

Adjustment of the exports using DSM2-PTM and PEI



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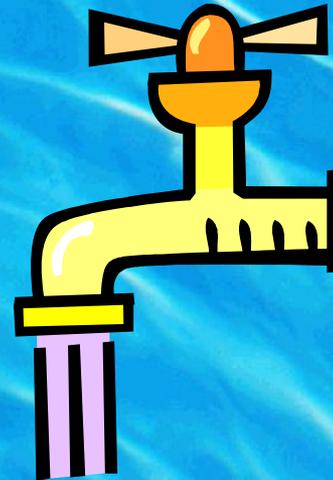
Acknowledgement

- Yiguo Liang (Flood Management, DWR)
- Eli Ateljevich (BDO, DWR)
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- Lan Liang (BDO, DWR)



Dilemma of the Delta

- Increasing water demand
- Dry years
 - Climate change
 - Short water supply
- Environmental Issues
 - Endangered species:
Pelagic Organism Decline
(POD)



Wanger Decision



- Issued on Dec 14, 2007
- Reduce pumping to protect delta smelts
 - Old and Middle River flow criteria
 - **The criteria are not actual fish entrainment.**
- Temporary measures until new Federal Biological Permits are issued

Challenge to Solve



- Instead of reducing the exports to meet flow criteria....
- Maximizing the water export while minimizing possible impact on the Delta.
 - Multi-objective optimization
- Two objectives
 - Minimize entrainment from the Delta
 - Maximize the water export

Potential Entrainment Index – PEI

- Delta-wide estimation of particle entrainment
 - Weighted-average of entrainment
 - The weight is relative abundance of each region.

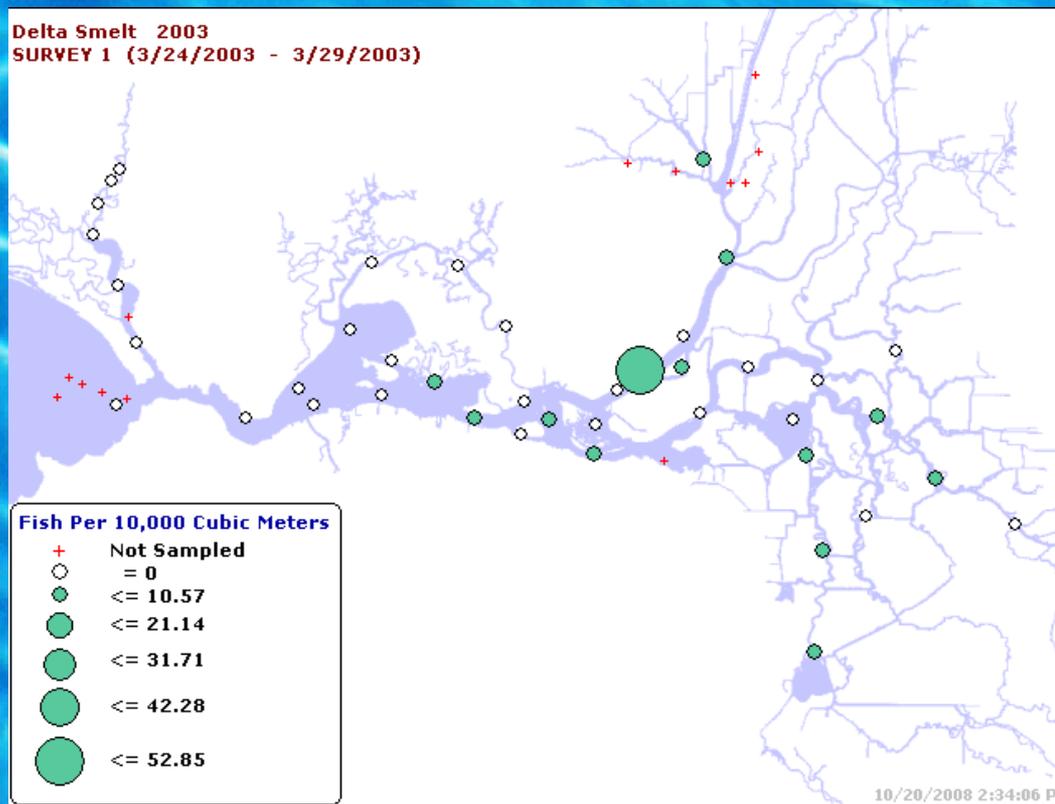
$$\begin{aligned} PEI &= (\text{Entrainment rate from location } i) \\ &\quad \times (\text{Relative Abundance around location } i) \\ &= \sum_{i=1}^N (E_i \times RA_i) \end{aligned}$$

$$\begin{aligned} RA_i &= (\text{Pop. in region } i) / (\text{Pop. in all the regions}) \\ &= (P_i \times V_i) / \sum_{i=1}^N (P_i \times V_i) \end{aligned}$$

- DSM2-PTM can be used.

PEI – Abundance

- Year 2003, late March (1st survey)



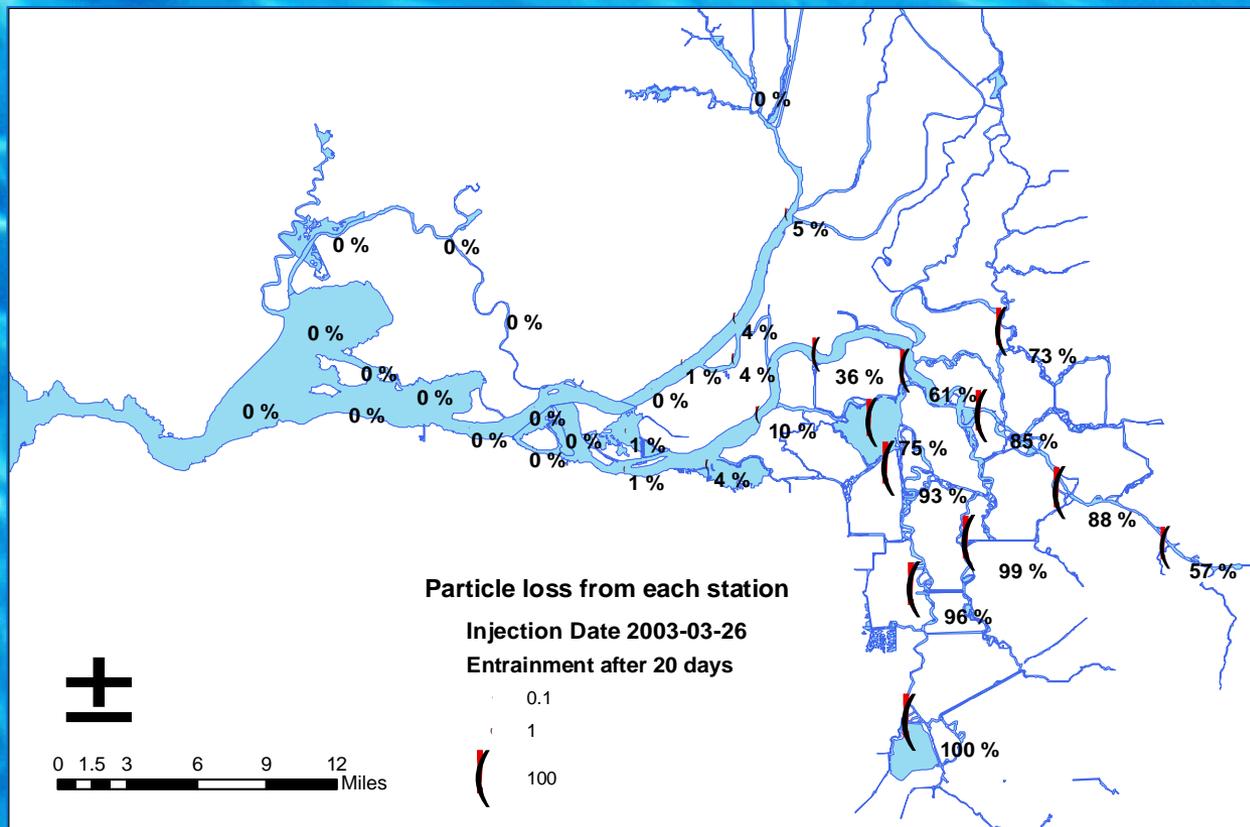
(From DFG website)

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

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

PEI – Entrainment

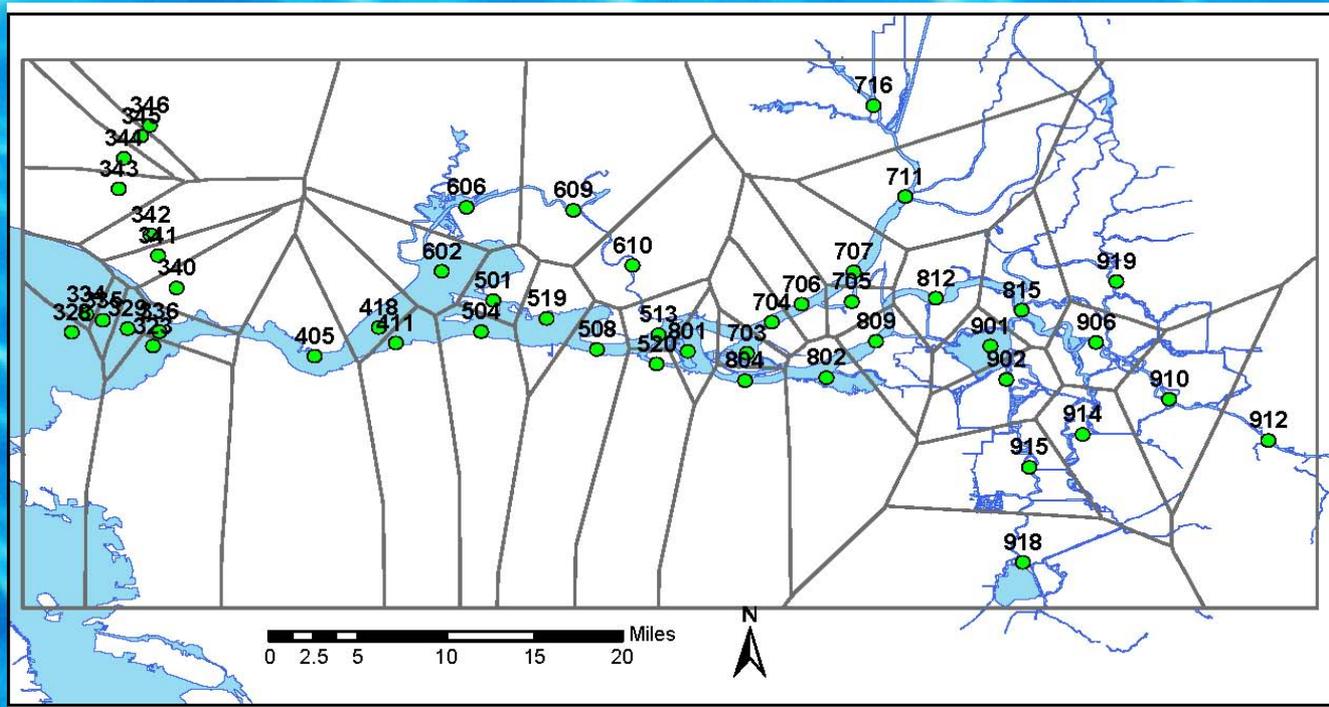
- With historical input, Year 2003, late March



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

Water Volumes

- Tessellation (Voronoi diagrams) with adjustment



Adjusting the Export

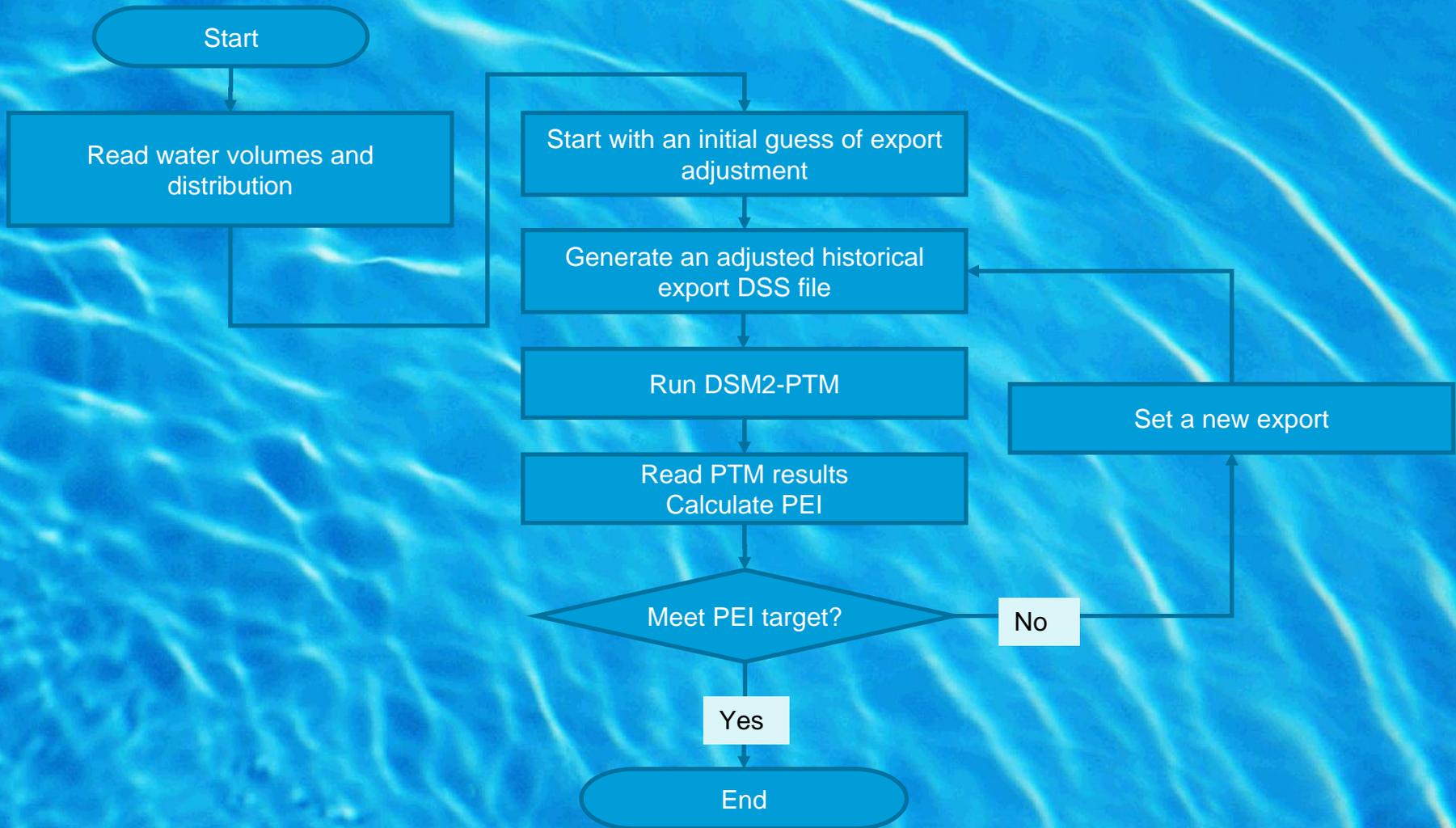


- When a target PEI is given with a hydrology and particle distribution, one can find an amount of the export that meets the PEI.



- An iterative procedure is necessary.

Iteration Procedure

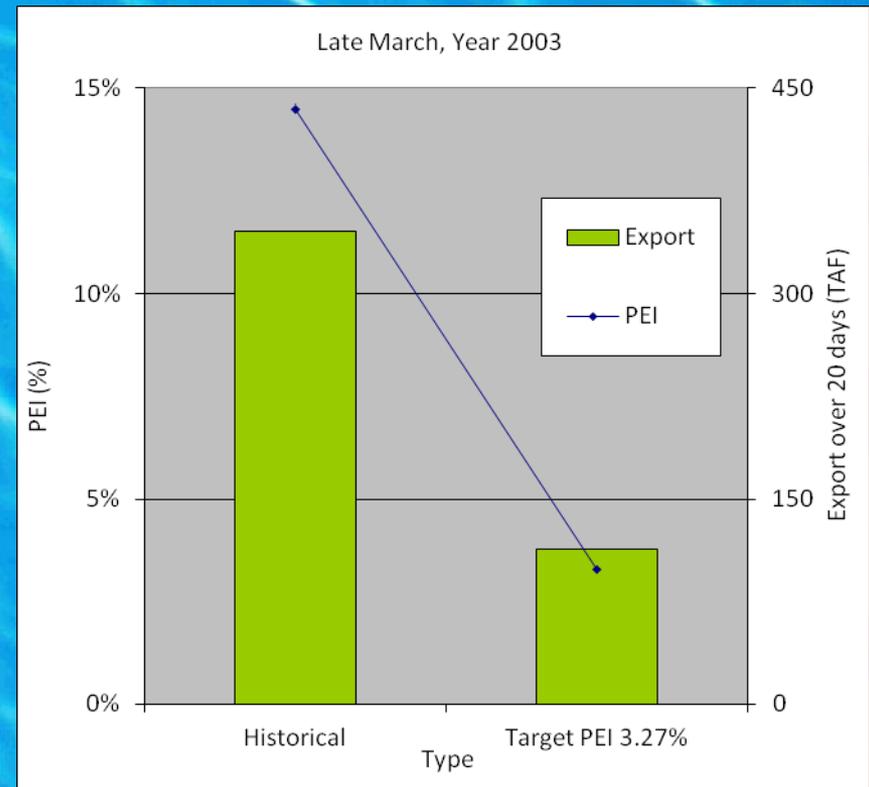


Implementation

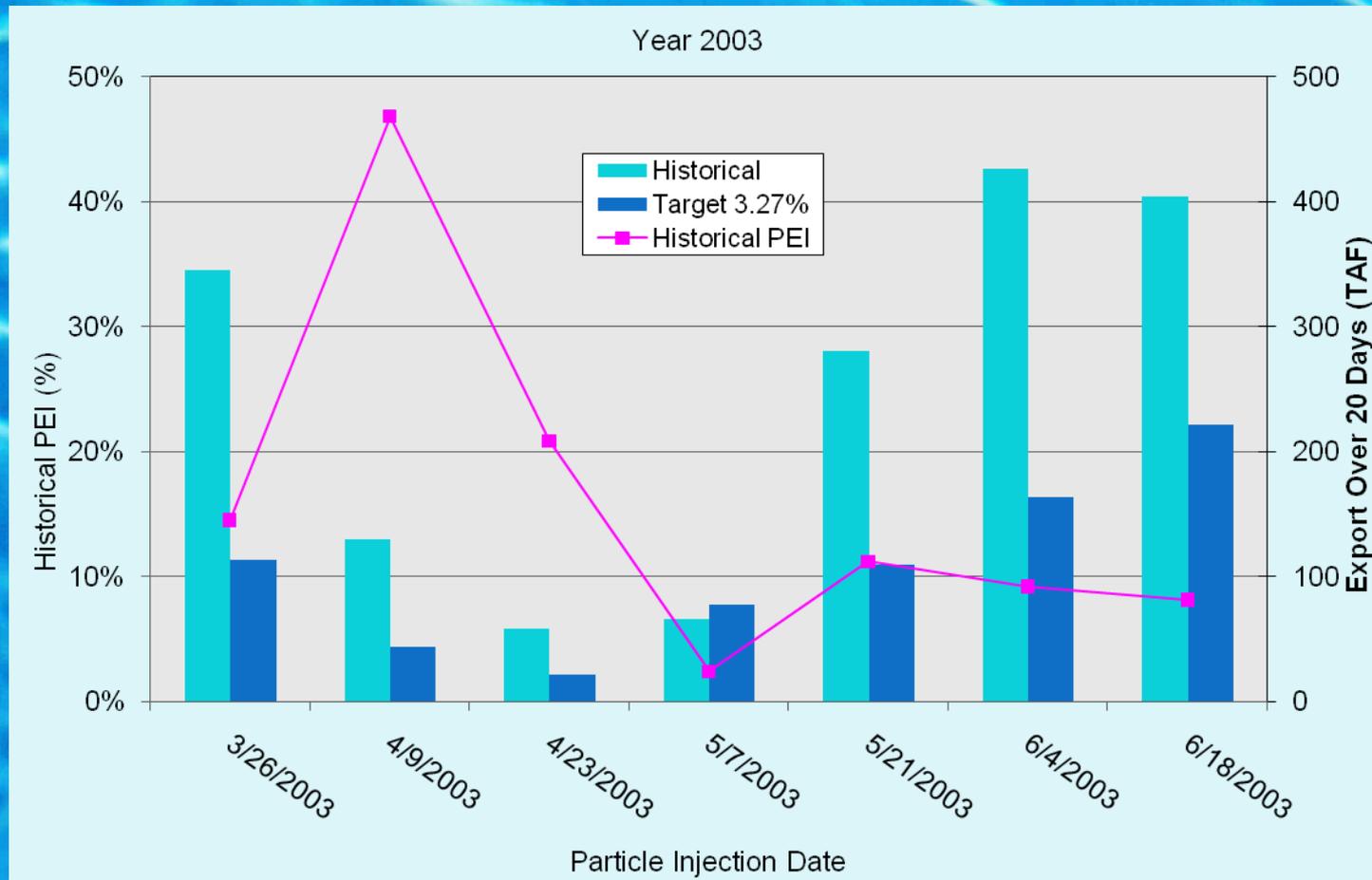
- The procedure requires reading inputs, adjusting the exports, running DSM2-PTM, reading output, and solving the optimization.
 - Uses Python to script DSM2-PTM runs.
 - Vtools manages DSS files (input and output time series of DSM2 and DSM2-PTM)
 - 'Brent algorithm' solves the optimization.

Application Example

- Year 2003, late March
- Target PEI: 3.27% over 20 days
 - Historical PEI: 14.51 %
 - Reduce 67% of historical exports to meet the target PEI
 - 345 TAF to 114 TAF over 20 days



Application – Year 2003



Limitations



- Uncertainties and Errors
 - Fish survey, volume, *etc.*
More often, more thorough surveys, *etc.*
 - DSM2-PTM has (possibly large) errors and uncertainties.
1-D assumptions, junction issue, *etc.*
- PTM simulates particles.
- Iterative procedure may require considerable computational time.

Conclusions

- Combination of PTM and PEI can provide a guideline of the export operations while meeting an Delta-wide entrainment target.
- The impact on the exports by different Delta management strategies such as barriers and reservoir operations can be estimated while maintaining a PEI.
- A target PEI is rather a relative value.
 - Further study can improve the effectiveness of PEI.

Quick Checklist

- Models: DSM2-PTM – 1-D hydrodynamics and particle tracking models
 - 1-D, Simplified Particle Model
- Data: CDEC, DFG fish survey, USGS bathymetry, *etc.*
- Purpose: To estimate the export while protecting fish
- Uncertainties of the method: Possibly high
 - Fish Survey
 - PTM

Questions and Suggestions



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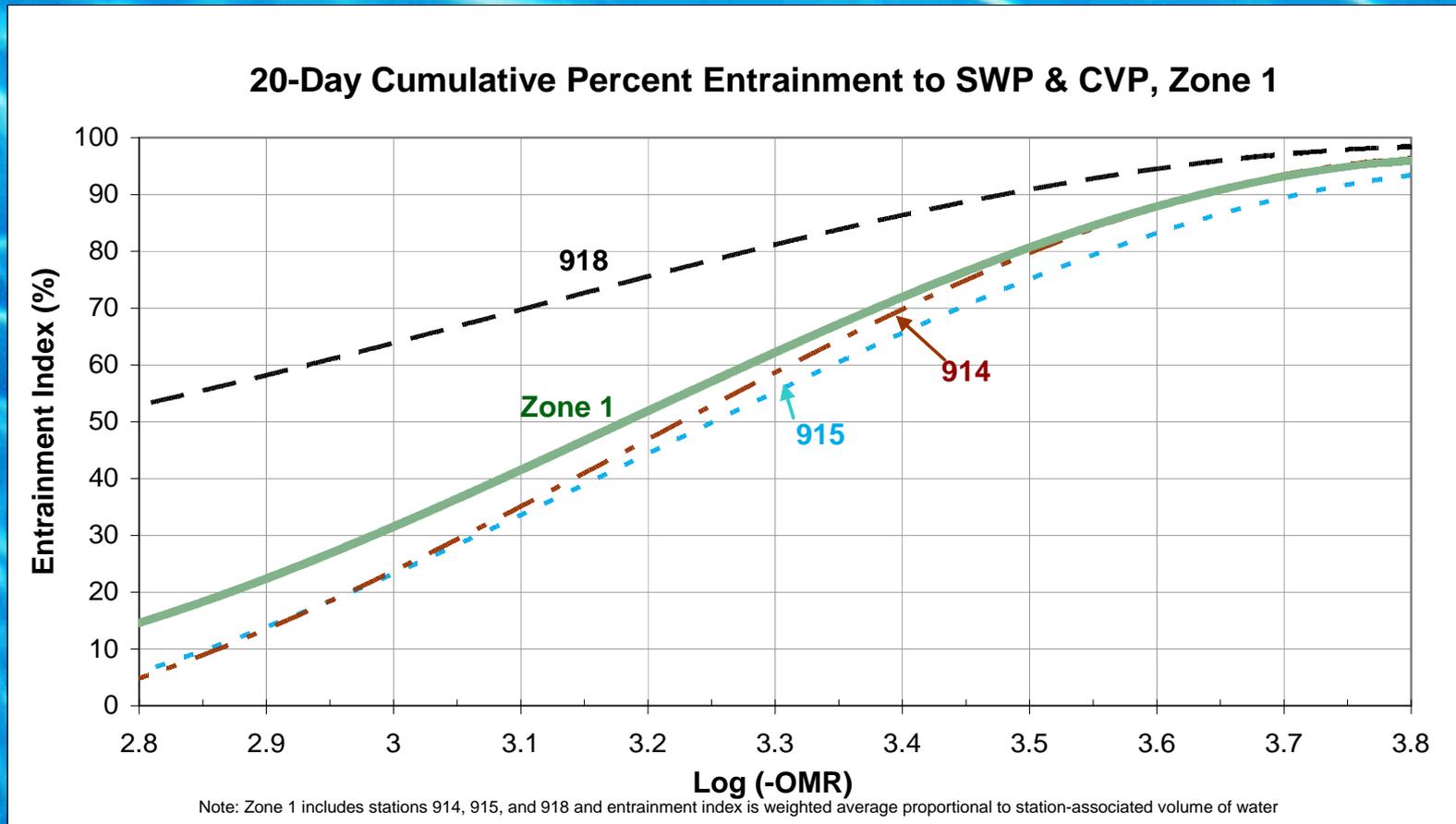
PEI Calculator

- Developed by Yiguo Liang
- Derived regression relationships between entrainment and OMR/QWEST at survey stations.

$$PP_i = f_i(\text{OMR or QWEST})$$

- Fast and easy to use
- Does not consider different hydrodynamics

An Example of EI Regression



(From Yiguo Liang's presentation in 2007)