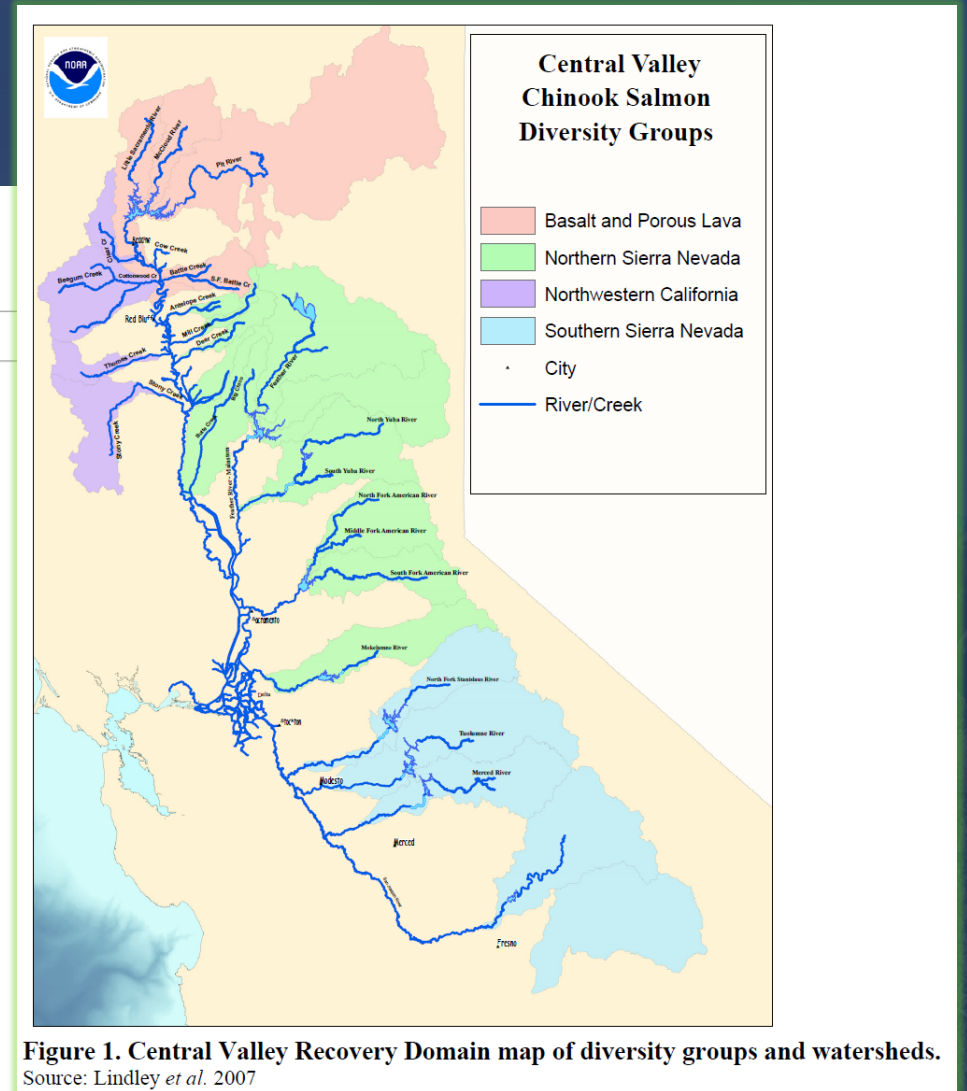
### Options

- Rolling 3 Year Geometric Mean
- Color Vision Deficiency (CVD) colors

Generate Query Result Link Only

### Query Notes & Resources

- As of 20 July 2023: Data presented through this query is based on GrandTab 2023.06.26. [California Central Valley Chinook Population Database Report "GrandTab"](#), CDFW via CalFish



# 5. River Conditions



[UW Columbia Basin Research](#)

Home	Data Queries & Alerts	Work Groups & Teams	Fish Model	Tools	Contact
<a href="#">Data Queries &amp; Alerts</a>	<a href="#">Alert: Weir Overtopping</a>	<a href="#">Temperature Thresholds</a>	<a href="#">Juvenile Monitoring &amp; Sampling</a>	<a href="#">Juvenile Salvage &amp; Loss</a>	<a href="#">Adult Escapement</a>
				<a href="#">River Conditions</a>	<a href="#">Exposure Index</a>
					<a href="#">Data Sites &amp; Inventory</a>

### River Conditions Graph & Text Query

Data Courtesy of [CDEC](#)

Queries: [River Graph&Text](#) || [River Graph&Text Map](#) || [Daily River Table](#) || [All Years River Graph](#) || [Basin Conditions](#)

#### Select Output Format

Graph 
  Day of Year [DOY] Data Table 
  Calendar Date [mm/dd] Data Table 
  Download CSV Only [mm/dd] 
  Download CSV Only [single data pt/row] 
  Download Graph Only [PNG]

#### Limit Locations by Hydrologic Area or Explore by Map

All Locations 
  Sacramento River Basin 
  San Joaquin River Basin 
  Delta

#### Select Calendar Year, Location, River Data

2023	Sacramento R blw Georgiana Slough (GES)	Reservoir Storage (AF)
2022	Sacramento R at Hamilton City-Main Ch (HMC)	River Flow (CFS)
2021	Sacramento R upstream of Hwy 44 (SAC)	River Stage (ft)
2020	Sacramento R at Jellys Ferry (JLF)	Spillway Discharge (CFS)
2019	Sacramento R, Keswick Reservoir (KES)	Turbidity (NTU/FNU)
2018	Sacramento R, Keswick, WQ (KWK)	Water Temperature

Water Temperature Unit  °F  °C

Multiple selections allowed for each (hold Ctrl key and click individual items to select multiple in a list).  
Query is calendar year based, not water year.  
Maximum 2 y-axes for graph output.  
Please refer to the [River Parameters](#) inventory below to look up location-parameter availability.

#### Set Date Range

Start  End   Remove dates to automatically scale graph.

#### Select 10 Year Averages

Reservoir Outflow (CFS) 
  Reservoir Storage (AF) 
  River Flow (CFS) 
  River Stage (ft) 
  Spillway Discharge (CFS) 
  Water Temperature

Multiple selections for 10 Year River Data Parameters allowed.

#### Customize Graph

Combine like Data Types on Axis 
  Graph Nulls 
  Grid 
  Monochrome w/Symbols 
  Plot Symbols

Min  Max  First Y-Axis

Min  Max  Second Y-Axis

Generate Query Result Link Only

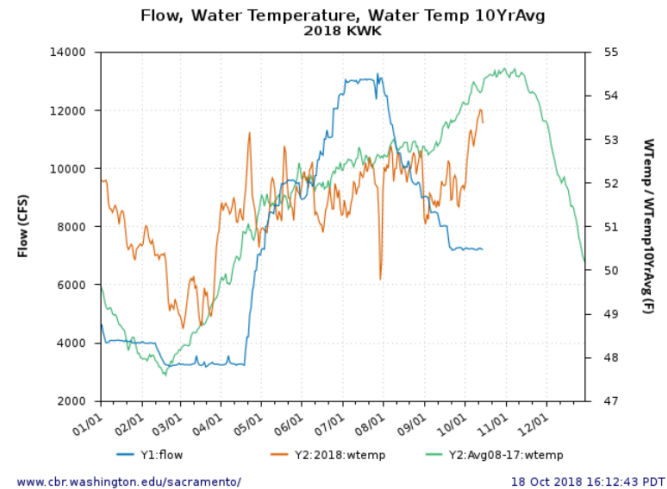
## 5. River Conditions



### River Parameters Location and Date Range Inventory

- [Air Temperature \(F\)](#)
- [Air Temperature Maximum \(F\)](#)
- [Control Regulating Discharge \(CFS\)](#)
- [Dissolved Oxygen \(mg/L\)](#)
- [Electrical Conductivity \(uS/cm\)](#)
- [Full Natural Flow \(CFS\)](#)
- [Pumping Discharge \(CFS\)](#)
- [Reservoir Elevation \(ft\)](#)
- [Reservoir Outflow \(CFS\)](#)
- [Reservoir Storage \(AF\)](#)
- [River Flow \(CFS\)](#)
- [River Stage \(ft\)](#)
- [Spillway Discharge \(CFS\)](#)
- [Turbidity \(NTU\)](#)
- [Water Temperature \(F\)](#)
- [Water Velocity \(ft/s\)](#)

### Example Daily Data Graph



# Map Interface for River Conditions Query

The screenshot shows a web browser window with the URL [cbr.washington.edu/sacramento/data/query\\_river\\_map/](http://cbr.washington.edu/sacramento/data/query_river_map/). The page title is "SacPAS: Central Valley Prediction & Assessment of Salmon". On the left, there is a "RIVER CONDITION QUERY" sidebar with a "Selection Filter" toggle (circled in green) and several filter categories: Output Types, Hydrologic Area(1/4), Location(0/113), Data Type(0/20), Year(0/34), and MAP OPTIONS with Additional Layers(0/1). The "Data Type(0/20)" filter is highlighted with a green oval and a callout bubble. The main area is a map of the Central Valley of California with numerous black circular markers representing data points. At the bottom, there are "Submit", "Get Url", and "Reset" buttons.

Data Type(0/20):  
0 selected  
20 possible

Exploration Question: what Data Types are available at 4 locations of interest in the San Joaquin River Basin in 2022 and 2023?

# Map Interface for River Conditions Query

The screenshot displays a web browser window with the URL [cbr.washington.edu/sacramento/data/query\\_river\\_map/](http://cbr.washington.edu/sacramento/data/query_river_map/). The page title is "SacPAS: Central Valley Prediction & Assessment of Salmon".

**RIVER CONDITION QUERY** (Selection Filter: ON)

- Output Types >
- Hydrologic Area(1/4) ▾
  - All Locations
  - Sacramento River Basin
  - San Joaquin River Basin**
  - Delta
- Location(0/57) >
- Data Type(0/20) >
- Year(0/34) >

**MAP OPTIONS**

- Additional Layers(0/1) >

At the bottom of the sidebar are buttons for "Submit", "Get Url", and "Reset".

The main map area shows a topographic map of the Sacramento River Basin in California. Key geographical features labeled include the Sacramento River, Feather River, San Francisco, San Jose, Fresno, Bakersfield, and the Delta. Specific locations marked on the map are Pioneer Seamount, Guide Seamount, Davidson Seamount, and Rodriguez. Numerous black circular data points are plotted across the basin, primarily concentrated in the central and eastern parts. The map includes a scale bar at the bottom with values 3789, 2410, 2994, and 790. The footer text reads: "Esri, GEBCO, Garmin, NaturalVue | California State Parks, Esri, HERE, Garmin, FAO, NOAA, USGS, Bureau of Land Managemen... Powered by Esri".



# Map Interface for River Conditions Query

Map Query River Conditions: Sa x +

cbr.washington.edu/sacramento/data/query\_river\_map/

### SacPAS: Central Valley Prediction & Assessment of Salmon

RIVER CONDITION QUERY ⓘ Selection Filter

- Output Types >
- Hydrologic Area(1/4) v
- Location(0/57) >
- Data Type(0/20) >
- Year(2/34) v
  - 2023
  - 2022
  - 2021
  - 2020
  - 2019
  - 2018
  - 2017
  - 2016
  - 2015
  - 2014
  - 2013
  - 2012
  - 2011

Submit Get Url Reset

Esri, GEBCO, Garmin, NaturalVue | California State Parks, Esri, HERE, Garmin, FAO, NOAA, USGS, Bureau of Land Managemen... Powered by Esri

# Map Interface for River Conditions Query

**SacPAS: Central Valley Prediction & Assessment of Salmon**

Location(4/57)

- Bear Creek blw Eastside Canal (BSD)
- Little Dry Creek (LDC)
- **Merced R at Cressy (CRS)**
- Merced R at Shaffer Bridge near Cressy (MBN)
- Merced R blw Crocker-Huffman Dam (MBH)
- Merced R near Stevinson (MST)
- Merced R, New Exchequer-Lk McClure (EXC)
- **Old River at Head (OH1)**
- San Joaquin R at Antioch (ANH)
- San Joaquin R at Brandt Bridge (BDT)
- San Joaquin R at Donny Bridge (DNB)
- San Joaquin R at Friant Dam (WQ) (FWQ)
- San Joaquin R at Gravelly Ford (GRF)
- San Joaquin R at Hwy 41 (H41)
- San Joaquin R at Jersey Point, USGS (SJJ)
- San Joaquin R at Maze Rd Bridge (MRB)
- **San Joaquin R at Mossdale Bridge (MSD)**
- San Joaquin R at Patterson Bridge (SJP)
- San Joaquin R at Prisoners Pt near Termino (PRI)
- San Joaquin R blw Friant (SJF)
- San Joaquin R blw Old R near Lathrop (S JL)
- **San Joaquin R near Vernalis (VNS)**

Submit Get Url Reset

Esri, GEBCO, Garmin, NaturalVue | County of Santa Clara, California State Parks, Esri, HERE, Garmin, SafeGraph, FAO, METI/N... Powered by Esri

# Map Interface for River Conditions Query

**SacPAS: Central Valley Prediction & Assessment of Salmon**

RIVER CONDITION QUERY ⓘ Selection Filter

- Output Types >
- Hydrologic Area(1/2) ▾
- Location(4/28) >
- Data Type(1/3) ▾
  - Flow (CFS)
  - Stage (ft)
  - Water Temperature (F)**
- Year(2/10) ▾

MAP OPTIONS

- Additional Layers(0/1) >

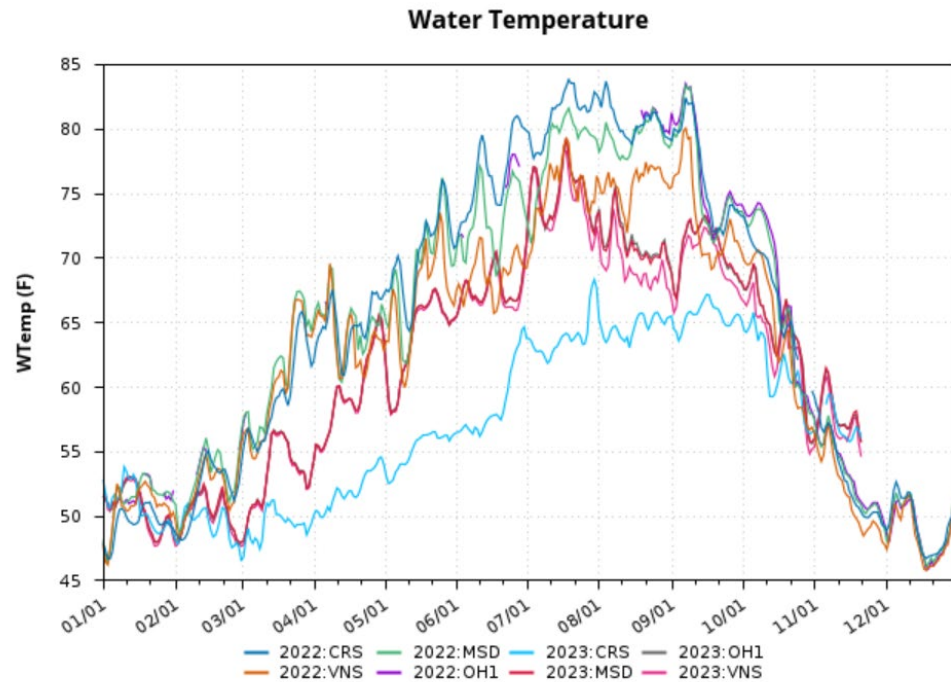
Submit Get Url Reset

Esri, GEBCO, Garmin, NaturalVue | County of Santa Clara, California State Parks, Esri, HERE, Garmin, SafeGraph, FAO, METI/N... Powered by Esri

Exploration Question: what Data Types are available at 4 locations of interest in the San Joaquin River Basin in 2022 and 2023?

# River Conditions Results

download CSV



www.cbr.washington.edu/sacramento/

22 Nov 2023 17:53:02 PST

download CSV

mm/dd	2022:CRS:wtemp (F)	2022:VNS:wtemp (F)	2022:MSD:wtemp (F)	2022:OH1:wtemp (F)	2023:CRS:wtemp (F)	2023:MSD:wtemp (F)	2023:OH1:wtemp (F)	2023:VNS:wtemp (F)
1/1	47.933	47.788	48.158		52.838	51.613	51.571	51.635
1/2	47.363	46.468	47.050		51.871	51.413	51.229	51.710
1/3	46.729	46.235	46.388	46.800	50.792	50.979	51.058	50.510
1/4	46.708	47.488	47.425		50.650	50.567	50.446	50.435
1/5	47.263	49.093	48.842		51.442	51.113	51.021	50.630
1/6	48.679	50.990	51.042		51.704	50.774	50.630	50.623
1/7	49.779	52.535	52.283		51.308	51.217	51.033	51.193
1/8	50.500	51.808	52.250		51.513	51.546	51.425	51.305
1/9	50.596	50.765	51.142		52.171	52.183	52.071	51.973
1/10	50.404	50.720	50.942	51.100	53.829	52.646	52.475	52.610
1/11	49.933	50.398	51.179	51.285	53.467	52.908	52.742	52.993
1/12	49.600	50.480	51.221	50.979	52.971	53.092	53.046	52.805
1/13	49.504	50.810	51.496	51.092	52.967	53.046	52.942	52.745
1/14	49.354	50.788	51.496	51.196	53.229	53.071	53.004	52.858
1/15	49.408	50.975	51.492	51.007	52.771	52.875	52.817	52.588
1/16	49.546	51.943	52.213	52.200	51.504	52.288	52.225	52.025
1/17	50.158	52.235	52.900		50.096	51.708	51.675	51.290
1/18	50.838	52.453	53.321	53.317	50.038	50.708	50.704	50.390
1/19	51.058	52.708	53.313	53.242	50.208	50.388	50.346	50.105
1/20	51.033	52.385	53.138	53.258	50.108	49.450	49.458	49.108
1/21	51.083	52.175	52.979	53.075	49.675	48.921	48.913	48.598
1/22	50.596	51.620	52.050	52.100	49.271	48.592	48.567	48.268
1/23	50.208	51.418	51.996		48.921	48.033	48.025	47.690
1/24	49.721	50.720	51.742		48.713	48.017	47.975	47.713
1/25	49.363	50.938	51.671		48.646	48.171	48.113	47.953
1/26	49.325	50.810	51.692		48.767	48.700	48.625	48.523
1/27	49.500	51.028	51.567	51.840	49.058	49.321	49.229	49.243
1/28	49.600	50.840	51.925	51.338	49.379	49.963	49.858	49.843
1/29	49.429	50.675	51.875	51.539	49.696	50.104	50.046	49.985
1/30	49.183	49.985	51.633	51.253	49.467	49.588	49.488	49.303
1/31	49.050	50.300	51.150	52.000	48.650	48.650	48.579	48.238
2/1	48.679	49.618	50.904		48.154	48.129	48.071	47.683
2/2	48.400	48.283	49.171		47.875	47.983	47.908	47.818
2/3	48.171	48.643	48.633		48.779	48.392	48.271	48.335
2/4	48.167	49.018	49.288	49.475	49.800	49.108	48.975	48.988
2/5	48.313	49.828	50.088	49.863	50.692	50.117	50.008	49.970

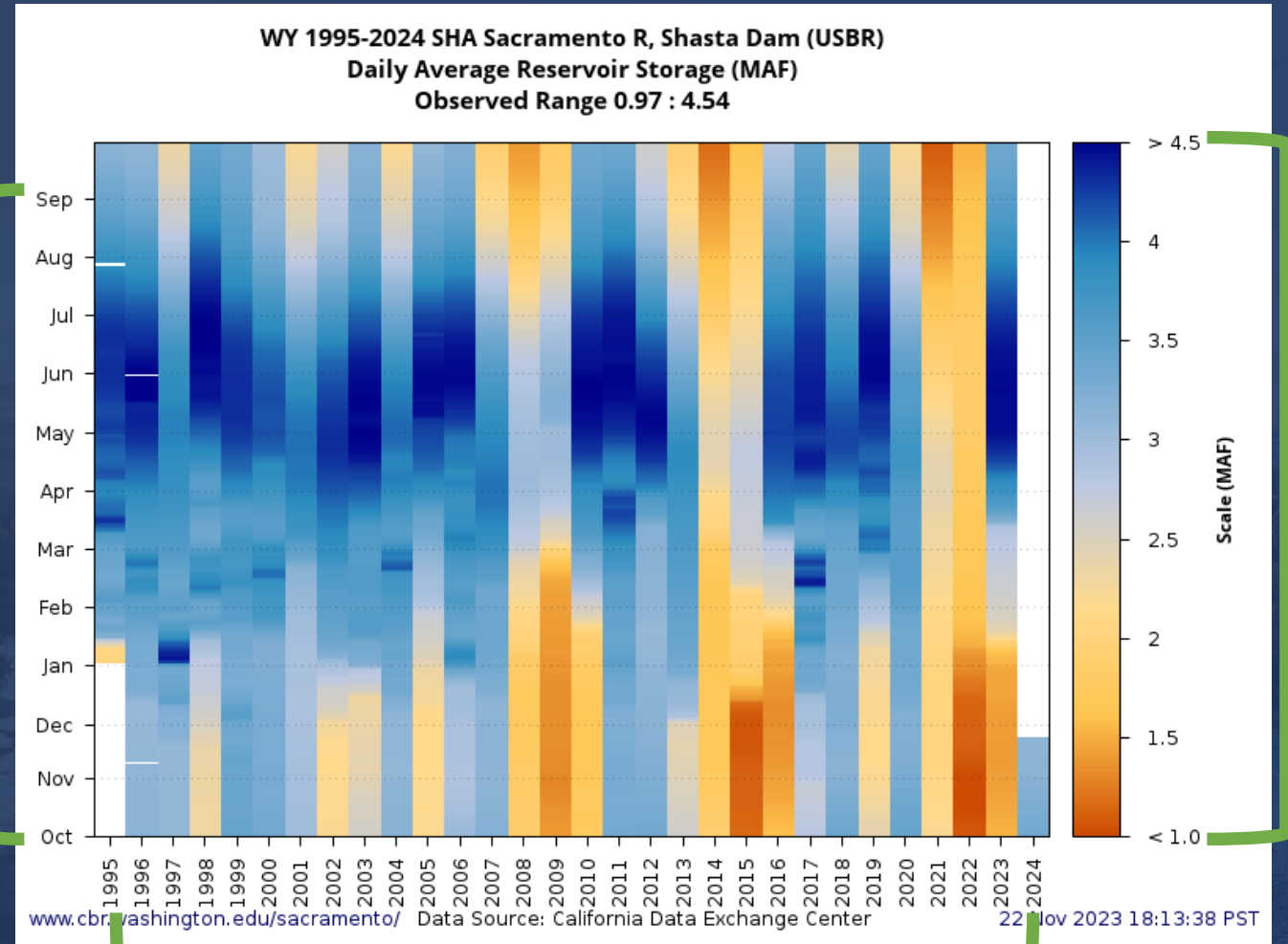
“River Conditions Graph & Text” [cbr.washington.edu/sacramento/data/query\\_river\\_graph.html](http://cbr.washington.edu/sacramento/data/query_river_graph.html)

“Map Interface River Conditions” [cbr.washington.edu/sacramento/data/query\\_river\\_map/](http://cbr.washington.edu/sacramento/data/query_river_map/)

# 5. River Conditions



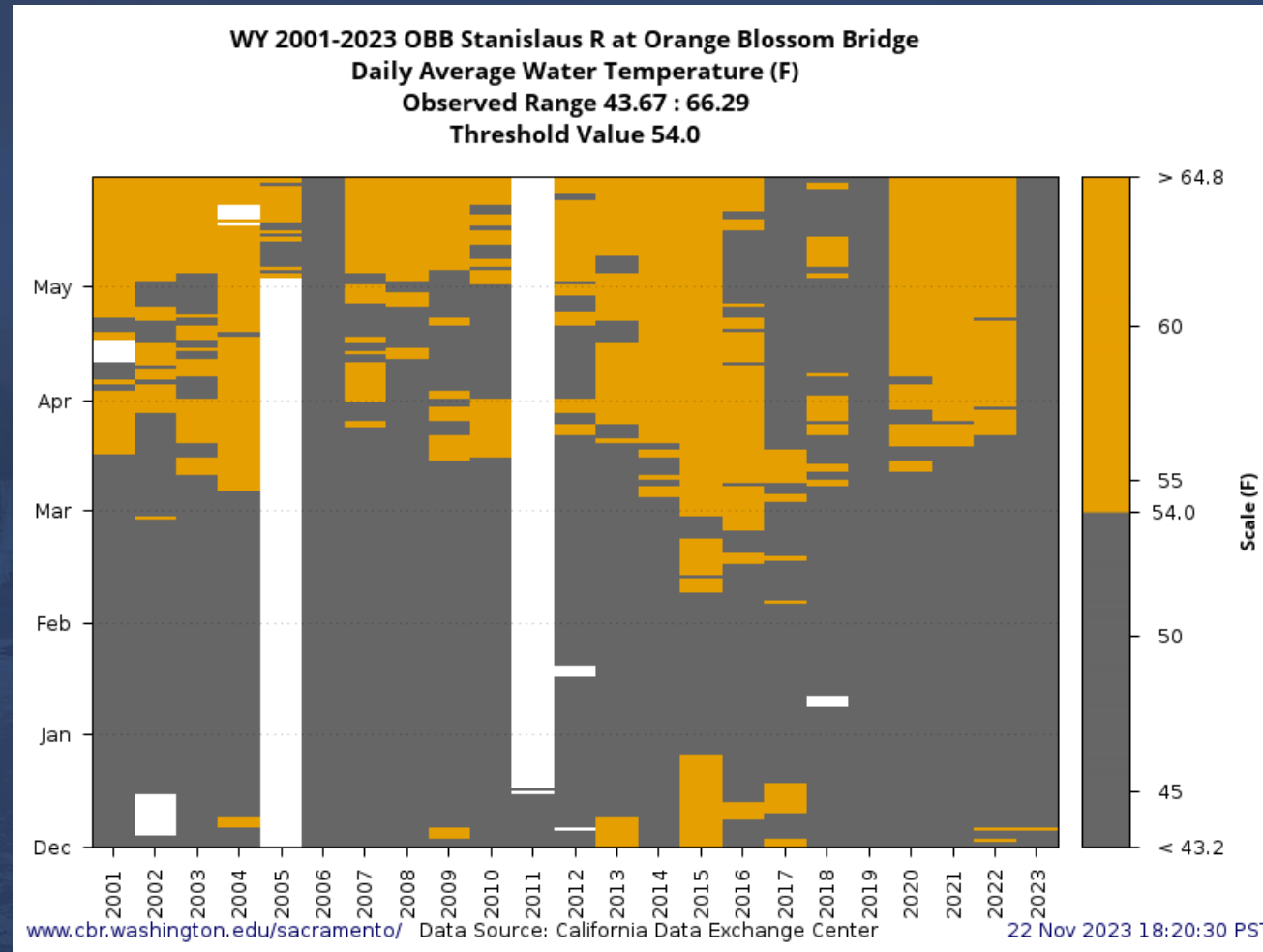
Months through the Water Year



Color Legend (MAF)

Water Years 1995-present

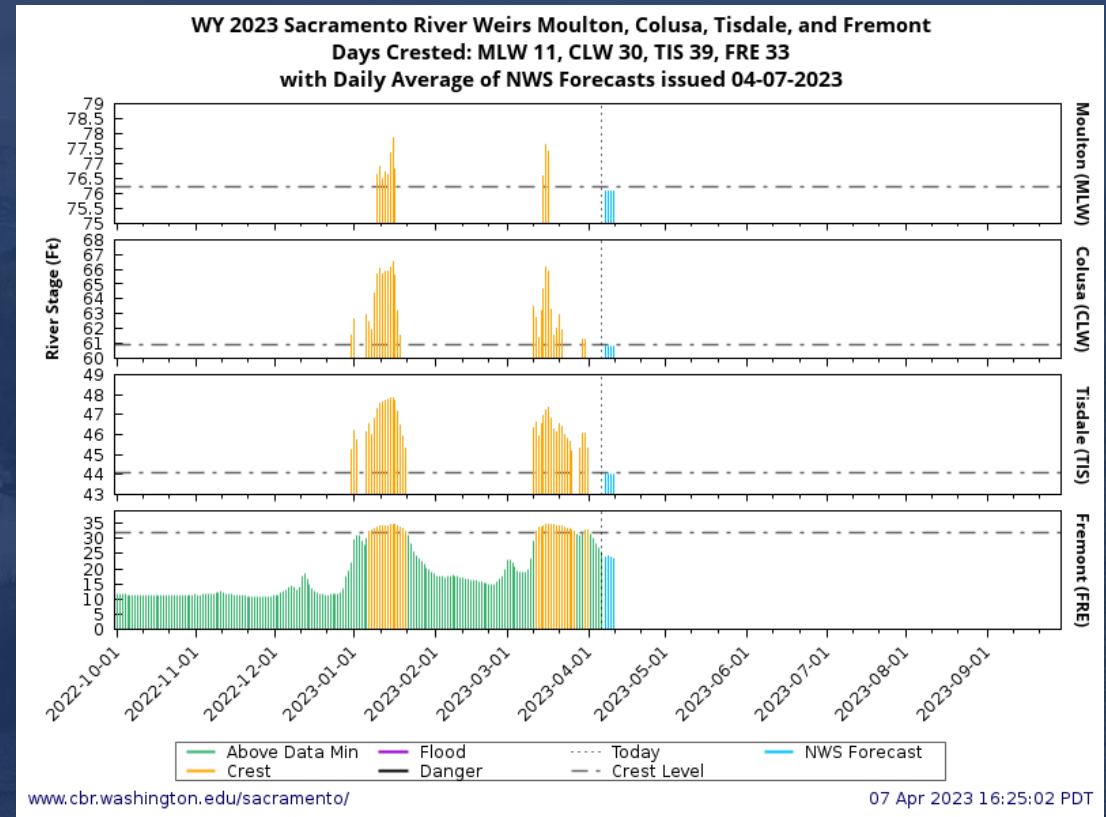
# All Years River Graph with Threshold Value



# Customized Tools from Requests

Example:

- Weir Overtopping Alert tool
  - Customized web page
  - Email alert service



# I. SacPAS Data Queries & Alerts

1. Juvenile Monitoring & Sampling



2. Juvenile Salvage & Loss



3. Adult Escapement



4. Temperature Thresholds



5. River Conditions



6. Exposure Index





# SacPAS tools



I. Data Queries & Alerts

**II. Work Groups & Teams**

III. Models: survival, migration, etc.

## II. SacPAS Work Groups & Teams

On SacPAS website:

- Salmon Monitoring Team
- Smelt Monitoring Team
- Stanislaus Watershed Team

In development:

- San Joaquin River Restoration Program

When requests are made:

We aim to provide process/product

- Automated
- Repeatable
- Public
- Consistent
- Current

All products and services are designed, developed, and refined in collaboration with team members and liaisons.



# Help with your tasks that are repeatable

- Data visualization tools online
  - Integrated data (hourly and daily river, fish sampling, salvage)
  - Summary or calculated metrics
  - Reference lines or thresholds
  - Alerts in real-time
- Periods of Coverage
  - Pre-season
  - In-season
  - Historical
  - Annual summaries
- Portions of handouts
  - Data tables and figures
  - Updated in real-time before meeting
  - All accessible from one place (rather than manual compilation)

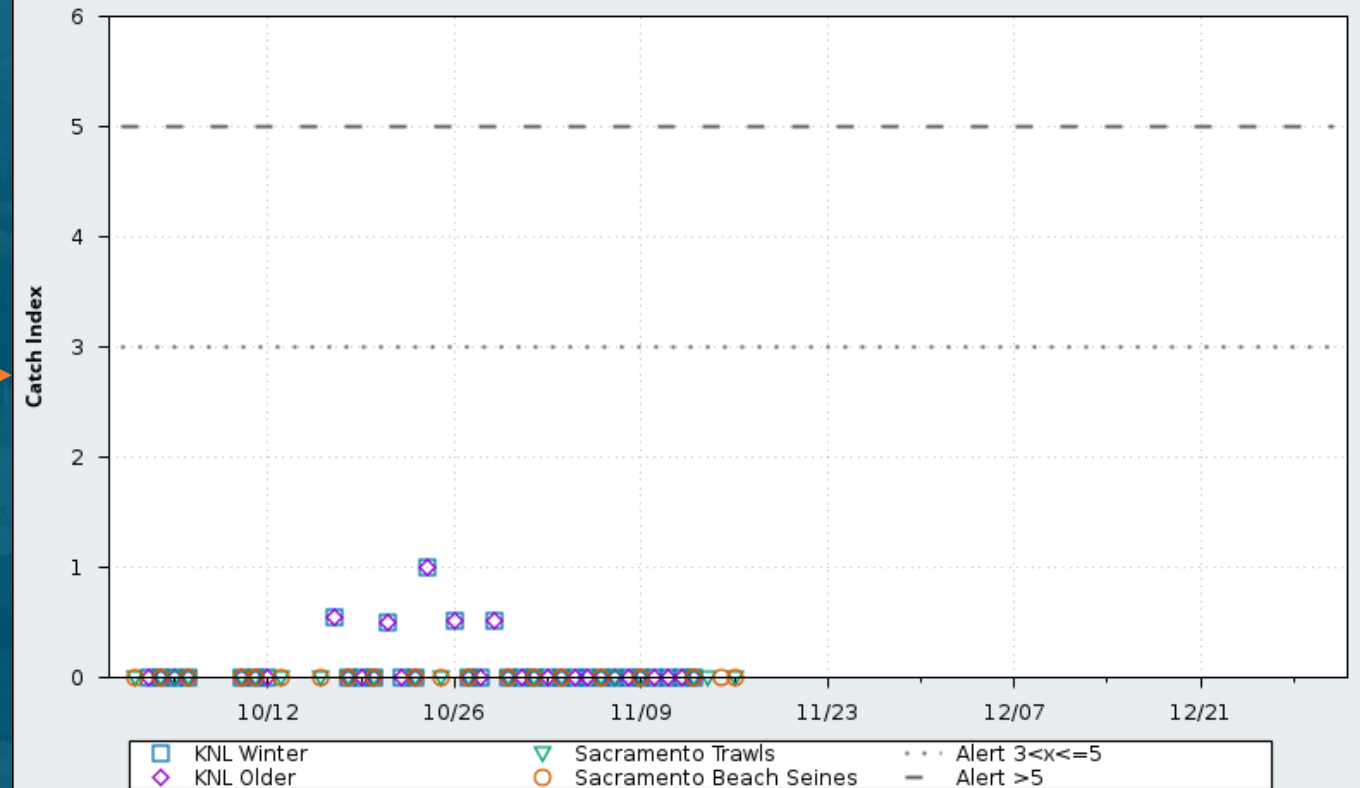
# Salmon Monitoring Team: Products Example

## WY2024 Salmon Monitoring Current Conditions

- DCC Operations (10/1 - 11/30)
- Alerts: Deer Creek, Mill Creek, Wilkins Slough, Knights Landing
- Juvenile Sampling (14 days)
- Historical Migration Pattern for "Today"
- Species Distribution Estimates
- Loss&Salvage Predictor Estimates
- Delta STARS Estimates
- Single-Year Loss Thresholds

Fish data to support trigger decision :  
DCC operations by  
Knights Landing or  
Sacramento Catch Indices  
(2019 BiOp PA 4-56)

Catch Index Knights Landing, Sacramento Trawls, Sacramento Beach Seines (10/1/2023 - 12/31/2023)



[www.cbr.washington.edu/sacramento/](http://www.cbr.washington.edu/sacramento/)

22 Nov 2023 16:15:09 PST

# Smelt Monitoring Team: Products Example

## Smelt Monitoring Current Conditions

Includes data for Delta and Longfin smelt in Enhanced Delta Smelt Monitoring (EDSM), Chipps Island Trawl, and Salvage, and monitoring of current conditions.

- Water Temperature
- Onset of OMR Management
- Turbidity Bridge Avoidance
- Larval and Juvenile Delta Smelt Protection
- End of OMR Management
- Operations and Hydrology

Data Source  
with Data  
Quality  
attribute

## EDSM WY 2024 (10/01/2023 - 09/30/2024)

Delta Smelt and Longfin Smelt caught in Enhanced Delta Smelt Monitoring (EDSM)

Sample Date Time	Species	Mark Code	nfish	Fork Length (mm)	Subregion	Stratum	Region	Method	Source
2023-10-05 10:24:00	Delta Smelt	None	1	60	Sacramento River near Rio Vista	Lower Sacramento	North	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-24 12:24:00	Delta Smelt	None	1	53	Lower Sacramento River	Lower Sacramento	West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-11-15 09:17:00	Delta Smelt	None	1	57	Lower Sacramento River	Lower Sacramento	West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-02 09:12:00	Longfin Smelt	None	1	48	Suisun Marsh	Suisun Marsh	West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-03 11:16:00	Longfin Smelt	None	1	60	West Suisun Bay	Suisun Bay	Far West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-03 11:16:00	Longfin Smelt	None	1	61	West Suisun Bay	Suisun Bay	Far West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-03 11:33:00	Longfin Smelt	None	1	69	West Suisun Bay	Suisun Bay	Far West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-04 08:45:00	Longfin Smelt	None	1	53	Grizzly Bay	Suisun Marsh	West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-04 08:45:00	Longfin Smelt	None	1	54	Grizzly Bay	Suisun Marsh	West	Kodiak Trawl	EDSM Provisional, USFWS Lodi
2023-10-05 10:41:00	Longfin Smelt	None	1	49	Grizzly Bay	Suisun Marsh	West	Kodiak Trawl	EDSM Provisional, USFWS Lodi

# Stanislaus Watershed Team: Products Example

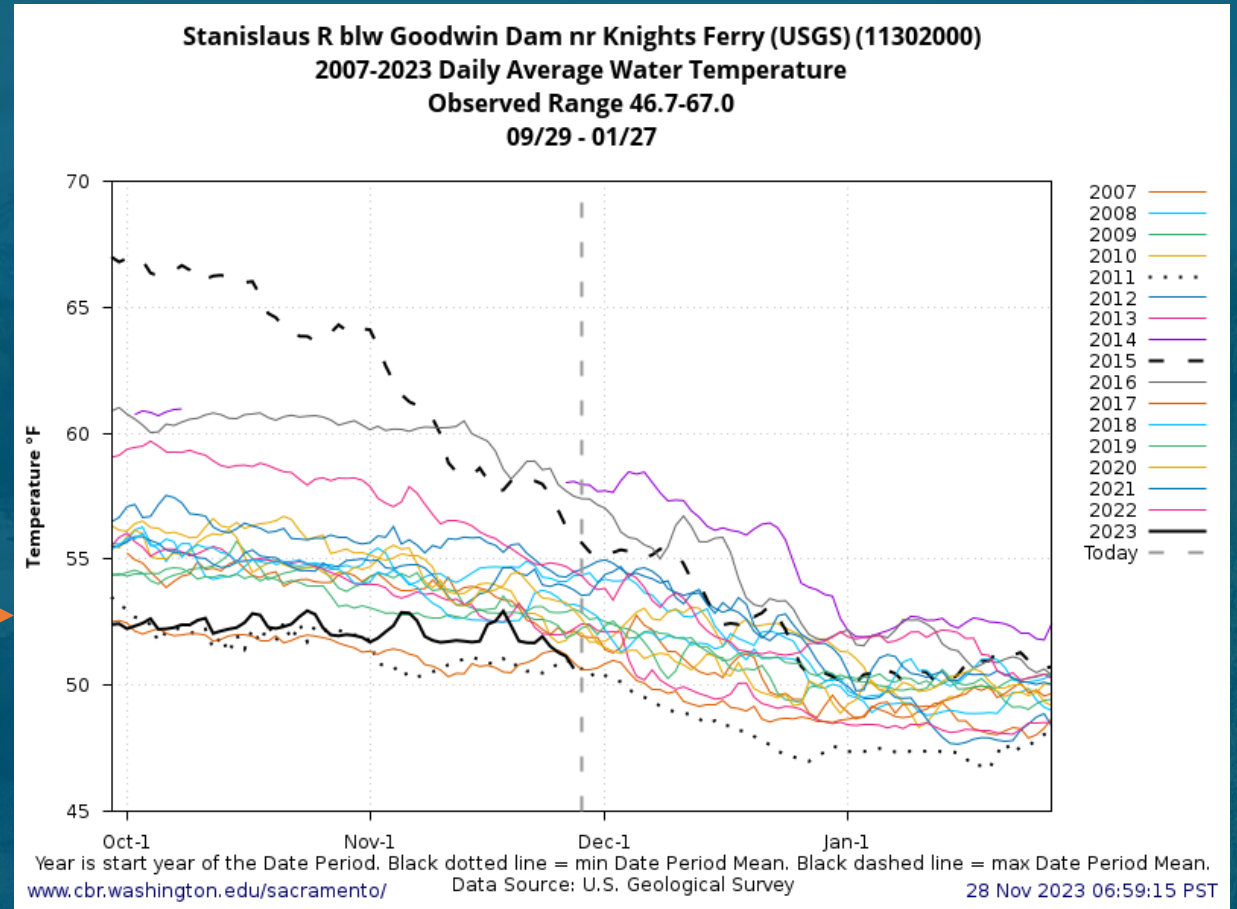
## WY2024 Stanislaus Watershed Monitoring Current Conditions -- In Development

- Stanislaus Temperature and Flow
- Current River Conditions
- Water Temperature Min, Max, Average
- Water Temperature Historical
- Hourly Dissolved Oxygen
- Goodwin Dam Spillway Discharge

### Previous Seasons

- [WY2023 Stanislaus Watershed Monitoring](#)

Visual prediction of near-term conditions : moving 60-day window for current and historical Water Temperature on either side of today





# Presentation Goals



**AWARENESS**  
of **SacPAS tools**  
available



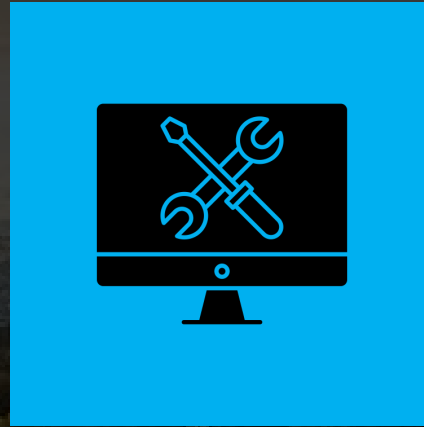
**APPROACH**  
of how we provide  
**SERVICE**



**Kickstart at**  
**workshop**  
for  
**FEEDBACK**  
and  
**COLLABORATION**



# SacPAS tools



I. Data Queries & Alerts

II. Work Groups & Teams

**III. Models: survival, migration, etc.**



# Models: Survival, Migration, etc.

- **Fish Model**

- **Egg-to-Fry model**

- (Anderson et al. 2022, Martin et al. 2016)

- **Loss & Salvage Model**

- (Tillotson et al. 2022)

- **STARS Model**

- (Survival Travel And Routing Simulation;  
Perry et al. 2018, Hance et al. 2021)

# Models: Survival, Migration, etc.

- **Fish Model**

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- **Loss & Salvage Model**

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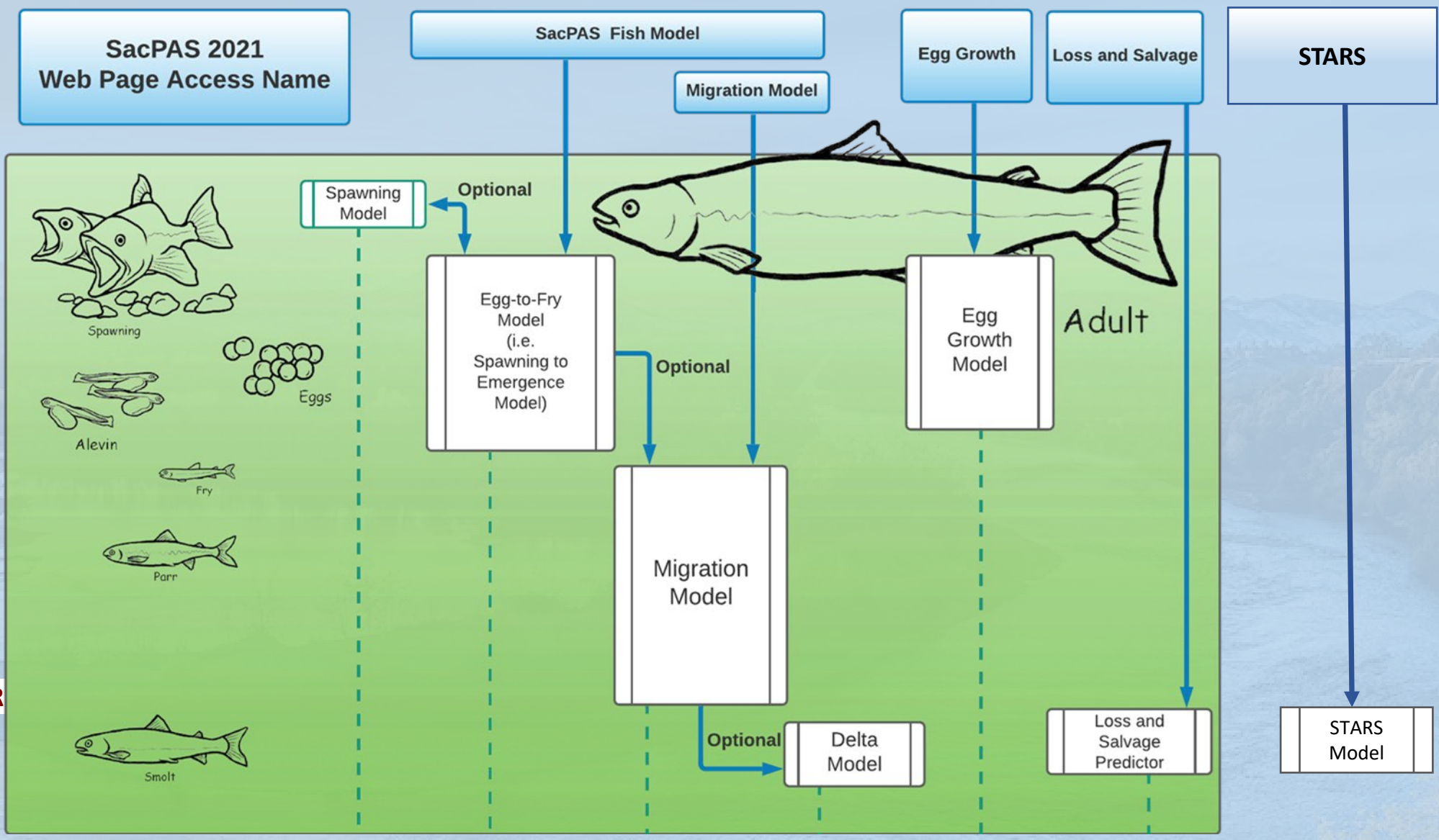
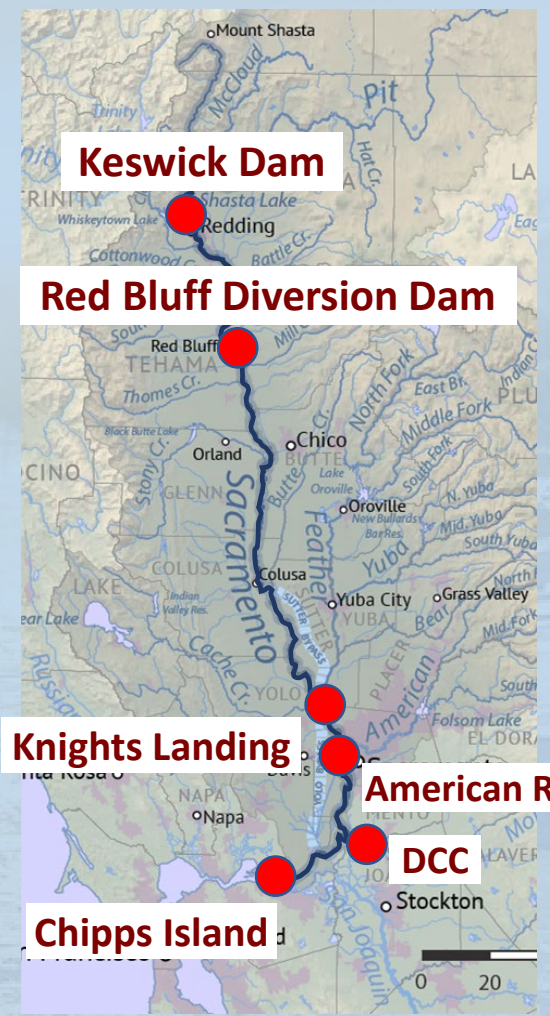
- **STARS Model**

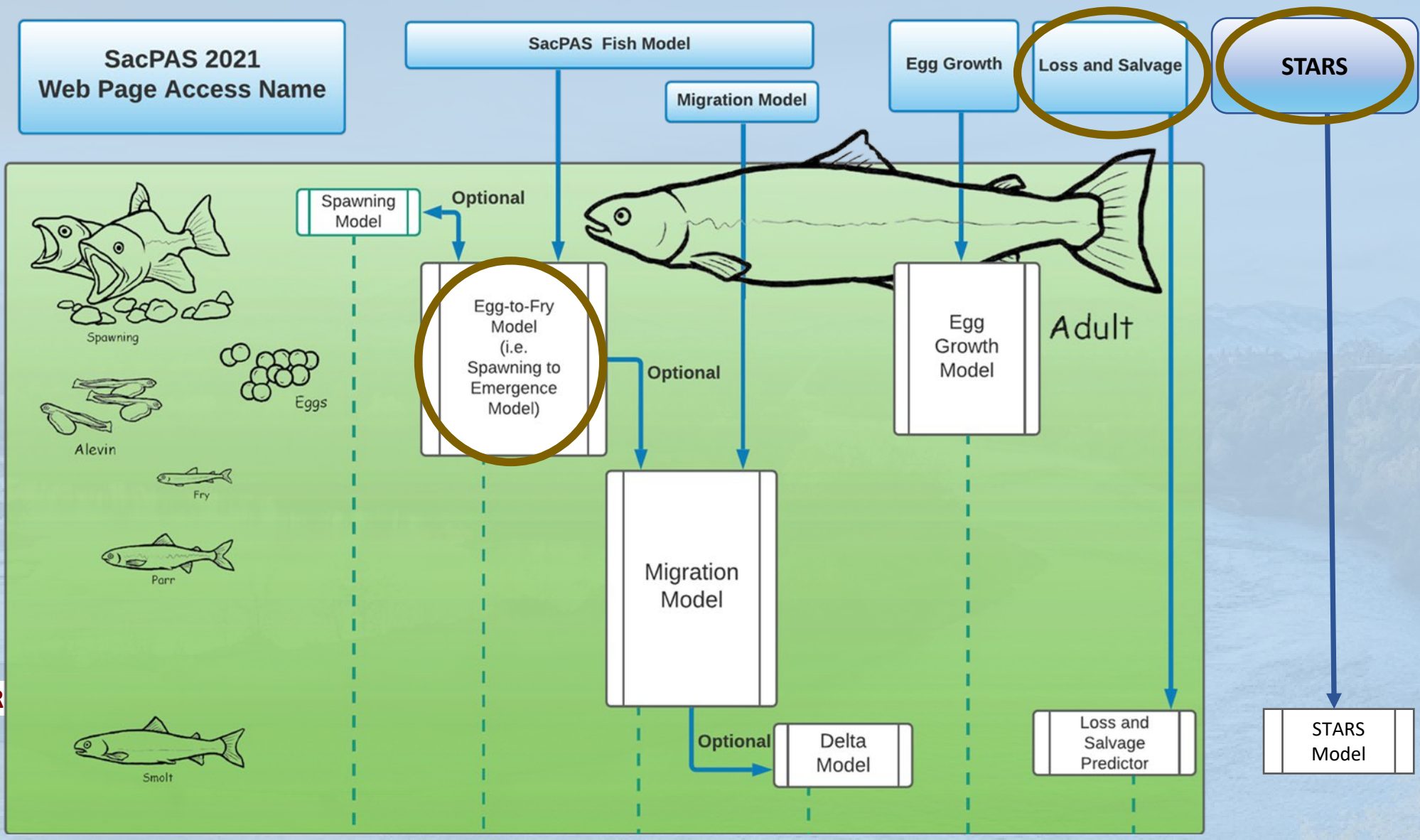
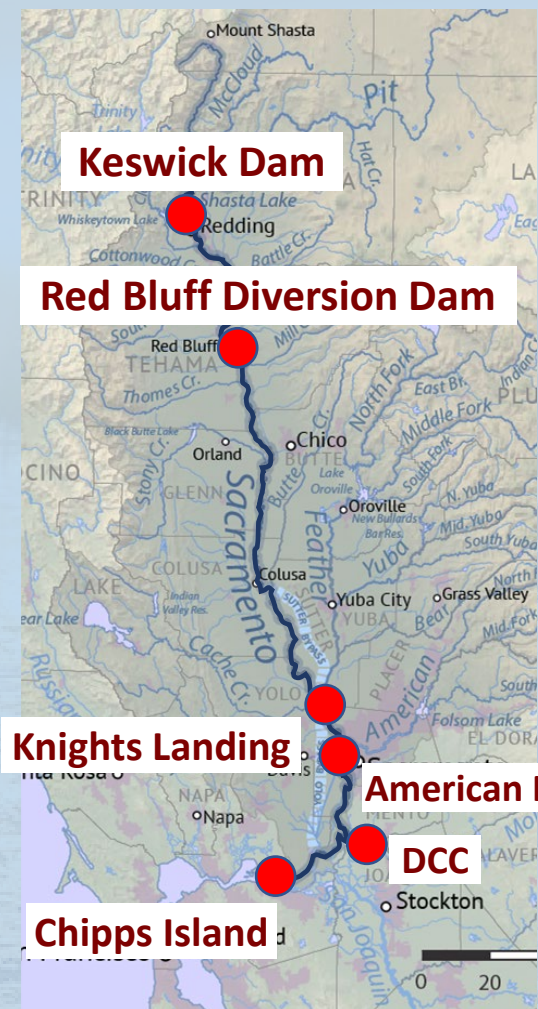
- (Survival Travel And Routing Simulation;  
Perry et al. 2018, Hance et al. 2021)

## Exploratory tools

(Shiny apps)

- **Growth model**
- **Survival Model**
- **Migration Model**
- **Temperature Profiler**  
etc.





# Short-term Forecasting and Scenarios

Model	Forecasting Timeframe	Scenario Generation	Data Input
<b>Egg-to-Fry</b> (survival & emergence timing)	~ months	Unlimited	River temperature timeseries Redds or carcasses timeseries Flow timeseries Mathematical parameters
<b>Loss &amp; Salvage</b>	7 days	7 days	Exports; SJR flow; DCC gate status; SR flow; OMR flow; precipitation at Stockton; Water temperature, Mallard Island
<b>STARS</b> (Delta Survival Travel And Routing Simulation)	5 days	NA	SR temperature, Freeport; Fremont Weir stage & overtopping; Discharge, SR at Freeport & Rio Vista, Yolo Bypass at Woodland; incl. forecasts from CA NV River Forecast Center
	NA	Fish distribution	Hypothetical Arrivals at Knights Landing

# Fish Model on SacPAS: Egg-to-Fry Model Online Tool

- Model focusing on thermal stress during egg incubation for Sacramento River Chinook salmon
- Predict survival & emergence timing
- Allows resource managers and the public equal access to evaluate water operation plans

**SacPAS Fish Model v.2.7.9: Sacramento River Chinook egg to fry development and in-river migration**

Temperature data inputs (Temps)  
 Current Year & Forecasts: 100A, CV-Temp  
 USER\_NO\_V0\_263MTO

Historical daily temps: 2022  
 Interpolated between sites successively downstream: (KWK, CCR, BSF, BND, and RDB).

Input or upload  
 Use SHINY Tool to create temps.  
 Choose File No file chosen

Sacramento Chinook redd sources  
 Winter Carcass Survey 2023  
 Winter Aerial Survey  
 Spring Aerial Survey Multi-year group info, PDF  
 Fall Aerial Survey  
 Late-Fall Aerial Survey  
 ALL aerial redds

Survival: Redds to RBDD  
 Temperature Dependent Mortality only  
 Hatching Stage mortality  
 Compute hatching  
 End crit. window ATUs (°C days) 600  
 T<sub>crit</sub>: 11.82 °C = 53.28 °F  
 S (days): 4 in critical window  
 b<sub>1</sub> (rate): 0.426 °C<sup>-1</sup>d<sup>-1</sup> = 0.242 °F<sup>-1</sup>d<sup>-1</sup>  
 Density effects per kilometer:  
 B (Base rate): 0.503 (background max. survival)  
 D (Carry cap): 85 per KM (averaged by reach).

Stage-independent mortality  
 T<sub>crit</sub>: 12.14 °C = 53.85 °F  
 b<sub>1</sub> (rate): 0.028 °C<sup>-1</sup>d<sup>-1</sup> = 0.0144 °F<sup>-1</sup>d<sup>-1</sup>  
 Density effects: (Beverton-Holt)  
 Base rate: 0.360 (background max. survival)  
 Carrying capacity: 1028 redds total.

Egg to emergence timing model  
 Mechanistic (Beer and Anderson 1997): Egg mass 300 mg.  
 Empirical (Densen et al. 1999)  
 Power law (Beacham/Murray 1990) Days = e<sup>15.404 - 2.043\*log(T<sub>c</sub> + 7.573)</sup>  
 Linear (Zeug et al. 2012): Target ATUs 688 degree C days.

Additional inputs  
 Eggs per Redd 4025 Oppenheim (2014)

Further information  
 Day-of-year and Date or Day-of-leaf-year and Date Look-up locations  
 Redd and Temp formats, and other details, usaoe, etc.  
 Version details  
 Using river temperature to optimize fish incubation metabolism and survival (Anderson 2018), PDF  
 Methods to compute time to hatching, PDF  
 Methods to infer redds from carcass survey, PDF  
 Methods to forecast redd distribution, PDF  
 Methods to forecast dewatering mortality, PDF  
 Temperature profile metrics, PDF  
 Temperature profile maker, SHINY  
 Explore Egg/Fry survival models, SHINY  
 View egg growth models comparison, PNG

# Fish Model on SacPAS: Egg-to-Fry Model Online Tool

**SacPAS Fish Model v.2.7.9: Sacramento River Chinook egg to fry development and in-river migration**

Framework for all Salmon Models See the framework of web-accessible salmon models.  
Migration Modeling Page Skip egg to fry modeling and input fish directly into the migration model.  
New Content developed November 28, 2023. See also: Version details

**Temperature data inputs (Temps)**  
Current Year & Forecasts: NOAA CV-Temp  
USBR\_NO\_V2\_25L3MTO

**Historical daily temps:** 2021  
Interpolated between sites successively downstream: (KWK, CCR, BSF, BND, and RDB).  
Input or upload Use SHINY Tool to create temps.  
Day: 807483, 807479, 807478  
1:730, 10, 11, 13  
Units: Centigrade Farenheit

**Sacramento Chinook redd source:**  
Winter Carcass Survey  
Winter Aerial Survey  
Spring Aerial Survey  
Fall Aerial Survey  
Late-Fall Aerial Survey  
All aerial redds  
Input or upload  
Day: 807483, 807479, 807478  
1:00, 10, 10, 10  
1:00, 10, 10, 10

**Winter Forecast:**  
Distrib. 3 reaches of 300 redds

**Survival: Redds to RBDD**  
Temperature Dependent Mortality only  
Hatching Stage mortality  
End crit. window ATUs (°C days) 400  
Compute hatching  
Tcrit: 11.82 °C = 53.28 °F  
θ (days): 4 in critical window  
b<sub>g</sub> (rate): 0.43 °C<sup>-1</sup>d<sup>-1</sup> = 0.24 °F<sup>-1</sup>d<sup>-1</sup>  
Density effects per kilometer:  
B (Base rate): 0.503 (background max. survival)  
D (Carry cap): 85 per KM (averaged by reach)

**Stage-independent mortality**  
Tcrit: 12.14 °C = 53.85 °F  
b (rate): 0.026 °C<sup>-1</sup>d<sup>-1</sup> = 0.15 °F<sup>-1</sup>d<sup>-1</sup>  
Density effects: (Beverton-Holt)  
Base rate: 0.399 (background max. survival)  
Carrying capacity: 1028 redds total.

**Egg to emergence timing model**  
Mechanistic (Beer and Anderson 1997): Egg mass 200 mg.  
Empirical (Jensen et al. 1999)  
Power law (Beacham/Murray 1990) Days = e<sup>10.404 - 2.043\*log(Tc + 7.575)</sup>  
Linear (Zeug et al. 2012): Target ATUs 958 degree C days.

**Additional inputs**  
Eggs per Redd 8925 Oppenheim (2014)

**Results**  
1663 Redds  
Exposure to 11.82 degrees: 99.9% Pre Hatch 100% Pre Emergence  
Emergence Day: 255.4 Mean Day Last Day 291  
26% Total Survival  
Surv. 0.26 Mort. 0.74 TDM 0.74 Spawner Density 1 0 Background 1 0 Dewaterer

**Download Input Report**  
All Details  
Summary results  
Redd distribution  
Pre-hatching exposure (mean)  
Pre-hatching exposure (max)  
All incubation exposure  
Emergence timing  
Hatch timing  
Survivals to emergence  
Hi-resolution PDF of time-series plot

**Download CSV file after run**  
Temperatures  
Summary results  
Redd distribution  
Pre-hatching exposure (mean)  
Pre-hatching exposure (max)  
All incubation exposure  
Emergence timing  
Hatch timing  
Survivals to emergence  
Hi-resolution PDF of time-series plot

**Further information**  
Day-of-year and Date or Day-of-Leap-year and Date Look-up locations  
Redd and Temp formats, and other details, usage, etc.  
Version details  
Using river temperature to optimize fish incubation metabolism and survival (Anderson 2018) (PDF)  
Methods to compute time to hatching (PDF)  
Methods to infer redds from carcass survey (PDF)  
Methods to forecast redd distribution (PDF)

**Temperature, redds, carcasses data inputs**

**Graphs**

**Survival model specifications**

**Results output, incl. downloads**

**Run Model**

**More info, incl. methods**



# Fish Model on SacPAS: Egg-to-Fry Model Online Tool

## Temperature data input:

**Forecasted**  
(NOAA; USBR)

**Historical**  
(CDEC)

**Custom**  
(text; upload;  
Shiny tool)

**Temperature data inputs (Temps)**

**Current Year & Forecasts:** [NOAA CV-Temp](#)  
USBR\_NO\_W2 25L3MT0

---

**Historical daily temps:** 2023

Interpolated between sites successively downstream:  
(KWK, CCR, BSF, BND, and RDB).

---

**Input or upload**  
Use [SHINY Tool](#) to create temps.  
Browse... No file selected.

```
Day, RKM483, RKM479, RKM470  
1: 730, 10, 11, 13
```

Units:  Centigrade  Farenheit

## Salmon redds data input:

**Redd,  
Carcass  
Survey data**  
(CDFW)

**Custom**  
(text; upload)

**Forecast**

**Sacramento Chinook redd source:**

**Winter Carcass Survey** 2023

**Winter Aerial Survey**

**Spring Aerial Survey** [Multi-year group info. \(PDF\)](#)

**Fall Aerial Survey**

**Late-Fall Aerial Survey**

**ALL Aerial Surveys**

**Input or upload**  
Choose File No file chosen

```
Day, RKM483, RKM479, RKM470  
180, 10, 10, 10  
190, 10, 10, 10
```

**Winter Forecast:**  
Distrib. 3 reaches of 300 redds

# Fish Model on SacPAS: Egg-to-Fry Model Online Tool

## Survival model specifications:

### Check-mark option:

Temperature-dependent mortality *only* is ON

- No density-dependent effects
- No background mortality rate for fry

### Input values:

- Default values from studies
- Enter custom values

#### Survival: Redds to RBDD

Temperature Dependent Mortality only

#### Hatching Stage mortality

End crit. window  ATUs ( $^{\circ}\text{C days}$ )

Compute hatching

$T_{\text{Crit}}$ :   $^{\circ}\text{C}$  =   $^{\circ}\text{F}$

$\delta$  (days):  in critical window

$b_{\delta}$  (rate):   $^{\circ}\text{C}^{-1}\text{d}^{-1}$  =   $^{\circ}\text{F}^{-1}\text{d}^{-1}$

Density effects per kilometer:

B (Base rate):  (background max. survival)

D (Carry cap):  per KM (averaged by reach).

#### Stage-independent mortality

$T_{\text{Crit}}$ :   $^{\circ}\text{C}$  =   $^{\circ}\text{F}$

$b$  (rate):   $^{\circ}\text{C}^{-1}\text{d}^{-1}$  =   $^{\circ}\text{F}^{-1}\text{d}^{-1}$

Density effects: (Beverton-Holt)

Base rate:  (background max. survival)

Carrying capacity:  redds total.

### Critical stage:

**Stage-dependent:**  
Egg Hatching Stage

**Stage-independent:**  
All of egg incubation

# Fish Model on SacPAS: Egg-to-Fry Model Online Tool

Graphic  
output  
controls

## Graphic output controls:

Plot days  to   
Apr 10 Feb 4

RKM range  to

Temp range °C:

Redd dewatering  
specifications  
(optional)

## Redd dewatering (optional)

NONE  Observed KWK flows  User's flows

RBDD configuration:  Boards Out  Boards In

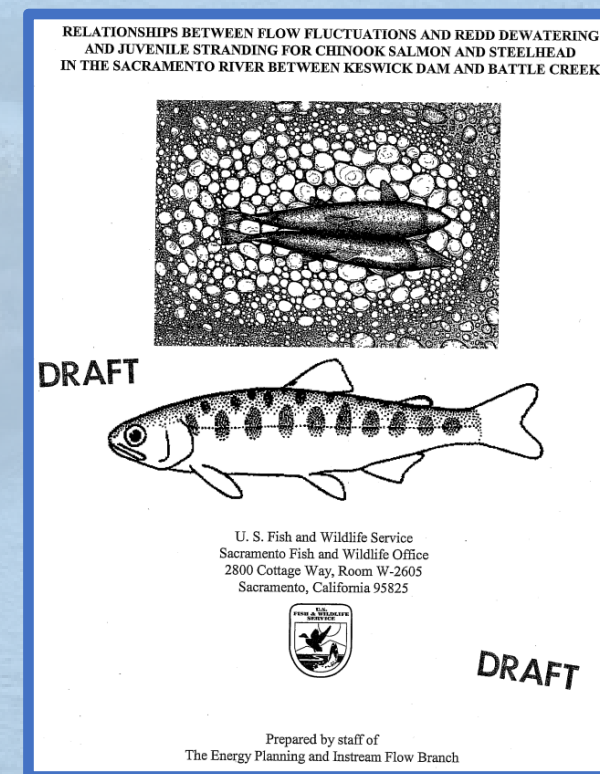
User's flows Upload or Input Column:

No file selected.

Units:  CFS  KCFS.

Day, KCFS  
1: 730, 10

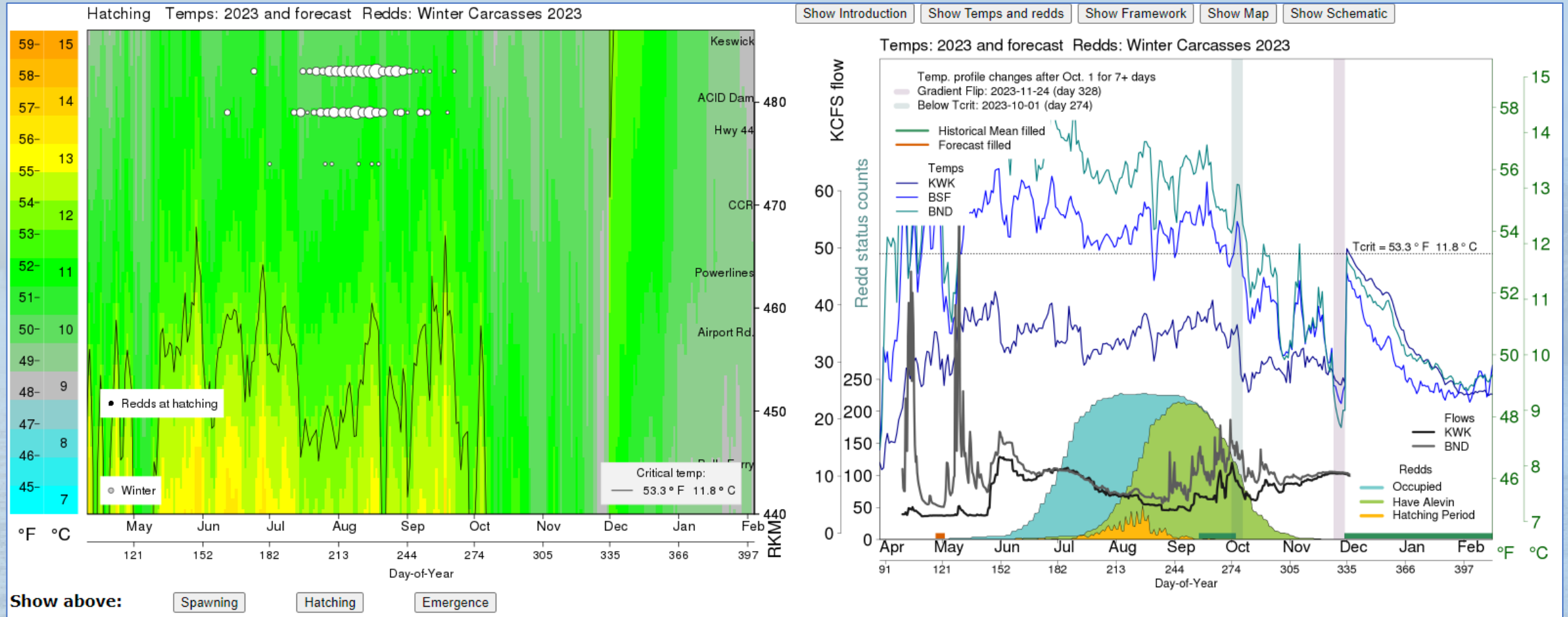
<https://www.cbr.washington.edu/sacramento/fishmodel/>



<https://www.noaa.gov/sites/default/files/legacy/document/2020/Oct/07354626849.pdf>

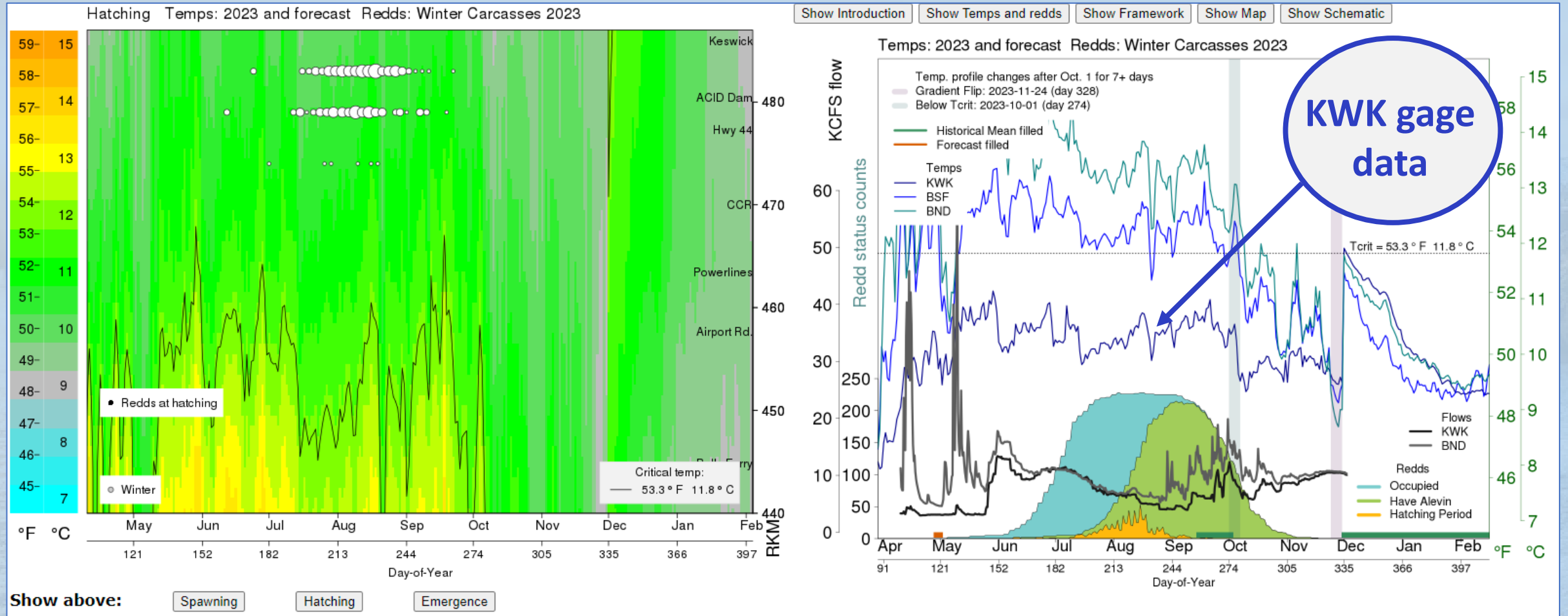
# Fish Model on SacPAS:

## Egg-to-Fry Model Online Tool



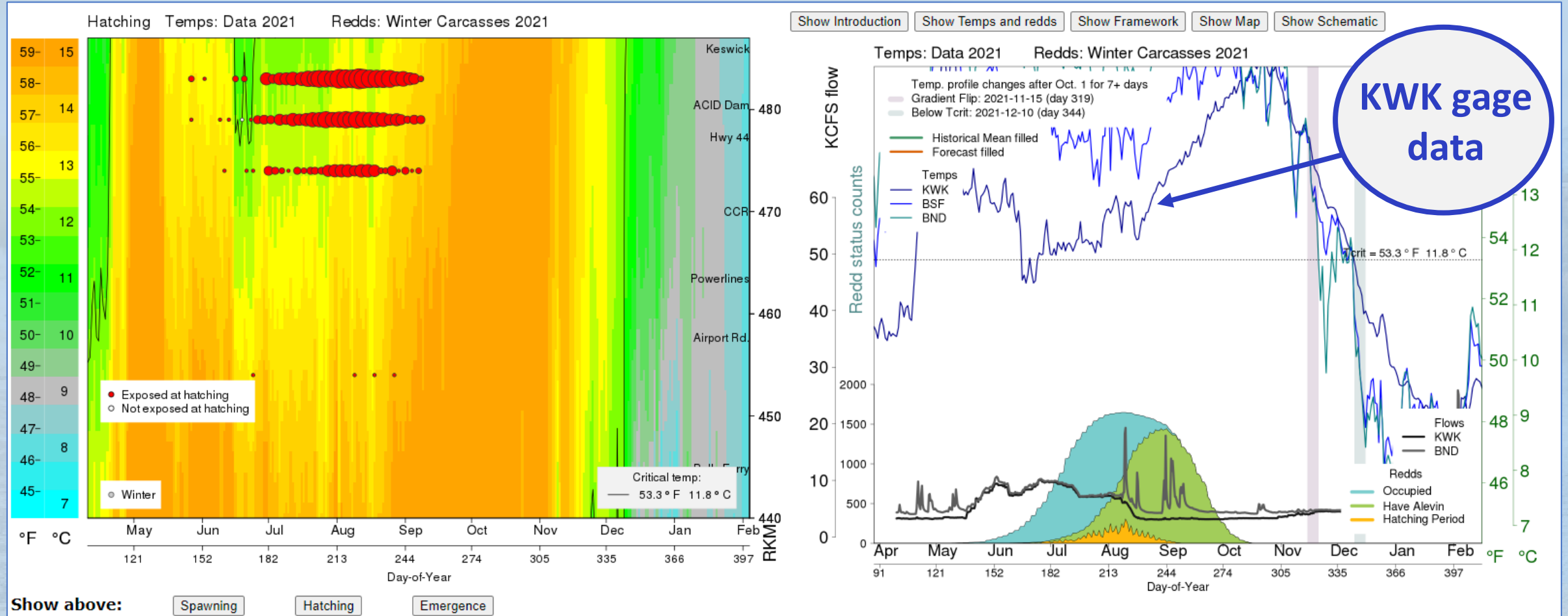
# Fish Model on SacPAS:

## Egg-to-Fry Model Online Tool



# Fish Model on SacPAS:

## Egg-to-Fry Model Online Tool



# Fish Model on SacPAS: Egg-to-Fry Model Online Tool

Reset

Generate Query strings only.

**RUN EGG Model**

**Send Results to Migration Model**

Check the box

```
# Results Summary has several metrics:  
https://www.cbr.washington.edu/sac-bin/fishmodel/getandplottemp.pl?  
TcritC=12&TcritF=53.6&dirUseId=TEST0&redds=dbAll&reddyear=2020  
&tempsource=dbtemp&tempyear=2020&temponly=on&raw=13
```

```
What,Value  
Redd source,All Aerial 2020  
Redd count,2897  
Redd year,2020  
Temp year,2020  
TcritC,12  
Critical Days,4  
Prehatch Exposure %,55.5  
PreEmerge Exposure %,87  
Mean Emergence Day,385.2  
Last Emergence Day,511  
Incubation Survival,0.884  
TDM mortality,0.1164  
Spawner Density mortality,0  
Dewater mortality,0  
Background mortality,0  
Temp. watch period in days,7  
Temp profile flips,2020-11-07  
Temp profile <TcritC,2020-11-30
```

**Send Results to Migration Model**

# Loss & Salvage Predictor

- Weekly forecasts of Steelhead & Chinook loss at the pumps
- Using historical observations of loss & environmental conditions
- Tillotson et al. (2022)
  - Quantile regression forest approach

**SAN FRANCISCO ESTUARY & WATERSHED SCIENCE**  
Sponsored by the Delta Science Program and the UC Davis Muir Institute

RESEARCH

## **Machine Learning Forecasts to Reduce Risk of Entrainment Loss of Endangered Salmonids at Large-Scale Water Diversions in the Sacramento-San Joaquin Delta, California**

Michael D. Tillotson<sup>1</sup>, Jason Hassrick<sup>2</sup>, Alison L. Collins<sup>3</sup>, Corey Phillis<sup>3</sup>

Loss & Salvage Predictor Online Tool: <https://www.cbr.washington.edu/sacramento/lossandsalvage/>

Historical & real-time data: [https://www.cbr.washington.edu/sacramento/data/delta\\_loss\\_summary.html/](https://www.cbr.washington.edu/sacramento/data/delta_loss_summary.html/)



# Loss & Salvage Predictor

Get latest **forecast**  
and access scenario  
forecasting

**Hindcast**

## Select Forecast:

Most recent

2023 ▾ Mar ▾ 8

Unavailable forecasts silently corrected.

## Select graphic scaling by:

Historical Loss in this week

Annual Loss limits

## Set Annual limits:

Winter Chinook

Steelhead (Dec-Mar)

Steelhead (Apr-June15)

## Calibration:

Water years: 2009-2024

Loss for both species

Salvage for steelhead and sum limits.

Water years: 1999-2024

Loss for both species.

Salvage for steelhead and sum limits.

**RUN**

**Reset**

# SacPAS Loss and Salvage Predictor

## Select Forecast:

Most recent  
 2023  Mar

Unavailable forecasts silently corrected.

## Select graphic scaling by:

Historical Loss in this week  
 Annual Loss limits

## Set Annual limits:

Winter Chinook   
 Steelhead (Dec-Mar)   
 Steelhead (Apr-June15)

## Calibration:

Water years: 2009-2022  
 Loss for both species  
 Salvage for steelhead and sum limits.  
 Water years: 1999-2022  
 Loss for both species.  
 Salvage for steelhead and sum limits.

You can explore how next week's environmental conditions will affect loss/salvage.

Week: 26

omr sum: 9583

exports: 10859

sac: 85000

sjr flow: 35000

temp mal: 12

precip: 0.14

DCC closed:  Open:

**RUN** **Reset**

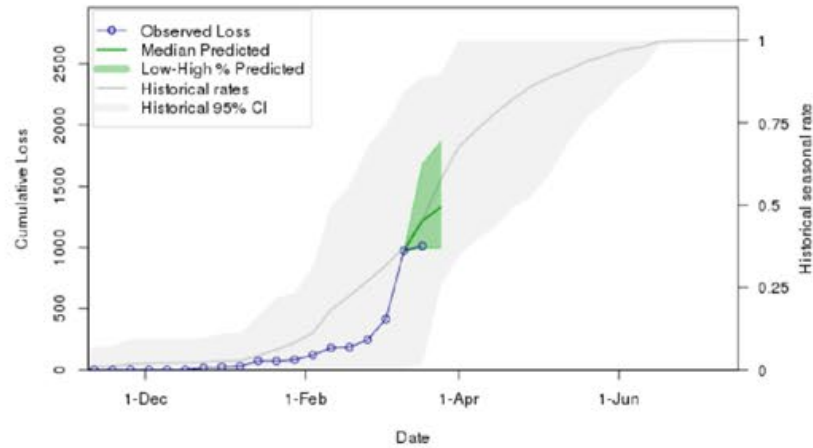
## Results and Forecast summary:

Most recent year is modeled with the calibration selected. Results are subject to revision in format and content.

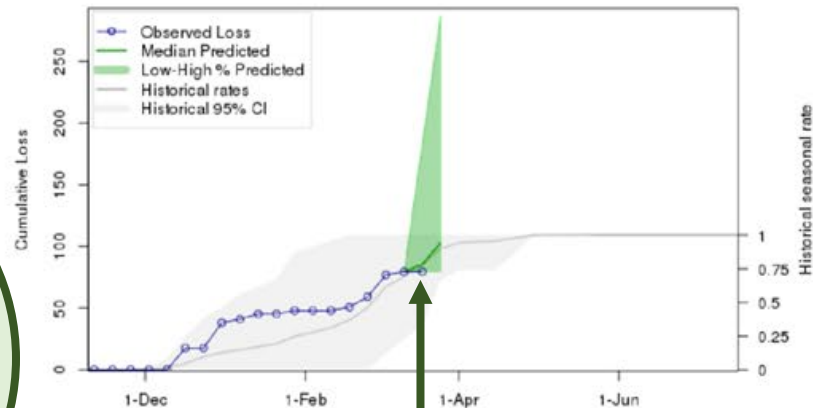
Week	25	26
	Model	
Steelhead.Low	17	1
Steelhead.Median	243	110
Steelhead.High	705	185
Winter.Run.Low	0	0
Winter.Run.Median	6	17
Winter.Run.High	104	104
	Data	
Steelhead.Observed.loss	37	NA
Winter.Run.Observed.loss	0	NA
Steelhead.Cumulative.loss	1011	1011
Winter.Run.Cumulative.loss	80	80

This week's averages. They are projected to the next week except "sac" flow which user has raised and the text is now colored green.

Steelhead Loss 2023-03-24 Water Year: 2023 & WY.week 25



Winter Run Loss 2023-03-24 Water Year: 2023 & WY.week 25



Counts are very low compared to historical numbers, so model was forecasting a "catch-up" and thus a wide confidence band

## Environmental details:

The 'most recent' forecast assumes that next week's environmental variables are the same as the current week, unless changed

wy = water year  
 temp = °C  
 sac = Sacramento flow (cfs),  
 om.sum = Old + Middle River flow (cfs)  
 mal = MallardIsland  
 precip = Inches of rain (5 day running sum)  
 dcc = Delta Cross Channel (open/closed)

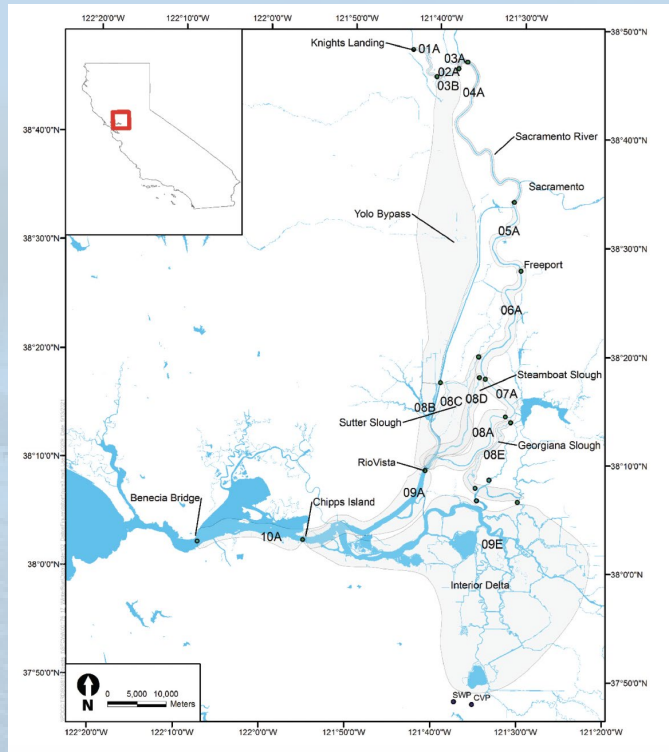
[Sources here](#)

Water Year	2023	2023
Week	25	26
	Data	Forecast
temp.mal	12.1	12.0
precip	0.14	0.14
om.sum	9583	9583
sac	73939	85000
dcc.closed	closed	closed
sjr	36078	35000
export	10859	10859
steelhead.pw	560.11	242.76
winter.pw	2.60	5.76

The forecast now includes an adjusted Sacramento flow

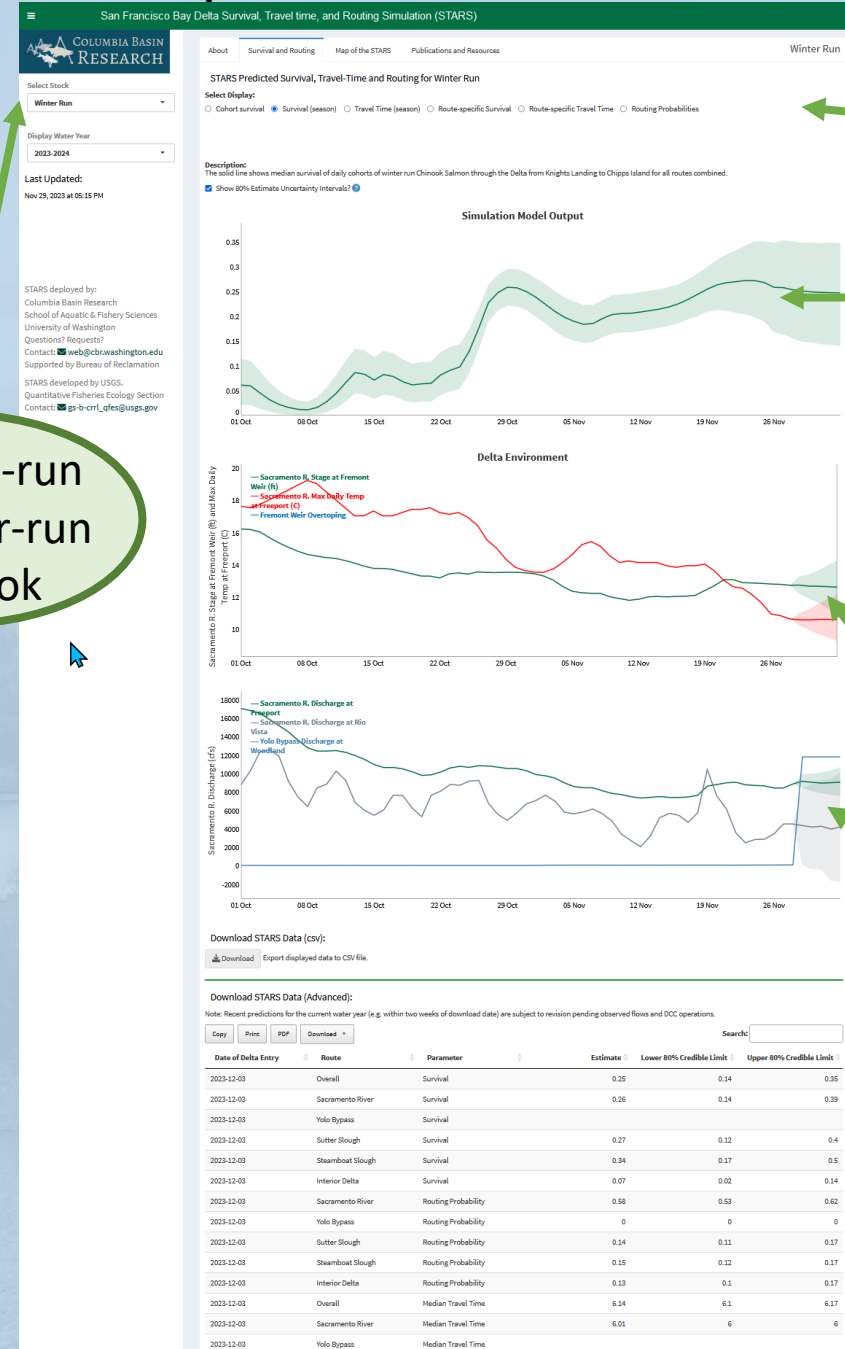
# STARS

(Delta Survival Travel And Routing Simulation;  
Perry et al. 2018, Hance et al. 2021)



Late Fall-run  
& Winter-run  
Chinook

## Example with Winter-Run Chinook Salmon



Select Display:  
Cohort survival,  
Survival (season),  
Travel Time (season),  
Route-spec. Survival,  
Route-spec. Travel Time

Delta Environment,  
Sacramento River:  
Fremont Weir stage (ft)  
& overtopping (0/1)  
Freeport Temp. (°C)  
Freeport Discharge (cfs)  
Rio Vista Discharge (cfs)  
Yolo Bypass Discharge  
at Woodland (cfs)

Download data  
(Advanced)

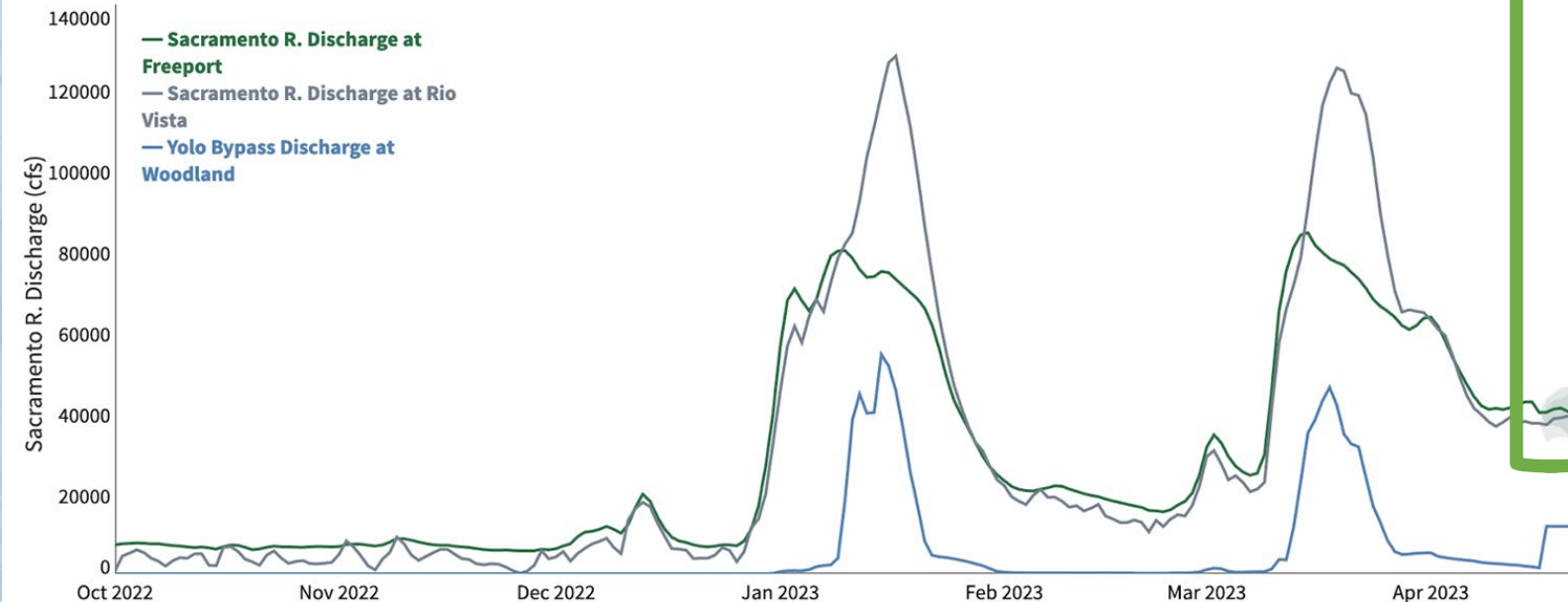
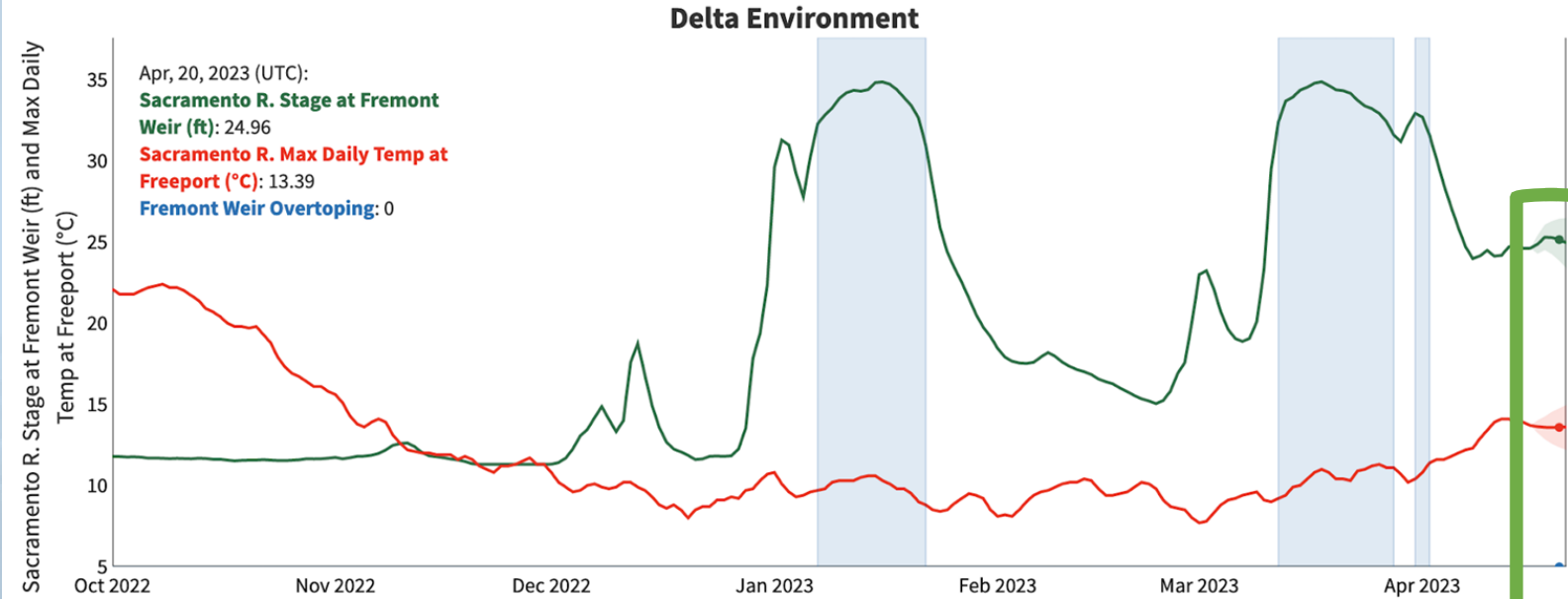
<https://www.cbr.washington.edu/shiny/STARS/>

<https://oceanview.pfeg.noaa.gov/shiny/FED/CalFishTrack/>

# STARS

Example with  
Winter-Run  
Chinook

Show 80% Prediction Uncertainty Intervals for Sacramento River flow? [?](#)



5-day  
forecasted  
flows &  
temperature

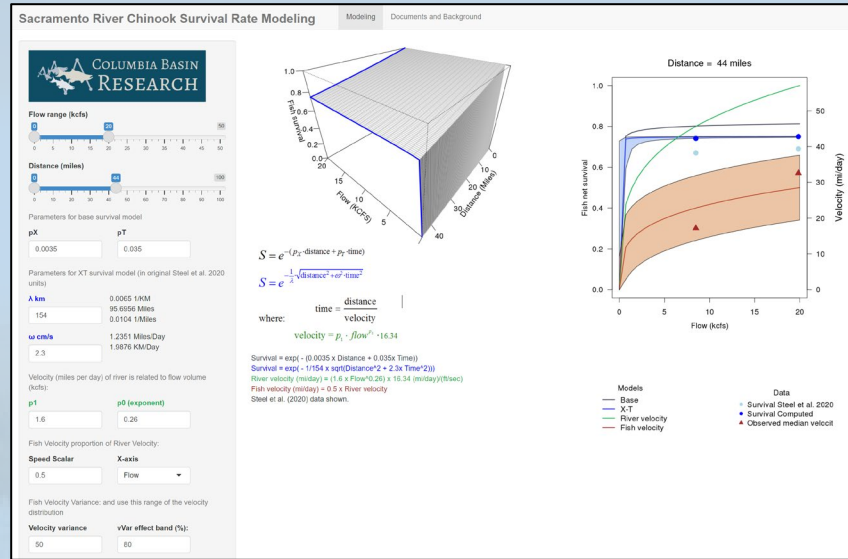
(data from  
CA NV River  
Forecast Center)

<https://www.cbr.washington.edu/shiny/STARS/>

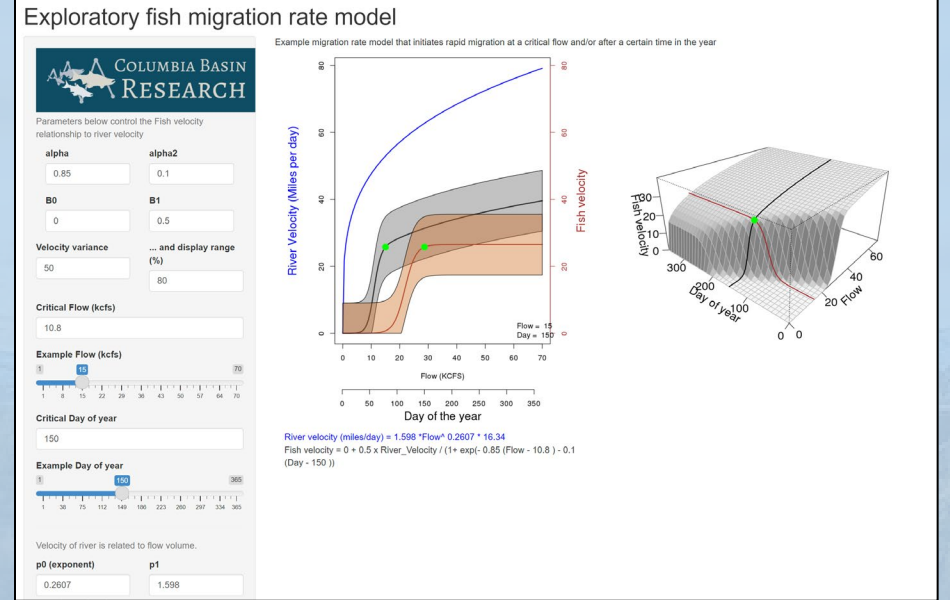
# Exploratory Shiny apps

Examples from <https://www.cbr.washington.edu/sacramento/tools/>

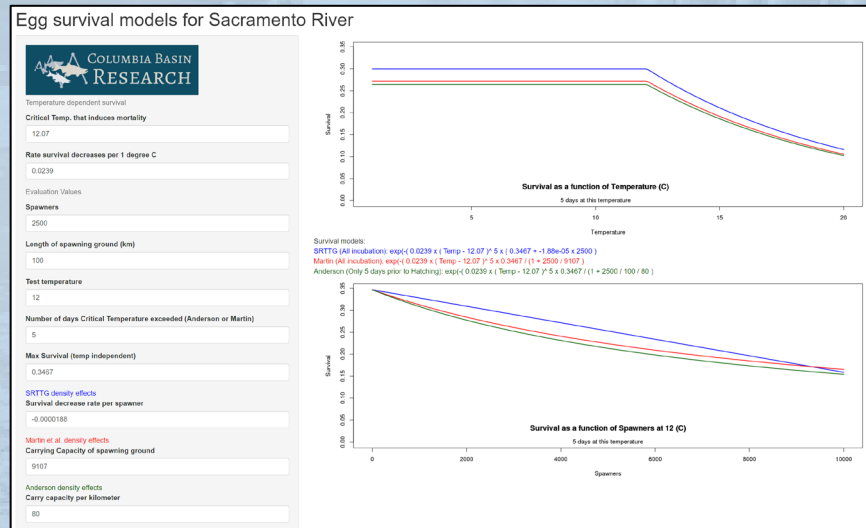
## Migration Survival



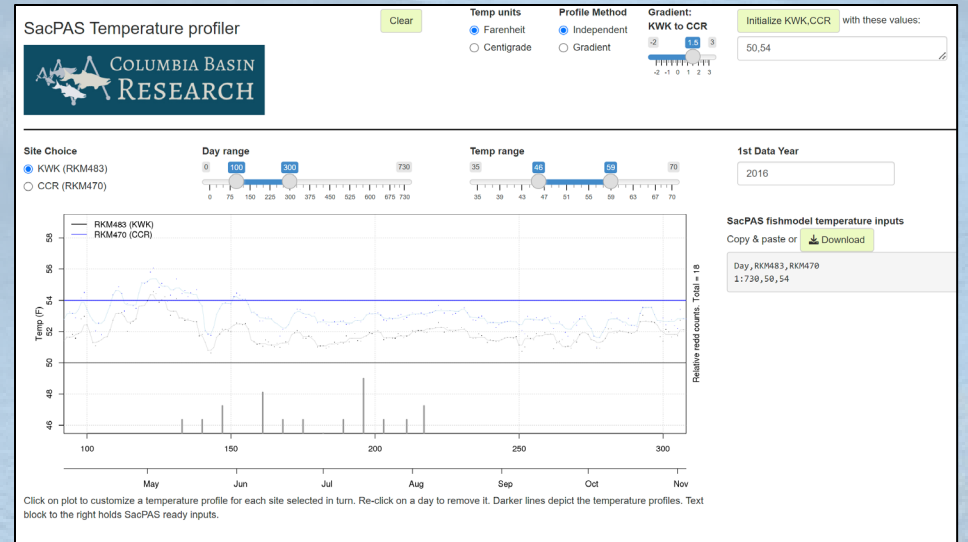
## Flow-pulse Migration Rate



## Egg Survival



## Temperature Profiler for Fish Model





# SacPAS tools & services

## I. Data Queries & Alerts

- Juvenile Monitoring & Sampling
- Juvenile Salvage & Loss
- Adult Escapement
- Temperature Thresholds
- River Conditions
- Exposure Index
- Weir Overtopping

## II. Work Groups & Teams

- Salmon Monitoring Team
- Smelt Monitoring Team
- Stanislaus Watershed Team

## III. Models

- Fish Model
  - Egg-to-Fry Model (Anderson et al. 2022)
- Loss & Salvage (Tillotson et al. 2022)
- STARS (Perry et al. 2018; Hance et al. 2021)
- Exploratory tools (Shiny apps)

# Assistance in accessing data and addressing knowledge-action gaps



... as we go about our work,  
adopt new lenses,  
deepen our understanding...

- FAIR & CARE principles
- Online Tools; handouts # 1 & 2
- Mechanistic modeling
- Science communication
- Human-computer interactions;  
UI/UX



# Hello!

[web@cbr.washington.edu](mailto:web@cbr.washington.edu)

- We seek your feedback
  - Errors/bugs
  - Refinement of tools
  - New customized tools
- We look forward to new collaborations

We are grateful for USBR in funding our SacPAS work.

We thank Catarina Pien, Elissa Buttermore, Josh Israel, and many more for their guidance, support, collaboration...