SacPAS: A real-time decision support system to predict and assess operational benefits and risks to Central Valley Salmon

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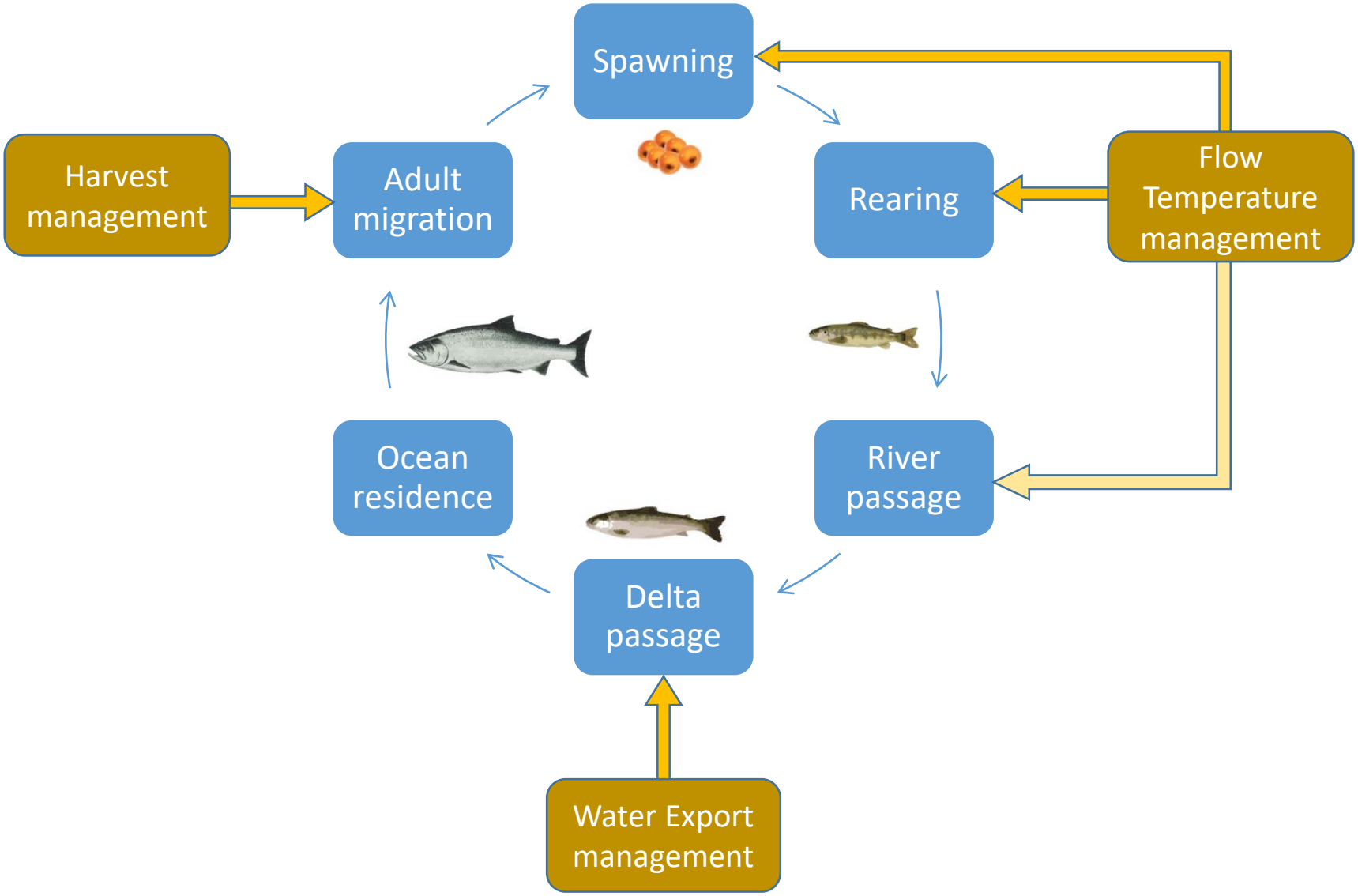
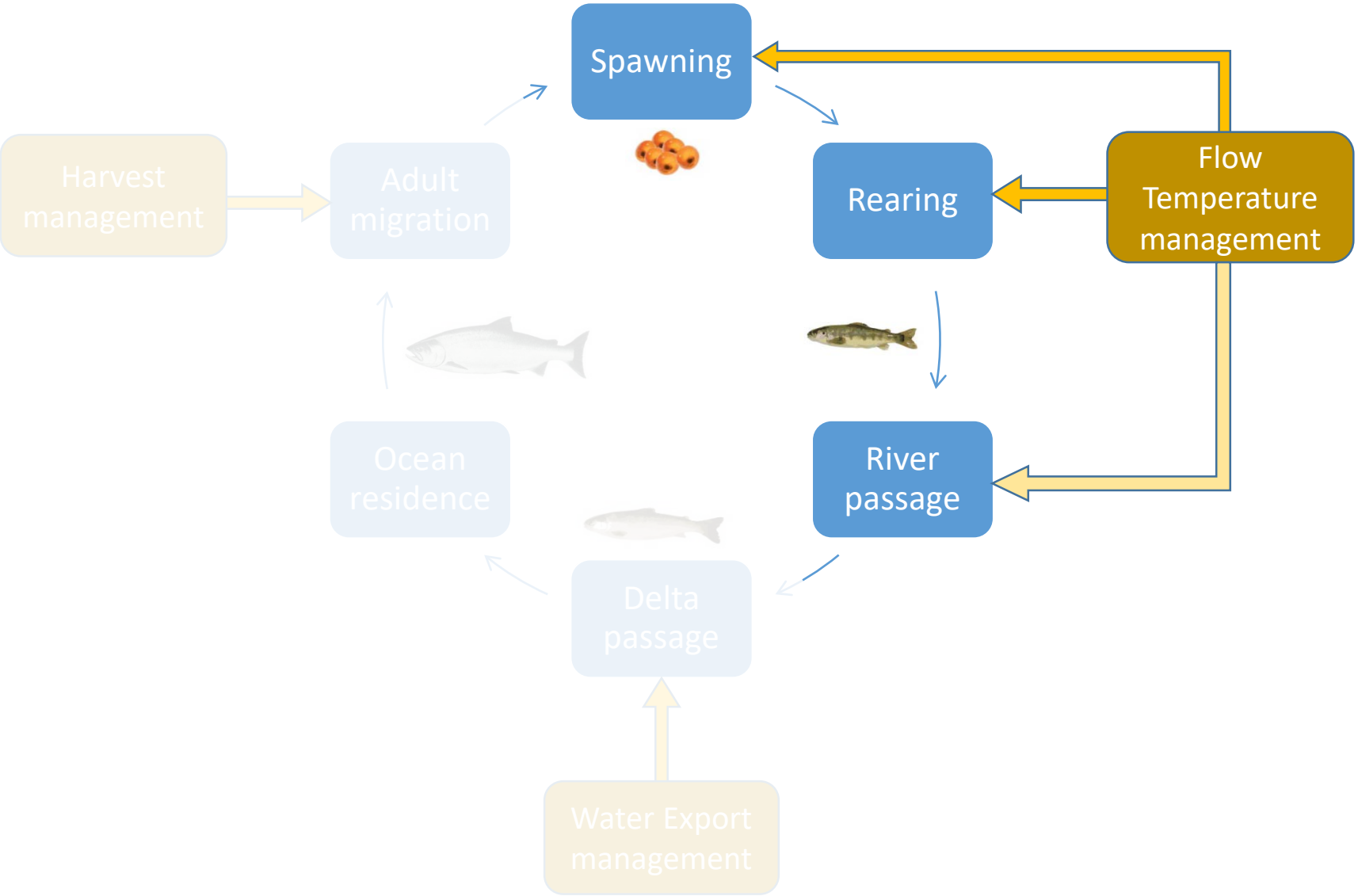
SacPAS in the context of Sacramento fish models

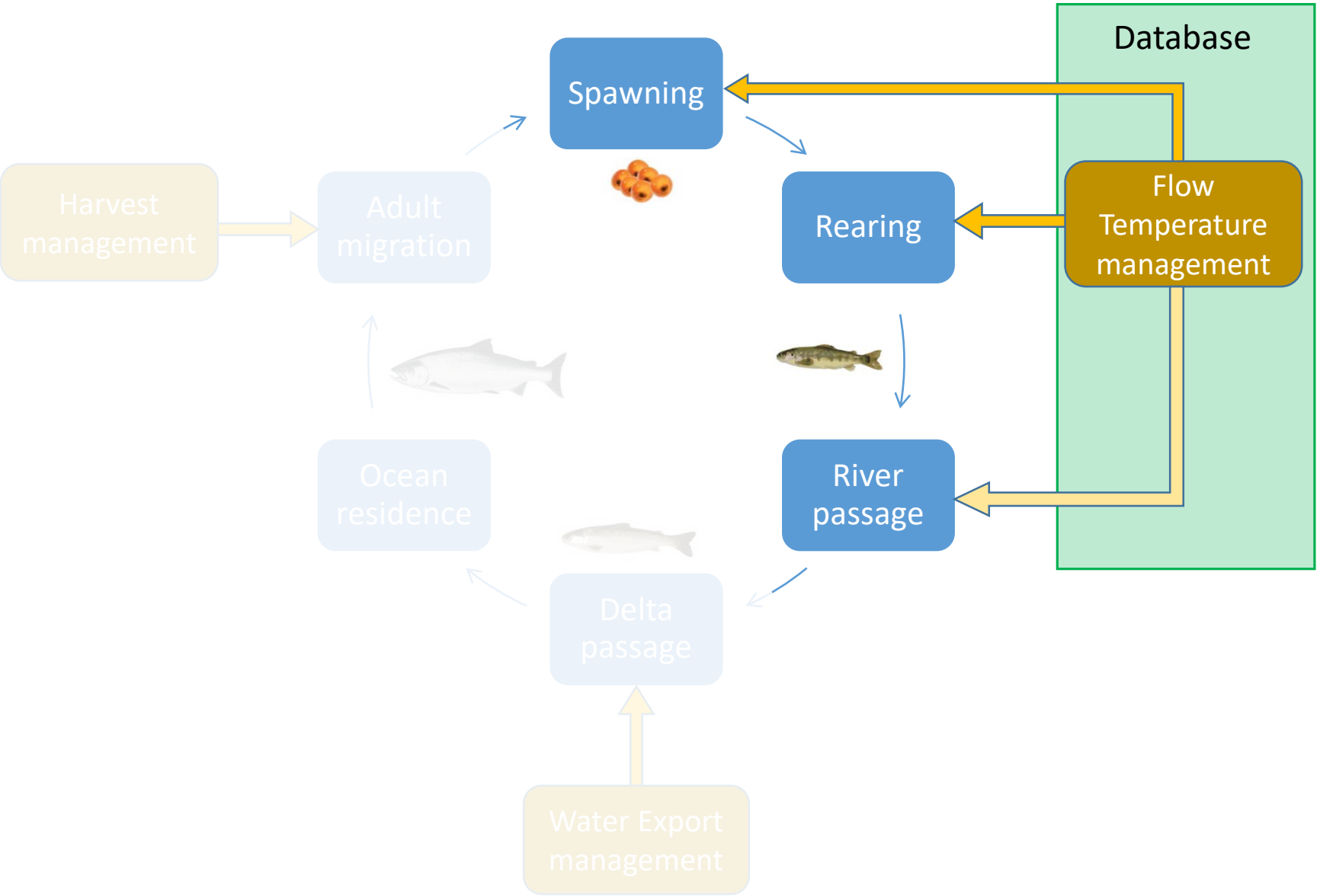
Current forms of Winter Chinook management



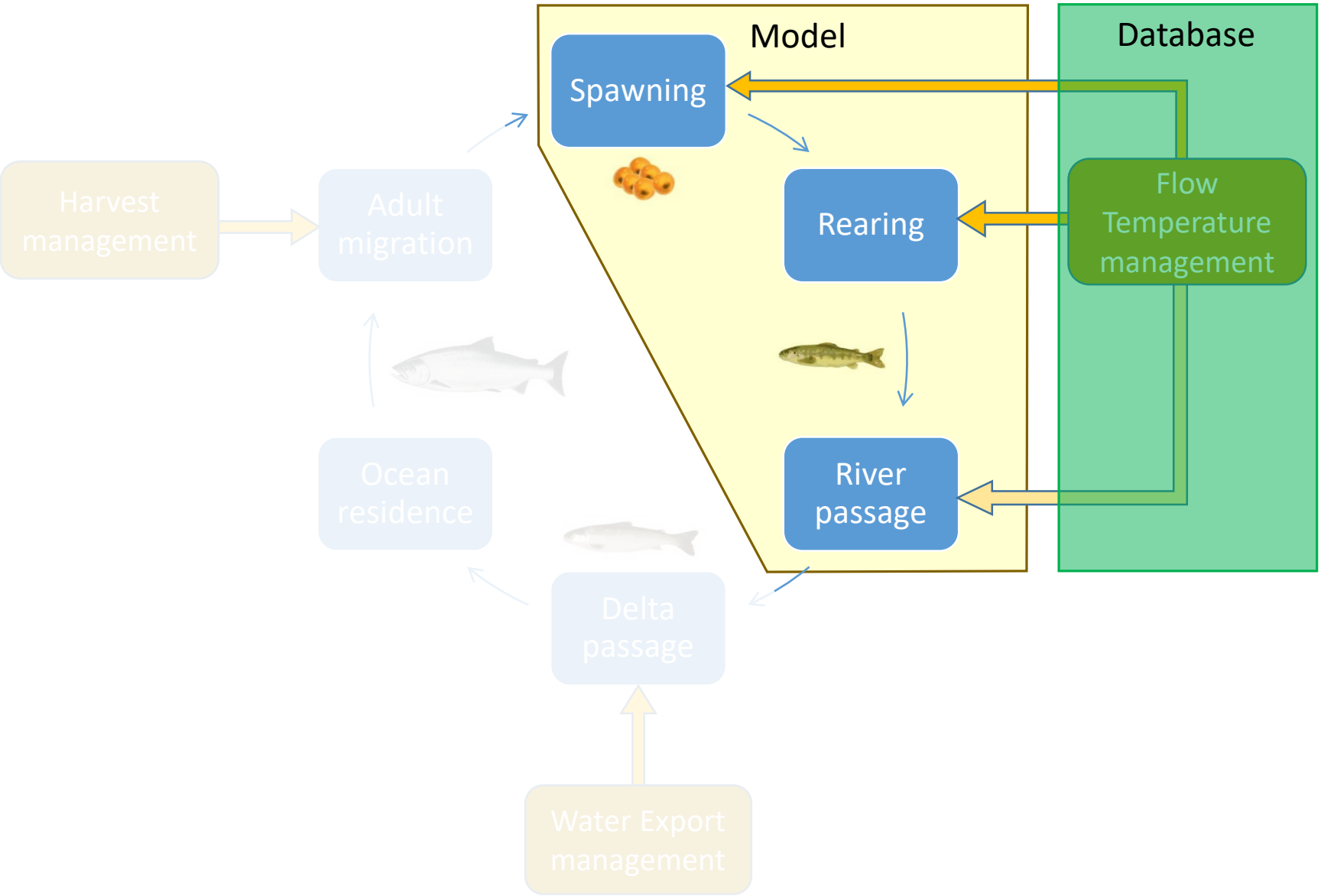
SacPAS targets real-time effects of flow on fish



By linking real-time environmental conditions



To models of spawning to river passage



Let’s go to the SacPass web page

SacPAS Sacramento Predic...

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SacPAS: Sacramento Prediction & Assessment of Salmon

UW Columbia Basin Research

BETA - Web Site Under Development

Home | Data Queries & Alerts | Fish Model | Maps | Contact

SacPAS: Sacramento Prediction and Assessment of Salmon through Ecological Data and Modeling for In-Season Management

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Mission: Provide web-based services to link data and science to in-season management.

This website will provide monitoring, evaluation, and web-based data products and services for primary and associated activities funded by the U.S. Bureau of Reclamation (USBR) and mandated by the Endangered Species Act (ESA). It will serve as a means by which information integration services can be provided to the Central Valley Project Improvement Act (CVPIA) and ESA participants. Web-based services will relate fish passage to environmental conditions and provide resources for evaluating the effects of river management and environmental conditions on salmon passage and survival.

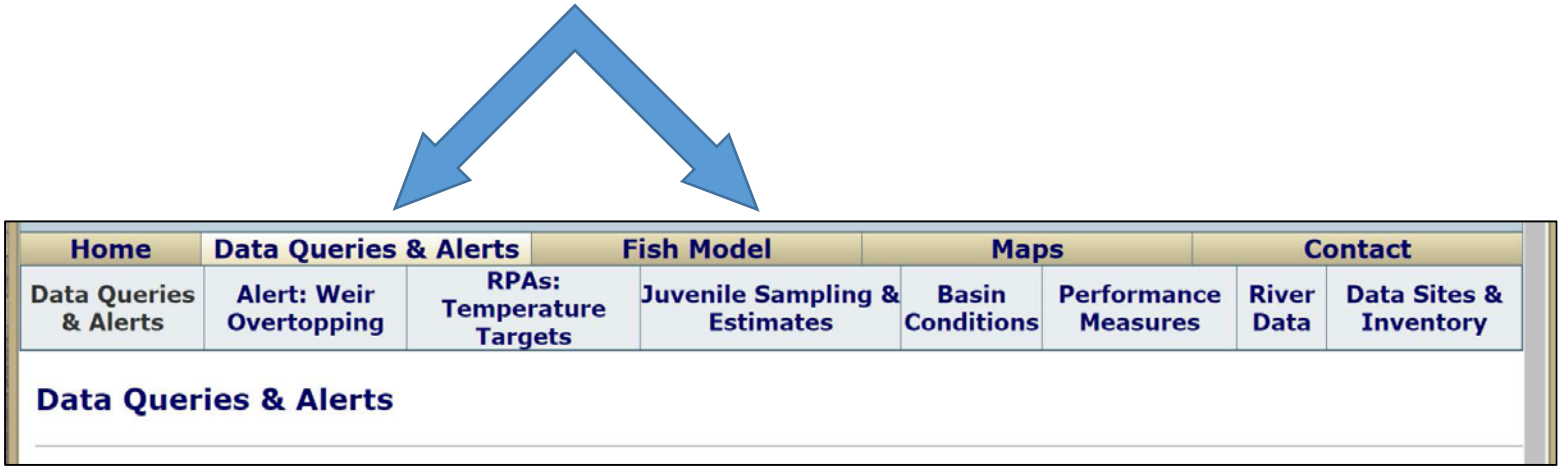
Data Queries & Alerts

Provide a 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 will 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.

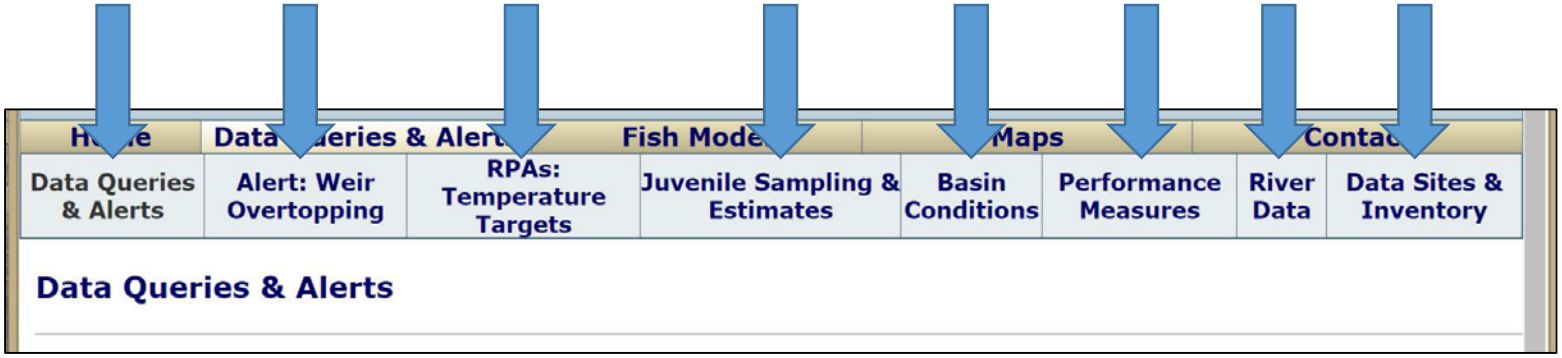
Fish Model

Adapt a smolt passage model based on NOAA's Comprehensive Passage (COMPASS) Model to characterize movement of water and juvenile fish through the Sacramento River system to the head of the San Francisco Bay Delta. The model uses available data from long-term monitoring sites. Physical data may include water velocity, temperature, and flow.

The database links to the fish model

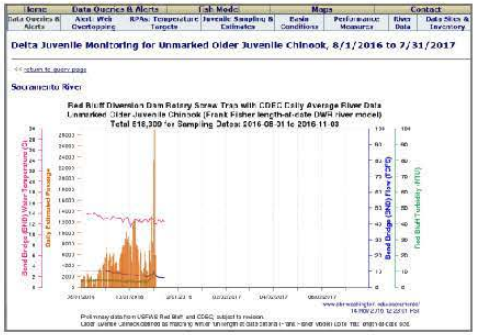


Database tools provide analysis relevant to fish and water management



Examples of database tools

Fish Monitoring

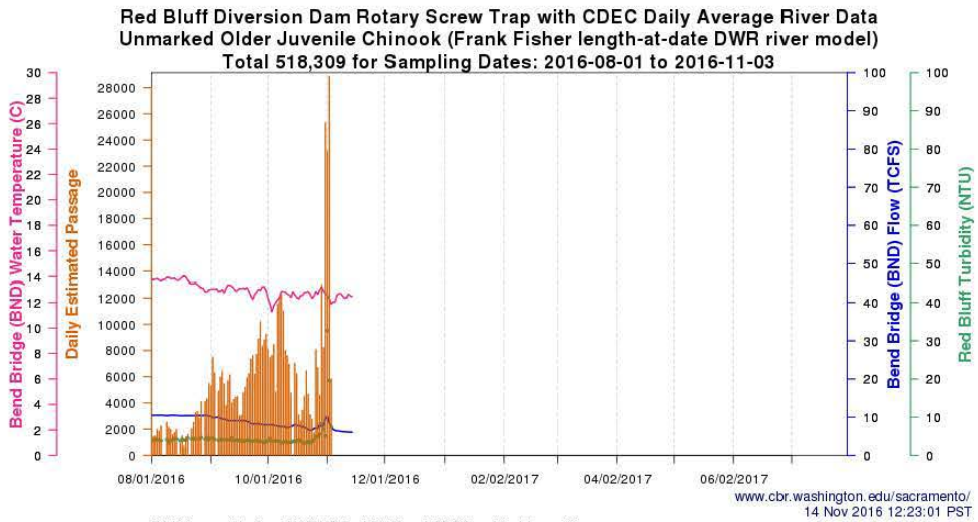


Home	Data Queries & Alerts		Fish Model	Maps			Contact
Data Queries & Alerts	Alert: Weir Overtopping	RPAs: Temperature Targets	Juvenile Sampling & Estimates	Basin Conditions	Performance Measures	River Data	Data Sites & Inventory

Delta Juvenile Monitoring for Unmarked Older Juvenile Chinook, 8/1/2016 to 7/31/2017

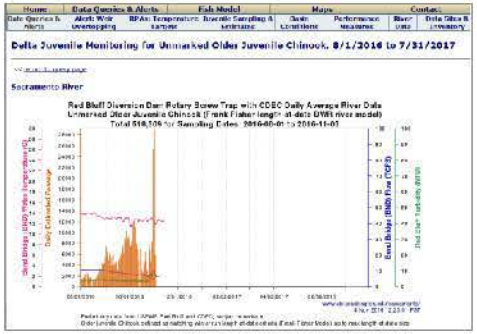
<< return to query page

Sacramento River



Preliminary data from USFWS Red Bluff and CDEC; subject to revision.
Older juvenile Chinook defined as matching winter run length-at-date criteria (Frank Fisher Model) up to max length-at-date size.

Weir Overtopping Monitoring



Home	Data Queries & Alerts		Fish Model		Maps		Contact	
Data Queries & Alerts	Alert: Weir Overtopping	RPAs: Temperature Targets	Juvenile Sampling & Estimates	Basin Conditions	Performance Measures	River Data	Data Sites & Inventory	

Alert: Sacramento River Weirs Overtopping

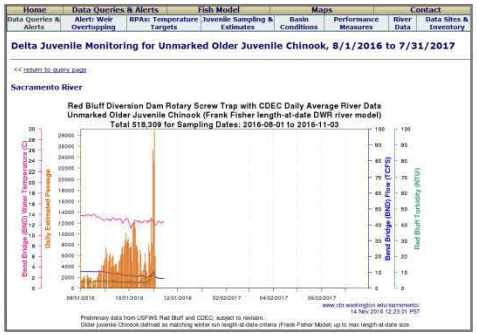
Below Crest	Crest	Flood	Danger	Peak Value in Period	Within 1 ft of Flood	Peak Value & Within 1 ft of Flood

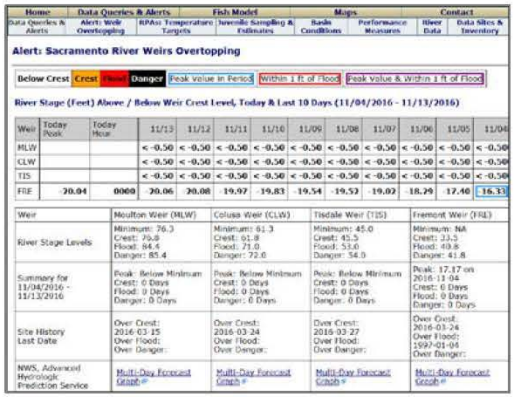
River Stage (Feet) Above / Below Weir Crest Level, Today & Last 10 Days (11/04/2016 - 11/13/2016)

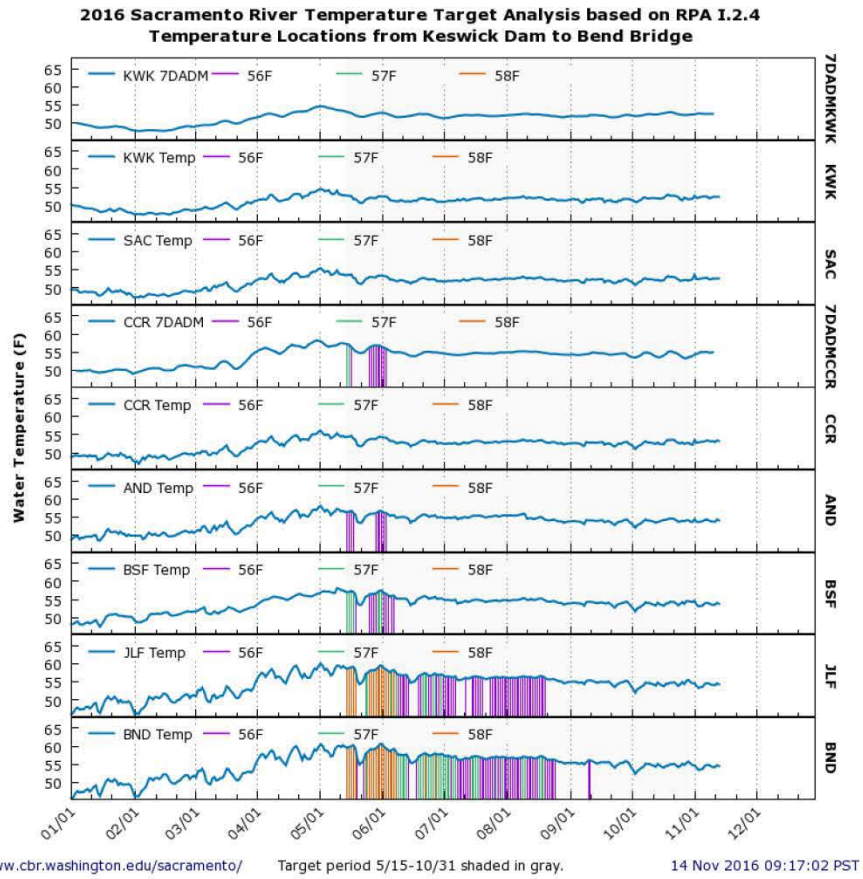
Weir	Today Peak	Today Hour	11/13	11/12	11/11	11/10	11/09	11/08	11/07	11/06	11/05	11/04
MLW			< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50
CLW			< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50
TIS			< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50	< -0.50
FRE	-20.04	0000	-20.06	-20.08	-19.97	-19.83	-19.54	-19.52	-19.02	-18.29	-17.40	-16.33

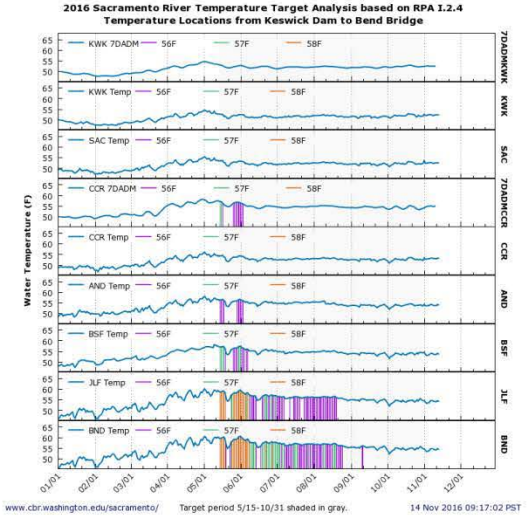
Weir	Moulton Weir (MLW)	Colusa Weir (CLW)	Tisdale Weir (TIS)	Fremont Weir (FRE)
River Stage Levels	Minimum: 76.3 Crest: 76.8 Flood: 84.4 Danger: 85.4	Minimum: 61.3 Crest: 61.8 Flood: 71.0 Danger: 72.0	Minimum: 45.0 Crest: 45.5 Flood: 53.0 Danger: 54.0	Minimum: NA Crest: 33.5 Flood: 40.8 Danger: 41.8
Summary for 11/04/2016 - 11/13/2016	Peak: Below Minimum Crest: 0 Days Flood: 0 Days Danger: 0 Days	Peak: Below Minimum Crest: 0 Days Flood: 0 Days Danger: 0 Days	Peak: Below Minimum Crest: 0 Days Flood: 0 Days Danger: 0 Days	Peak: 17.17 on 2016-11-04 Crest: 0 Days Flood: 0 Days Danger: 0 Days
Site History Last Date	Over Crest: 2016-03-15 Over Flood: Over Danger:	Over Crest: 2016-03-24 Over Flood: Over Danger:	Over Crest: 2016-03-27 Over Flood: Over Danger:	Over Crest: 2016-03-24 Over Flood: 1997-01-04 Over Danger:
NWS, Advanced Hydrologic Prediction Service	Multi-Day Forecast Graph	Multi-Day Forecast Graph	Multi-Day Forecast Graph	Multi-Day Forecast Graph

Temperature Monitoring









The Fish Model

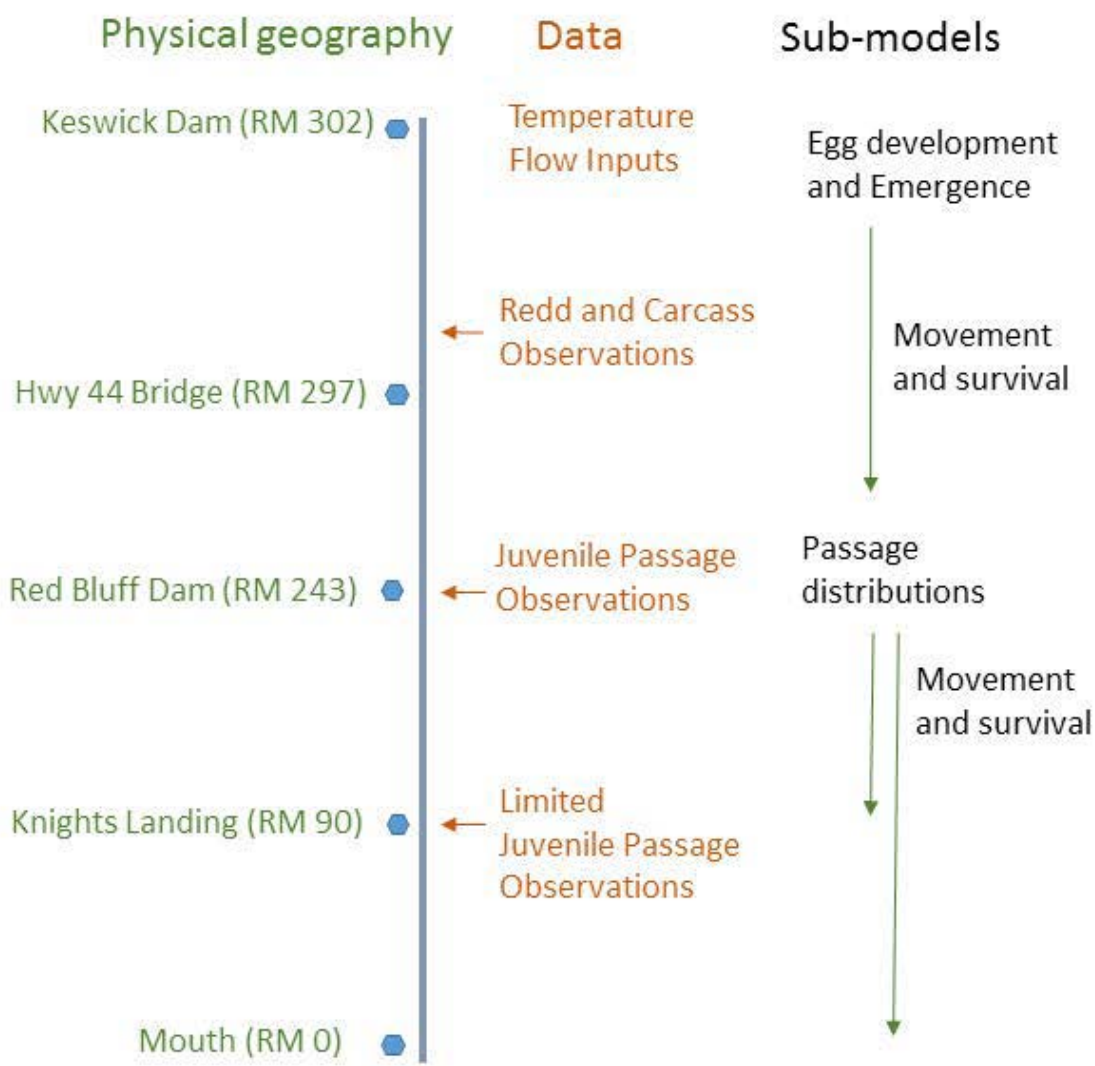
Fish Model for Sacramento River

Geography

Data

Sub-models

- Data I/O at nodes
- Flexible use of movement & survival models
- Web interface



Model Input Page
Emergence model

Home | Data Queries & Alerts | Fish Model | Maps | Contact
Fish Model | Geography | References and Notes | Model Overview

Fish Model: Spawning to Migration

The SacPAS fish modeling process begins with egg deposition at the time of spawning. Development rate and survival can be modeled by various methods to determine fry emergence from the gravel. On this page you can control temperature inputs, redd/carcass/adult counts and survival details for egg development modeling. The outputs of this process become the input for the migration model, COMPASS.

Specify Temperature Data

Query database: 2016 | Daily Average [KWK] Keswick (WQ) — *Data provided as a courtesy by CDEC.*

Upload file: Choose File | No file chosen
- File should be a comma or tab delimited text file with at least 2 columns.
- Lines are paired values. 1st column is Day-of-year. 2nd or other column is temperature. Header line is

Specify Spawning Data

Winter Chinook redds: 2016 — Combined counts from "Keswick Dam to A.C.I.D. Dam" and "A.C.I.D. Dam to Highway 44 Bridge" for Winter Run Chinook.

Winter Chinook carcasses 2016 — *Redd and Carcass database provided as a courtesy by CDFW and USBR.* Data Disclaimer

Upload file: Choose File | No file chosen
- File should be a comma or tab delimited text file with at least 2 columns.
- Lines are paired values. 1st column is Day-of-year. 2nd or other column is redd, adult or carcass count. Header line is ignored.

Use column: 2
Units: Redds / Adults or Carcasses.

Adult and Carcass Handling

Adults/carcasses
- This divides the count to get redds. Positive integer only. If you are uploading adult or carcass counts, this will adjust those

Specify Egg Development model

View egg growth models comparison

Chinook Mechanistic (Beer and Anderson 1997): Egg mass 200 mg. (Allowed Range: $100 \le x \le 400$)
Chinook Empirical (Jensen et al. 1999)
Chinook Power law (Beacham/Murray 1990) Days = $e^{10.404 - 2.043 * \log(T_{\circ C} + 7.575)}$
Chinook Linear (Zeug et al. 2012): Target ATUs 958 degree C days. (Allowed Range: $700 \le x \le 1200$)
- Default linear value 958 is centigrade equivalent of ATUs accumulated at the published daily rate: $0.00058 * T_{Farenheit} - 0.018$
- Enter a value in either box to convert between ATU-Centigrade 0 and ATU-Farenheit 0.
- Farenheit ATUs are accumulated above 32. This calculation is NOT a temperature conversion tool.

Eggs per Redd 4926 Oppenheim (2014) (Allowed Range: $1000 \le x \le 6000$)

Specify Survival model

Survival from spawning to fry passing RBDD. Sacramento River Temperature Task Group model (SRTTG)

Temperature-dependent mortality parameters.
T_{Crit} = 53.72 °F or 12.07 °C. Temperature below which there is no temperature dependent mortality.
b_T = 0.0133 °F^{-1} or 0.0239 °C^{-1}. Rate at which an increase of 1°F increases daily mortality

Specify Analysis and Results Display

Use redd or carcass value data set *as is*. Smooth redd or carcass values. See Notes

Date Range: Range of Fish Data

Run Emergence (to an output tab) | Run Emergence (new tab each click) | Reset

Emergence model results

Home | Data Queries & Alerts | Fish Model | Maps | Contact

Fish Model | Geography | References and Notes | Model Overview

download CSV view PDF run migration model

Spawning to Emergence Results

Model

Data

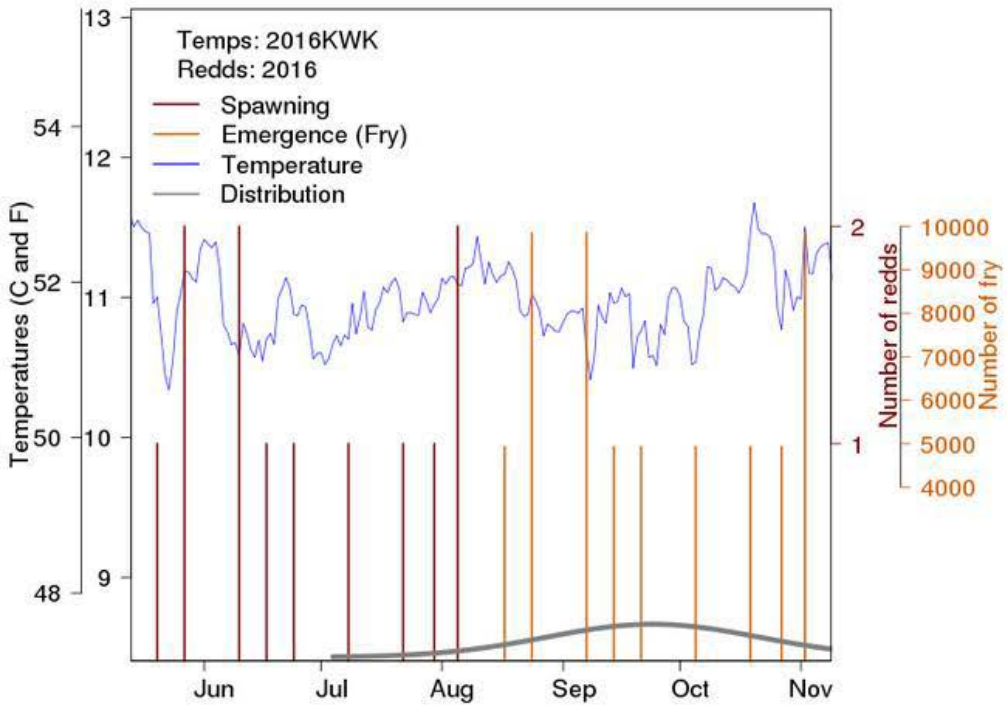
Results

Emergence Specifications

Species:	Chinook
Development model:	Zeug
Target ATUs:	958
Egg survival model:	TaskGroup
Fry survival model:	TaskGroup
Eggs per redd:	4925
Adults/carcasses per redd:	NA
Offset used for redd timing:	NA
Temperature Source:	SacPAS database 2016 KWK:DailyAvg
Spawning Data Source:	SacPAS database 2016 Redds

Emergence Results

Total Redds:	12
Mean Emergence Day:	267
Timing from Emergence to RBDD:	NA
Variance:	612.1
STD:	24.7
Expansion:	0 Days
Eggs:	59100
Fry:	NA
Passage:	20472
Survival, Egg to Fry:	NA
Survival, Fry to RBDD pass:	NA
Survival, Egg to RBDD pass:	0.346



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Passage model input

Run Migration passage model with Emergence Results

Specify Flow

Fixed Flow: flow observations at a single site with 10 year averages for missing/future values:
July 2016 - June 2017 Obs. and/or 10 year avg. flow at: KWK

User Provided Flow: Browse... No file selected.
Use column: 2 Needs 18 months of values from Jan.1 of spawning year. First column is day and other columns are values. Comma or space delimited. Units: CFS KCFS/TCFS.

Specify Optional Configuration

Adjust the migration rate equations:
Above Red Bluff, Miles/Day = 0.1 + 0.05 x River_Velocity
Below Red Bluff, Miles/Day = 0.1 + 0.07 x River_Velocity

Run

Run Passage | Run Passage (new tab)

Note: At this time, migration can ONLY be modeled for Winter Chinook from the upper Sacramento.

Home	Data Queries & Alerts	Fish Model	Maps	Contact
Fish Model	Geography	References and Notes	Model Overview	

view PDF

Passage model results

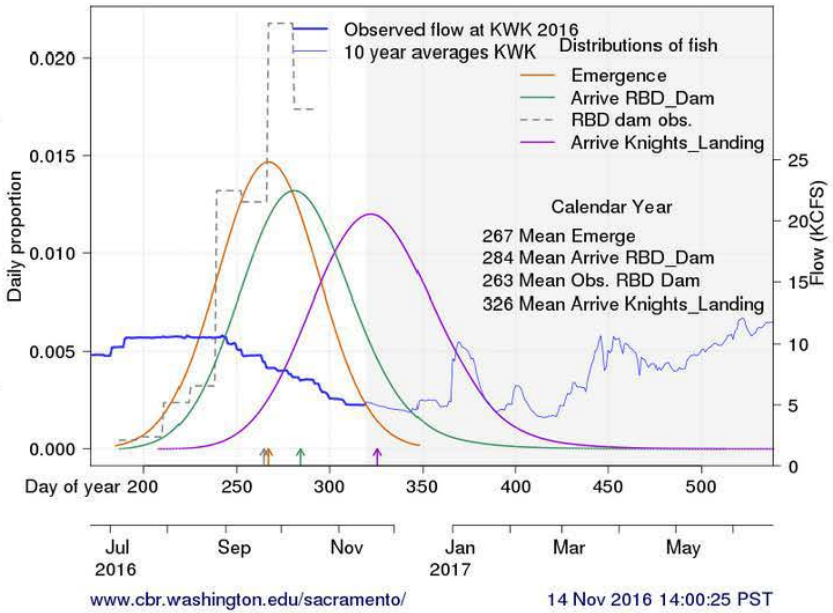
Passage Model Results -- for DEMONSTRATION purposes only

Stock: Winter_Chinook
Temps: 2016
Flows: simple
Mean emergence: 2016-09-23

Travel to RBD_Dam
Mean arrival: 2016-10-10
Mean Travel Time: 16.8 Days
Survival: 34.6% (previously computed)

Travel to Knights_Landing
Mean arrival: 2016-11-20
Mean Travel Time: 41.5 Days from RBD_Dam to Knights_Landing
Survival: 68.2%

Emergence to Knights_Landing
Travel Time: 58.3 Days
Survival: 23.5%



Comparison of 2015 to 2016 Model Results

2015

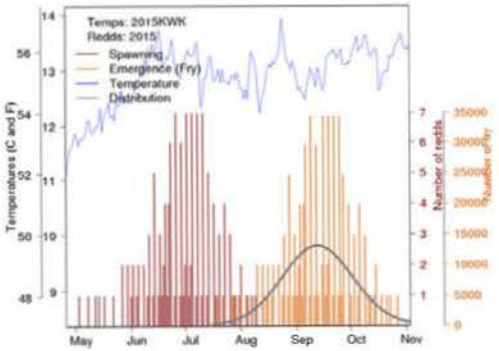
Spawning to Emergence Results

Emergence Specifications

Species:	Chinook
Development model:	Zeug
Target ATUs:	958
Egg survival model:	TaskGroup
Fry survival model:	TaskGroup
Eggs per redd:	4925
Adults/carcasses per redd:	9
Offset used for redd timing:	-12
Temperature Source:	SacPAS database 2015 KWK:DailyAvg
Spawning Data Source:	SacPAS database 2015 Carcass Counts

Emergence Results

Total Redds:	132
Mean Emergence Day:	255.4
Timing from Emergence to RBDD:	NA
Variance:	339.6
STD:	18.4
Expansion:	-2 Days
Eggs:	650100
Fry:	NA
Passage:	44135
Survival, Egg to Fry:	NA
Survival, Fry to RBDD pass:	NA
Survival, Egg to RBDD pass:	0.067



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Passage Model Results -- for DEMONSTRATION purposes only

Stock:	Winter_Chinook
Temps:	2015
Flows:	simple
Mean emergence:	2015-09-12

Travel to RBD_Dam

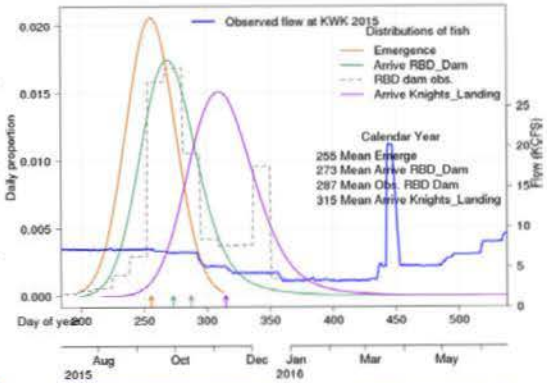
Mean arrival:	2015-09-29
Mean Travel Time:	17 Days
Survival:	6.7% (previously computed)

Travel to Knights_Landing

Mean arrival:	2015-11-10
Mean Travel Time:	41.7 Days from RBD_Dam to Knights_Landing
Survival:	68.7%

Emergence to Knights_Landing

Travel Time:	58.7 Days
Survival:	4.6%



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Survival 4.6%

2016

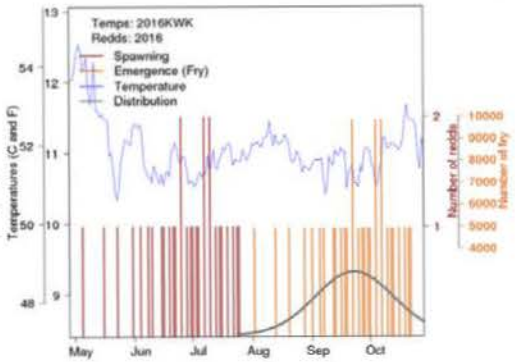
Spawning to Emergence Results

Emergence Specifications

Species:	Chinook
Development model:	Zeug
Target ATUs:	958
Egg survival model:	TaskGroup
Fry survival model:	TaskGroup
Eggs per redd:	4925
Adults/carcasses per redd:	9
Offset used for redd timing:	-12
Temperature Source:	SacPAS database 2016 KWK:DailyAvg
Spawning Data Source:	SacPAS database 2016 Carcass Counts

Emergence Results

Total Redds:	30
Mean Emergence Day:	265.6
Timing from Emergence to RBDD:	NA
Variance:	336.5
STD:	18.3
Expansion:	0 Days
Eggs:	147750
Fry:	NA
Passage:	51097
Survival, Egg to Fry:	NA
Survival, Fry to RBDD pass:	NA
Survival, Egg to RBDD pass:	0.345



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Passage Model Results -- for DEMONSTRATION purposes only

Stock:	Winter_Chinook
Temps:	2016
Flows:	simple
Mean emergence:	2016-09-22

Travel to RBD_Dam

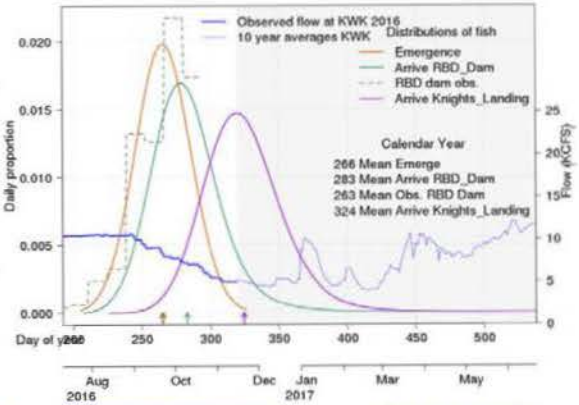
Mean arrival:	2016-10-08
Mean Travel Time:	16.7 Days
Survival:	34.5% (previously computed)

Travel to Knights_Landing

Mean arrival:	2016-11-19
Mean Travel Time:	41.5 Days from RBD_Dam to Knights_Landing
Survival:	68.6%

Emergence to Knights_Landing

Travel Time:	58.2 Days
Survival:	23.6%



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Survival 23.6%

Summary

This open-access web-based system provides historical and real-time environmental data and predictions of movement and survival of winter Chinook salmon from adult spawning to passage of juveniles into the San Francisco Bay Delta.

The system provides:

- Easy access to historical and real-time environmental and fish data
- Retrospective analysis of fish movement and survival under different historical conditions and model assumptions
- Sensitivity analysis of fish passage to differing assumptions of conditions and mechanisms
- Quantitative estimates of benefits and risks of management decisions on salmon populations
- A web-based modeling framework that can be readily modified to incorporate new models, data and user-specified analysis tools.

This project is funded by US Bureau of Reclamation Bay-Delta Office, Mid-Pacific Region

We wish to especially thank

- Models
  - Rich Zabel (NOAA Seattle) for providing the COMPASS passage model
  - Sacramento River Temperature Task Group
- Data Providers
  - California Data Exchange Center (CDEC)
  - California Department of Fish and Wildlife (CDFW)
  - California Department of Water Resources (CDWR)
  - NOAA
  - US Fish and Wildlife Service, Lodi and Red Bluff (USFWS)
  - US Geological Survey (USGS)
  - 34 North / Bay Delta Live
- Columbia Basin Research Staff, University of Washington
  - W. Nicholas Beer
  - Susannah Iltis
  - Chris Van Holmes

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