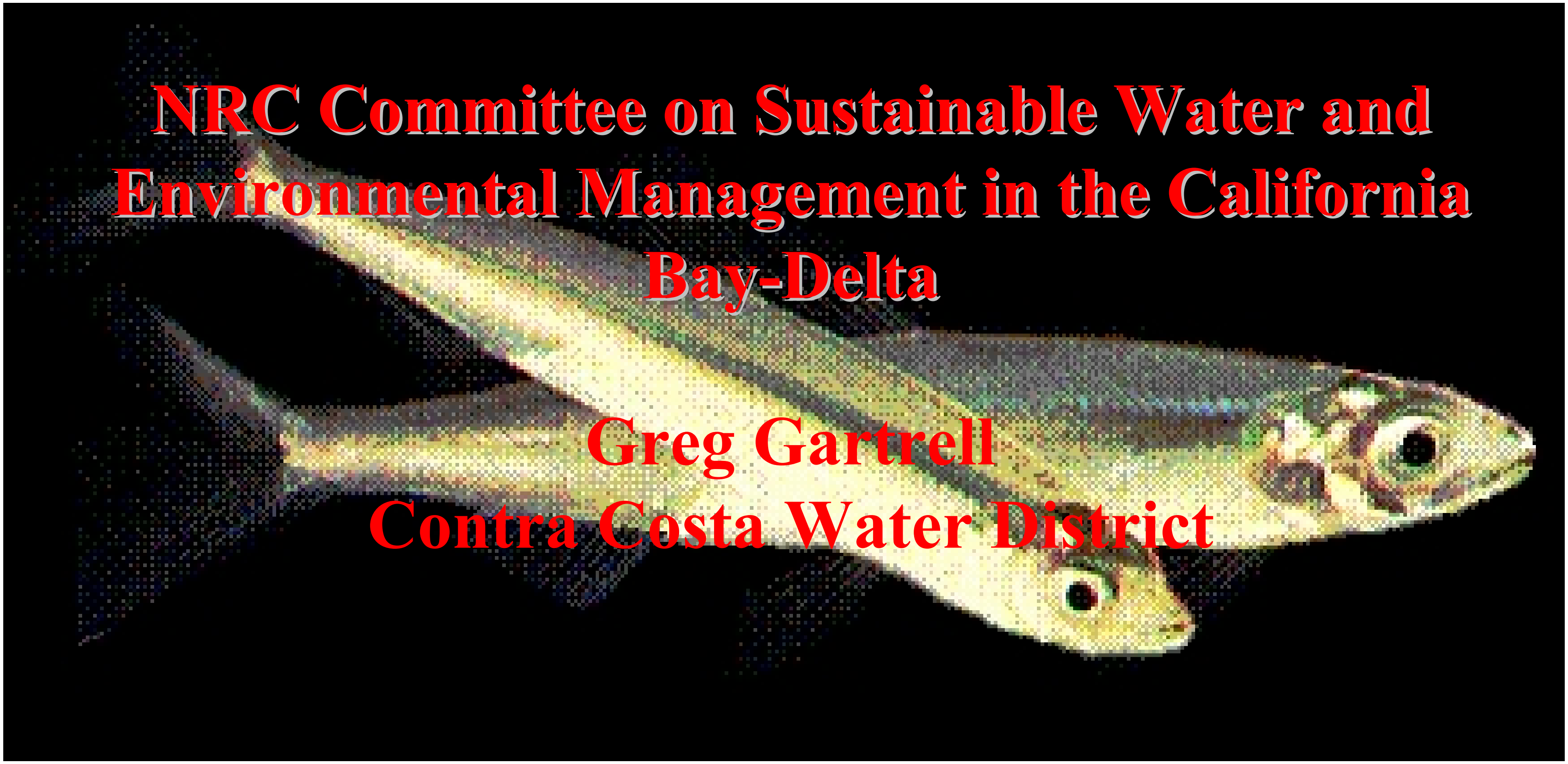
NRC Committee on Sustainable Water and Environmental Management in the California Bay-Delta



Greg Gartrell
Contra Costa Water District

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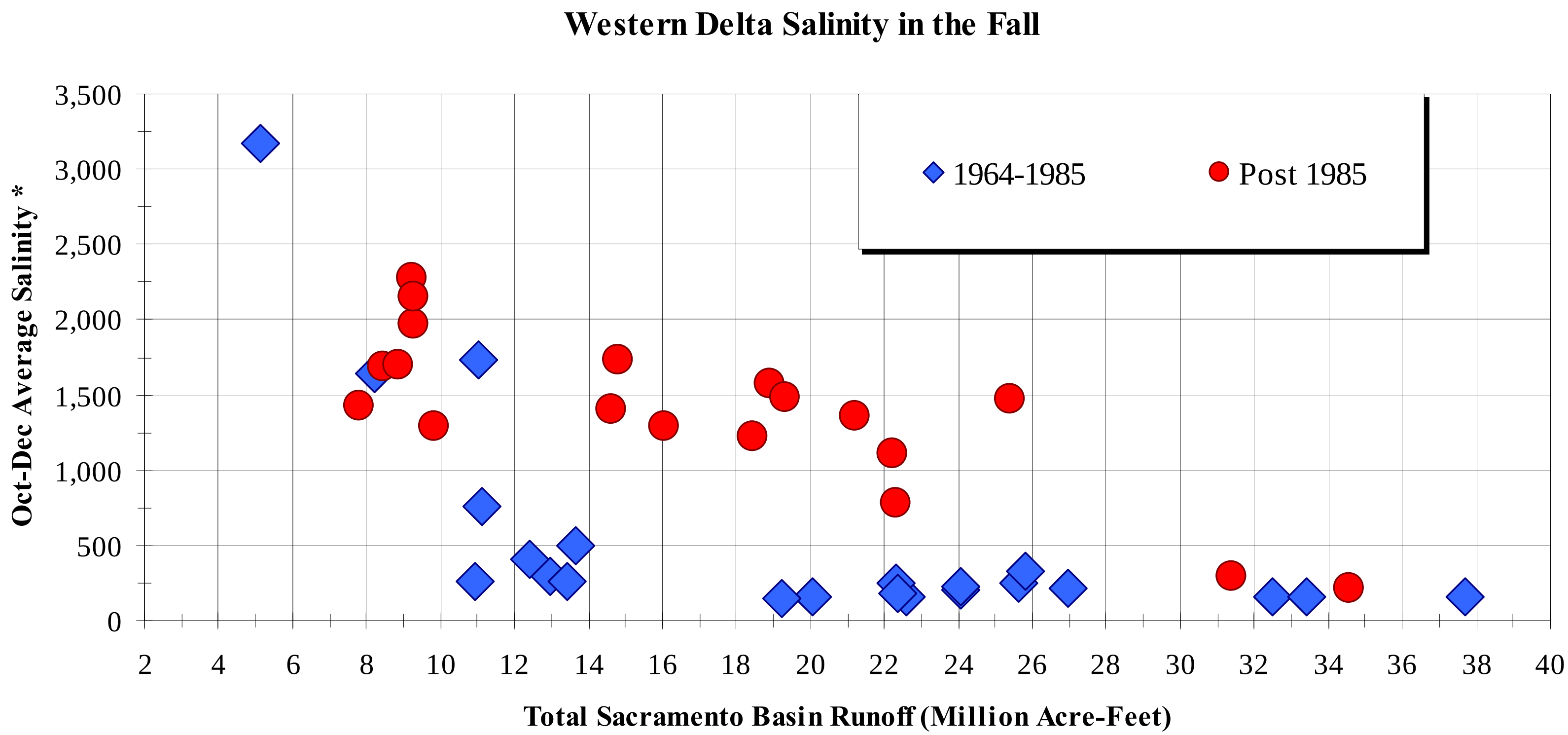
Key Messages

- The fall salinity regime in the western Delta shifted in the mid-1980's and it appears to be related to a number of factors that affect delta smelt.
- Tidal flows dominate in the Delta; to understand dynamics, tidal flows are as important as average flows
- Salvage of aquatic species in the context of tides suggests mechanisms to provide protection of species at reduced water cost

Fall Delta salinity regime change since mid-1980's



* Jersey Point electrical conductivity, microS/cm

Since the mid-1980's, fall salinity in the western Delta has increased compared to the prior two decades for similar hydrological conditions

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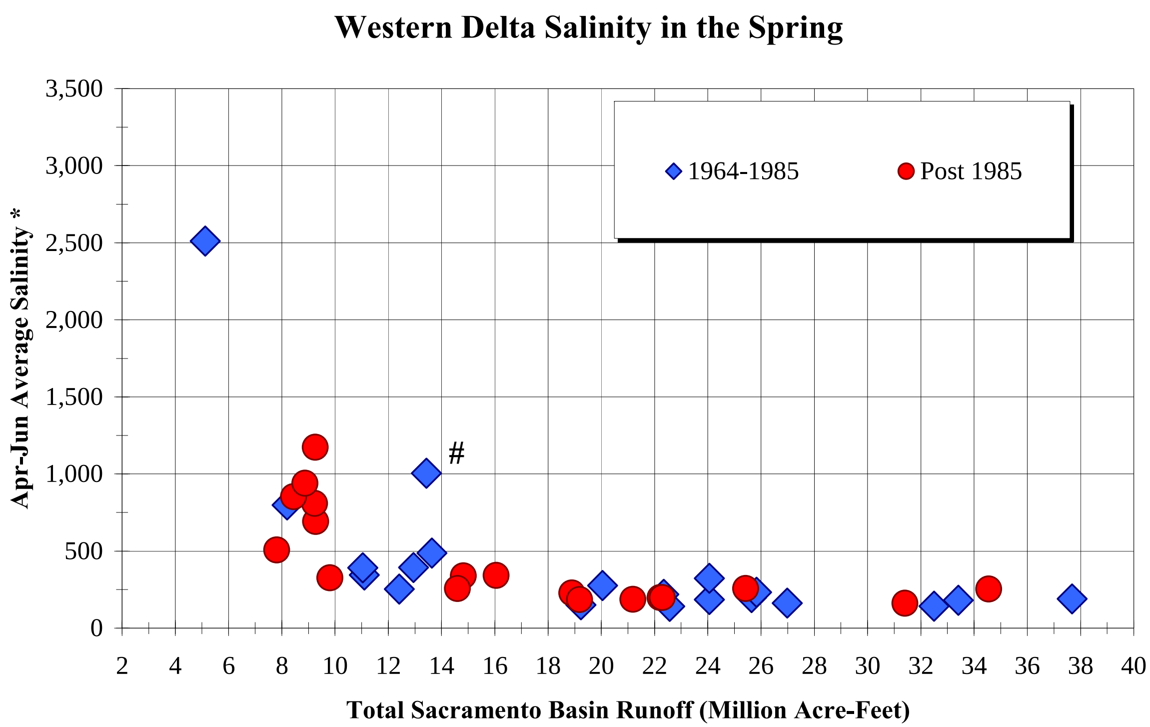
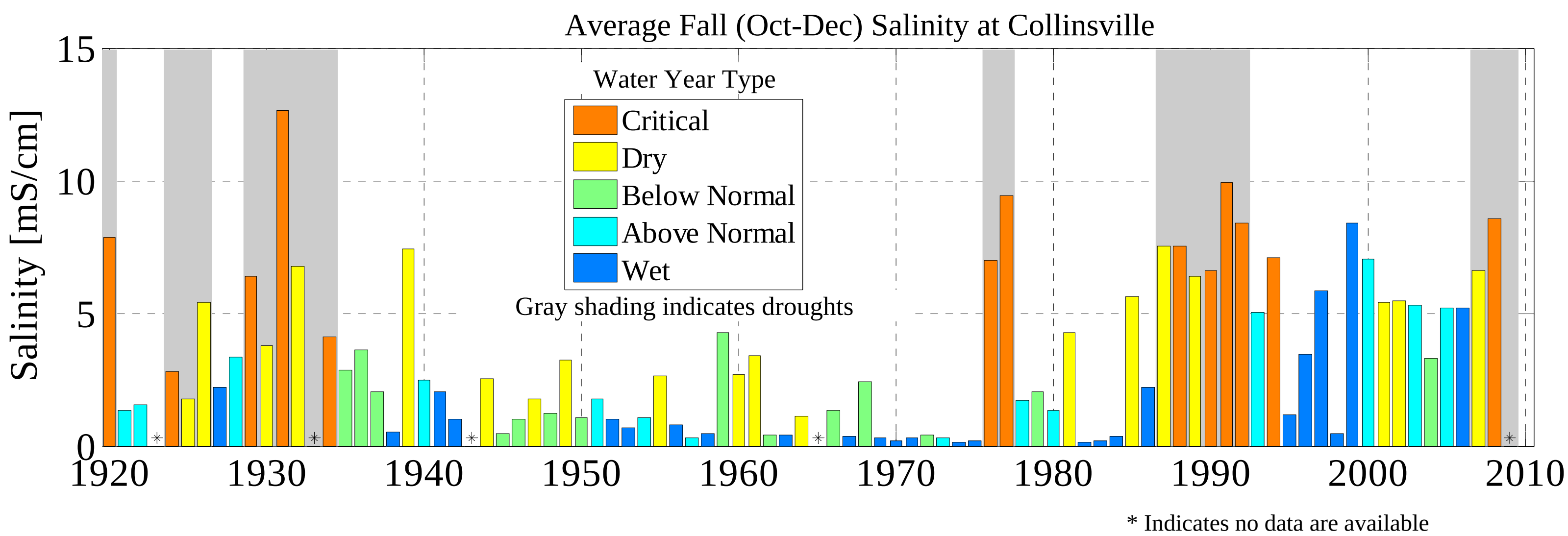
The Delta salinity regime has not changed since 1964 in other seasons



* Jersey Point electrical conductivity, microS/cm # affected by 1972 levee failure

The western Delta salinity regime since the mid-1980's remains similar to levels since the 1960's

Fall Delta salinity is high in most years since the mid-1980's



Since the mid-1980's, fall salinity in the western Delta has increased compared to earlier conditions with similar hydrological conditions; it has been high in most of the past 25 years, more than half of which have been dry. This is unlike the prior 65 years of record.

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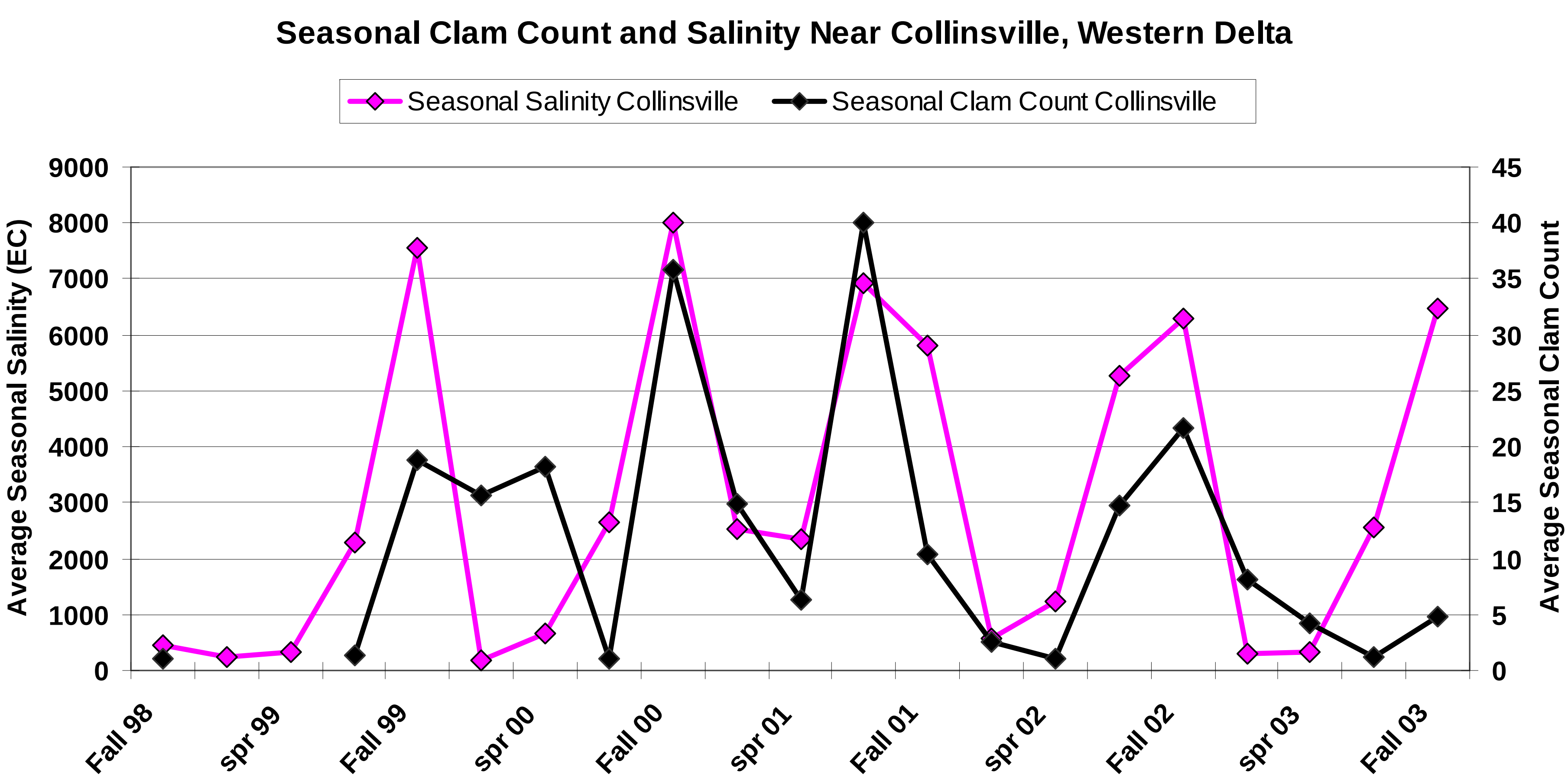
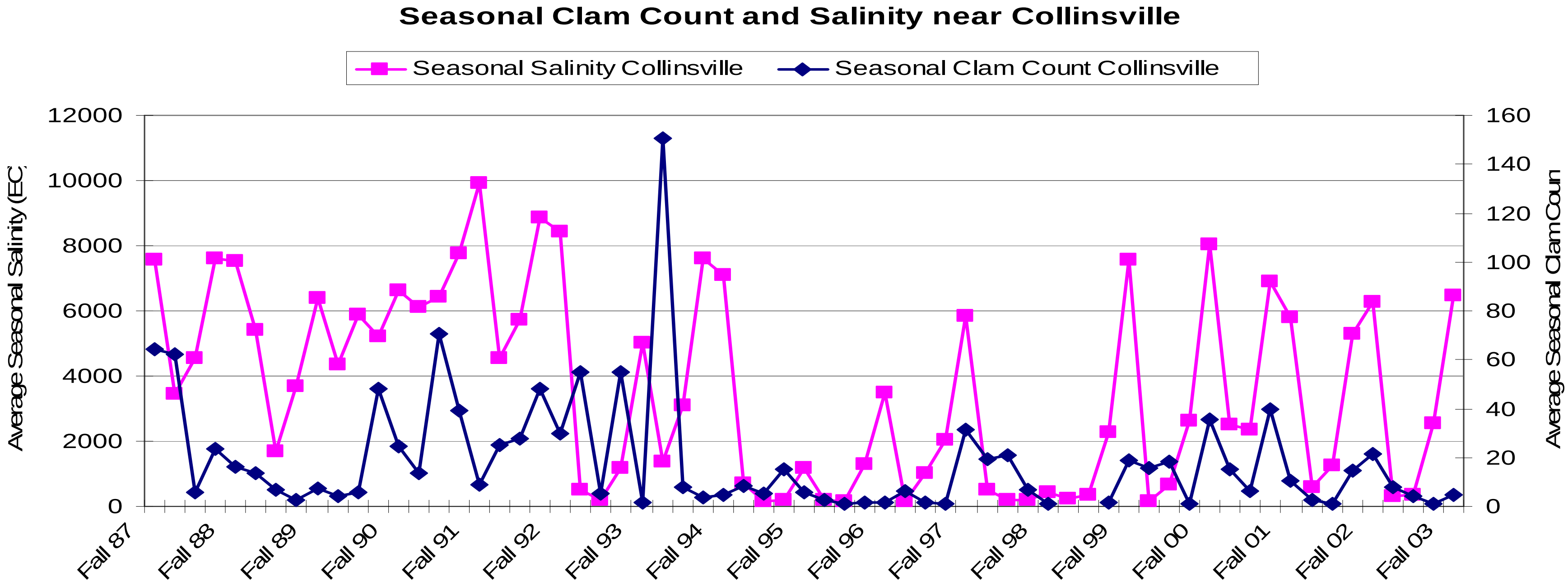
Salinity is related to several factors of importance

- *Corbula* numbers in the western Delta increase with increasing salinity
  - Impact on western Delta food web
- Delta smelt location is near the 2 part per thousand location (X2)
  - Delta smelt move upstream in response to increased salinity
- High salinity results from low outflow
  - Residence time increases (on the order of months), pollutants accumulate and remain in the system longer

Corbula numbers In Western Delta Increase when Fall Salinity Increases



Corbula numbers declined during the 1995 and 1998 wet years

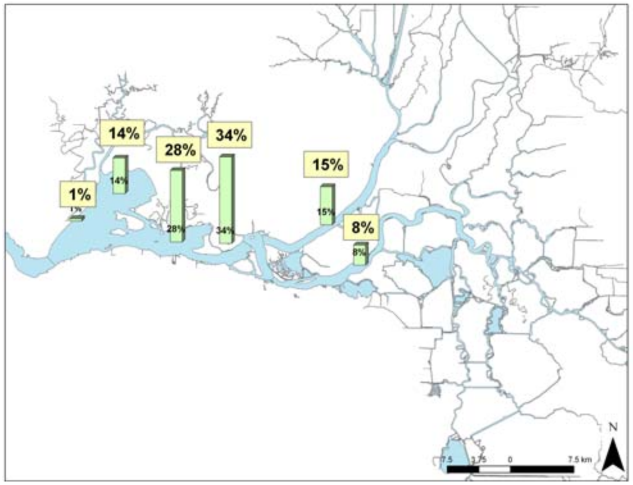


Corbula **numbers increase with salinity; numbers were low during the wet periods of 1995-2000,** ***but salinity levels were low for long periods***

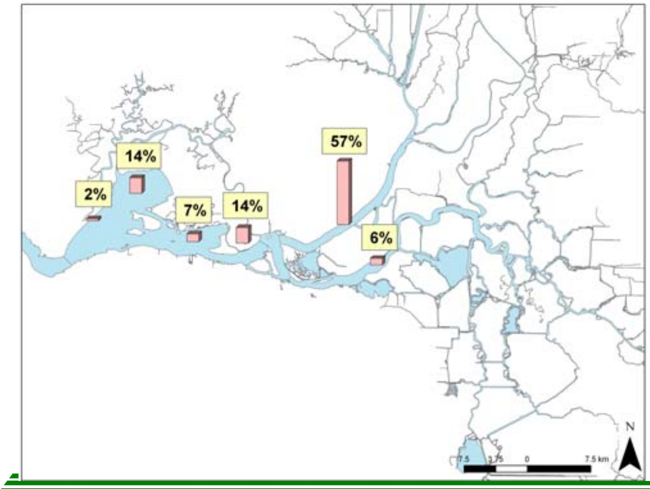
Delta smelt move eastward in the fall as salinity intrusion increases

FMWT Delta Smelt Average Catch Percentages (Oct-Dec)

Pre-1985, lower fall salinity



Post-1985, higher fall salinity



Delta smelt location is now more typically eastward as salinity levels in the fall have increased

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Fall Delta salinity change: Multiple causes

- **Upstream inflows reduced**
  - **Forestry practices**

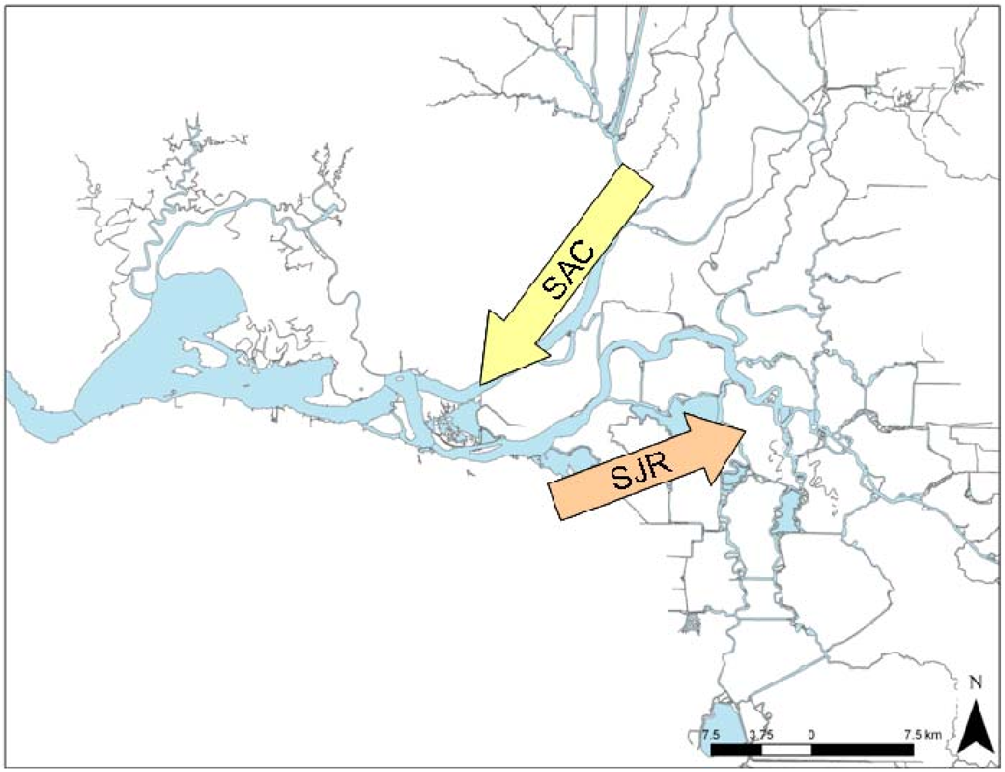
- **Upstream diversions**
  - **Land use**
  - **Rice farming practices**

- **Shift in export timing**

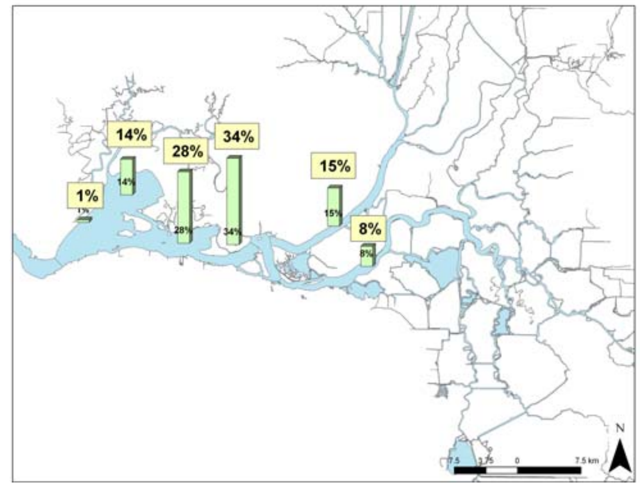
- **Reservoir releases timing: clear conflict for species protection**

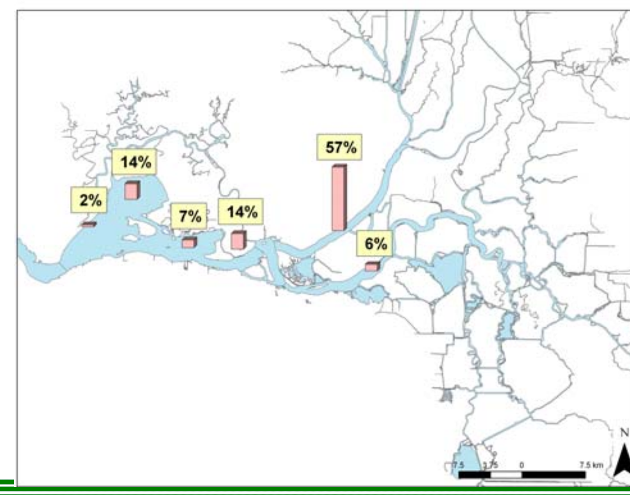
Conceptual models must include tidal flows

Fall Net Flows



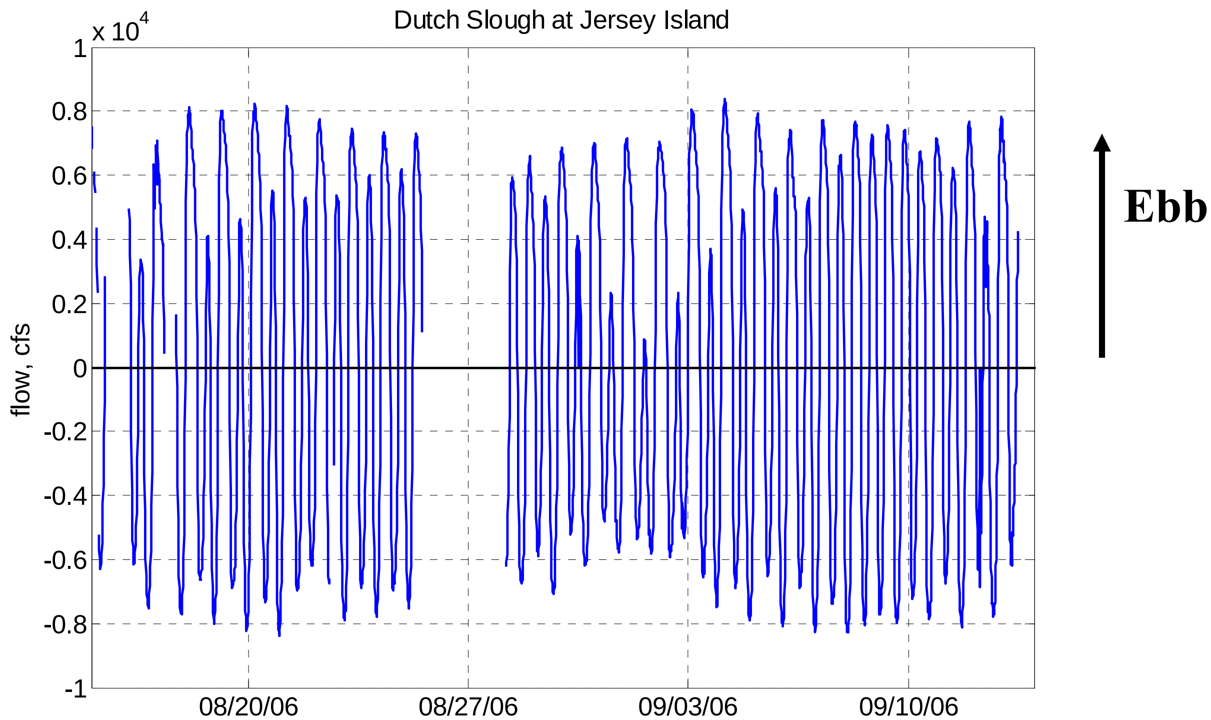
FMWT Delta Smelt Average Catch Percentages (Oct-Dec)



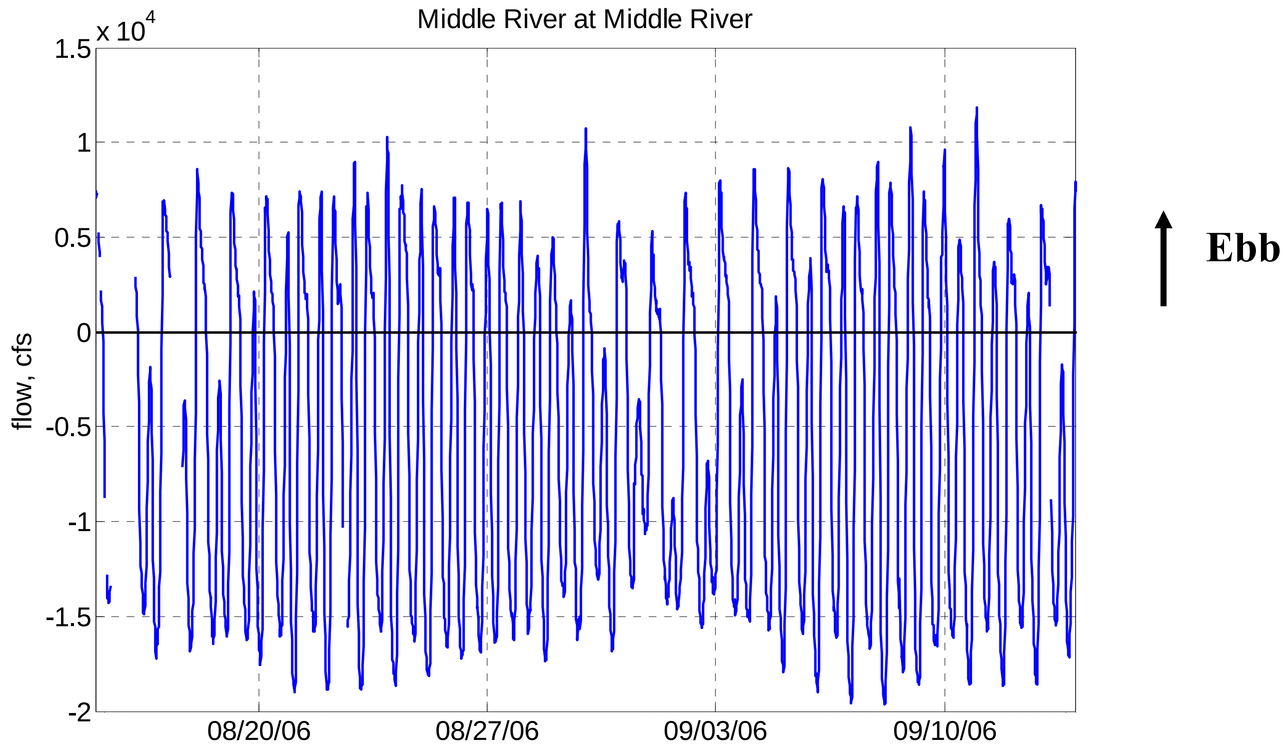


In this region, tidal flows are about 30 to 100 times net flow.

Tidal flows generally much greater than net flow



However, tidal flows can be altered

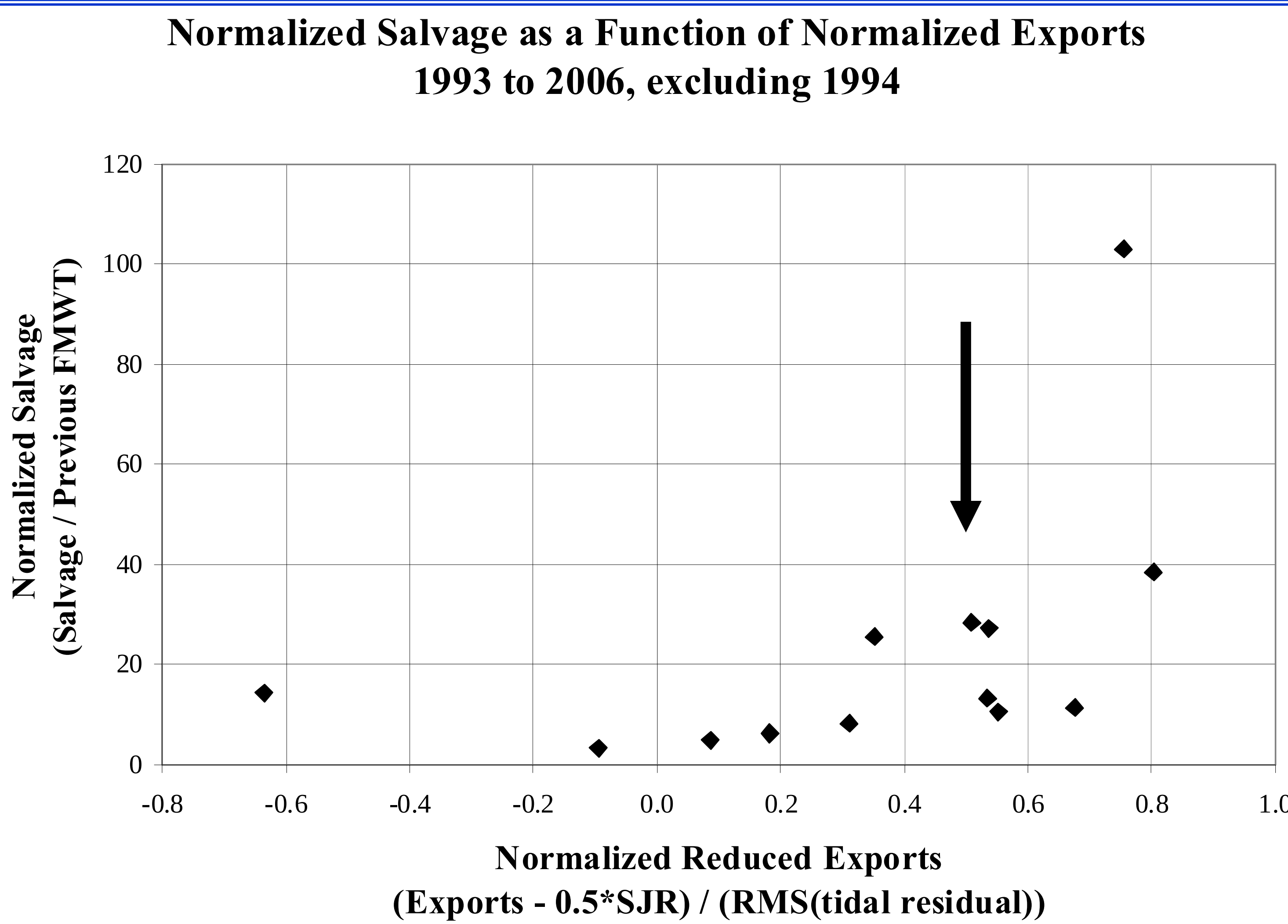


Tidal flows remain important. In this case the effect of exports is to reduce ebb tides and enhance flood tides

Salvage and export levels

- Normalized salvage: salvage should be greater if the population is greater
- The major independent variables (export levels and San Joaquin inflow) are sufficient to describe the relationships
- Normalization with tidal flow “amplitude” explains the threshold level

Threshold of large salvage at about ½ tidal amplitude



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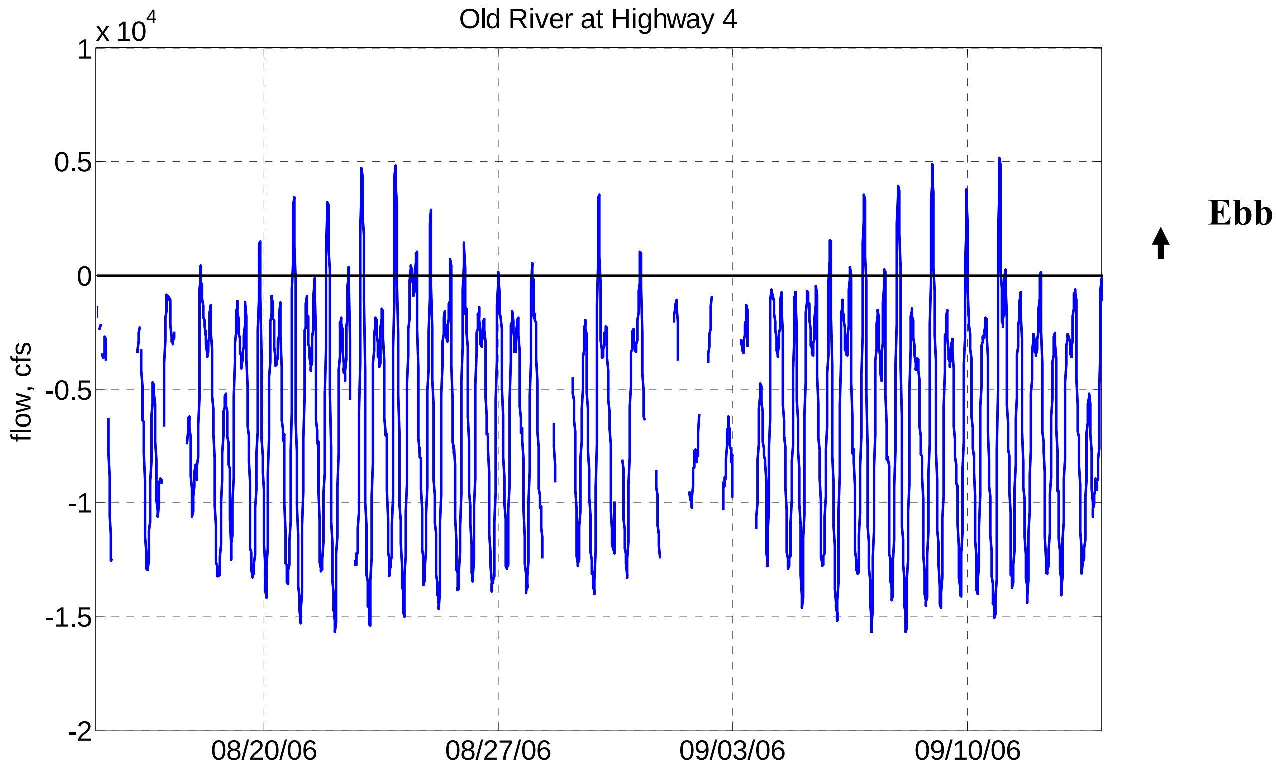
Ebb tide can be completely lost



Tidal flows remain important. In this case the effect of exports is to eliminate the ebb. Flow is nearly unidirectional with large tidal excursion.

(Exports-0.5 SJR)/RMS (OMR Residual) ≈ 0.8

Exports and OMR

Exports (reduced by 0.5 San Joaquin inflow)

1. Independent variables (OMR is dependent on unrelated factors)
2. The two significant variables (other factors are too small to be statistically important or are unknown)
3. Avoids non-physical solutions that salvage can occur when exports are zero
4. Results are statistically identical
5. Eliminates noise (uncertainty in OMR is greater than 1,000 cfs)

Threshold Level

Exports (reduced by 0.5 San Joaquin inflow) normalized to tidal flow amplitude

1. Threshold for markedly increased salvage is about ½ tidal flow amplitude
2. That level corresponds to substantial loss of ebb tide.
3. At lower levels, ebb tide is significant, tides flow dominates
4. At higher levels, ebb tide is lost, and flow is unidirectional

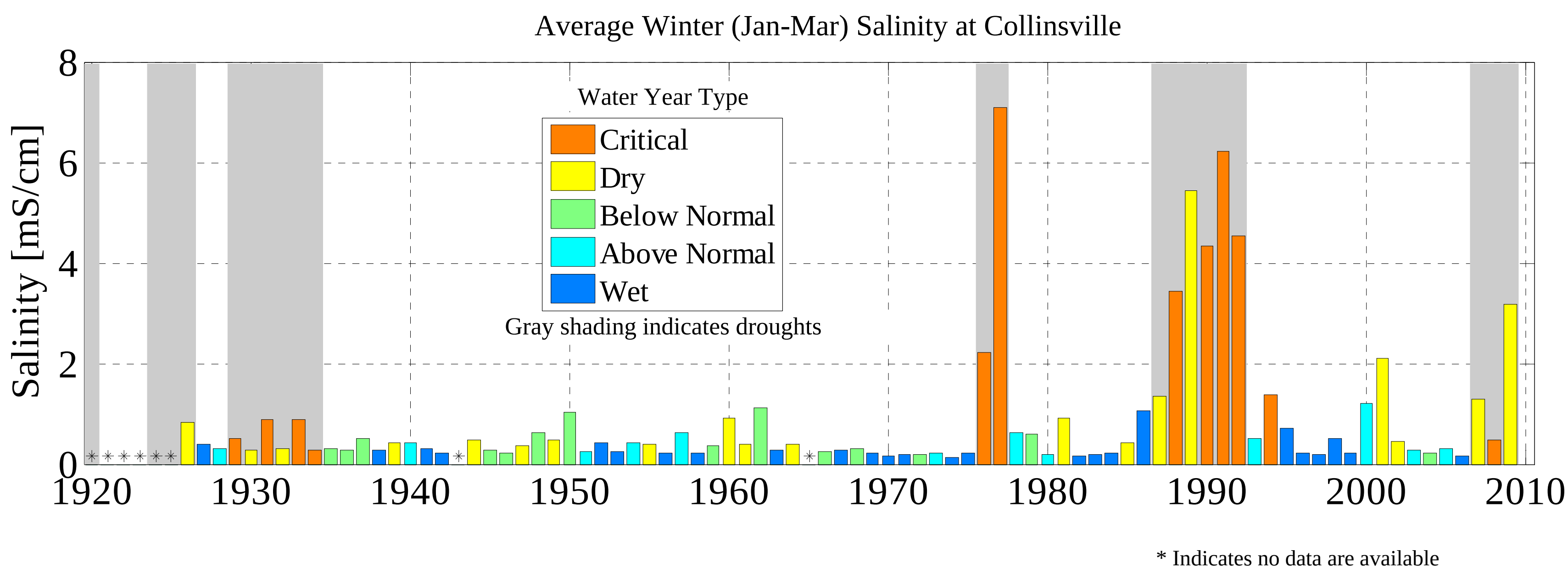
Issues to Consider

- The fall salinity regime in the western Delta shifted in the mid-1980's. While it appears to be related to a number of factors affecting delta smelt, there are tradeoffs to consider

- Tidal flows dominate in the Delta; don't obliterate all information with averages

- Use of the significant independent variables (exports and San Joaquin flow), and the threshold level suggest ways to maintain to provide protection of species at reduced water cost

Winter Delta salinity is now high in very dry years



Winter salinity in the western Delta has increased in critically dry years compared to earlier conditions

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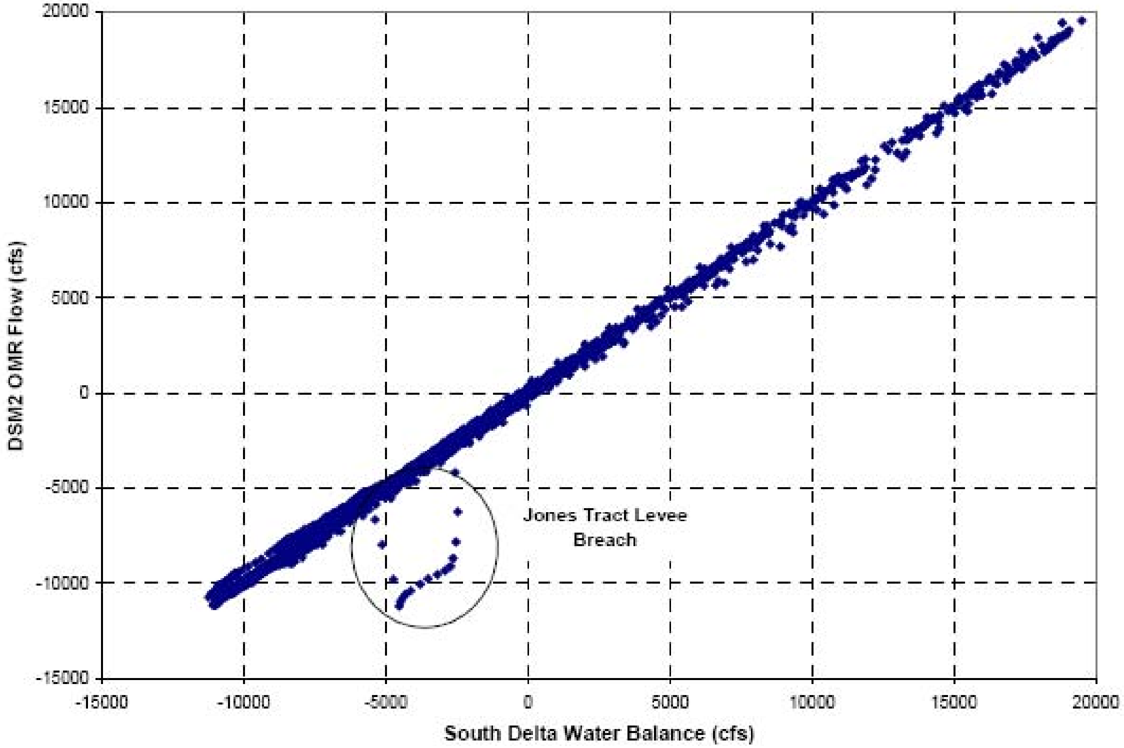

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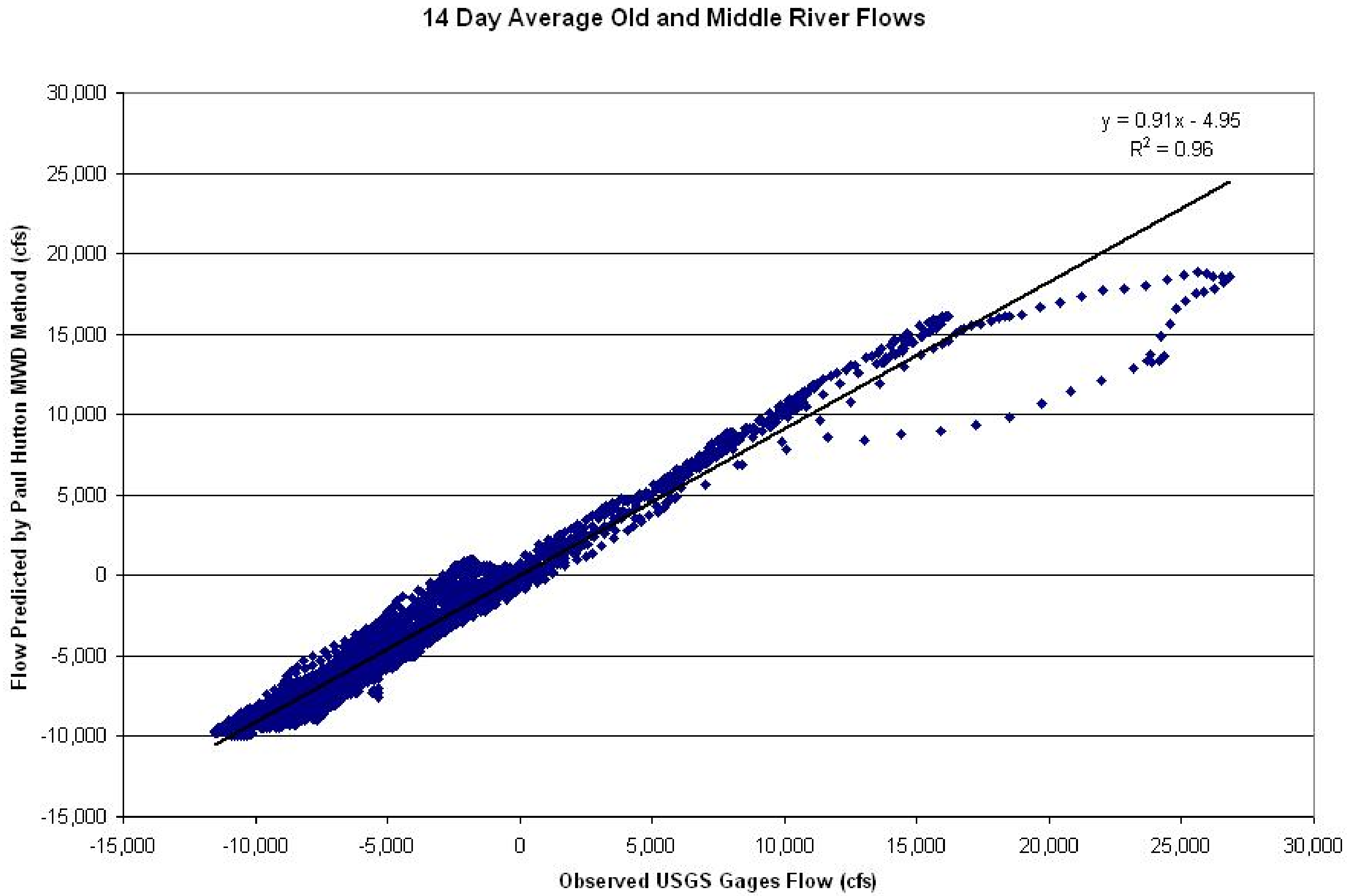
14 Day Average Old and Middle River Flows
y = 0.91x - 4.95
R^2 = 0.96
Flow Predicted by Paul Hutton MWD Method (cfs)
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-15,000
-10,000
-5,000
0
5,000
10,000
15,000
20,000
25,000
30,000
Observed USGS Gages Flow (cfs)