San Joaquin River Fall-run Chinook Salmon Population Model

"SalSim"

Management Challenges

- Ecosystem limiting factors
- RPA's protective for salmon
- South Delta inflow objectives
- FERC instream flow objectives
- Hatchery augmentation influence
- Restore delta ecosystem concurrent with water supply reliability
- Water temperature standards
- Friant Restoration Program

Tough Questions

- **What are the primary production parameters within the inland, delta, and ocean ecosystem and what are the relative influences of these parameters on salmon production?**
- **How can temperature goals, critical for salmon production, be implemented and still maintain the other legally recognized beneficial water uses?**
- **What is the natural production fraction of SJR salmon stocks for purposes of evaluating restoration efforts?**
- **What seasonal flow magnitude, duration and frequency for improving inland salmon production is needed now?**
- **What are the "pass through" benefits that accrue from releasing additional water from the tributaries as this water passes into the mainstem and through the South Delta?**
- **What are the various juvenile salmon life history stage to adult survival relationships?**

Project Team

Active Role:

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Support Role:

- Tim Heyne
- Dr. Carl Mesick
- Dr. Yetta Jager
- Steve Tsao
- Richard Starfield
- Scott Fortmann-Roe
- Dr. Brian Wells

Model goals and objectives

- Develop a fishery planning tool:
  - Informs flow decisions
  - Has broad scientific community acceptance
  - Advances fishery science
    - identifying testable hypotheses & implementing new studies
    - refining existing studies & data collection
  - Has broad management utility & confidence
  - Has broad spectrum accessibility
  - Is cutting-edge: a full web-based application
  - Is fully transparent

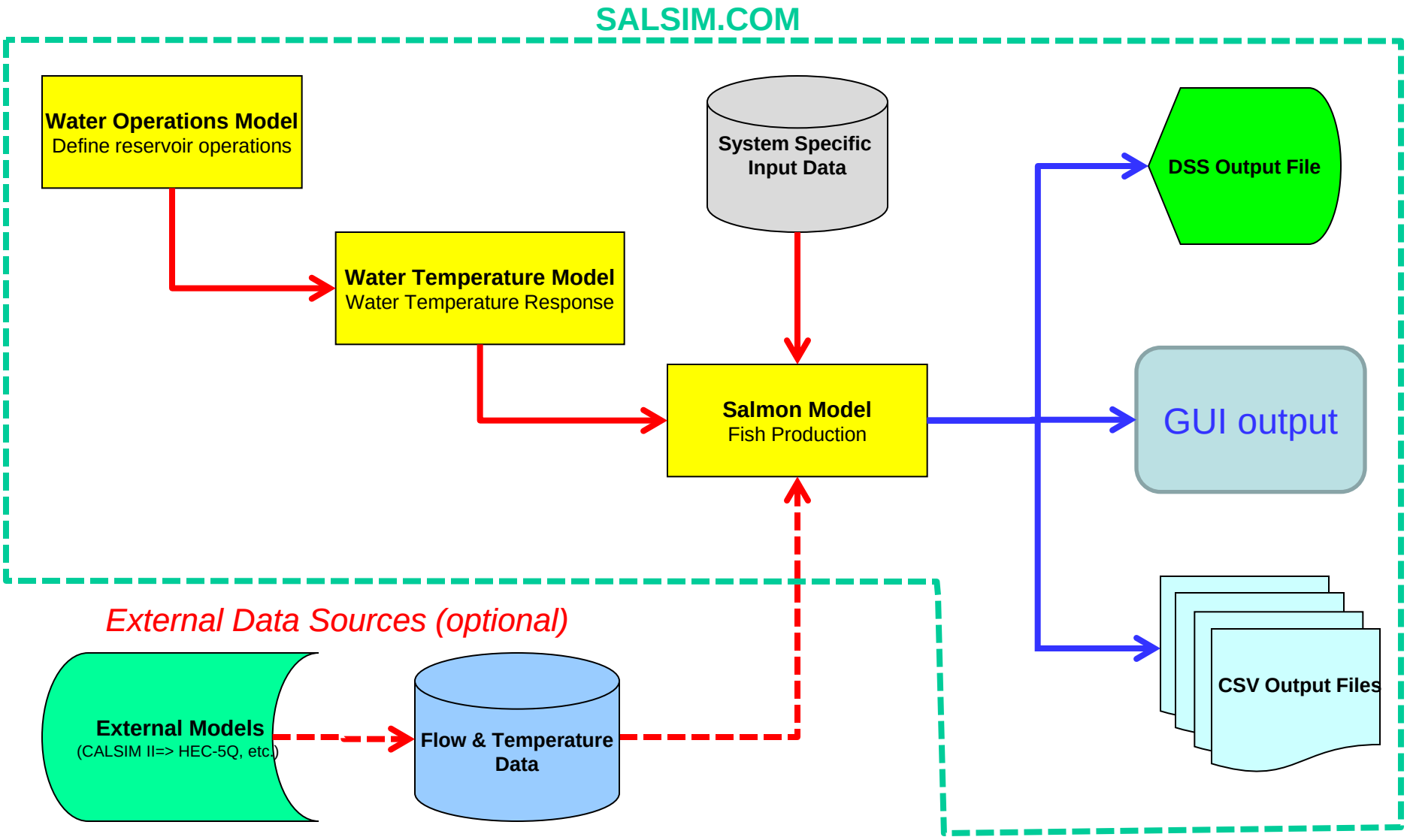
Model Evolution

- 2005: SWRCB Periodic Review
  - ❑ Built simple salmon production model
  - ❑ Preliminary flow recommendations
- 2006: Peer review (V.1)
- 2007: Model Contracting
- 2008: Preliminary Model Refinement
  - ❑ Peer Review response
  - ❑ Intermediate models (V.1.5 & V.1.6)
- 2009: Nothing (contract funding frozen)
- 2010: Advanced Model Refinement
- 2012: Peer Review (SalSim)
- 2012: Fishery Agencies Feedback
- 2012: Update to the SWRCB

SalSim Overview

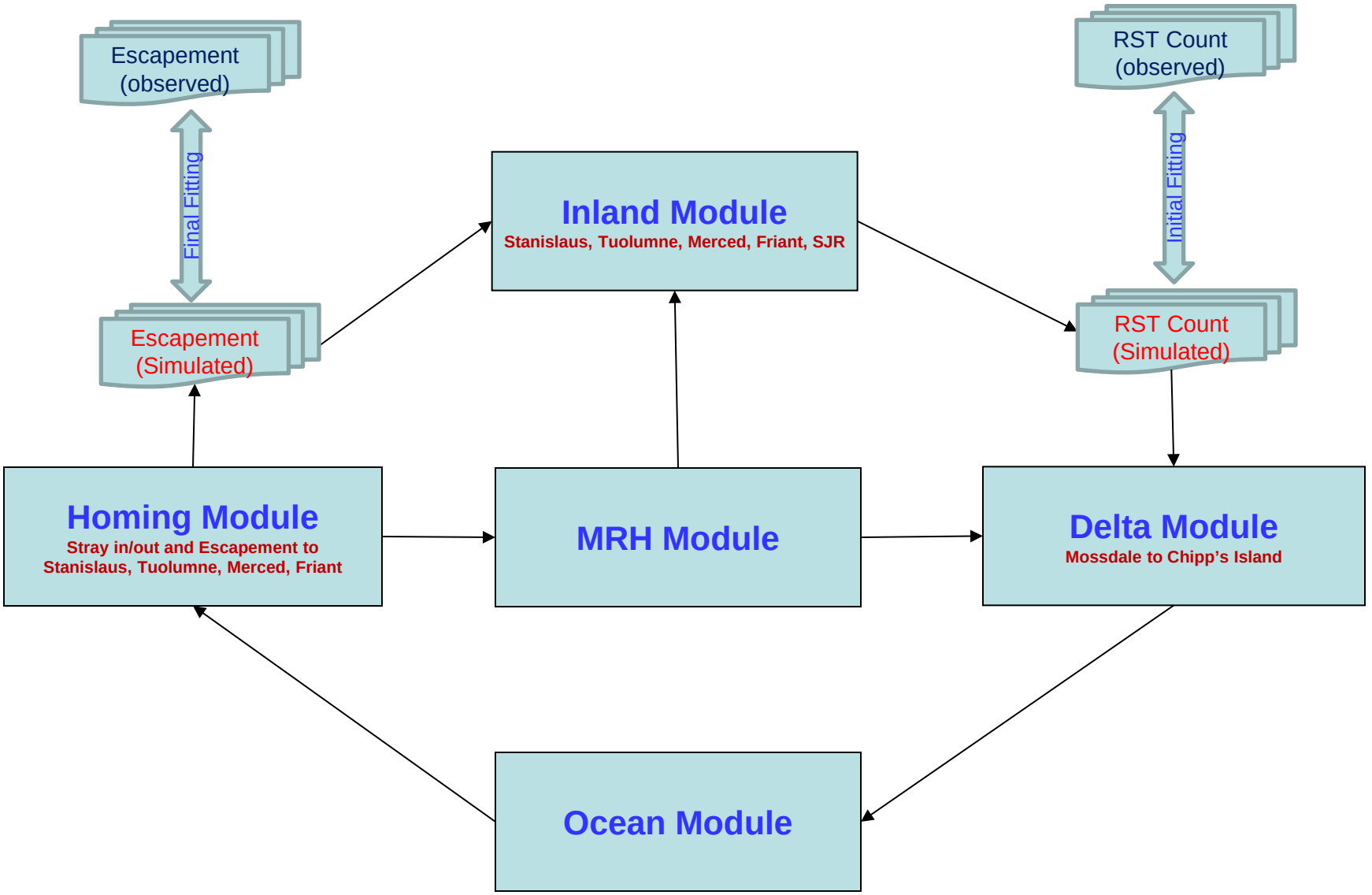
- SalSim is an integrated system-wide model designed to assess fish production (salmon) response to water management strategies in the San Joaquin River Basin
- Contains three sub-models
    - Water Operation Model
    - Water Temperature Model
    - Salmon Model
- Contains three inter-related geographical areas
    - Inland
    - Delta
    - Ocean

SalSim – Package Design



SalSim - Geographical Areas

SalSim Design



Inland Module

(Stanislaus, Tuolumne, Merced, Friant)

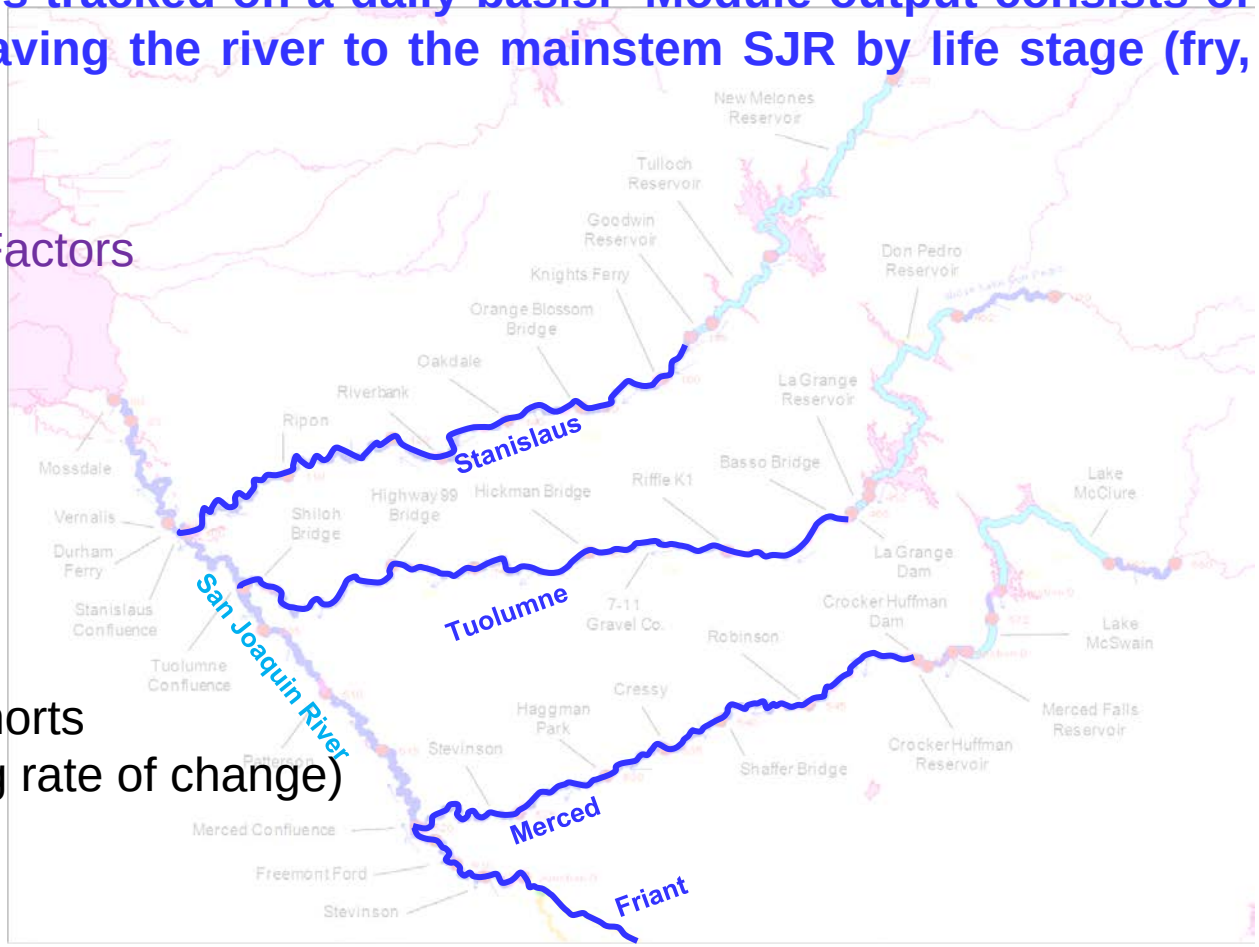
Converts female spawners data to redds (nests). Then, on a salmon redds by reach basis, takes eggs in the redds and develops them in time and space into juveniles (alevins, fry, parr and smolts). Juvenile fish development, survival and movement within the river is tracked on a daily basis. Module output consists of the number of juveniles leaving the river to the mainstem SJR by life stage (fry, parr and smolt).

Development and Survival Factors

- Flow
- Water temperature
- Density dependence
- Predators areas

Movement Factors

- Slow, medium and fast cohorts
- Velocity and flow (including rate of change)
- Temperature
- Floodplain encroachment



SJR Survival Module

(mainstem San Joaquin River)

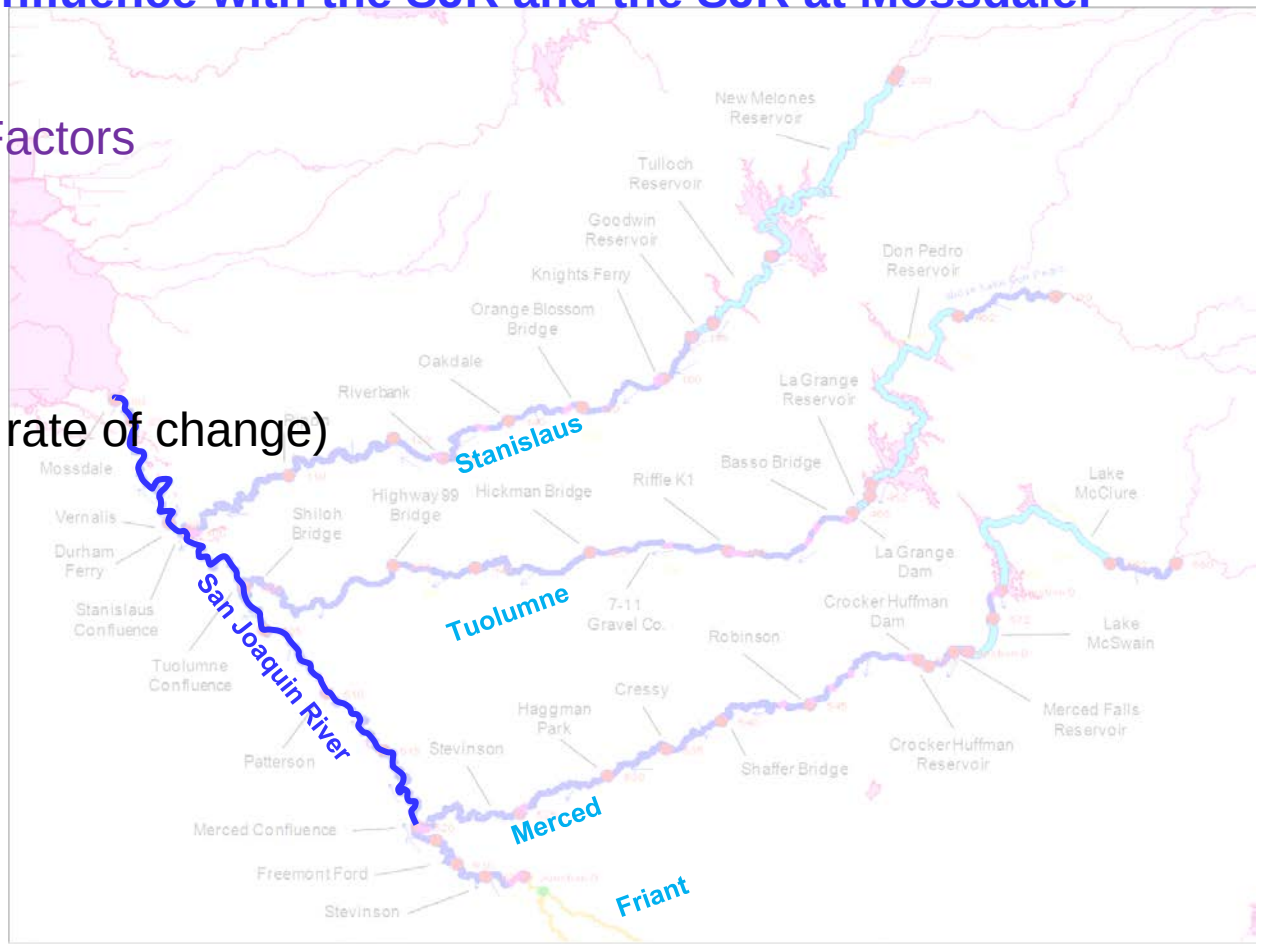
Takes the juveniles leaving the individual tributaries, by life stage, and computes how many survive the journey from the confluences to Mossdale on a daily basis. Module output consists of the number of juvenile fish surviving on a daily basis between each tributary's confluence with the SJR and the SJR at Mossdale.

Survival and Development Factors

- Flow
- Water temperature

Movement Factors

- Velocity and flow (including rate of change)
- Temperature



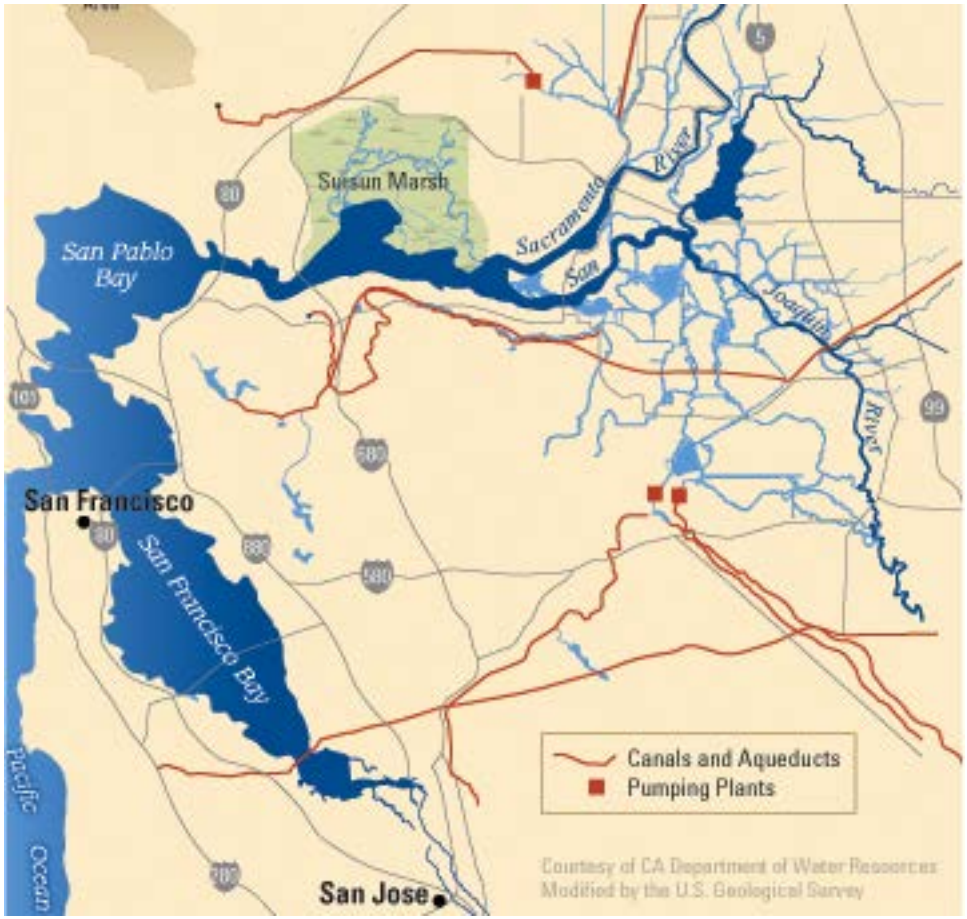
RiverXSections.kml

Juvenile Delta Module

Takes daily number of fry/parr/smolt arriving at in the SJR at Mossdale and routes them through the delta by estimating survival on a daily basis. Module output consists of number of fry/parr/smolts surviving through the delta for the entire year (daily survivors are aggregated into a yearly total).

Survival Factors

- Inflow to the Delta
- Water temperature entering Delta
- Water export
- Striped bass abundance
- HORB status (by day)



Ocean Module

Taking the Juvenile Delta Module output (aggregated annual total number of smolts surviving to Chipp's Island) it predicts the probability of: being harvested in the sport fishery, being harvested in the commercial fishery, and escaping inland to spawn. In addition, it predicts the probability of these events occurring by age of fish (for age 2, age 3, and age 4). Module output is number of juveniles that successfully survive to adult and returned to the inland Central Valley to spawn (by age).

Aging and Survival Factors

- Sport fishing (Cal & Ore)
- Troll fishing (Cal & Ore)
- Ocean conditions (upwelling)

Complementary/Competing Models

Model	Type	Location & Generality	Temporal Resolution	Spatial Resolution	Management Analysis	Pros	Cons
OBAN	Statistical life cycle	Sacramento Chinook Winter run version and Spring run version	Production season	Lumped inland section	Variety of lumped factors (incl. gravel, dam storage, exports, fish regs.)	Statistically rigorous	Lack of resolution for weekly water releases
SALMOD +WEAP	Detailed life cycle	General and adaptable to different locations	Daily	Fine	Implicitly linked through dependence on hydrology	Biologically detailed	Lack of statistical rigor, unsuitable for management studies, no ocean component
IOS (= JPE +DPM+ Ocean)	Explanatory, exploratory	Sacramento Chinook salmon	Daily, degree-day	Fine	Management actions embedded	Biological life cycle and process oriented	Lack of statistical rigor
Shiraz	Multistage GIS-based	Sacramento inland production	Daily	Very fine	Not management oriented, but various actions implicitly	Explore impacts of climate change	Lack of statistical rigor; difficult to validate
SLAM	Strings modules together	General	Relatively coarse	Relatively coarse	Uncertain	Unsure	Unsure
ORCM	Individual-based, spatially explicit, habitat detailed, bioenergetic growth model	General	Daily	local feeding territories	Hydrology dependent, juvenile production	generality and biological detail	Inland only, many parameters
SALSIM	Multistage developmental and statistical movement	San Joaquin Fall Run Chinook. Can be refitted in other systems	Daily Inland, weekly Delta, seasonal ocean	Mile by mile inland, two regions: Delta and ocean	Management oriented for scenario comparisons	temp driven development, statistical rigorous, designed for management	No explicit ecology