

# Using the EWA to Protect Delta Smelt: Does the Shoulder-on- VAMP Make a Difference?

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# Questions

1. What is the “combination of physical conditions in the Delta (flows, transport, temperature) that give rise to entrainment events of [young] delta smelt”? *(2002 EWA Review Panel report)*
2. What affect does the “post” shoulder-on-VAMP export curtailment have on young delta smelt?
3. Should the shoulder-on-VAMP implementation occur under an explicit experimental framework?

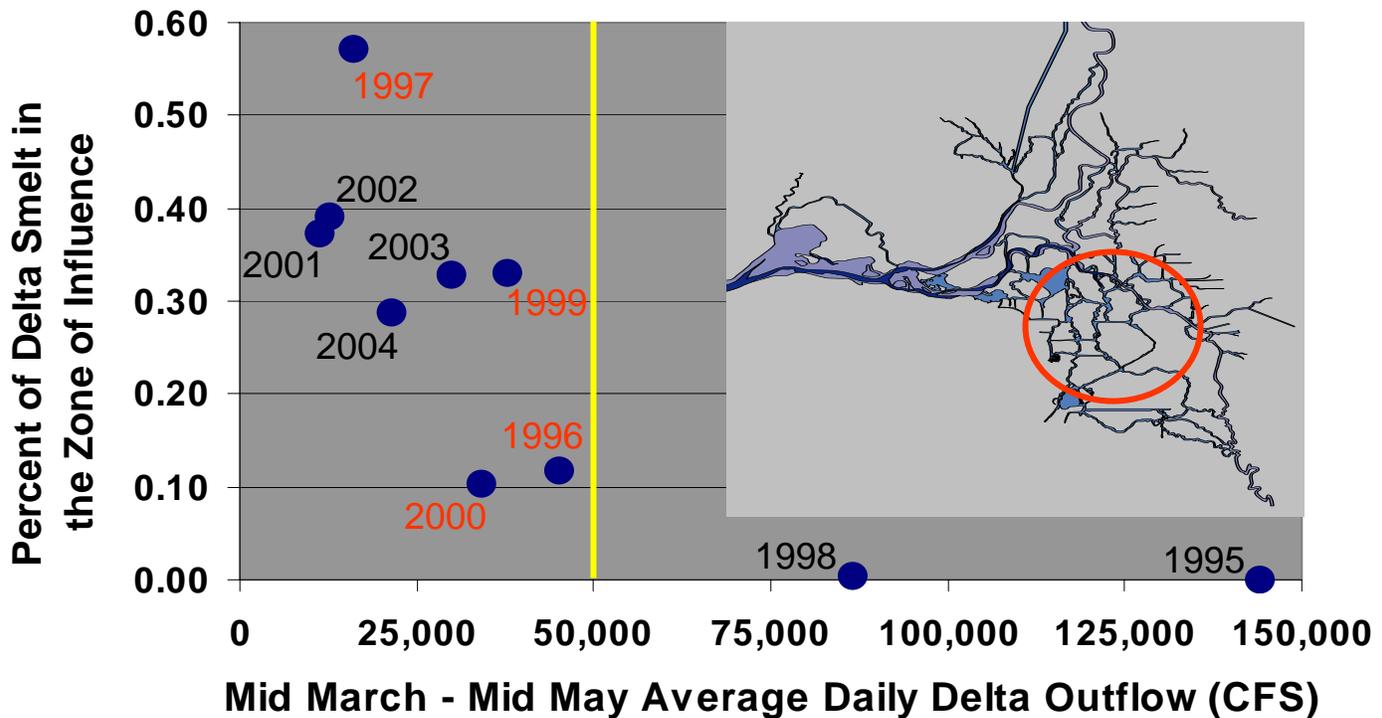
# Conclusions

- SWP salvage often dominates combined salvage and extreme salvage events.
- High SWP salvage events consistently occur during or immediately after a low export period and when water temperature  $\geq 20$  C.
- Water temperatures  $\geq 20$  C motivates delta smelt movement  $\rightarrow$  high salvage.
- Export curtailments at the CVP likely result in direct reductions in delta smelt entrainment.
- Results from shoulder-on-VAMP less clear for the SWP.
- Shoulder-on-VAMP likely reduced SWP entrainment of delta smelt.
- Benefit of SWP curtailment depends on temporal relationship of spawning and Clifton Court diversions.
- Post shoulder less beneficial than pre-shoulder curtailment.

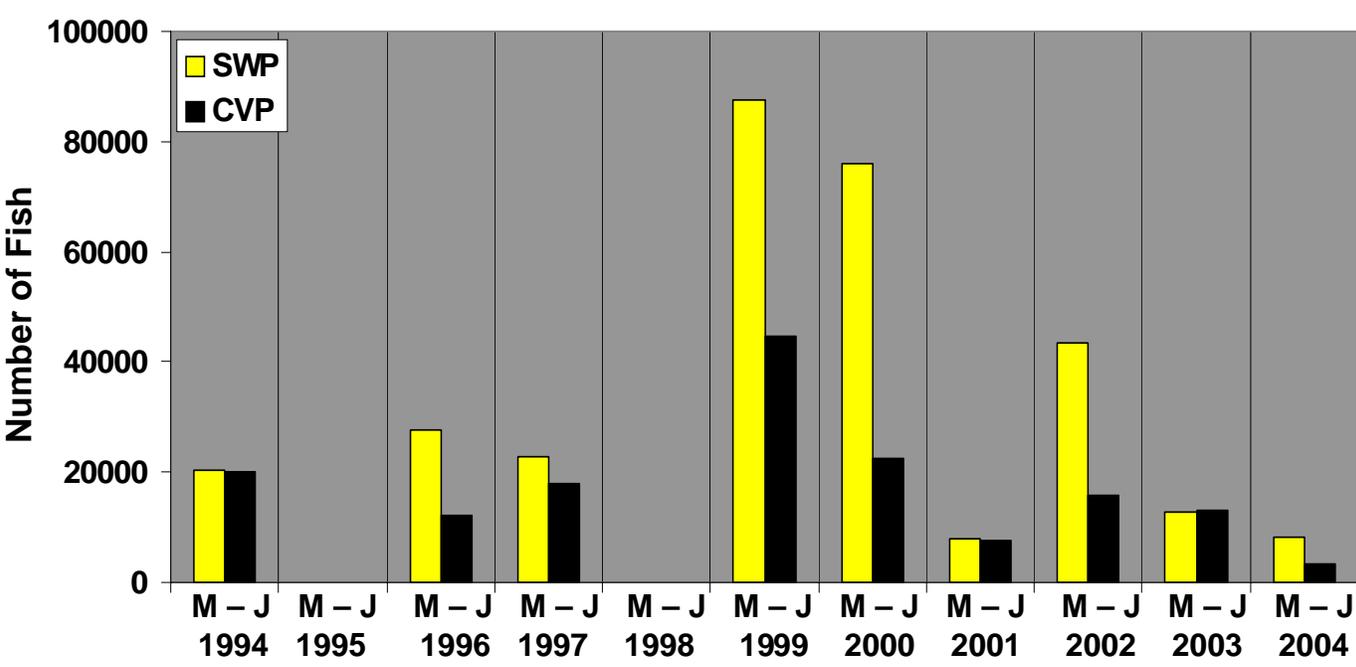
# Monthly combined (SWP+CVP) delta smelt incidental take

| Year     | March | April | May    | June   | July   |
|----------|-------|-------|--------|--------|--------|
| 1995(AN) | 16    | 24    | 0      | 0      | 0      |
| 1996(AN) | 155   | 111   | 30,399 | 9,465  | 148    |
| 1997(AN) | 1,730 | 1,159 | 32,828 | 7,876  | 228    |
| 1998(AN) | 592   | 48    | 4      | 66     | 124    |
| 1999(AN) | 564   | 410   | 58,929 | 73,368 | 19,822 |
| 2000(AN) | 2,746 | 1,746 | 49,401 | 49,124 | 1,513  |
| 2001(BN) | 3,748 | 519   | 13,134 | 2,325  | 6      |
| 2002(BN) | 225   | 372   | 47,361 | 11,926 | 24     |
| 2003(BN) | 483   | 492   | 16,216 | 9,580  | 12     |
| 2004(BN) | 2,267 | 276   | 5,239  | 6,416  | --     |

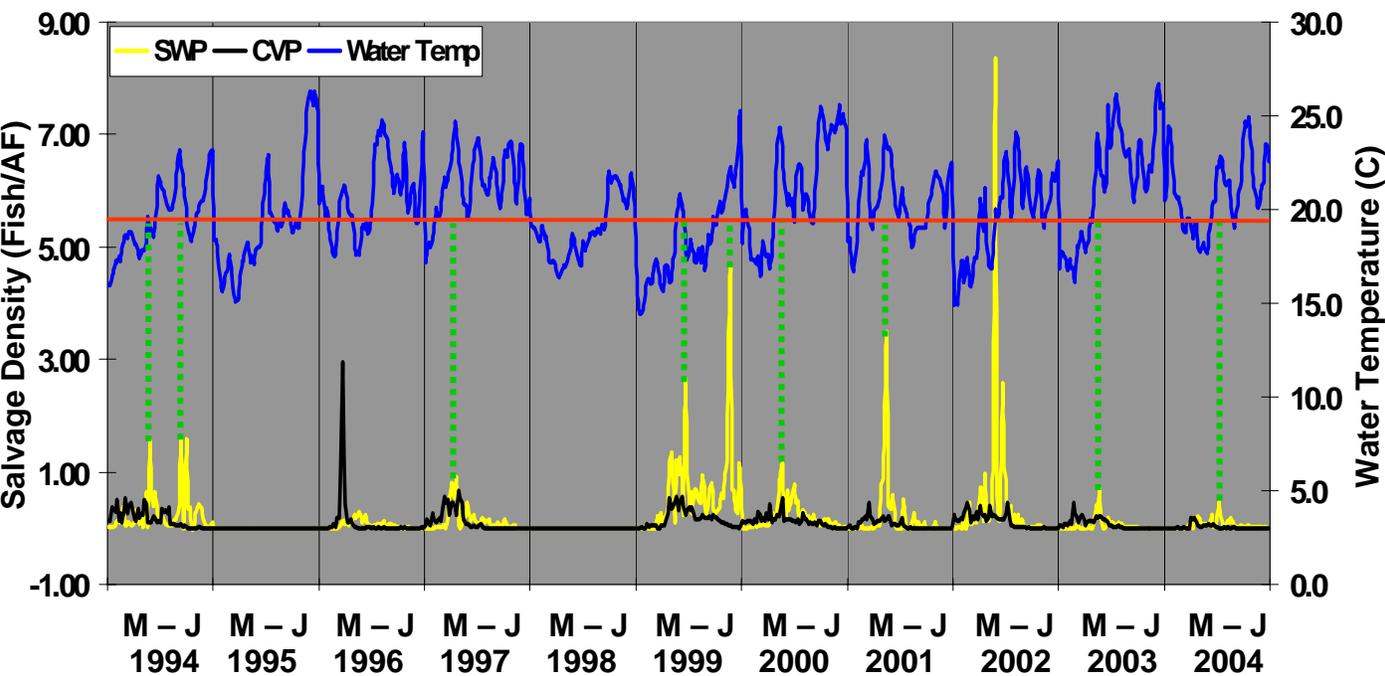
## Percentage of Young Delta Smelt in the Zone of Influence vs. Spring Delta Outflow



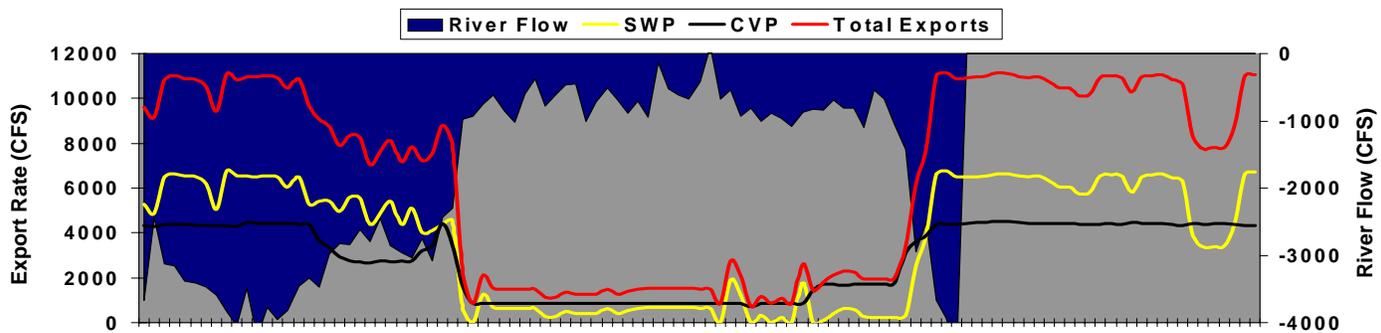
- SWP salvage often dominates combined salvage and extreme salvage events.
- Extreme SWP salvage events often coincide with water temperature  $\geq 20$  C.



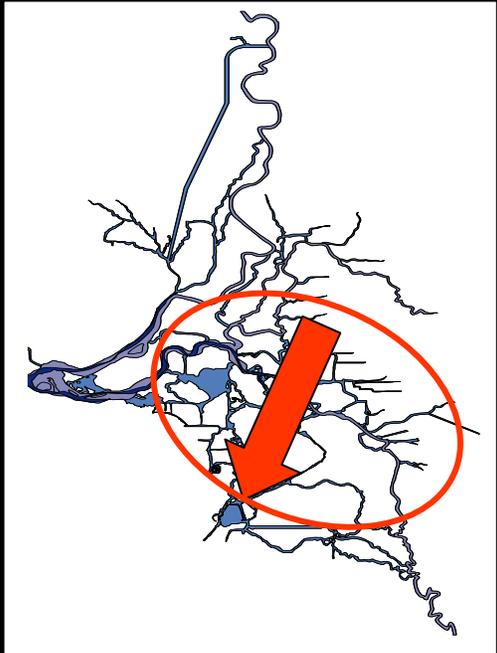
Daily SWP and CVP Delta Smelt Salvage Density and SWP Water Temperature 1994 - 2004



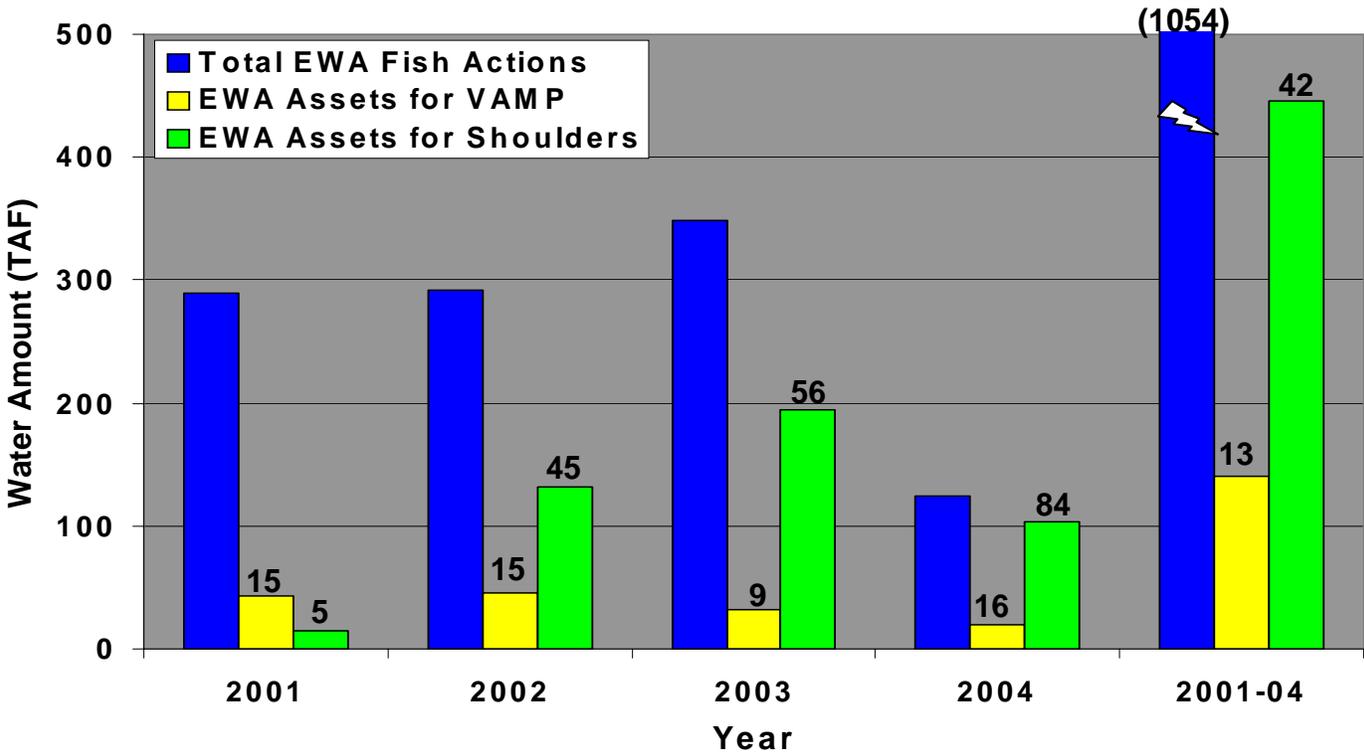
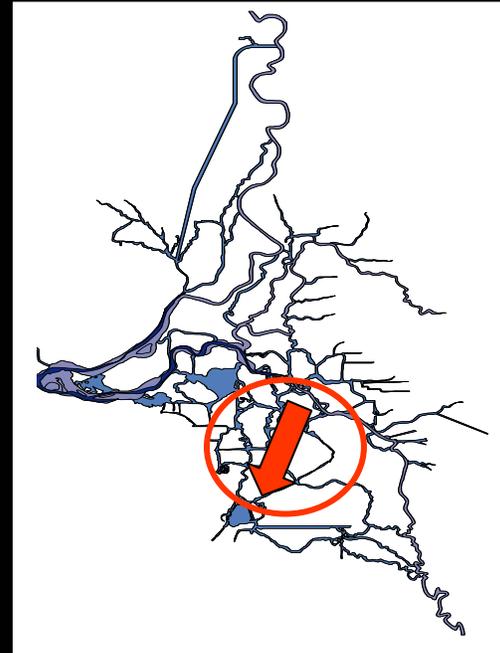
### Daily Export Rate and River Flow



### Without VAMP or Shoulders

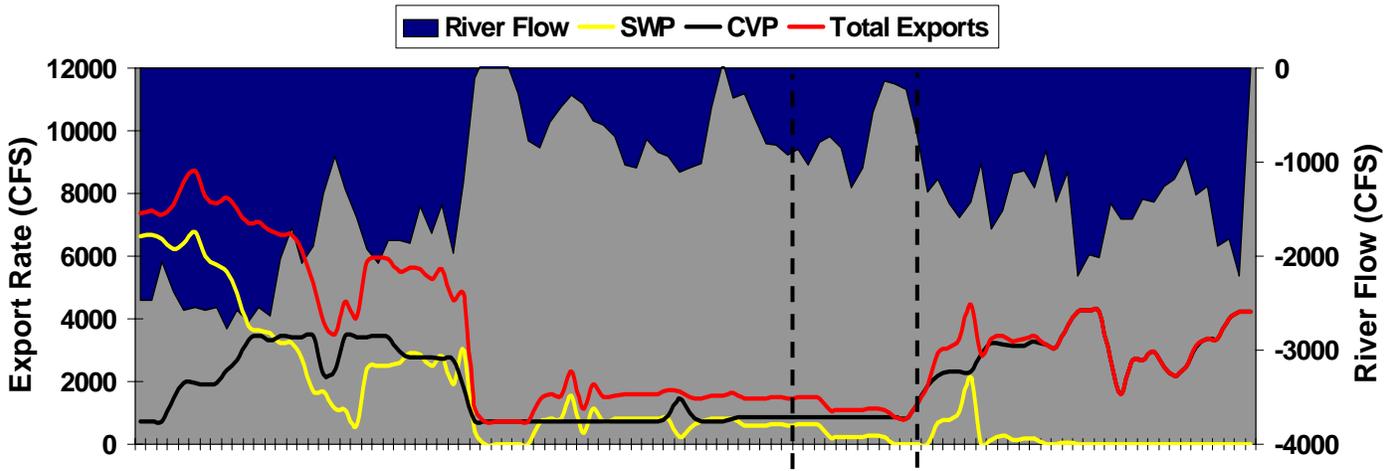


### With VAMP and Shoulders

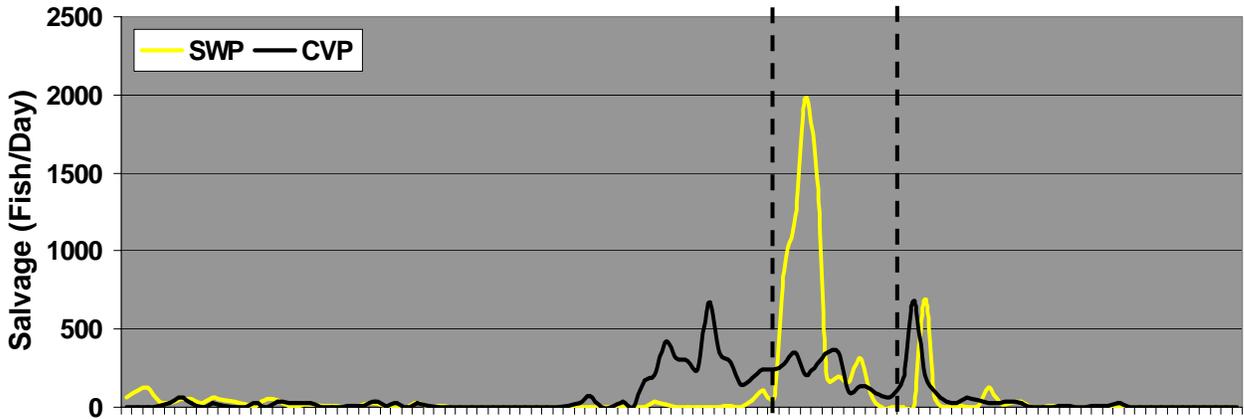


# March to July 2001

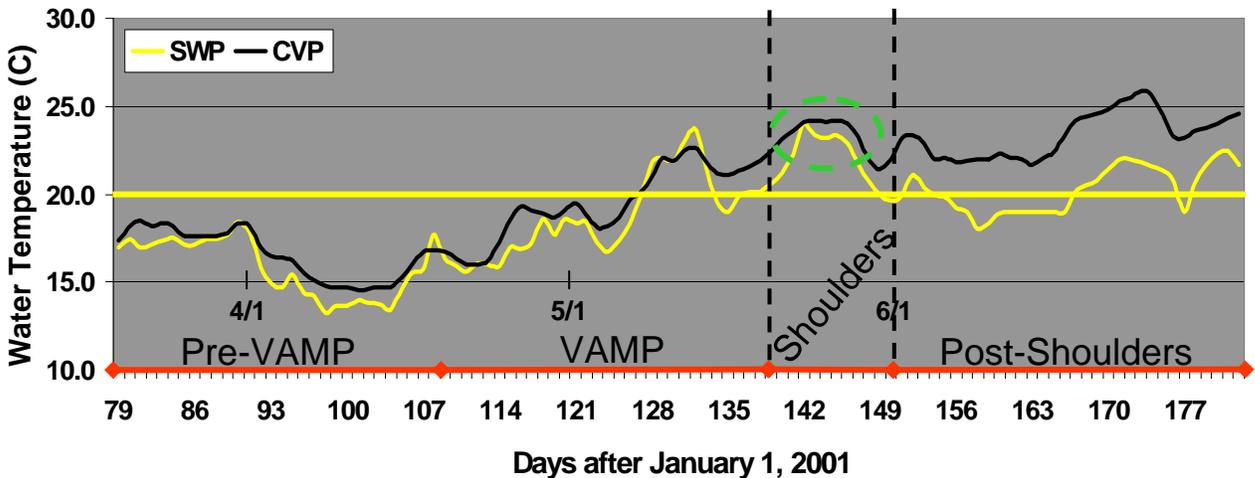
## Daily Export Rate and River Flow



## Daily SWP and CVP Delta Smelt Salvage

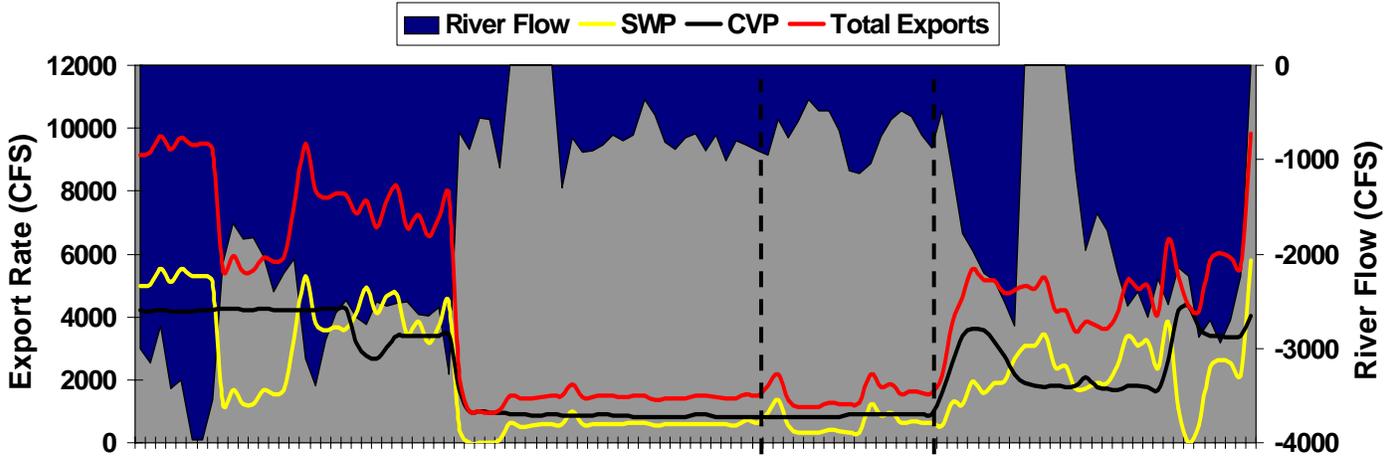


## Daily Water Temperature at the SWP

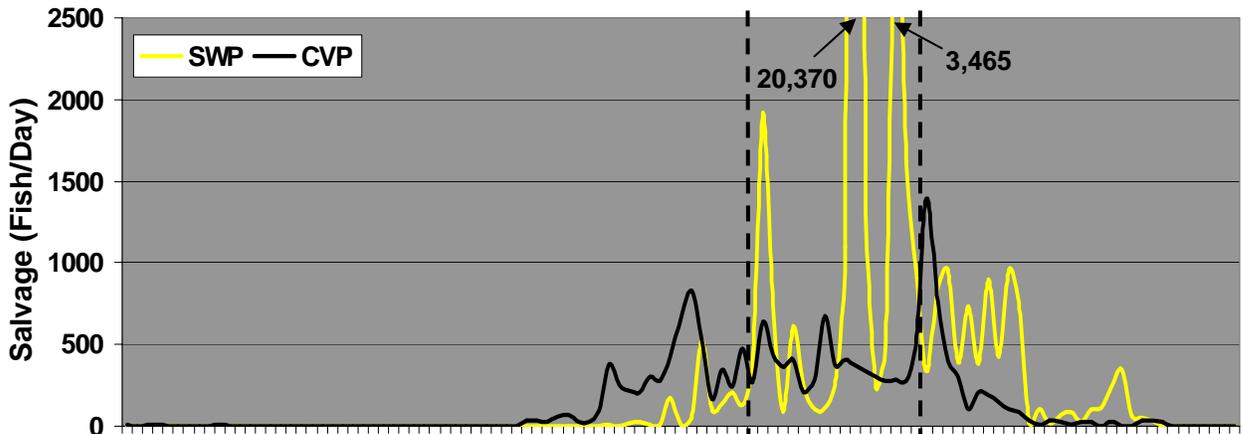


# March to July 2002

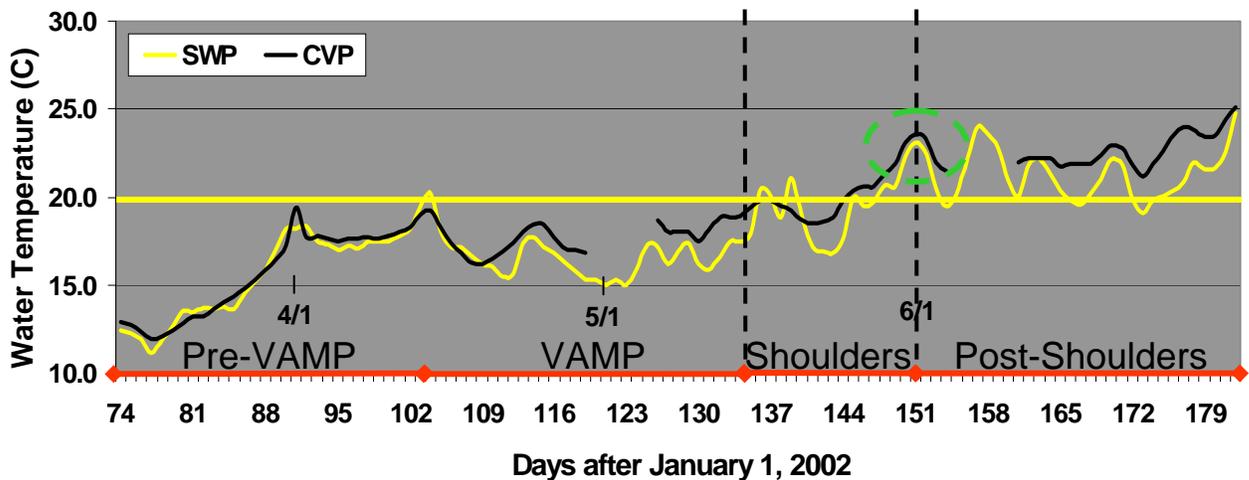
## Daily Export Rate and River Flow



## Daily SWP and CVP Delta Smelt Salvage

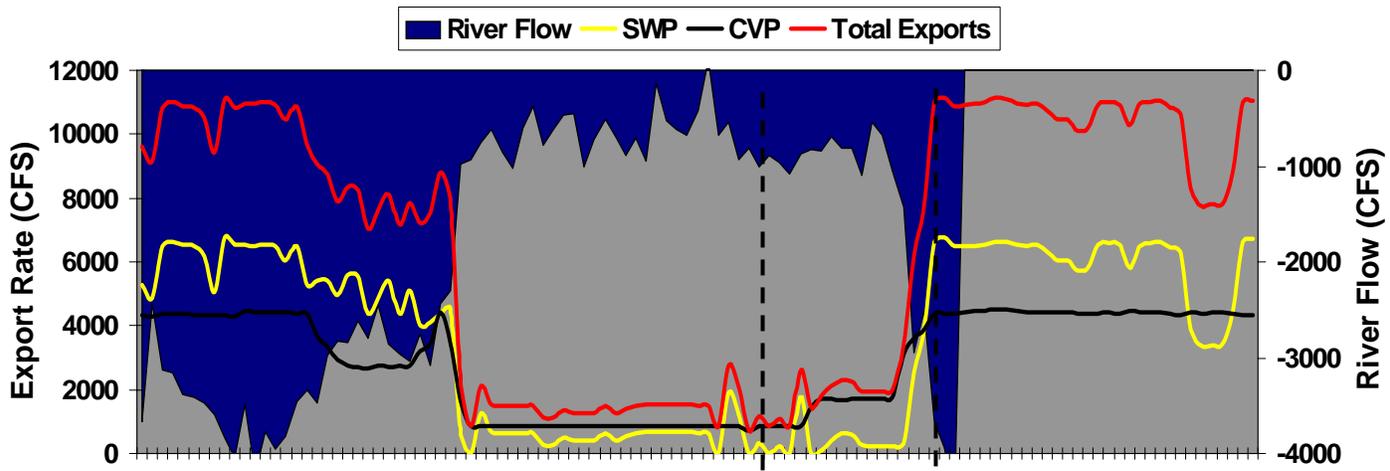


## Daily Water Temperature at the SWP

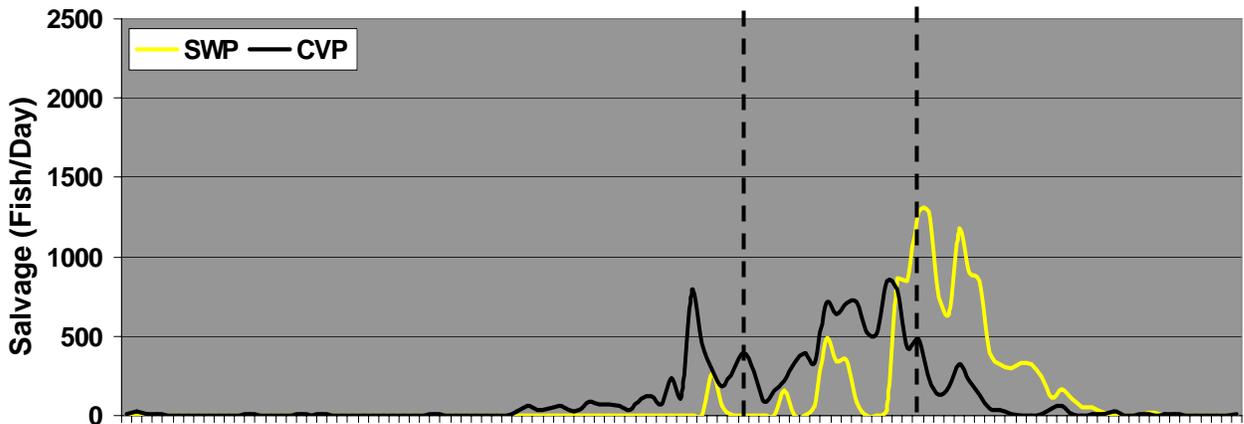


# March to July 2003

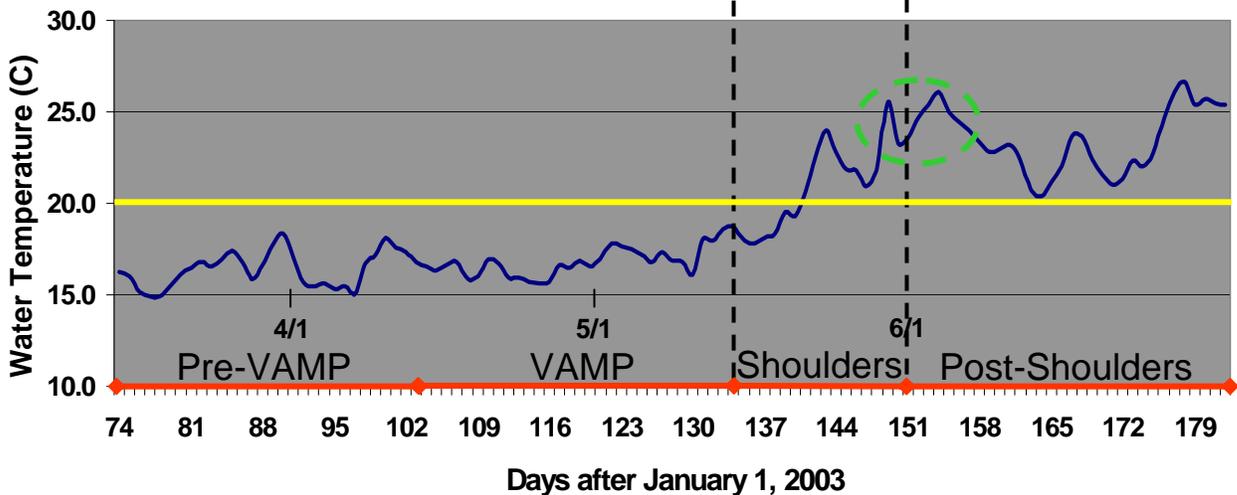
## Daily Export Rate and River Flow



## Daily SWP and CVP Delta Smelt Salvage

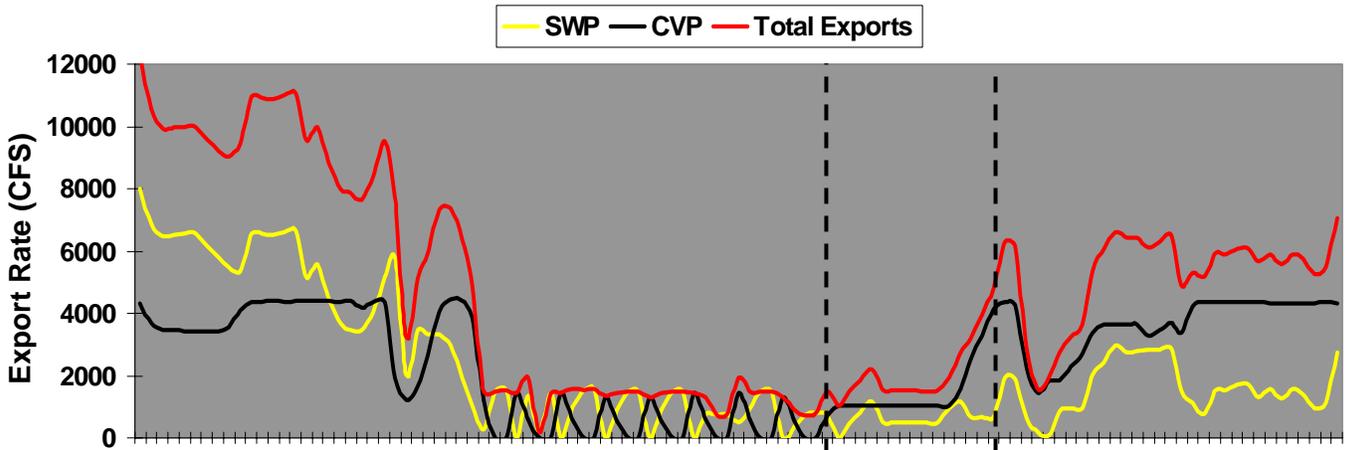


## Daily Water Temperature at the SWP

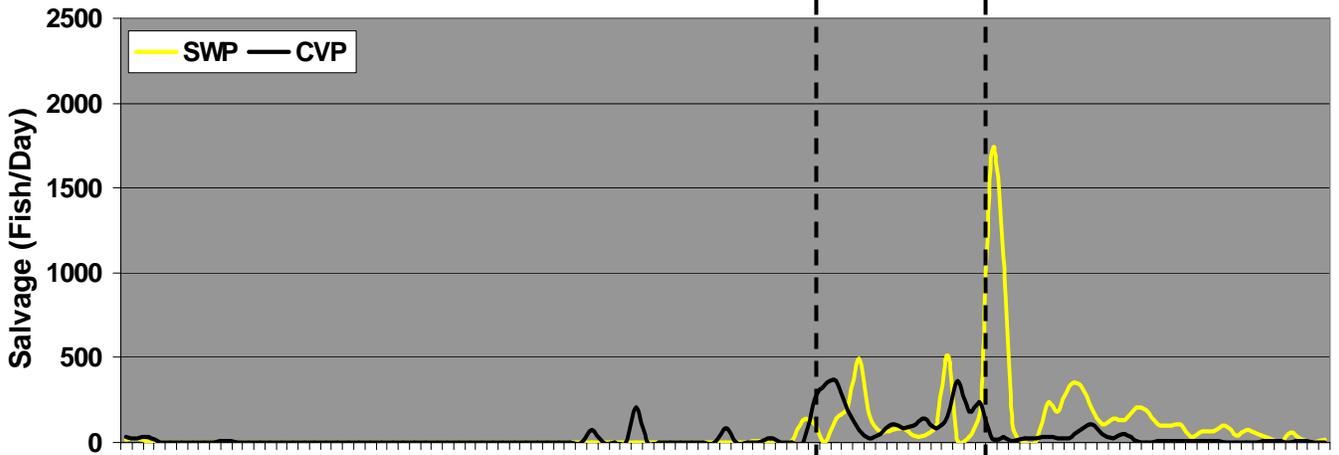


# March to July 2004

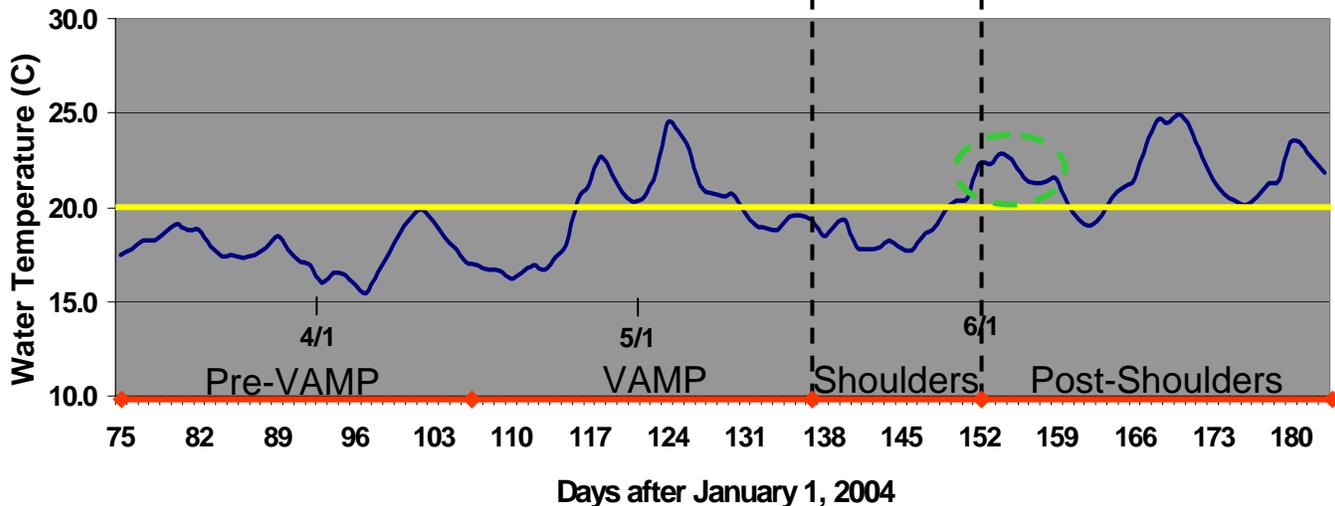
## Daily Export Rate



## Daily SWP and CVP Delta Smelt Salvage

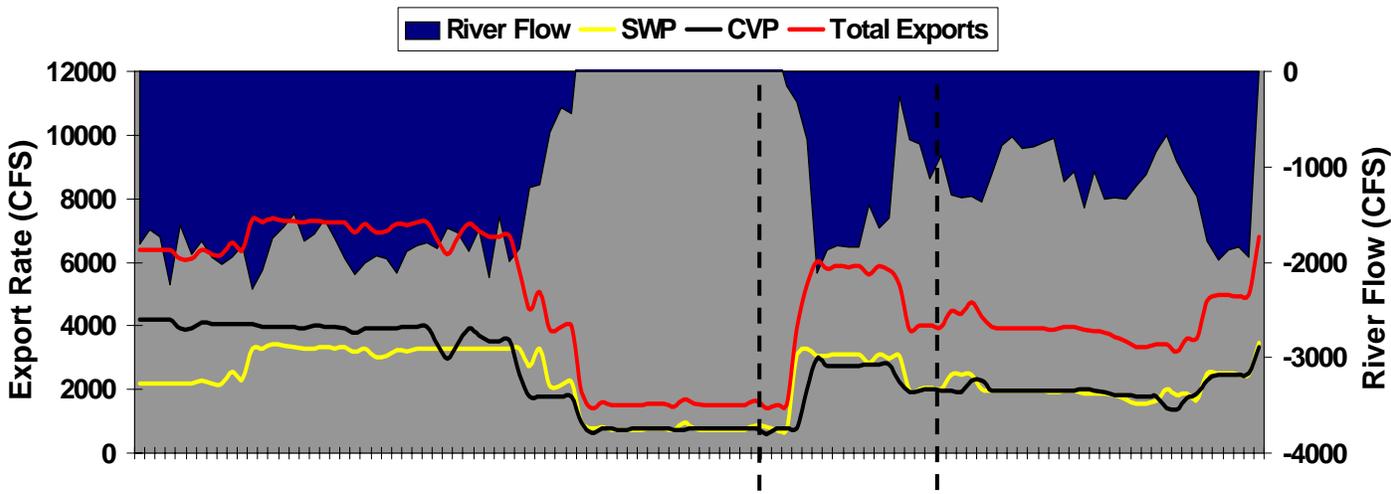


## Daily Water Temperature at the SWP

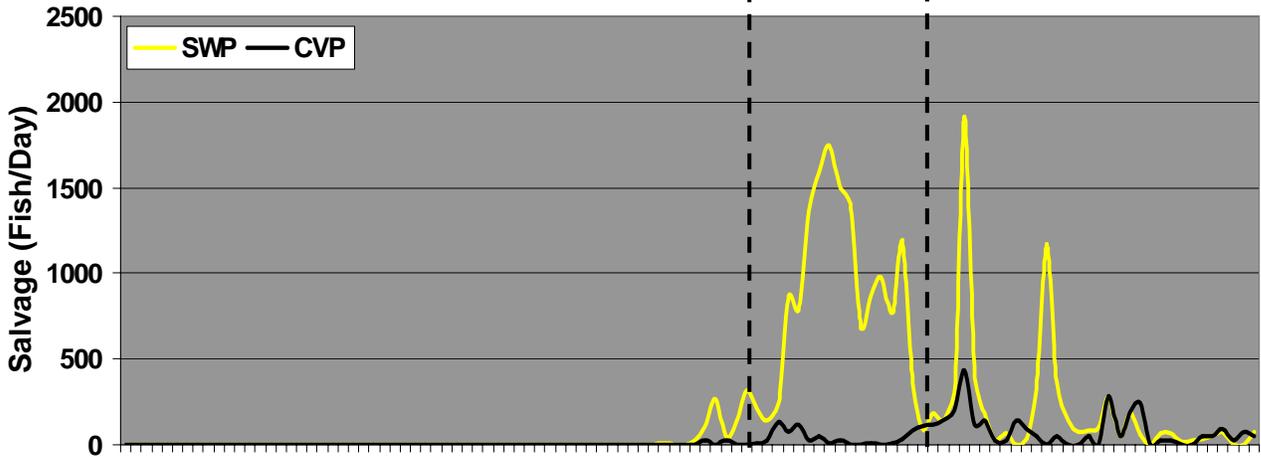


# March to July 1993

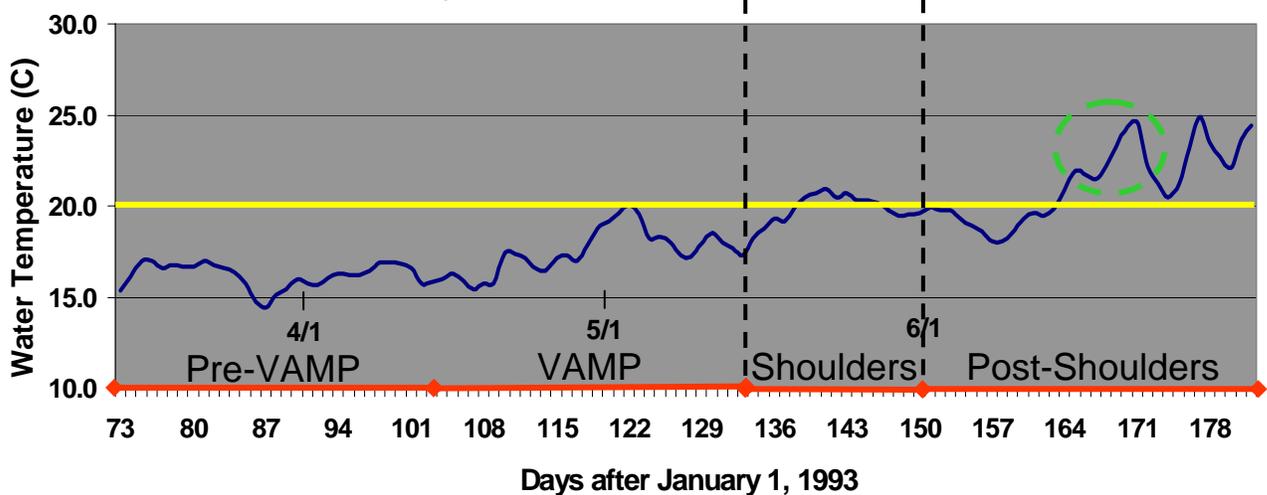
## Daily Export Rate and River Flow



## Daily SWP and CVP Delta Smelt Salvage

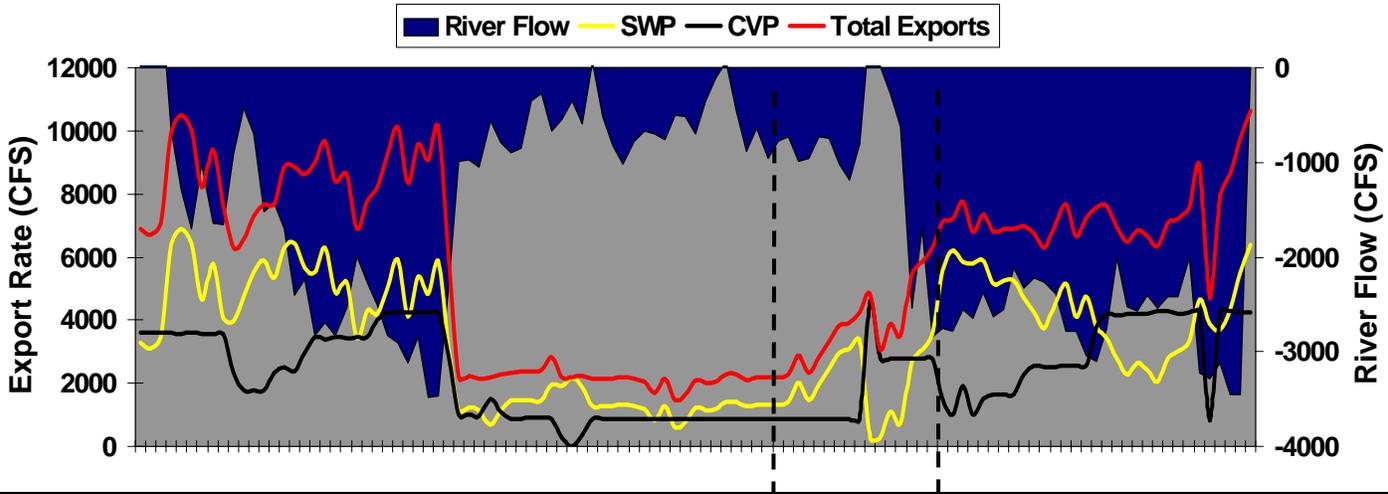


## Daily Water Temperature at the SWP

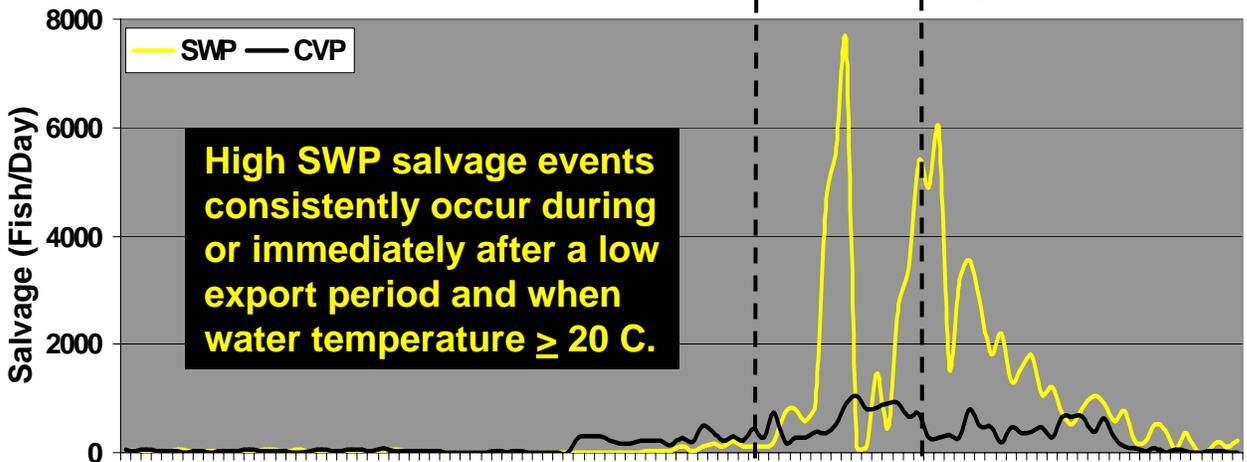


# March to July 2000

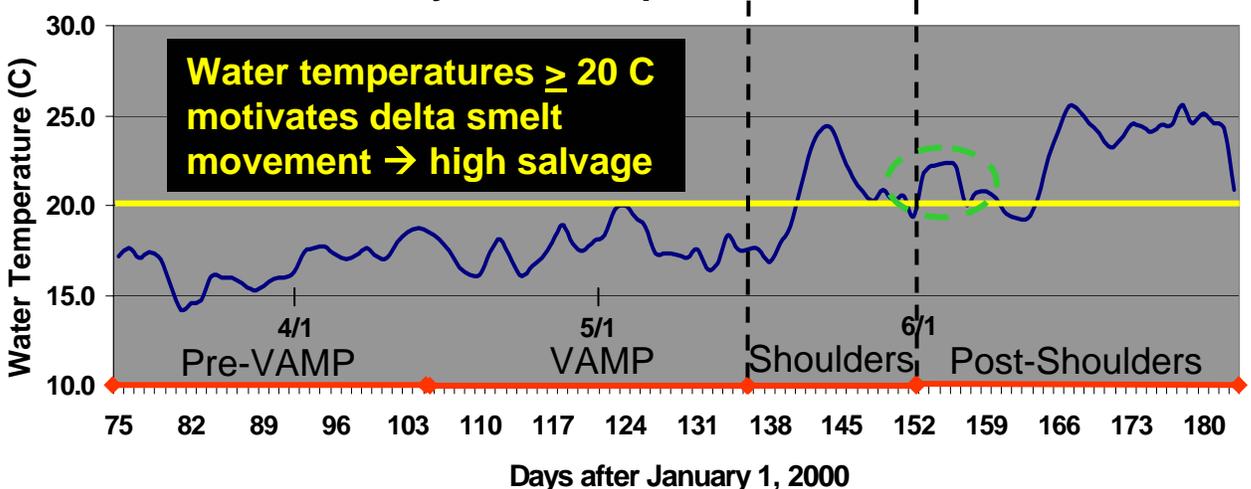
## Daily Export Rate and River Flow



## Daily SWP and CVP Delta Smelt Salvage



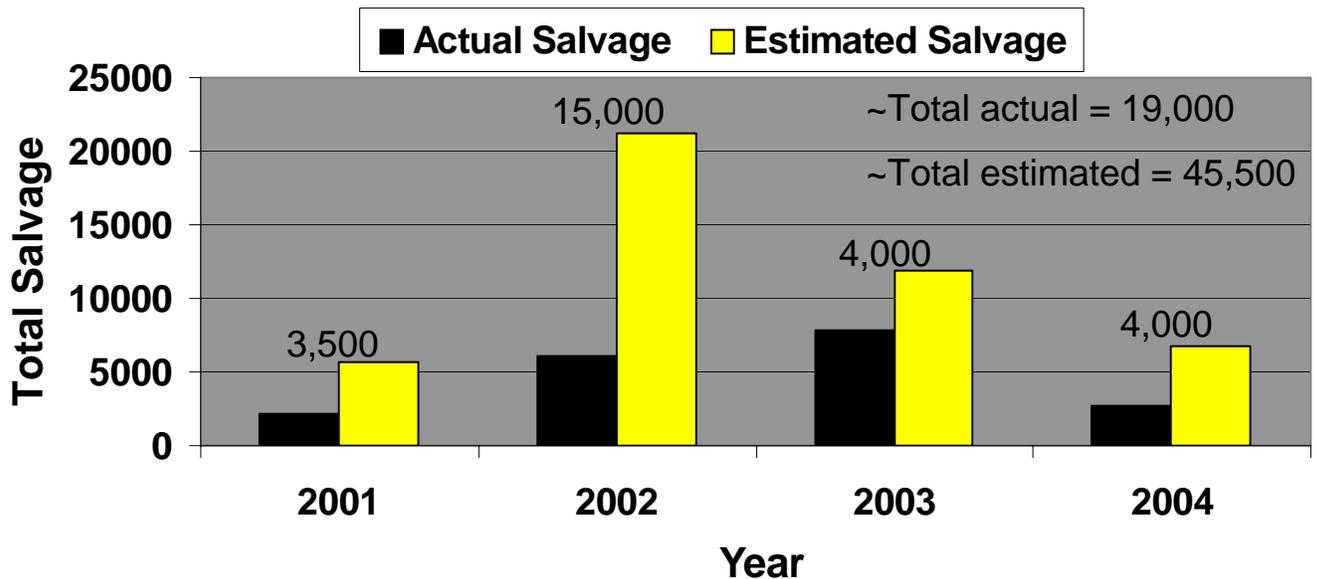
## Daily Water Temperature at the SWP



# VAMP Shoulder Effects on CVP Salvage



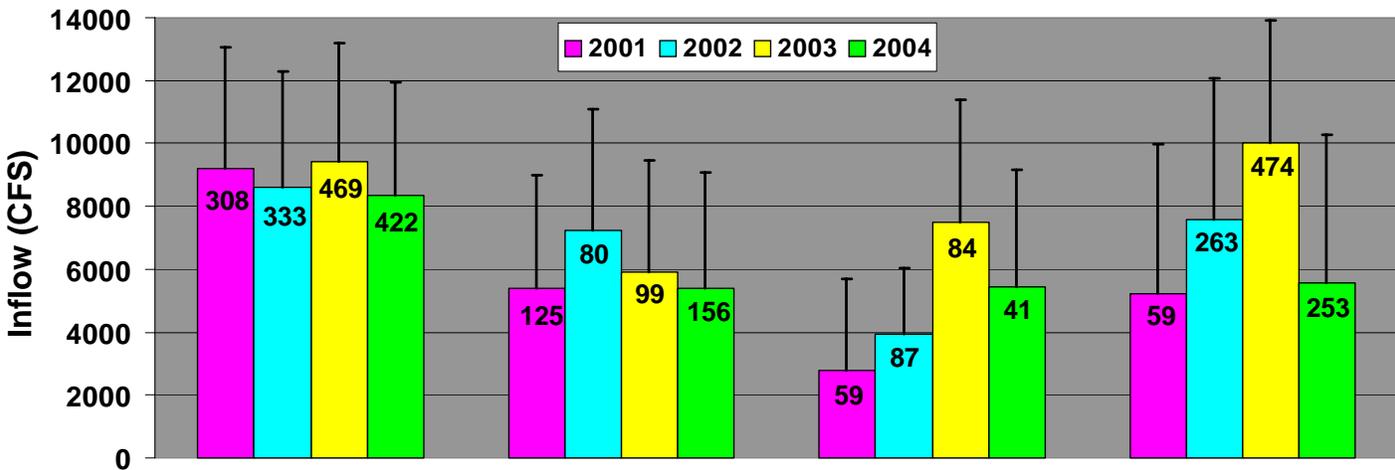
## CVP Delta Smelt Salvage During VAMP and Shoulders Periods 2002 - 2004



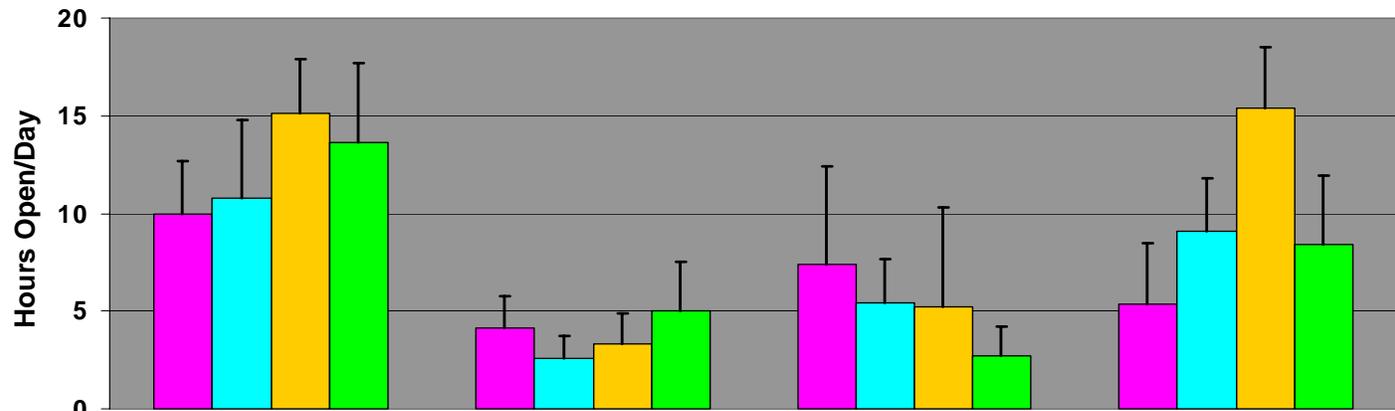
# Clifton Court Forebay and Associated Facilities



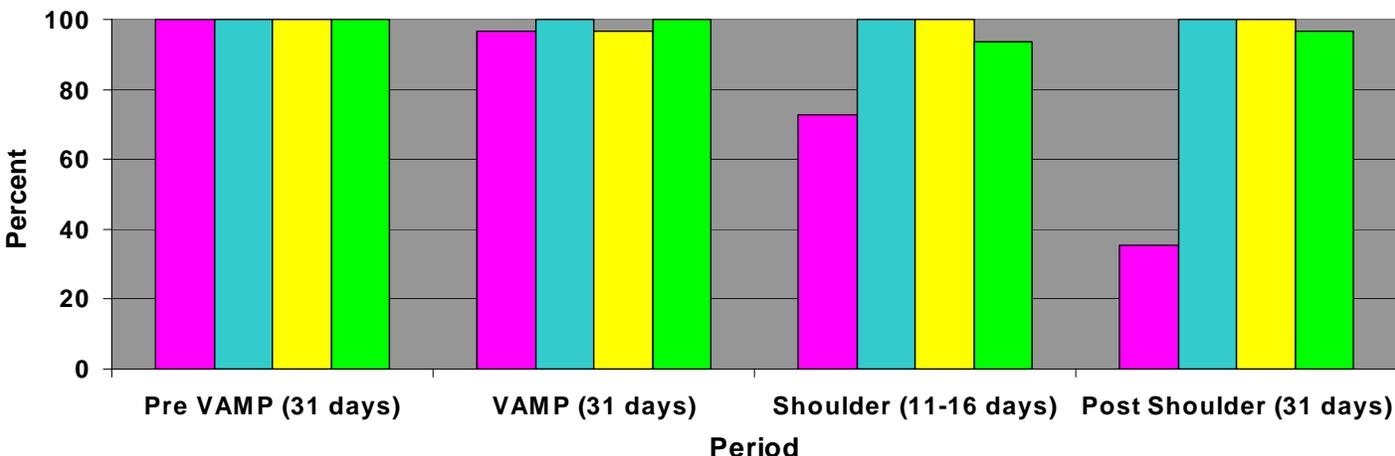
Clifton Court Average Hourly Inflow When Gates Open During Four Periods Between March and July 2001 - 2004



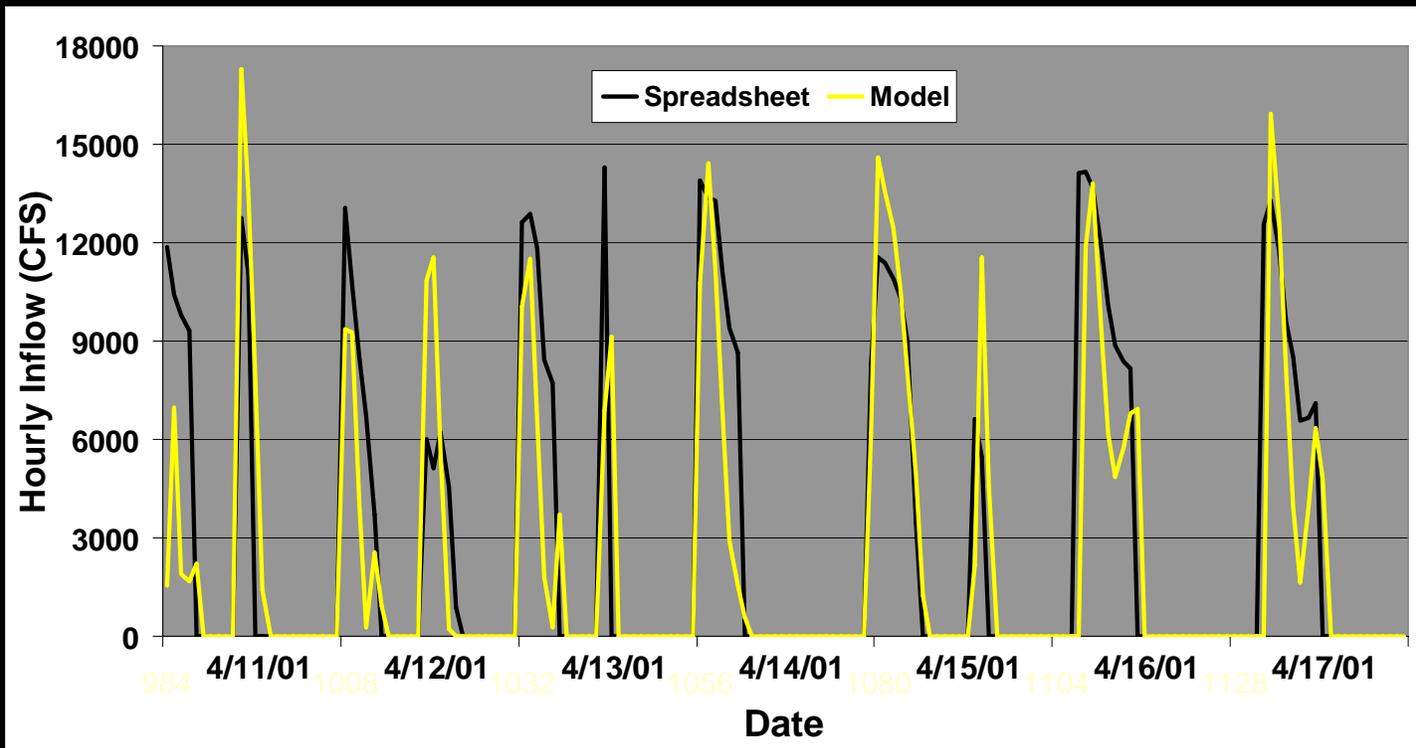
Average number of hours Clifton Court Intake Gates Open During Four Periods Between March and July 2001 - 2004



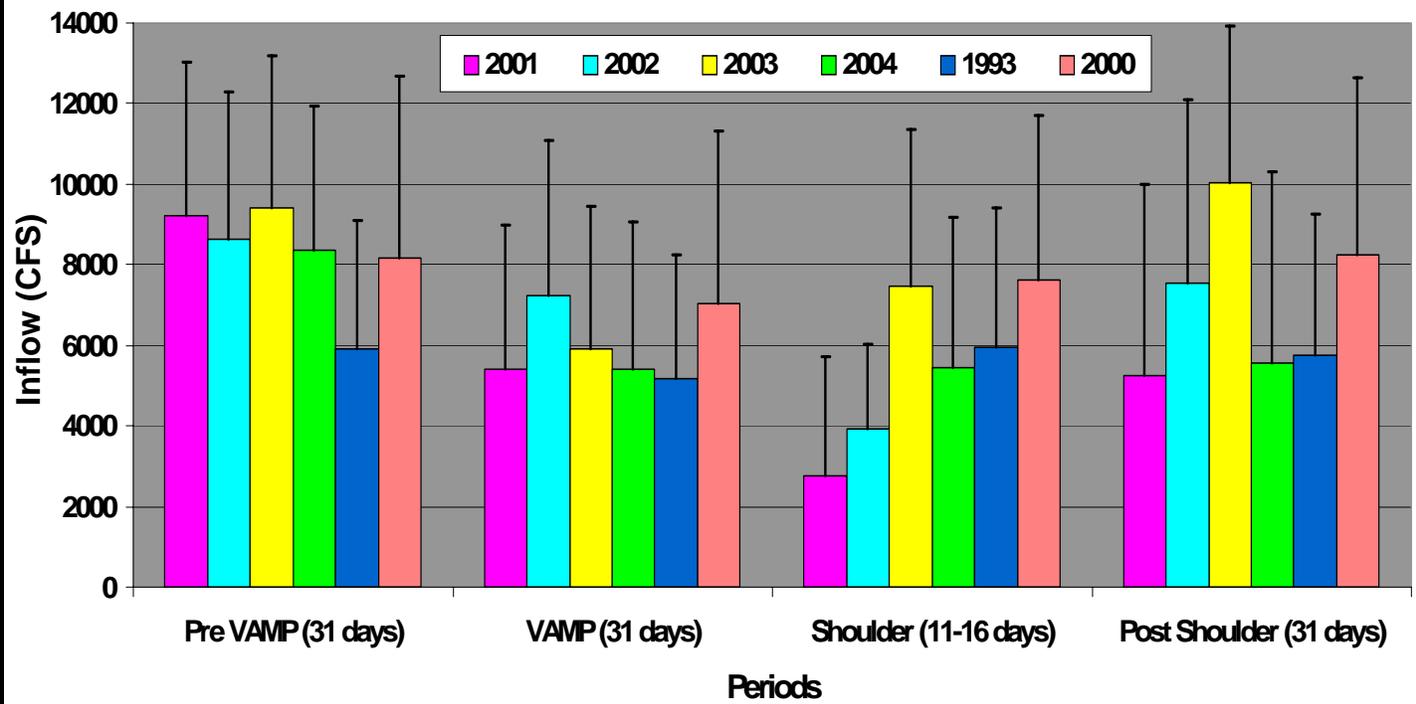
Percentage of Days Clifton Court Intake Gates Opened During Four Periods Between March and July 2001 - 2004



# Estimating Clifton Court Inflow for 1993 and 2000

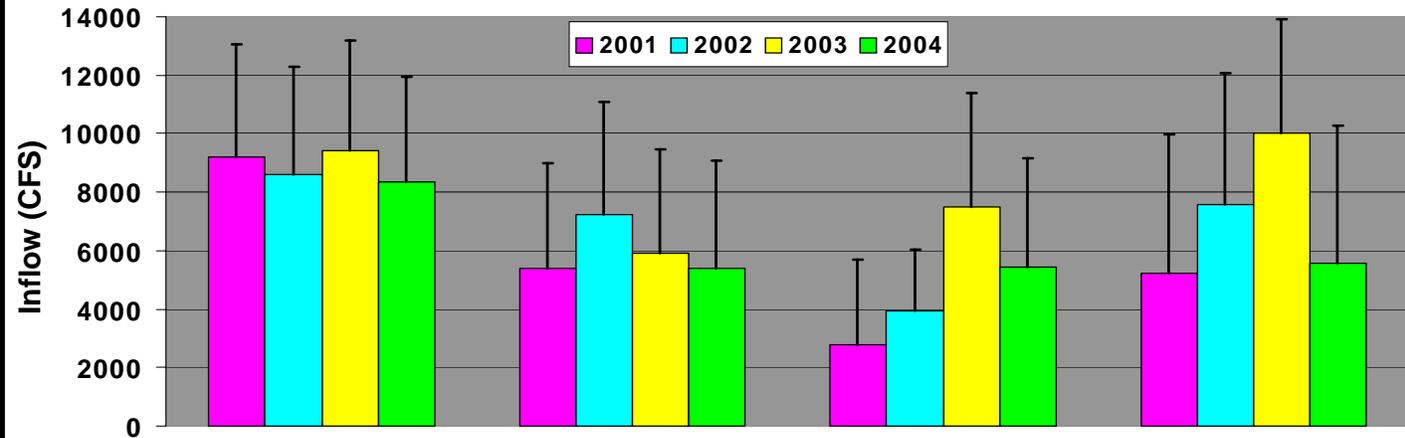


Clifton Court Average Hourly Inflow When Gates Open During Four Periods March to July 1993, 2000 - 2004

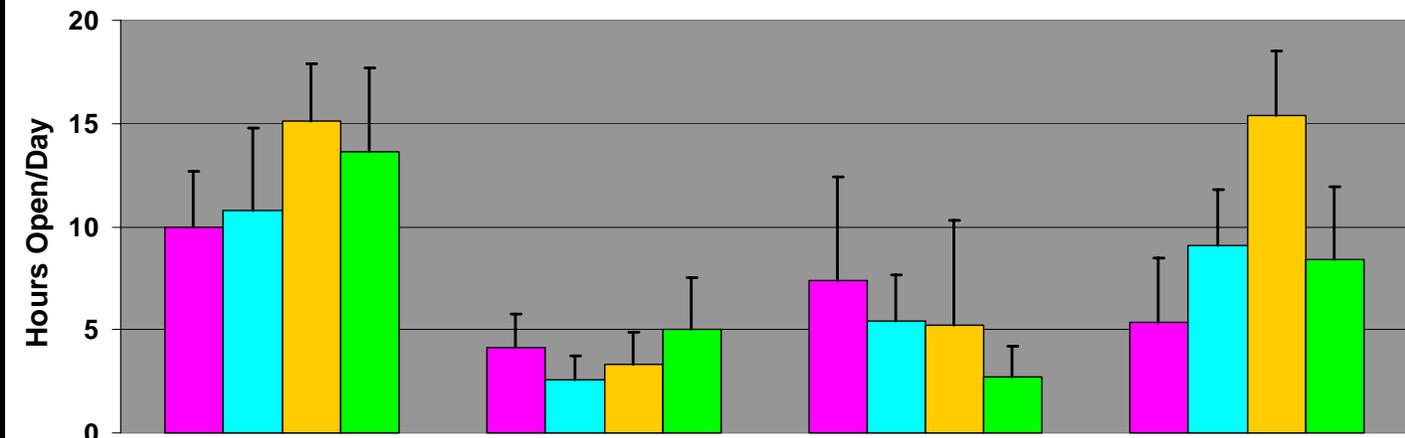


- Shoulder on VAMP likely reduced SWP entrainment of delta smelt.
- Benefit depends on temporal relationship of spawning and exports.
- Post shoulder less beneficial than pre-shoulder curtailment.

Clifton Court Average Hourly Inflow When Gates Open During Four Periods Between March and July 2001 - 2004



Average number of hours Clifton Court Intake Gates Open During Four Periods Between March and July 2001 - 2004

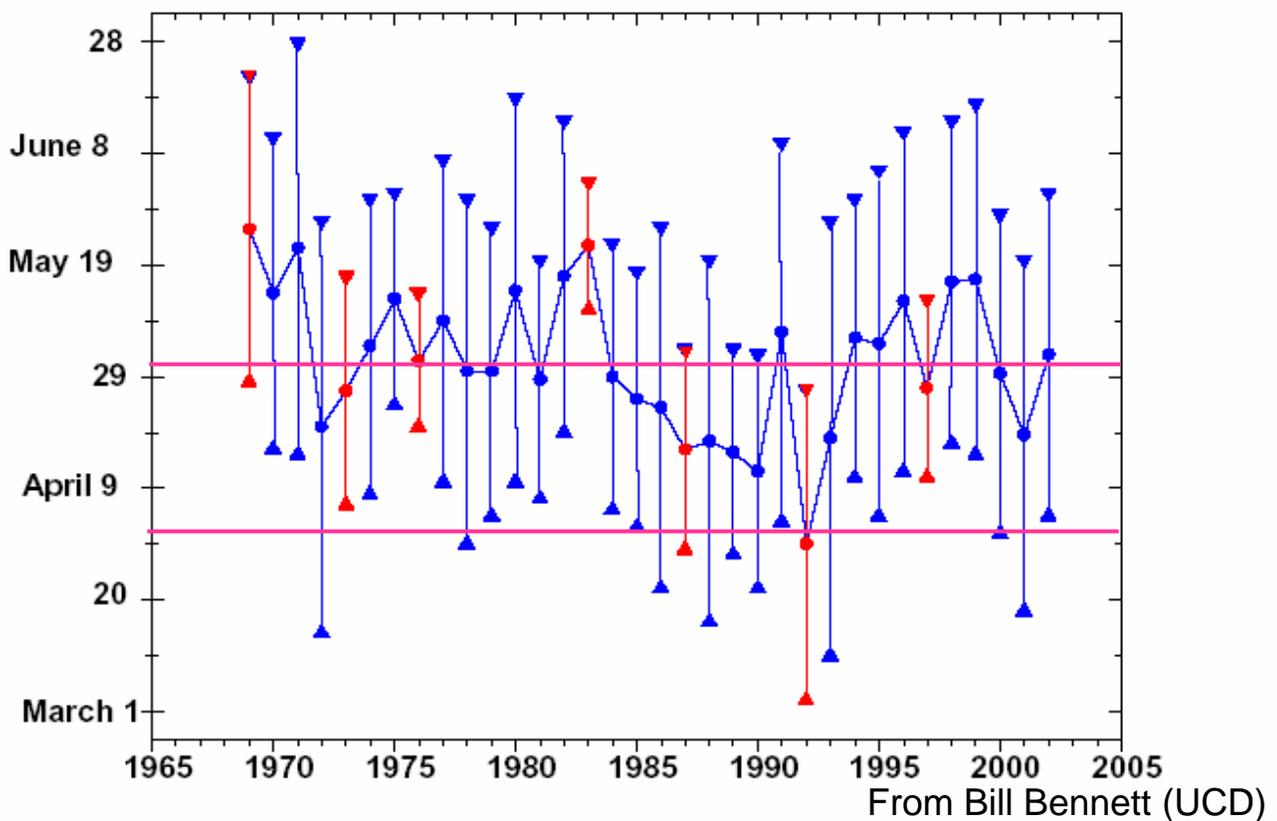
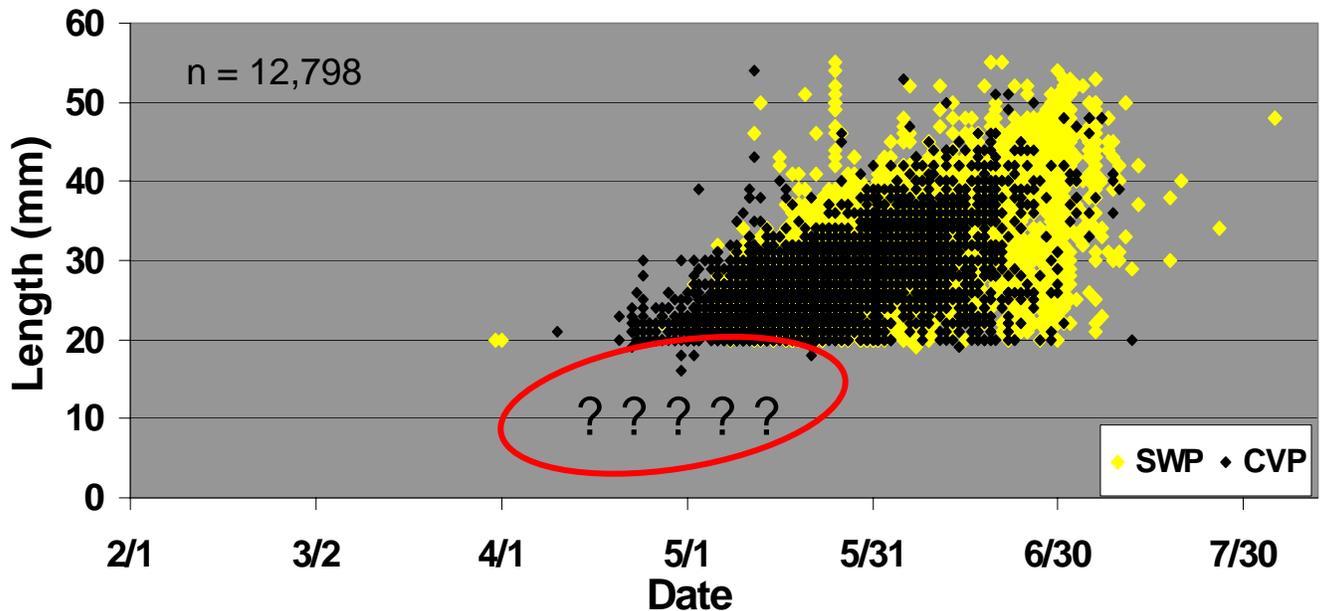


# Conclusions

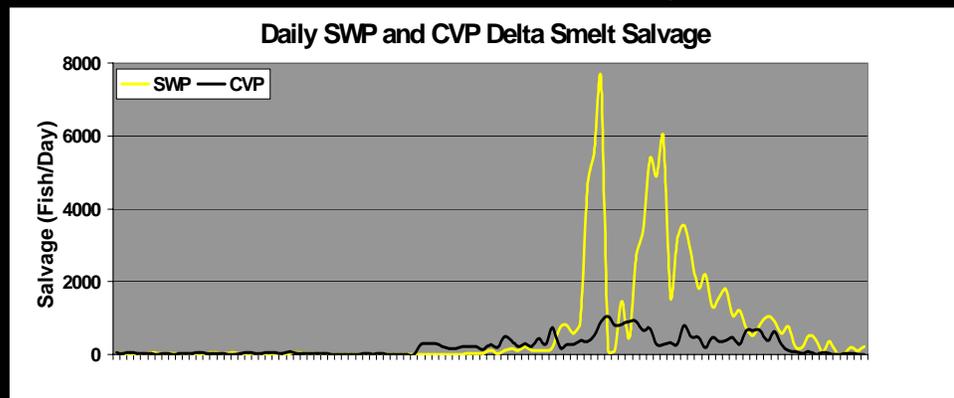
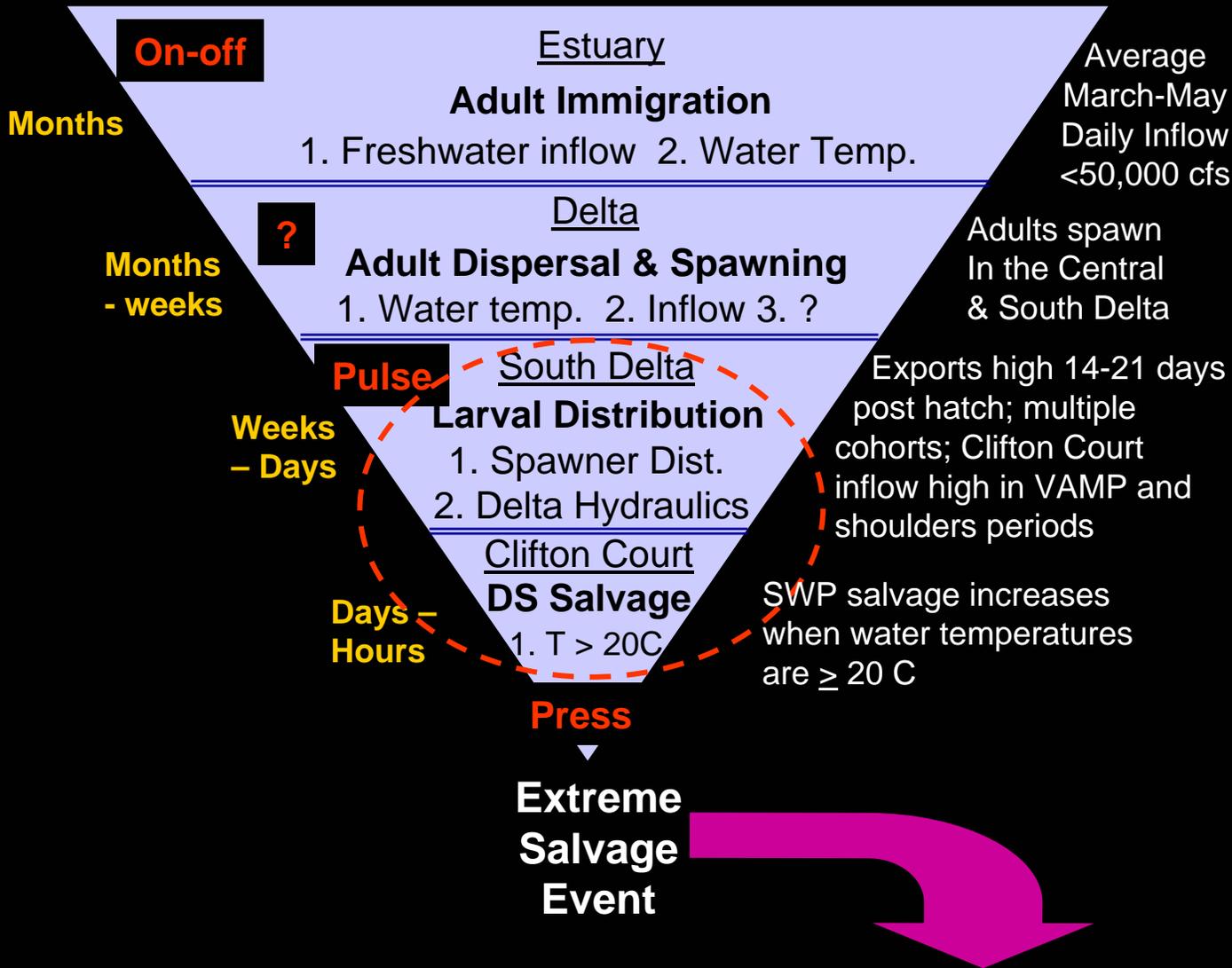
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- High SWP salvage events consistently occur during or immediately after a low export period and when water temperature  $\geq 20$  C.
- Water temperatures  $\geq 20$  C motivates delta smelt movement  $\rightarrow$  high salvage.
- Export curtailments at the CVP likely result in direct reductions in delta smelt entrainment.
- Results less clear for the SWP.
- Shoulder-on-VAMP likely reduced SWP entrainment of delta smelt.
- Benefit of SWP curtailment depends on temporal relationship of spawning and Clifton Court diversions.
- Post shoulder less beneficial than pre-shoulder curtailment.

# ➤ Salvage is an incomplete estimate of young delta smelt entrainment.

## Length of Young Delta Smelt Salvage at the SWP and CVP 1995 - 2003

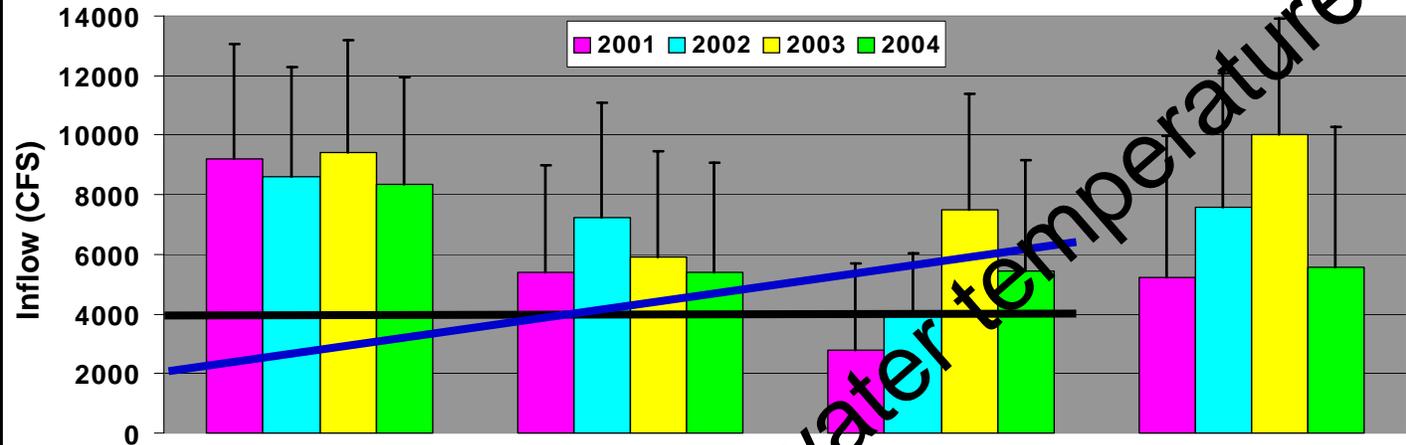


# Extreme SWP salvage is a function of the integrated response of delta smelt to environmental conditions that vary in time and space

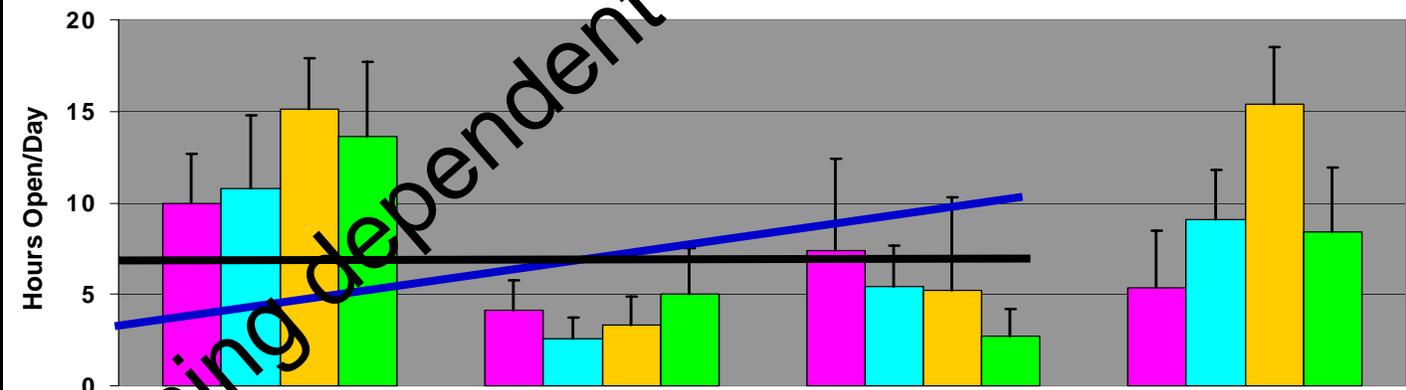


# Goal: increase the average probability of cohort survival

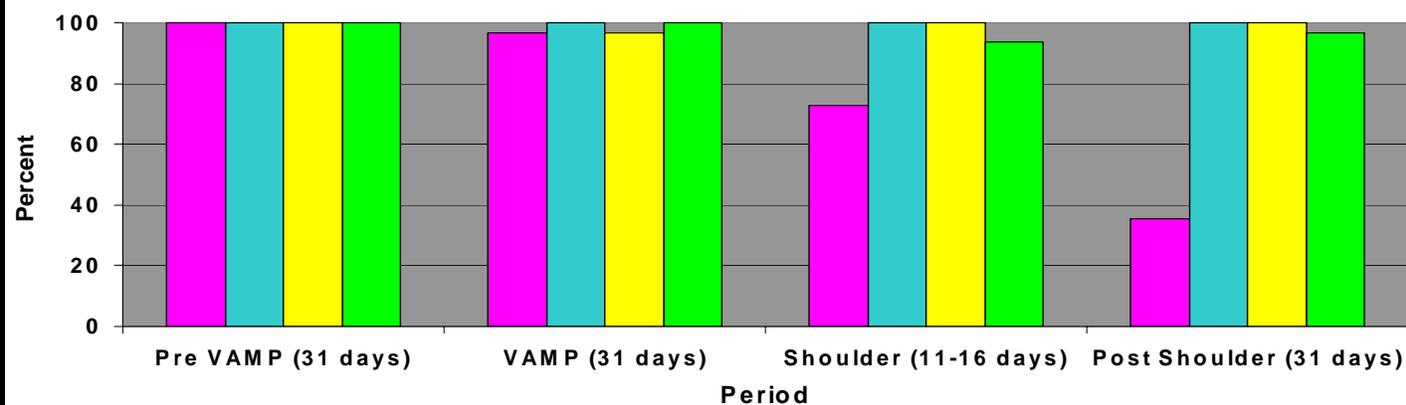
Clifton Court Average Hourly Inflow When Gates Open During Four Periods Between March and July 2001 - 2004



Average number of hours Clifton Court Intake Gates Open During Four Periods Between March and July 2001 - 2004



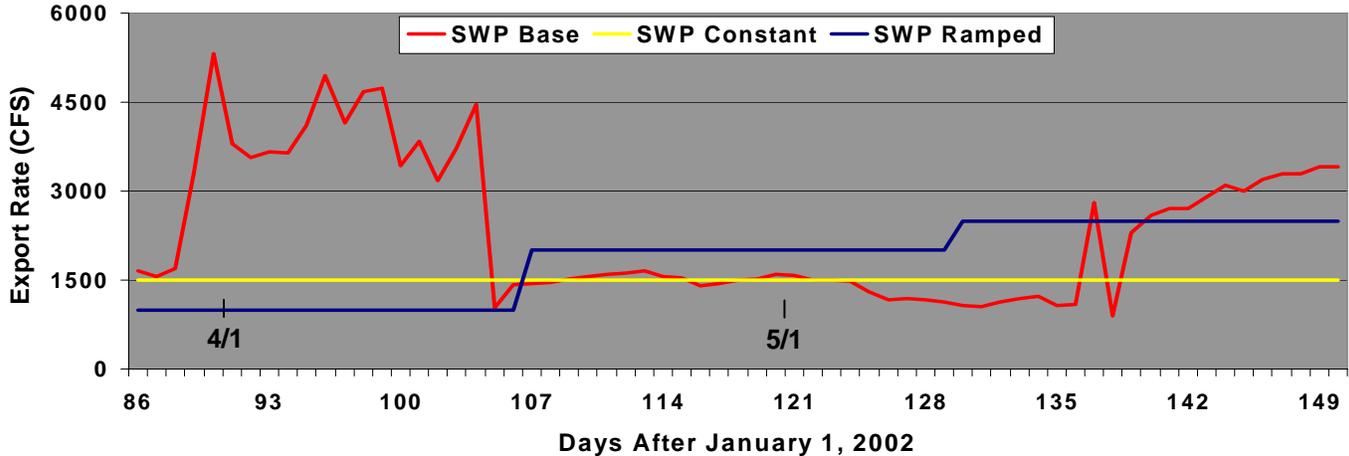
Percentage of Days Clifton Court Intake Gates Opened During Four Periods Between March and July 2001 - 2004



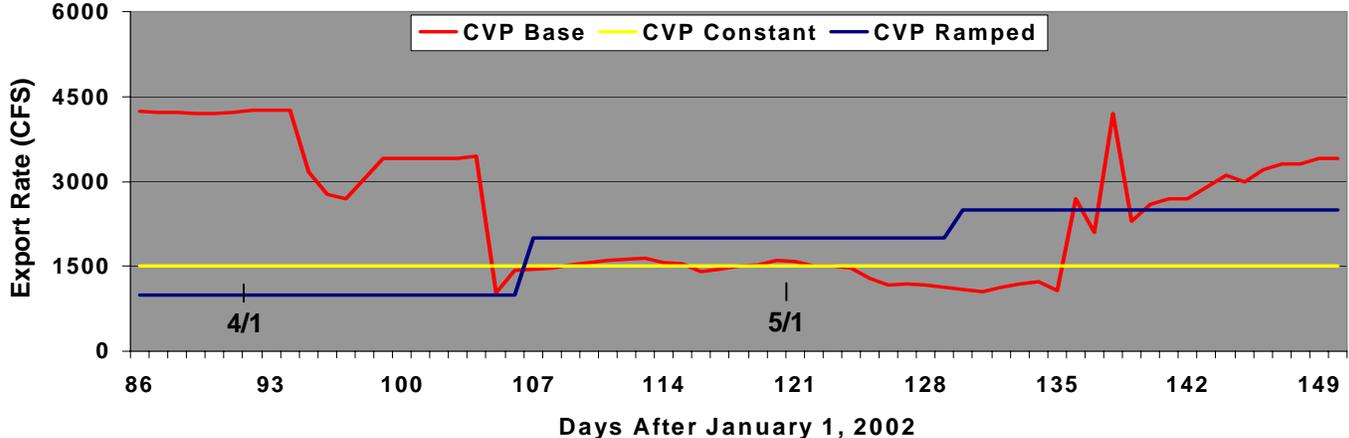
Timing dependent on water temperature

# Comparing Export Reduction Scenarios

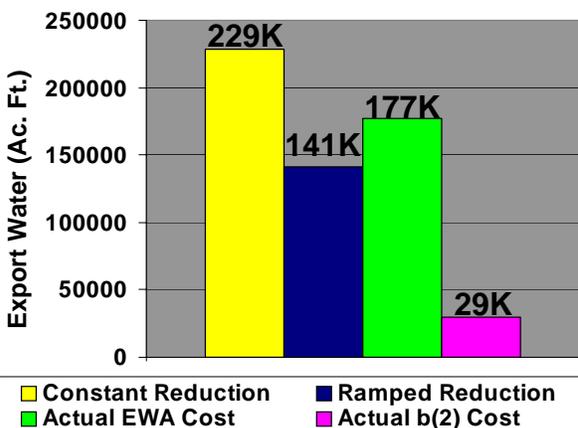
## SWP Export Reductions During the Delta Smelt Spawning Window



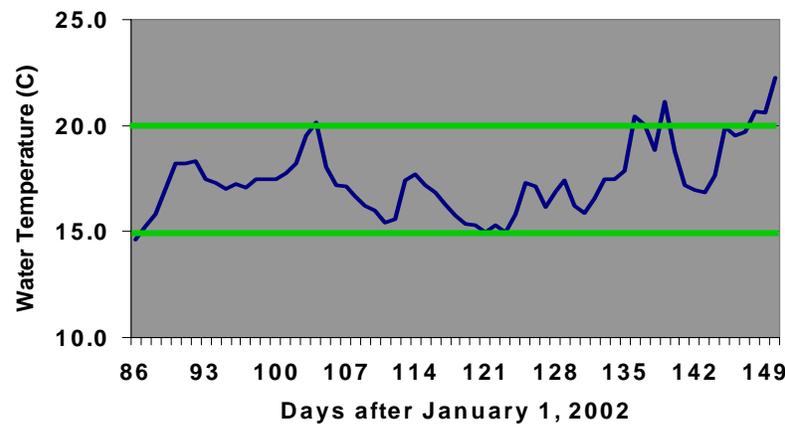
## CVP Export Reductions During the Delta Smelt Spawning Window



## Water Costs for Various Types of Export Reductions



## Daily Water Temperature at the SWP



# Information Needs

- **Verify estimates of Clifton Court Inflow with *in-situ* measurements.**
- **Estimate CVP and SWP entrainment of young delta smelt with field sampling.**
- **Study young delta smelt accumulation in Clifton Court Forebay with field sampling.**
- **Conduct experiments to estimate the magnitude of delta smelt mortality in Clifton Court Forebay.**
- **Gather larval distribution data to verify particle tracking model predictions.**
- **Conduct mesocosm studies of young delta smelt behavior to changes in hydraulics and water temperature.**

# Questions & Answers

1. What is the “combination of physical conditions in the Delta (flows, transport, temperature) that give rise to ~~entrainment~~ salvage events of [young] delta smelt”?  
Interactive effects of:  
March-May average daily inflow < 50,000 cfs  
Adult spawning distribution  
South delta hydraulics post-hatch  
Delta warming above 20 C motivating movement/emigration
2. What affect does the “post” shoulders on VAMP export curtailment have on young delta smelt?  
CVP: direct reduction in entrainment  
SWP: affect is variable depending on temporal relationship of spawning period and export schedule
3. Should the shoulders on VAMP implementation occur under an explicit experimental framework?  
Yes! Determine export reduction schedule based on water temperatures. At SWP, focus on reducing the magnitude and duration of Clifton Court inflow.