A Potential Entrainment Index for Delta Smelt

1/26/10

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Presentation Overview

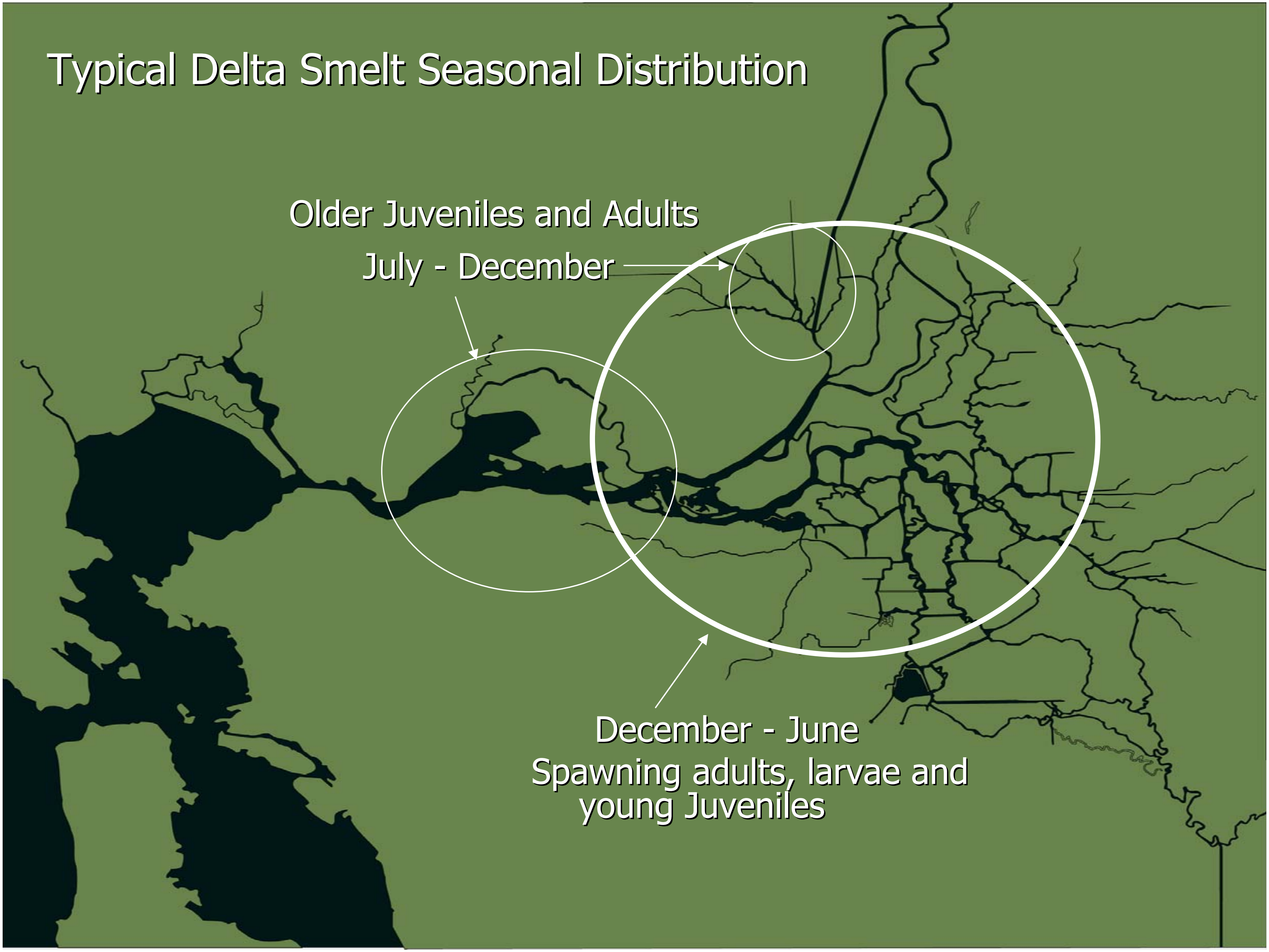
- Delta smelt susceptibility to entrainment
- Need for better tools
- Overview of the Potential Entrainment Index (PEI)
- Developing PEI methodology
- Example applications
- Conclusions

Why PEI?

- Uses full distribution of Delta smelt
- Relates entrainment risk to real-time distribution rather than one area of habitat
- Flexible
  - Operations
  - Using different models
- Can be implemented within the current BiOp

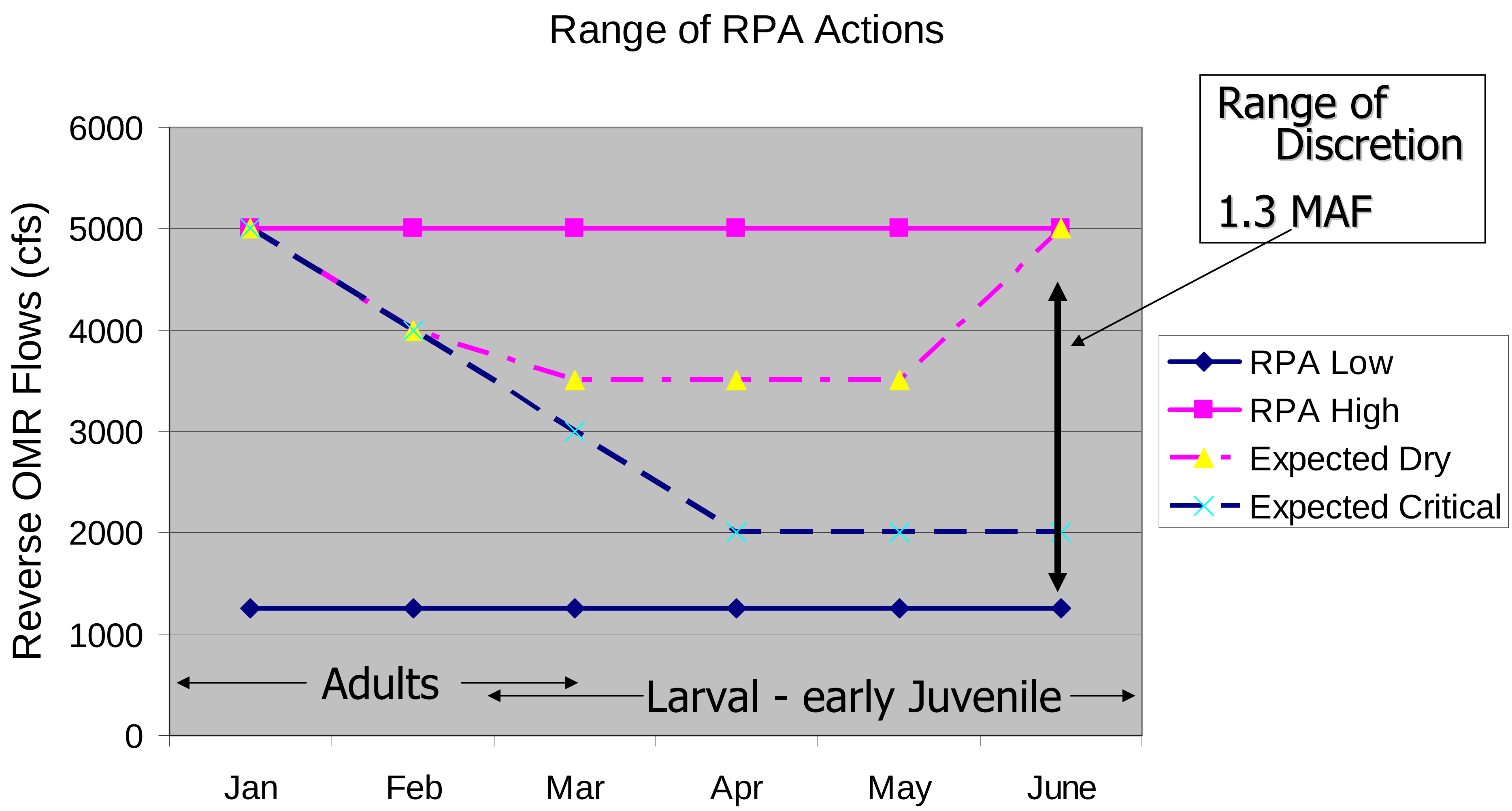
Introduction

- Susceptibility to SWP/CVP entrainment a function of
  - Smelt distribution at different life stages
  - Old and Middle River (OMR) flows
- Delta smelt spawning primarily occurs from mid-February through April.



Typical Delta Smelt Seasonal Distribution
Older Juveniles and Adults
July - December
December - June
Spawning adults, larvae and young Juveniles

ESA RPAs to address Delta Smelt Take (Entrainment)



Entrainment vs. Abundance

Relationship between entrainment and abundance of delta smelt difficult to evaluate

- Manly and Chotkowski (2006)
  - OMR flow only weakly associated with the long-term variability of adults (a few percent)

- Kimmerer (2008)
  - entrainment effects unclear
  - summer to fall survival variability high (50 fold change)
  - likely food availability

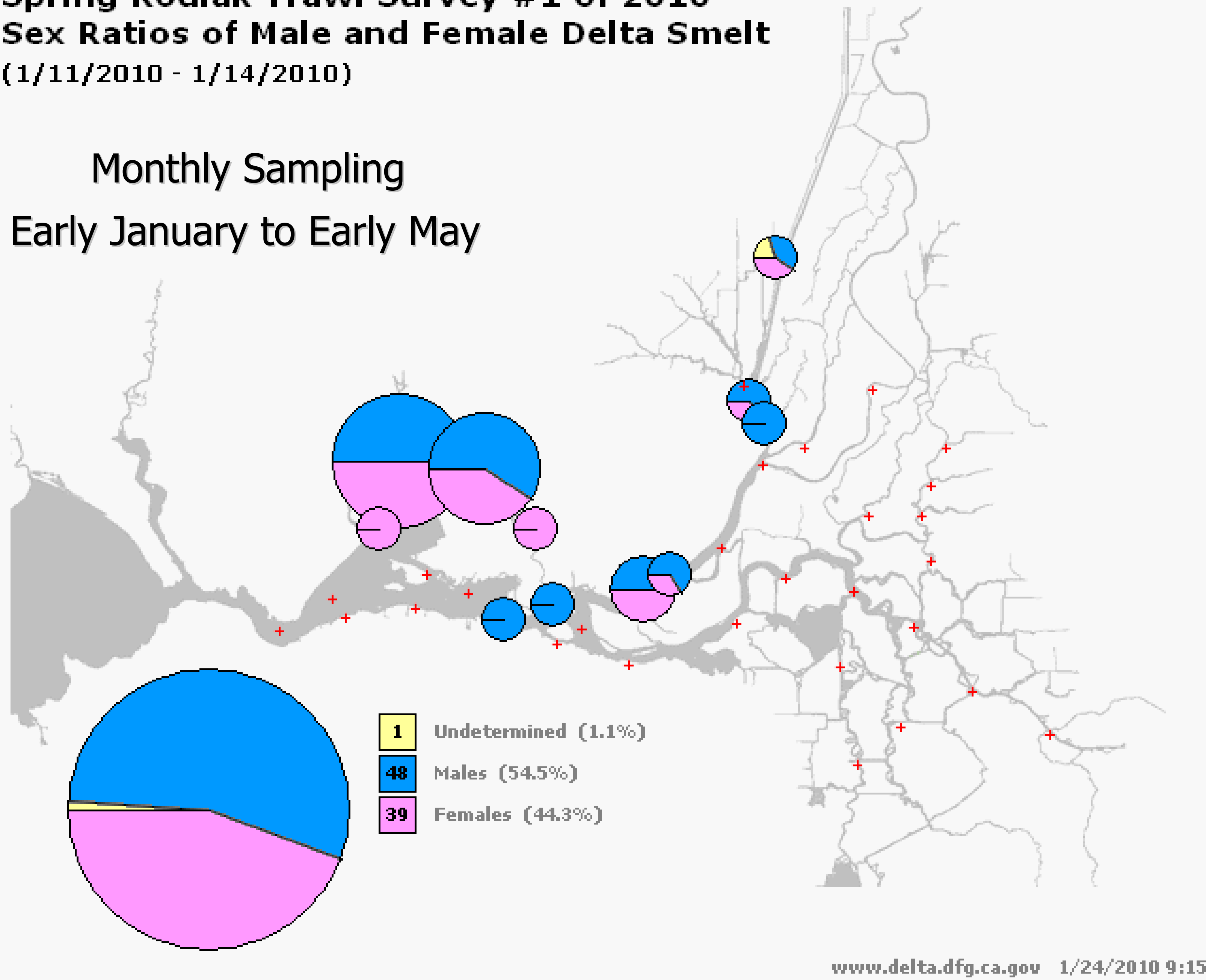
Better Tools Needed

- Adult salvage
  - Shorter time step assessment (month v. season)
- Larval/juvenile salvage
  - Utilize real-time distribution data
  - Reproducible, objective method

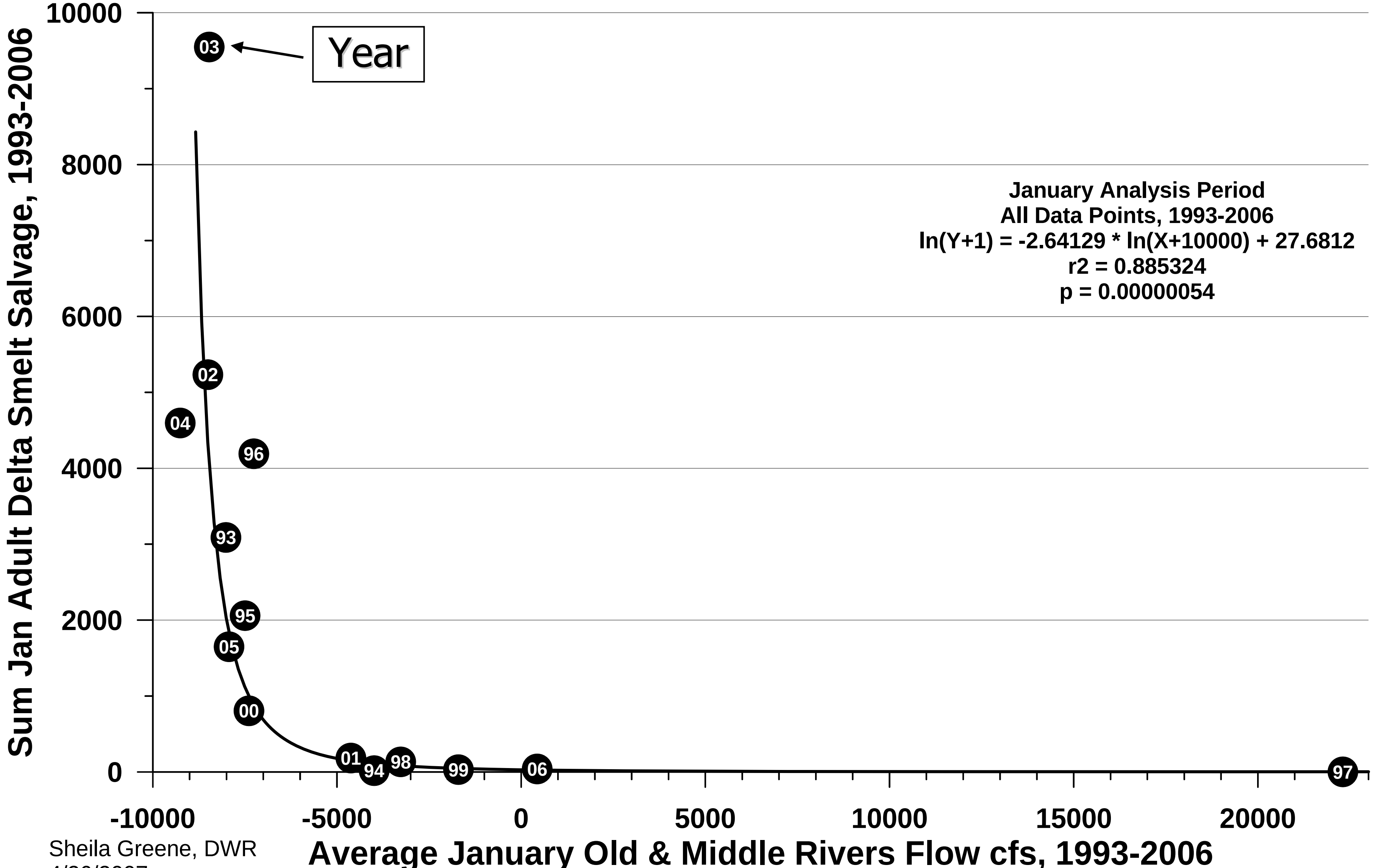
Spring Kodiak Trawl Survey #1 of 2010
Sex Ratios of Male and Female Delta Smelt
(1/11/2010 - 1/14/2010)

Monthly Sampling

Early January to Early May



Delta Smelt Adult Salvage as a Function of OMR Flows - January



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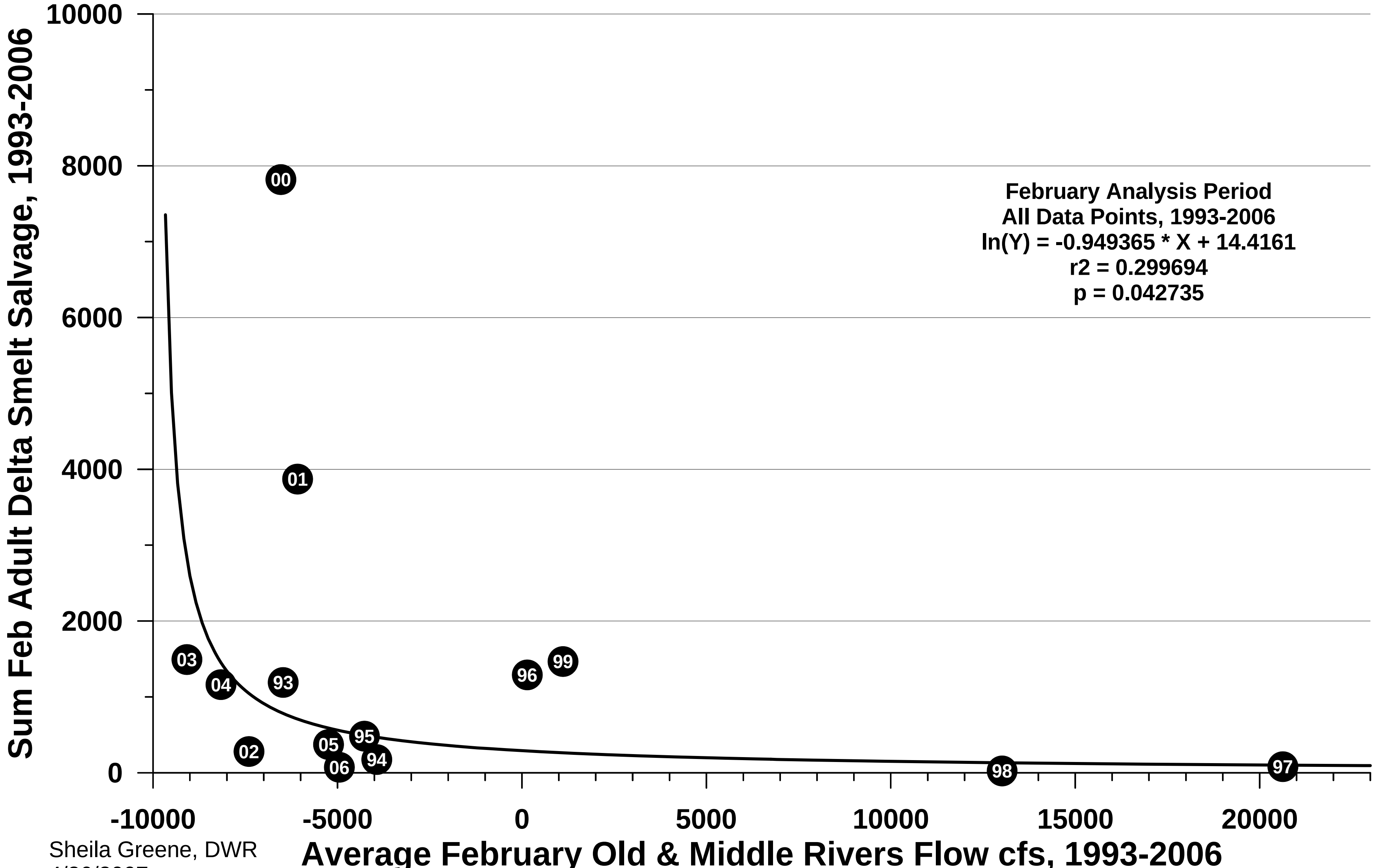
Delta Smelt Adult Salvage as a Function of OMR Flows - February



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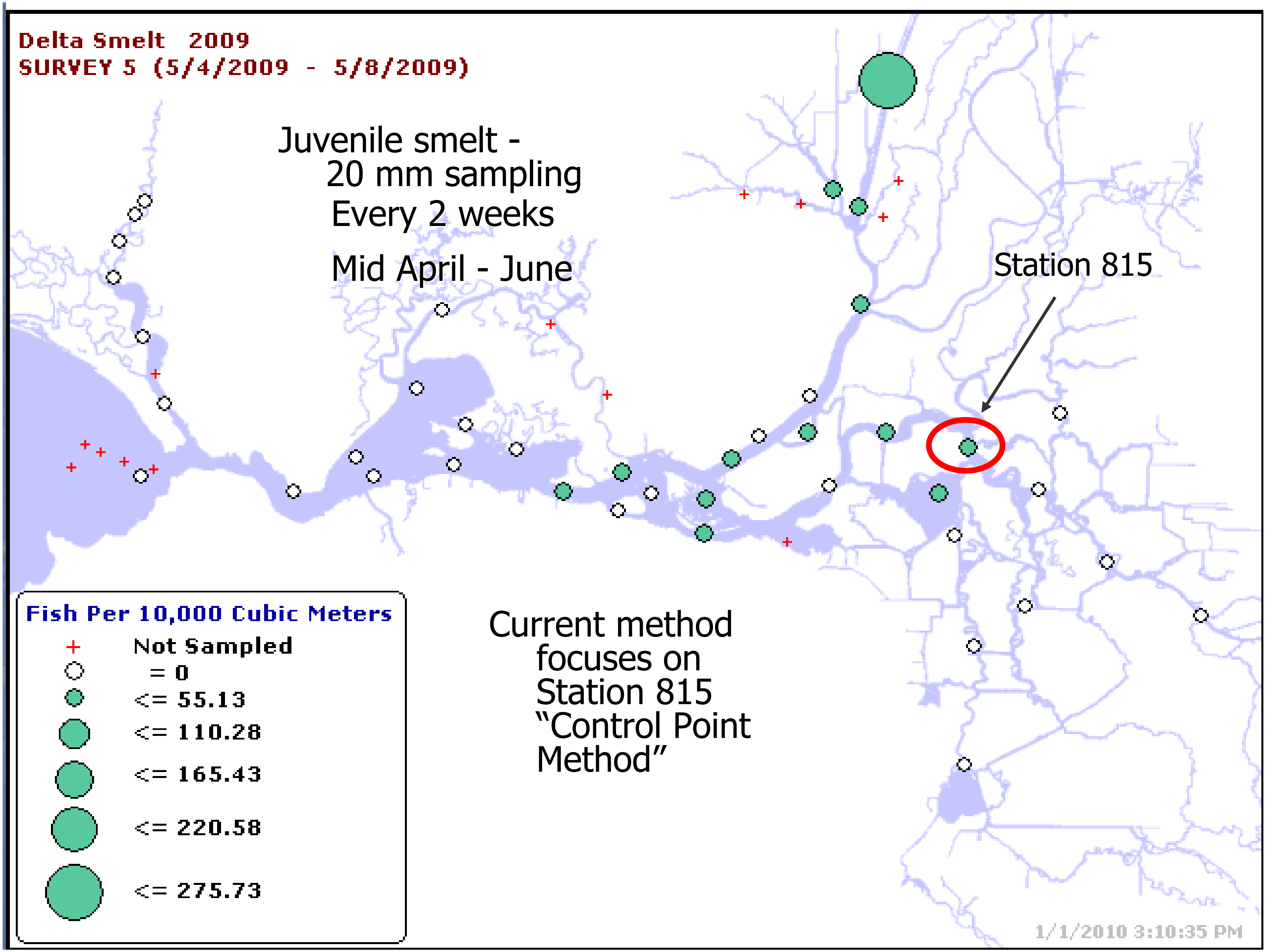
  - PEI


Delta Smelt 2009
SURVEY 5 (5/4/2009 - 5/8/2009)
Juvenile smelt - 20 mm sampling Every 2 weeks
Mid April - June
Station 815
Fish Per 10,000 Cubic Meters
Not Sampled
= 0
<= 55.13
<= 110.28
<= 165.43
<= 220.58
<= 275.73
Current method focuses on Station 815 “Control Point Method”
1/1/2010 3:10:35 PM

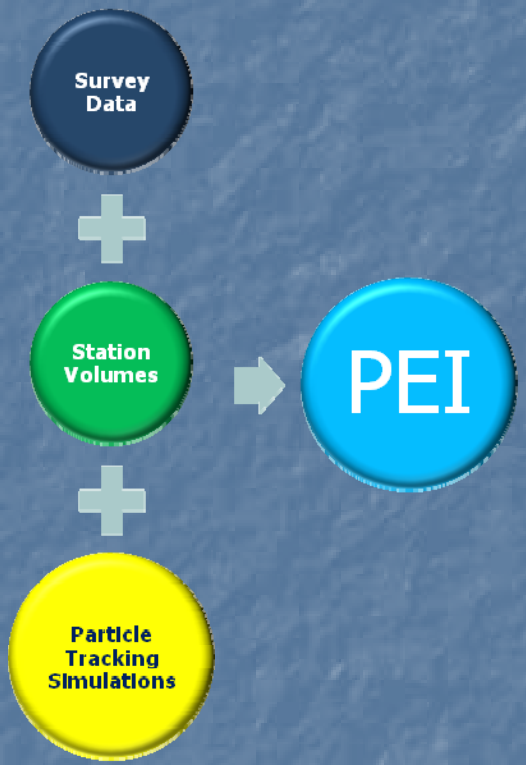
PEI Methodology

- Evaluates relative susceptibility of larval and juvenile delta smelt to entrainment by SWP/CVP
- Useful for near-term and annual goals
- Allows predictions of salvage in advance
- Different PEI tools currently available depending on need

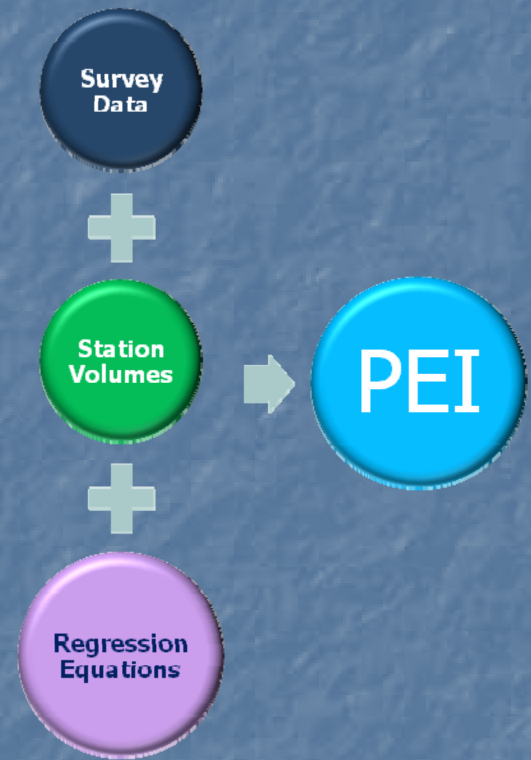
Different PEI Tools

- Delta Simulation Model 2-Particle Tracking Model (DSM2-PTM)
- PEI Calculator (regression based)
- Other PTM models (UNTRIM, RMA,…)

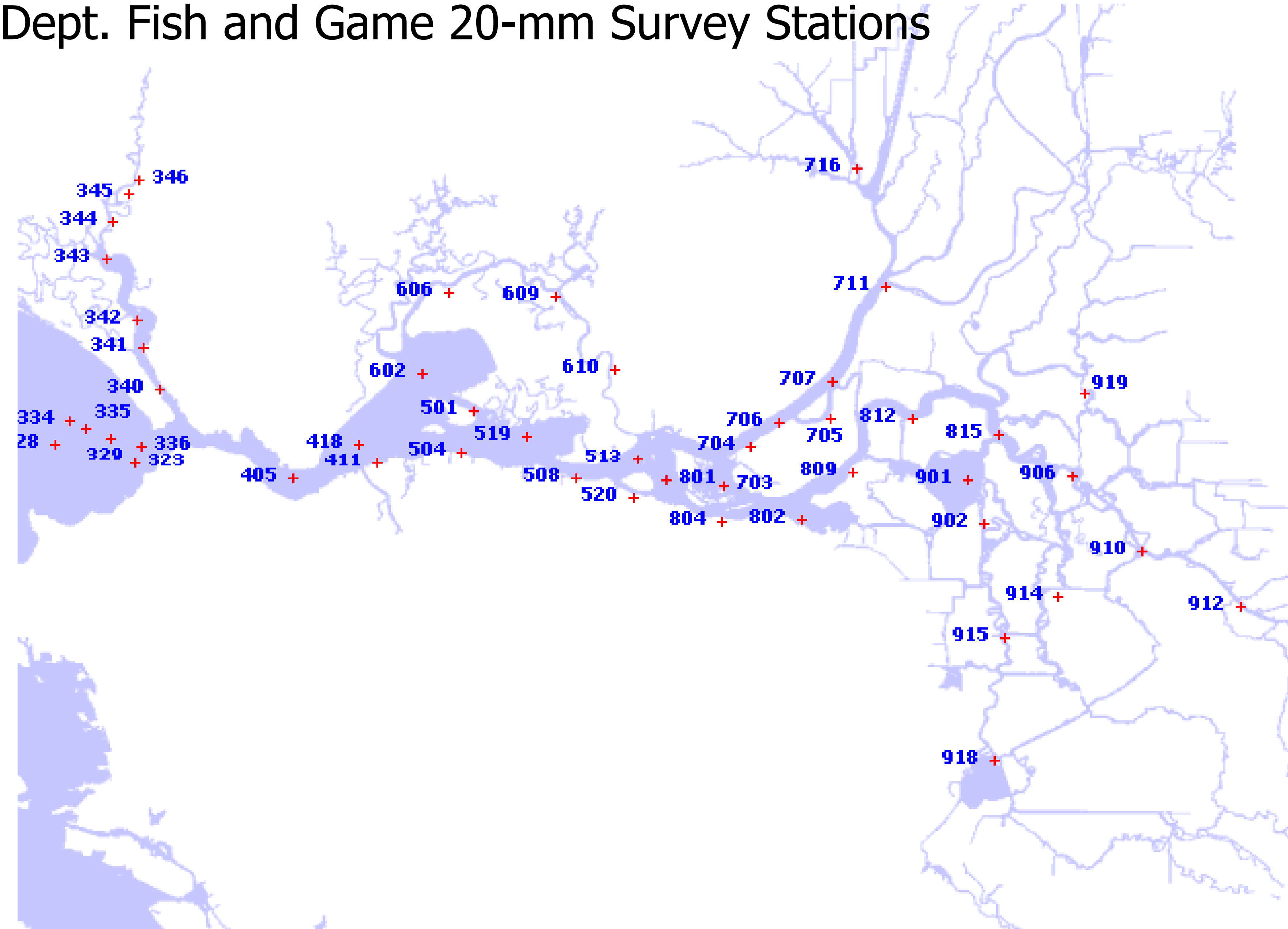
DSM2-PTM PEI



PEI Calculator

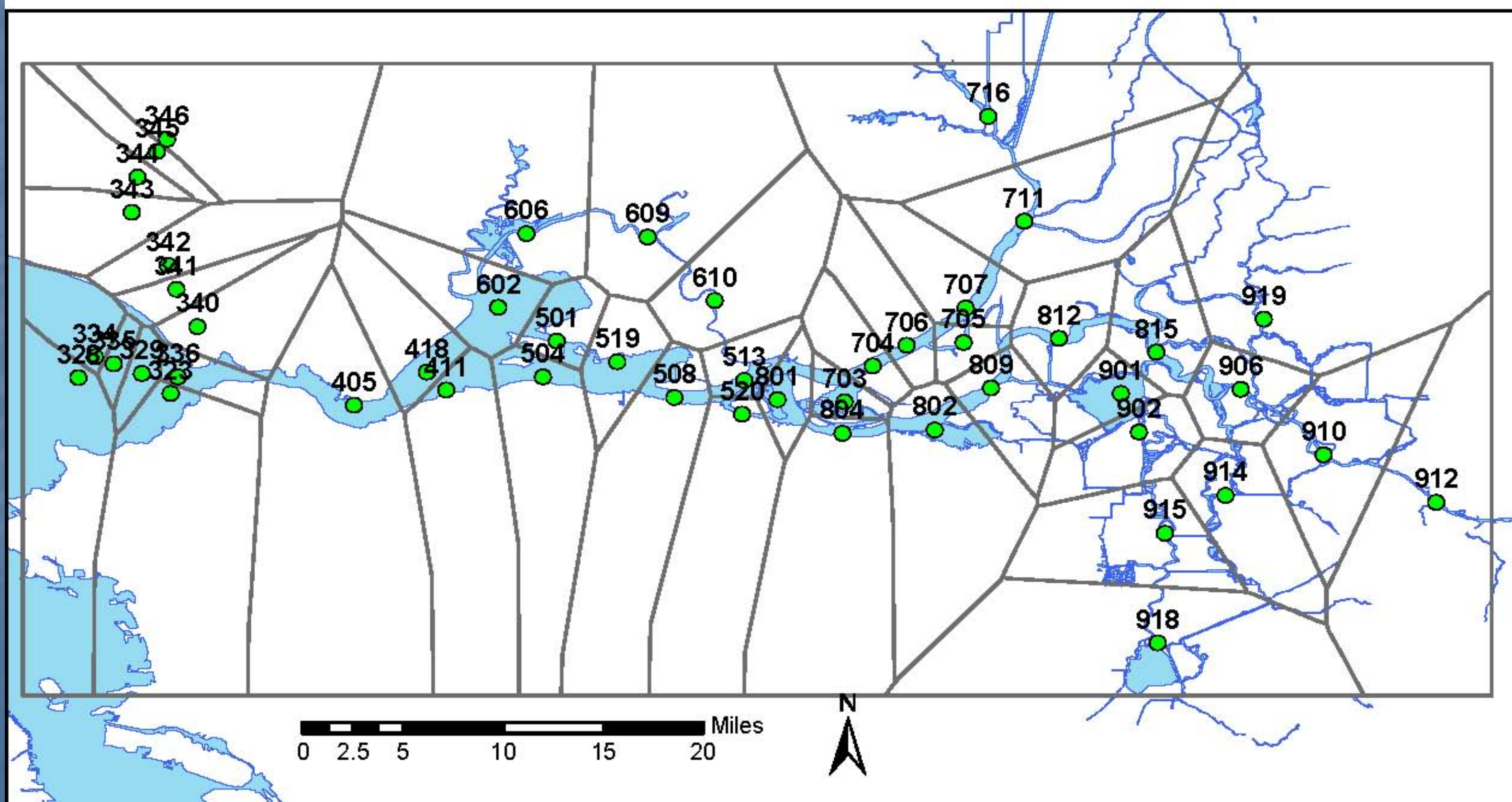


Dept. Fish and Game 20-mm Survey Stations



Water Volume for 20-mm Stations

- Tessellation (Voronoi diagrams) with adjustment
  - Typical Tow 900 m^3 X 3 = 2,700 m^3
  - Typical Delta Volume per cell ~ 40 Million m^3



PEI Methodology Process (DSM2-PTM)

- Multiply station volumes by density of fish
- Run PTM with particles inserted at each survey station
- Determine percent of particles entrained by CVP/SWP for each station
- Determine PEI
  - PEI = Sum of the relative entrainment percentages for each station divided by the total abundance

PTM Animations

Developing PEI Methodology (DSM2-PTM)

$$PEI = \sum_{i=1}^{N} (PP_i \times RA_i)$$

- PP_i : Percentage of particles from stations i to exports
- RA_i: Relative abundance of particles at station i
- N: Total number of stations

$$RA_i = (P_i \times V_i) / \sum_{i=1}^{N} (P_i \times V_i)$$

- P_i : Number of particles at station i
- V_i : Water volume of station i
- N: Number of stations

PEI Methodology
PEI Calculator (Regression model)

- Regression-based model builds on DSM2-PTM historical simulations
- Evaluates relationships between hydrodynamic conditions and particle entrainment for individual 20-mm Stations
- Provides a rapid method for calculating PEI

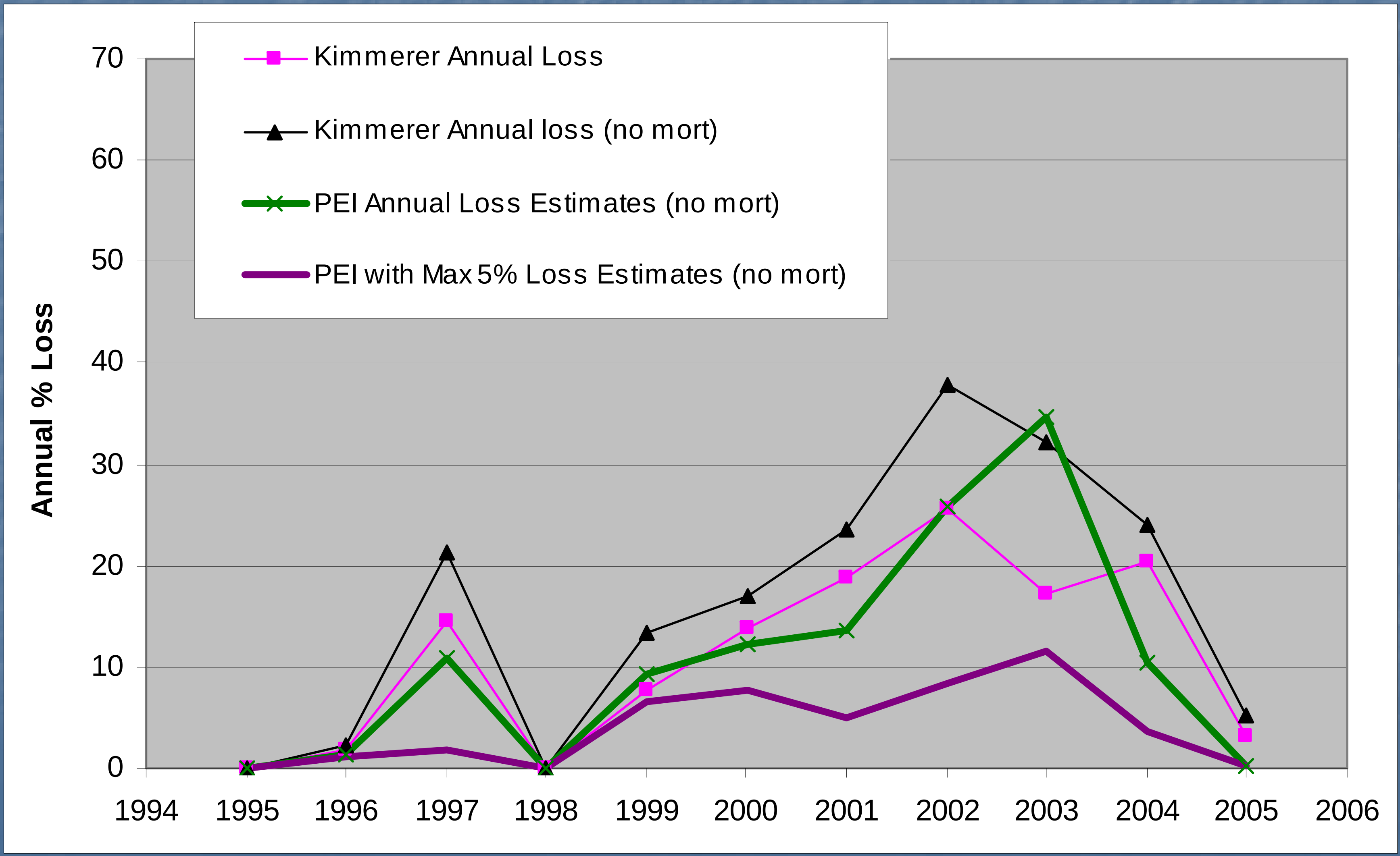
PEI Applications using PEI Calculator

- Estimating annual PEI
- Estimating annual loss (PEI v. Kimmerer, 2008)
- Comparing historical PEI, example target PEI and water supply impacts
- Seasonal real-time application
- Predicting juvenile salvage

Developing an Annual PEI

- 20-mm sampling
  - Sampling every two weeks mid March -June
  - Data available the week following the sample run
  - Typically 7 sample runs
- Annual PEI ≈ sum of 7 sampling PEI targets
  - Discounted for lower population effect
    - Like reverse compound interest
  - Constant rate of recruitment
  - No adjustments for natural mortality
  - Remember this is an index

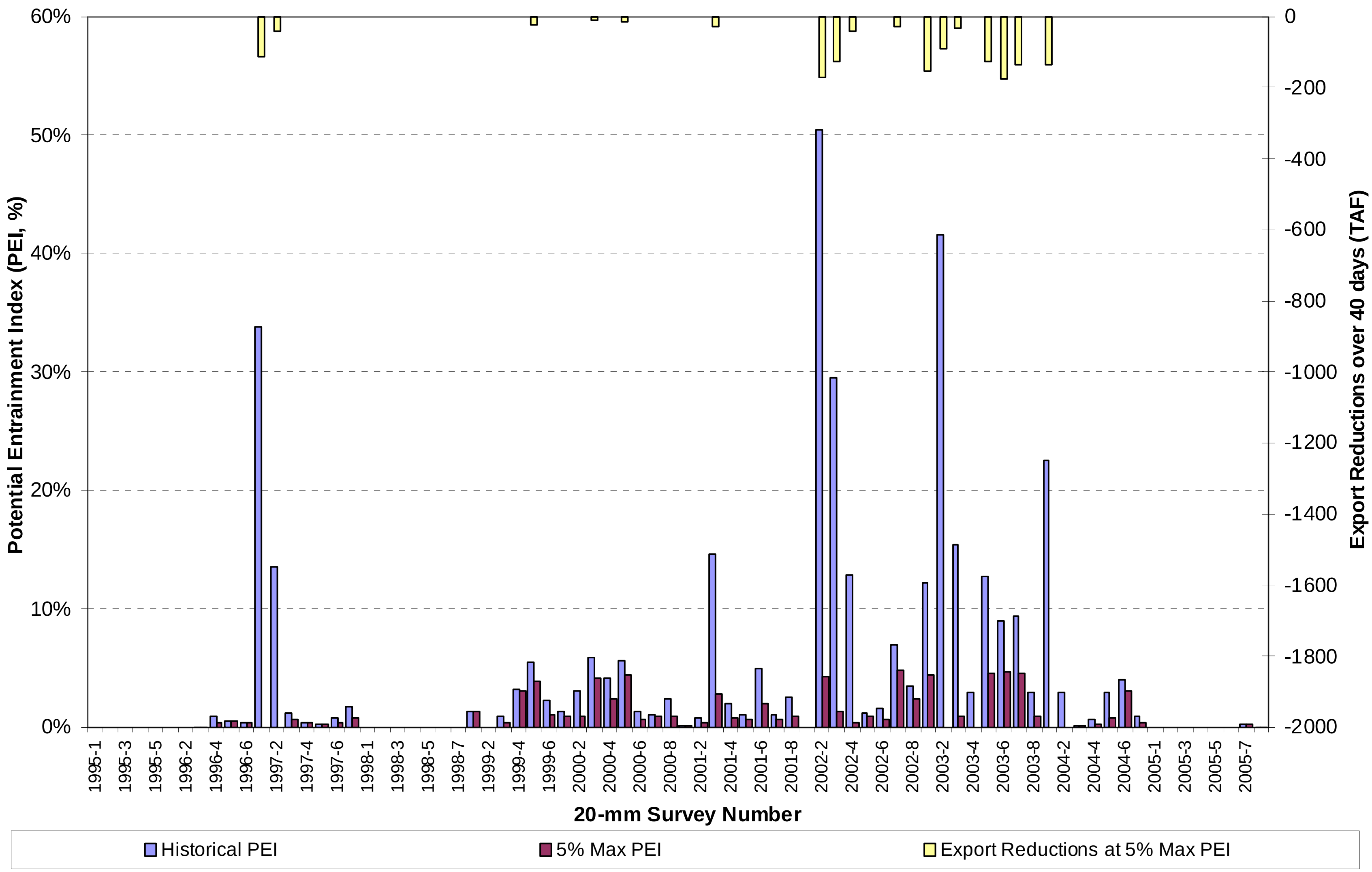
Evaluating Annual Loss Estimates



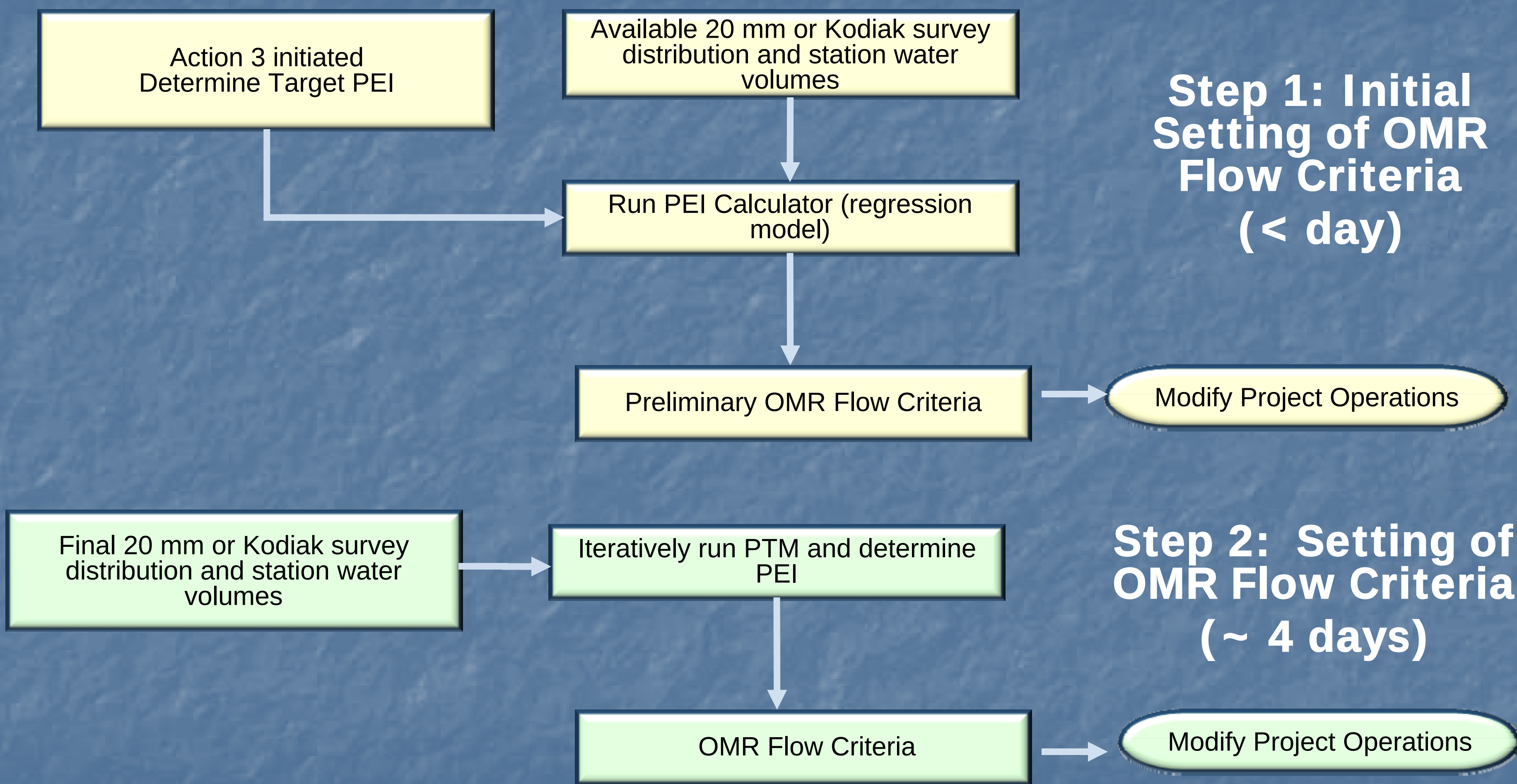
Evaluating Annual Loss Estimates

- Kimmerer (2008) –
  - effect of entrainment losses on the population abundance was unclear and obscured by subsequent 50-fold variability in the survival of delta smelt from summer to fall, possibly due to substantial variations in summer zooplankton abundance.
- Fall 2002 to Fall 2003
  - Adult salvage in 2003 high – 38,000 smelt
  - PEI for young smelt over 30%
  - Yet the FMWT in 2003 increased by 1/3 over 2002

Historical PEI, 5% Target PEI and Water Supply Impacts



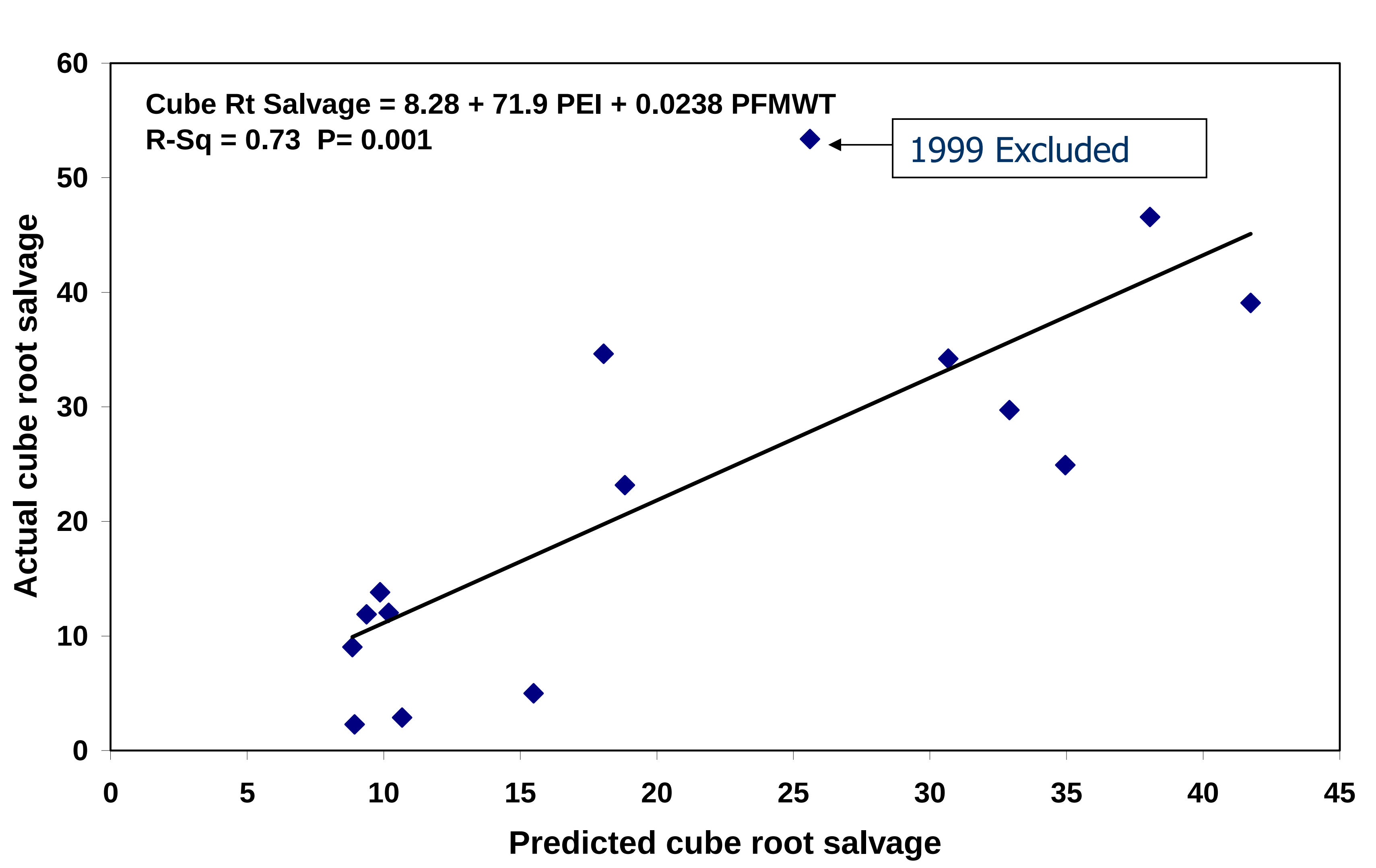
Application to Real-time Operations



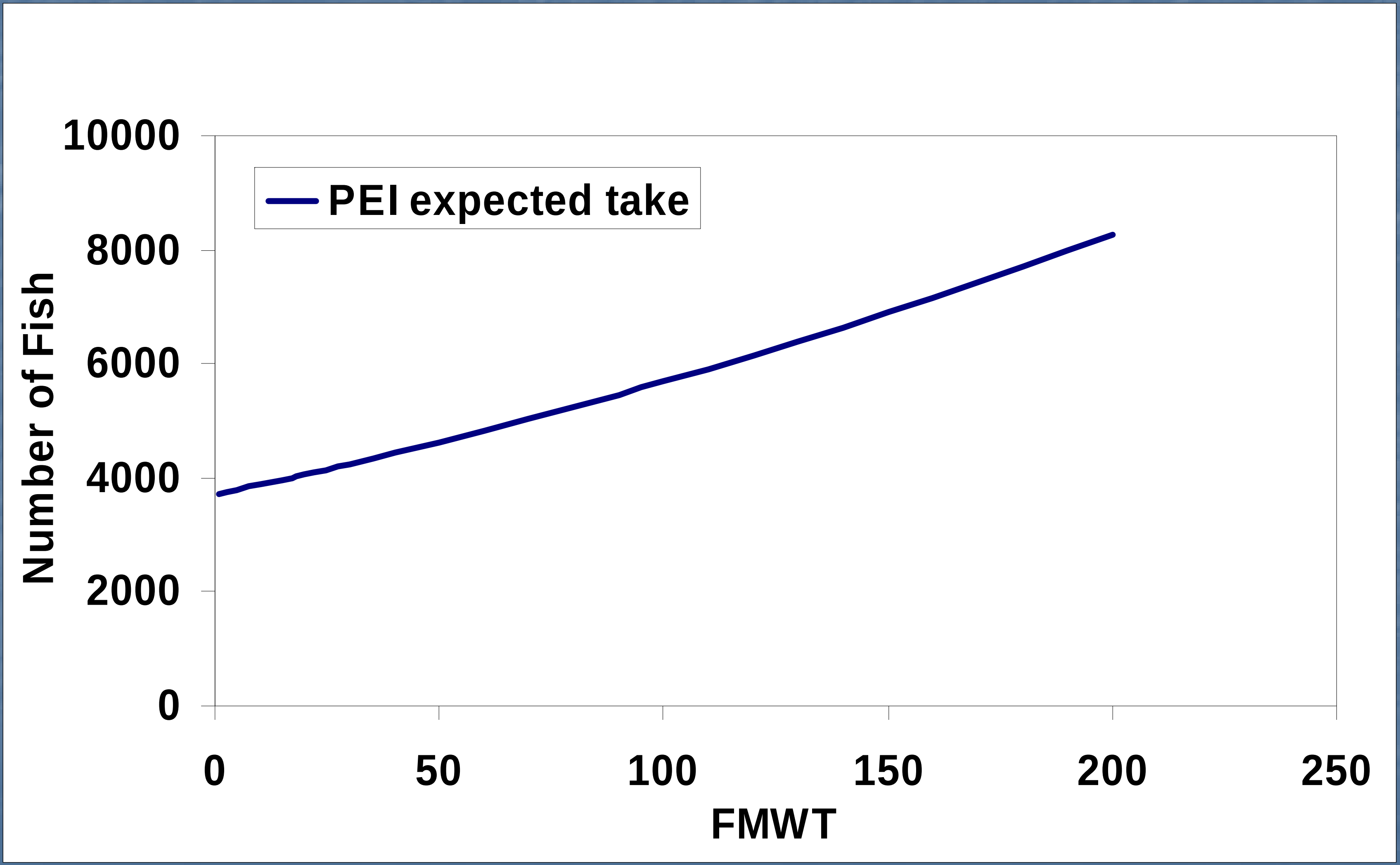
Predicting Juvenile Salvage

- Model uses previous FMWT Index and annual PEI estimates
- Used historical data from 1995 to 2009 (excluding 1999)
- Used multiple regression analysis
- Methodology still undergoing review.

Actual vs. Predicted Juvenile Delta Smelt Salvage



Predicted Juvenile Delta Smelt Salvage at 10% PEI and FMWT Indices (1-200)



Advantages of using PEI

- Uses full distribution in analysis
- Relates entrainment risk to relative abundance
- Flexible
  - Operations
  - Using different models
- PEI approach allowable under the BiOp
- Systematic method for estimating entrainment risk – reproducible - transparent
- Provides rapid results

Concerns/Resolution for Using PEI

- Fish abundance low, affecting distribution data for models - R- more extensive sampling
- Does not incorporate salvage as indication of fish in the south Delta - R- can be added, CPUE different
- 20-mm Survey data not real time - R- 72hrs
- PEI annual or sampling target levels high - R- reasonable targets needed
- Behavior simulation, recruitment and mortality estimates not included in the DSM2-PTM - R- could be added

Conclusions

- PEI is an existing tool that uses full distribution of delta smelt to estimate entrainment risks
- PEI can be implemented within the current BiOp
- Can be improved to address concerns

End

Acknowledgements

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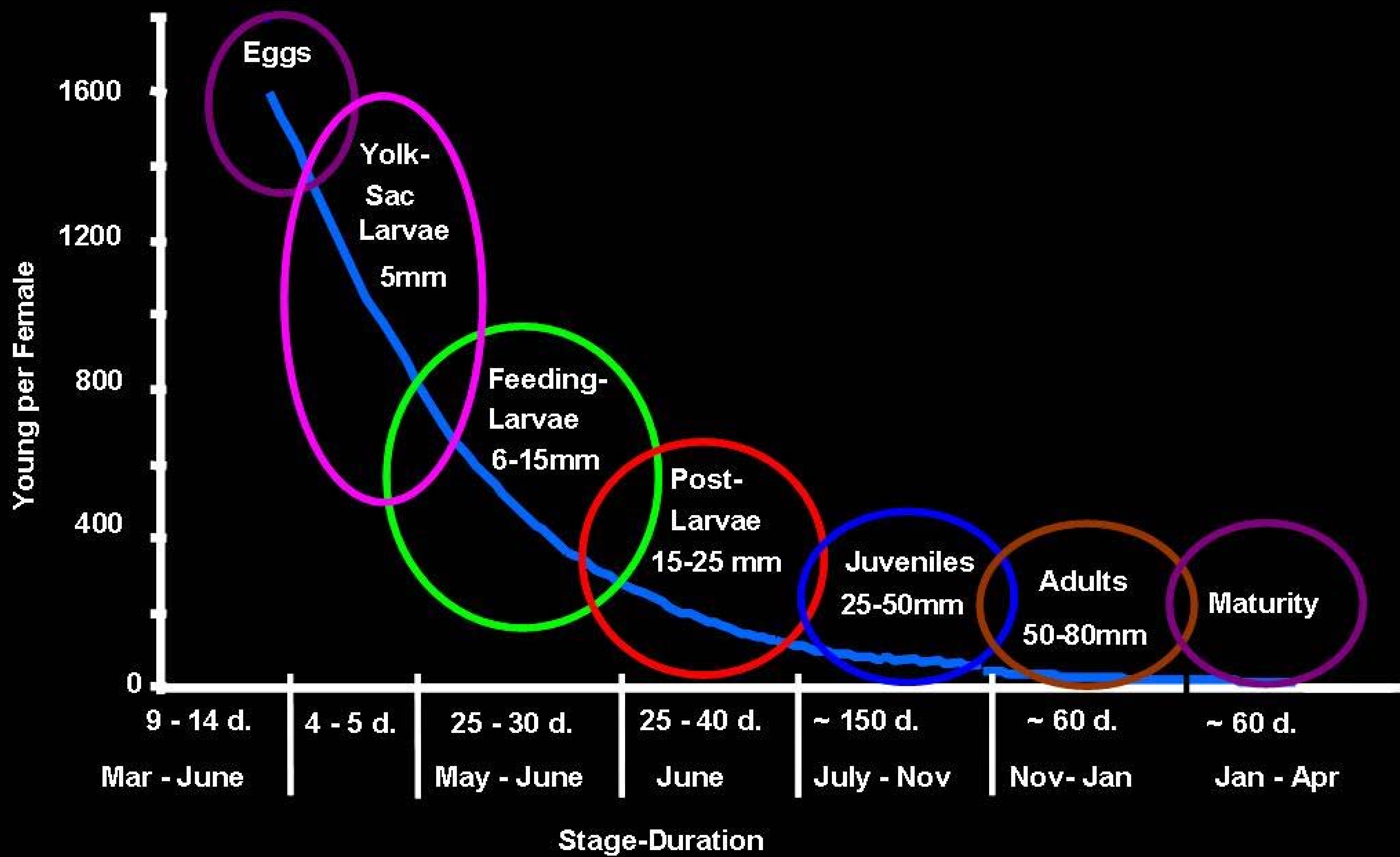

Hobbs et al. Age and Growth Validation for delta smelt, submitted 2004