

# Delta Smelt Population Modeling: How will it help to Understand the effects of SWP and CVP operations?

Presentation to the  
South Delta Fish Facilities Forum  
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# Take Home Points

- Several modeling efforts underway – two at the pop. Level. All will help in understanding the effects of operations on delta smelt.
- Additional research is needed to quantify vital rates, understand how various factors affect these rates, and understand how delta smelt are affected by env. conditions.
- Understanding the population level affects of operations will require:
  - 1) quantifying the sources of delta smelt mortality, and
  - 2) understanding how delta smelt distribution/entrainment is affected by water movement and water temperature.

# Why are we interested in population modeling?

- Model development focuses scientists on key biological and ecological information important to species conservation. Learn a lot during model development.
- Broad suite of analytical tools
- Estimate and understand consequences of actions at a level most important to the species.

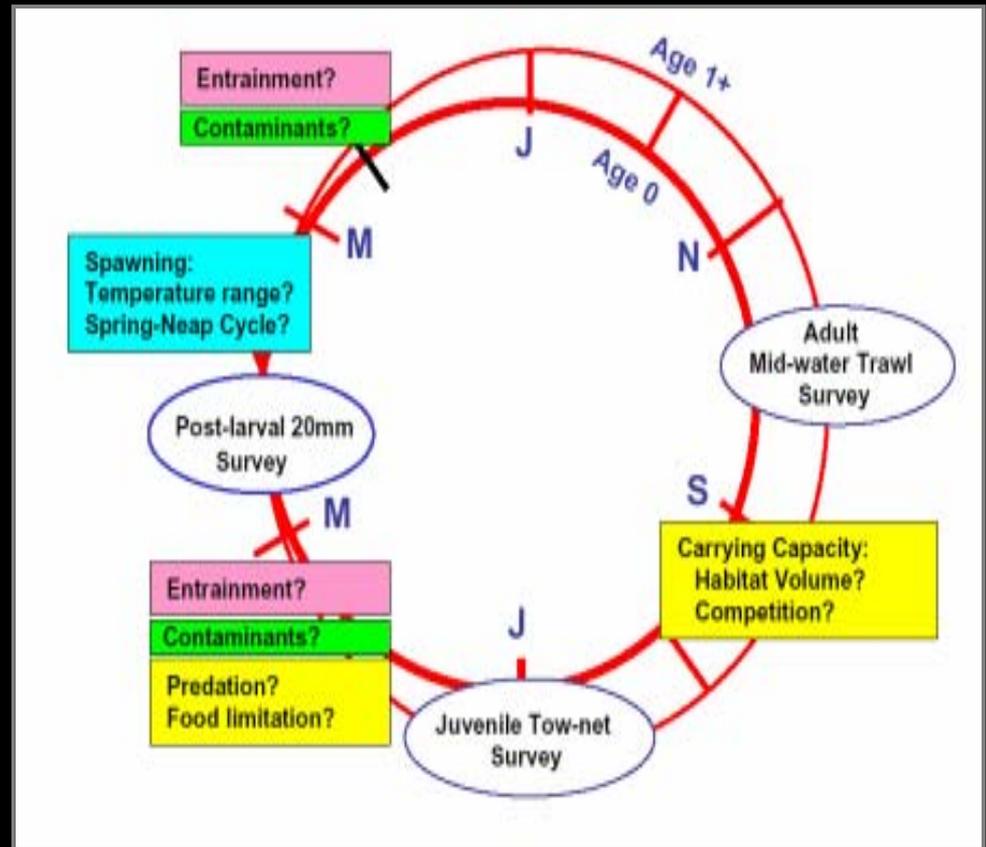
# Questions population models can help answer

1. How does delta smelt abundance vary?
2. What are principal controls of abundance?
3. What is the probability of extinction?
4. How important are controlled vs. uncontrolled factors?
5. What can be done to protect delta smelt?
6. How effective is EWA in protecting delta smelt?

# Delta Smelt “Models”

Vital rates: fecundity, growth and mortality

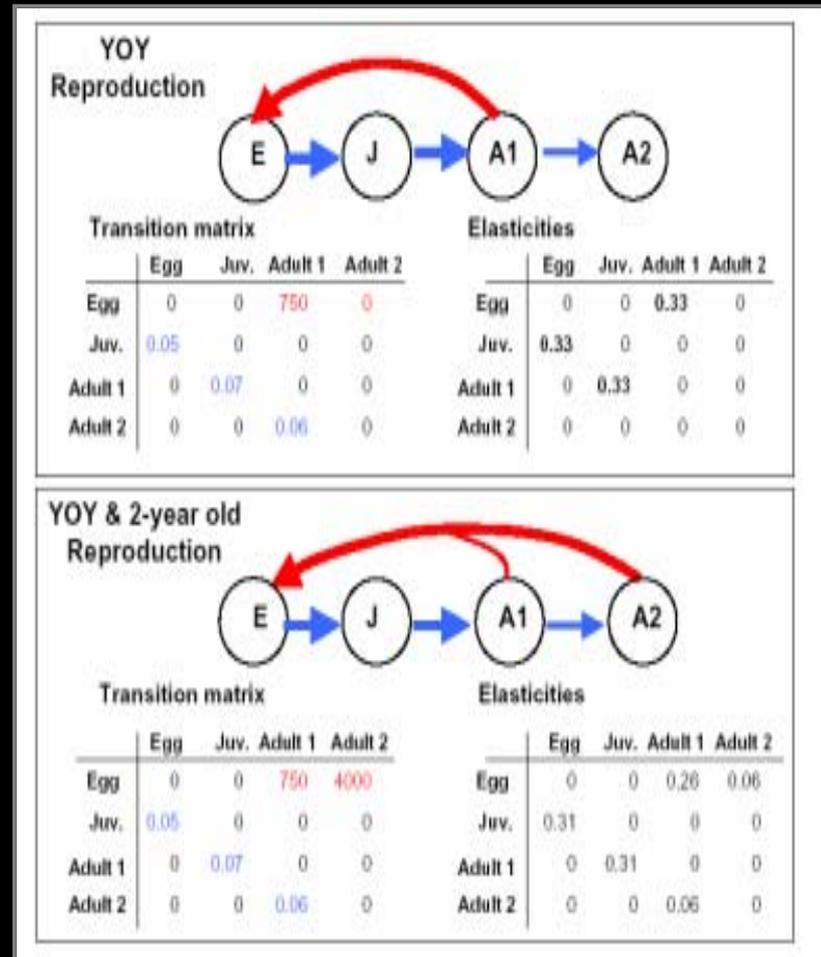
- Stage-based modeling (Bennett)
- Individual based modeling (Rose, Kimmerer, and post-doc)
- Delta smelt decision tree (FWS, DFG, Tech. Team)
- Particle tracking model (Nobriga, et al., and Smith, et al.)



From Bill Bennett, UCD

# Stage-Based Model

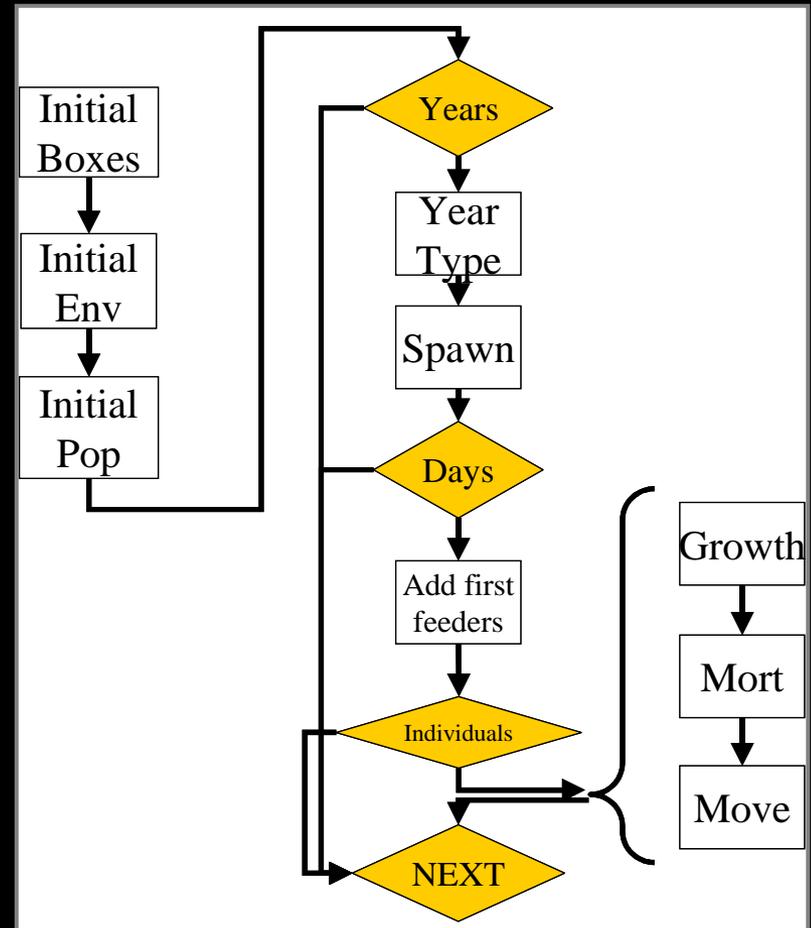
- Matrix model used to explore long-term consequences of changes in population vital rates.
- Examine probability of extinction or relative responses of the population to changes in vital rates (e.g., consequences of management actions).
- Describes transitions between life stages as single numbers (fecundity or survival).
- Defining life stages and a consistent aging process are key.



From Bill Bennett, UCD

# Individual Based Model (IBM)

- IBM is used to explore probabilistic, long-term changes in the population.
- The IBM could assess the long-term consequences of different decision trees, or investigate the principal controls on population abundance.
- Largely a bookkeeping exercise with most programming effort to keeping track of individual “model” fish.
- Vital rates, environmental conditions in time and space, and movement are all key.



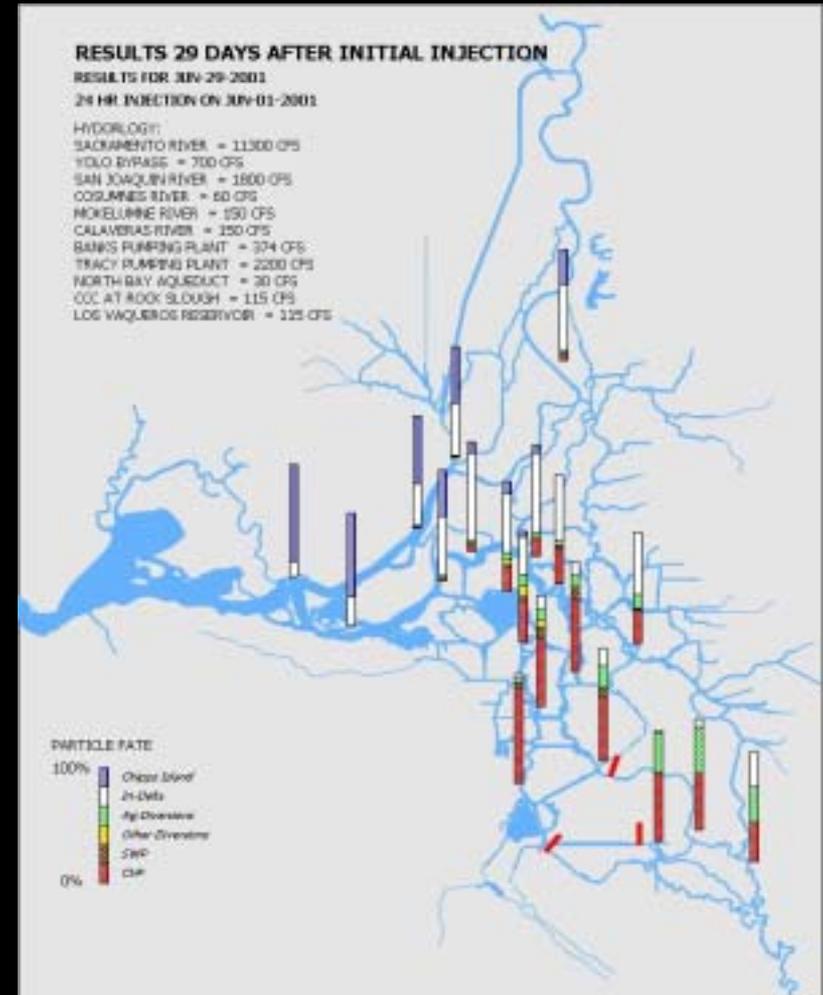
# Delta Smelt Decision Tree

- Used to make qualitative decisions about the short-term effects (days to weeks) of management actions.
- It is not a model and population level effects are at best implied.
- A description of factors considered in qualitatively evaluating the short term concern for a specific life stage
- Evaluation based on expert opinion; easily modified.

<b>Life stage:</b>	Adults
<b>Timing:</b>	Pre-VAMP (February 1 - April 15)
<b>Concerns:</b>	High relative densities of adults in the south Delta are a concern due to the potential for increase entrainment at the SWP and CVP. High relative densities of delta smelt in the south Delta also suggest spawning may occur in the south Delta, increasing the chances for exceeding the red light level <sup>1</sup> of incidental take in the late spring and early summer.
<b>Data of interest:</b>	<ol style="list-style-type: none"><li>1) Previous fall mid-water trawl indices</li><li>2) Spring mid-water trawl</li><li>3) Salvage levels</li><li>4) Beach seine</li><li>5) Chipps Island trawl</li><li>6) Hydrology (wet or dry year; placement of X2)</li><li>7) Water quality conditions and water temperature</li><li>8) Condition of the fish</li></ol>
<b>Assessment of conditions:</b>	<ol style="list-style-type: none"><li>1) Adult distribution in Delta and downstream</li><li>2) Salvage levels/densities, yellow light</li><li>3) Potential high numbers in juvenile salvage if high numbers of adults are in the south Delta</li></ol>
<b>Tools for change:</b>	Reduction in exports, either concurrently at both facilities or at the facility that is salvaging the most fish
<b>Biological questions using the available data:</b>	<ol style="list-style-type: none"><li>1) Is the adult distribution broad or not? (Maybe hard to answer with spring mid-water trawl, should consider other approaches, i.e. adding Kodiak trawls in the spring to determine adult distribution)</li><li>2) Is salvage elevated or not?</li><li>3) Is previous FMWT index high or low?</li><li>4) Are water quality conditions conducive to spawning, (e.g. water temperatures)?</li><li>5) Are fish ripe for spawning (both of above may help determine if there will be a protracted spawn)</li></ol>

# Particle Tracking Model (PTM)

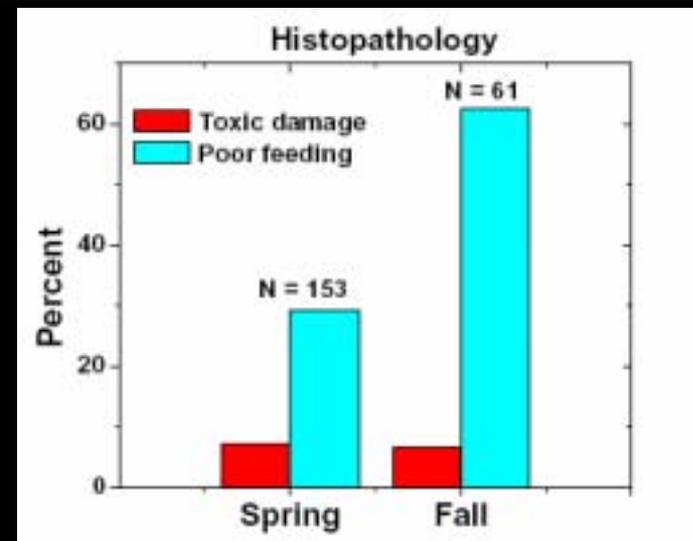
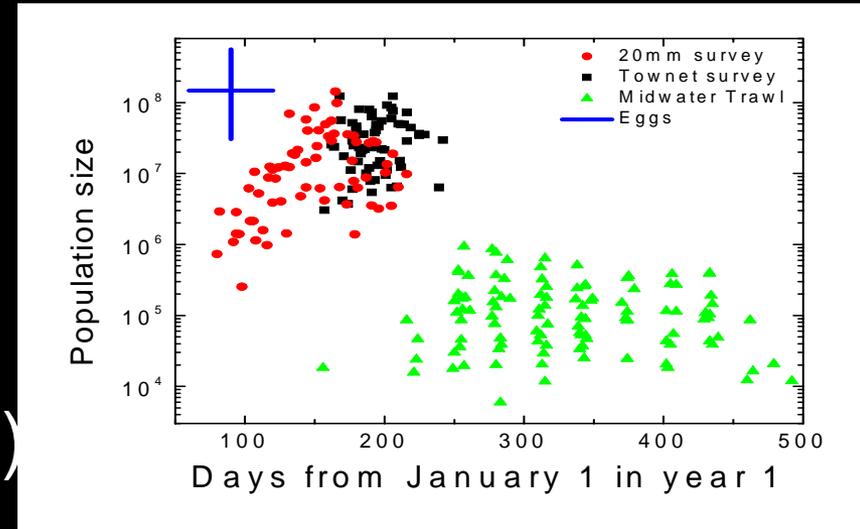
- Used to assess short-term relative effects of management actions.
- Could be used to better understand ZOI, physical changes and their effects on direct and indirect mortality.
- PTM is an overlay model to a hydro. Model that tracks the distribution and fate of particles ( $\pm$  behavior).
- Underlying assumption is that water movement is the dominant force controlling the distribution of young delta smelt.



# Research for Population Models

## Focus is on vital rates

- Develop and refine abundance estimates (Kimmerer; Bennett)
- Age, growth and condition surveys (Bennett and DFG)
- Basic biology from culture/lab. studies (Bridges and Lindberg; Cech, et al.)
- Interactions between Delta hydraulics and fish distribution. (Nobriga et al., Smith et al.)



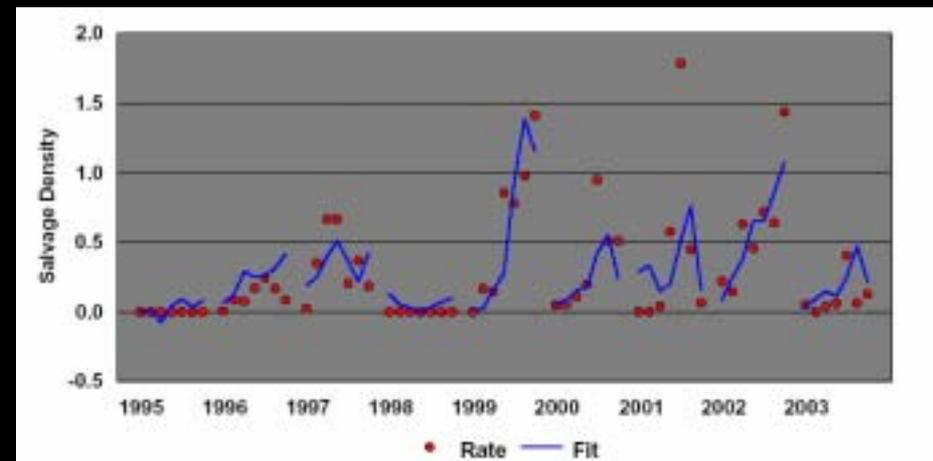
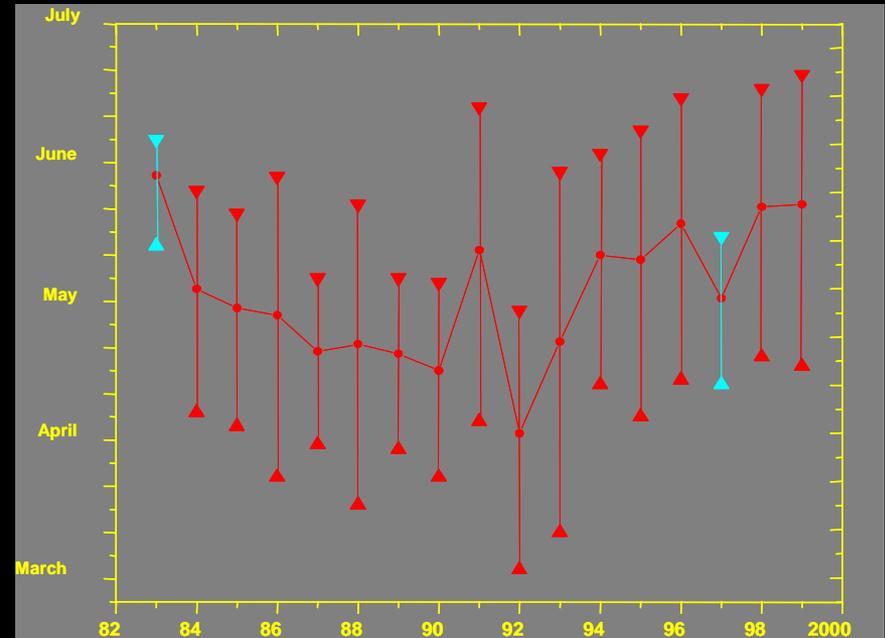
# Connections between Operations and Population Models

- Vital rate: Direct and indirect mortality.
- Methods of Operation: Affects of water movement on fish distribution.
- Timing of operations: Affects of water temp. on reproduction, growth, and distribution.



# More on Water Temperature

- Water temperature affects vital functions (e.g., reproduction and growth).
- Water temperature also appears important to movement and salvage
- Water temperature is easily monitored and a potential indicator in operations planning.



# Summary

- Population model efforts have started. They are complimentary. Probably 2-3 years to completion. Best applied over long-term.
- Delta smelt decision tree and PTM are the “models” used to assess short-term effects.
- Research underway and proposed will inform/improve all models
- Link between models and operations is through vital rates (mortality) and environmental conditions.