
Salinity, Delta Outflow and Delta Smelt Population Decline

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Delta Smelt and Salinity

Pelagic Organism Decline

- Improved population following 1994 Accord
 - Subsequent decline
- New operations since 1994
- Salinity regime change since 1990
- Relationship to exports levels?

Delta Smelt and Salinity

Delta smelt decline Findings

- No significant relationships with export levels
- Striking relationships with salinity levels
- Population indices are related to salinity and related hydrological parameters
- Possible factors are clams, food and habitat quality/size
- Exports may be part of the problem but not all—
solution lies with more than just exports and EWA uses
should be expanded

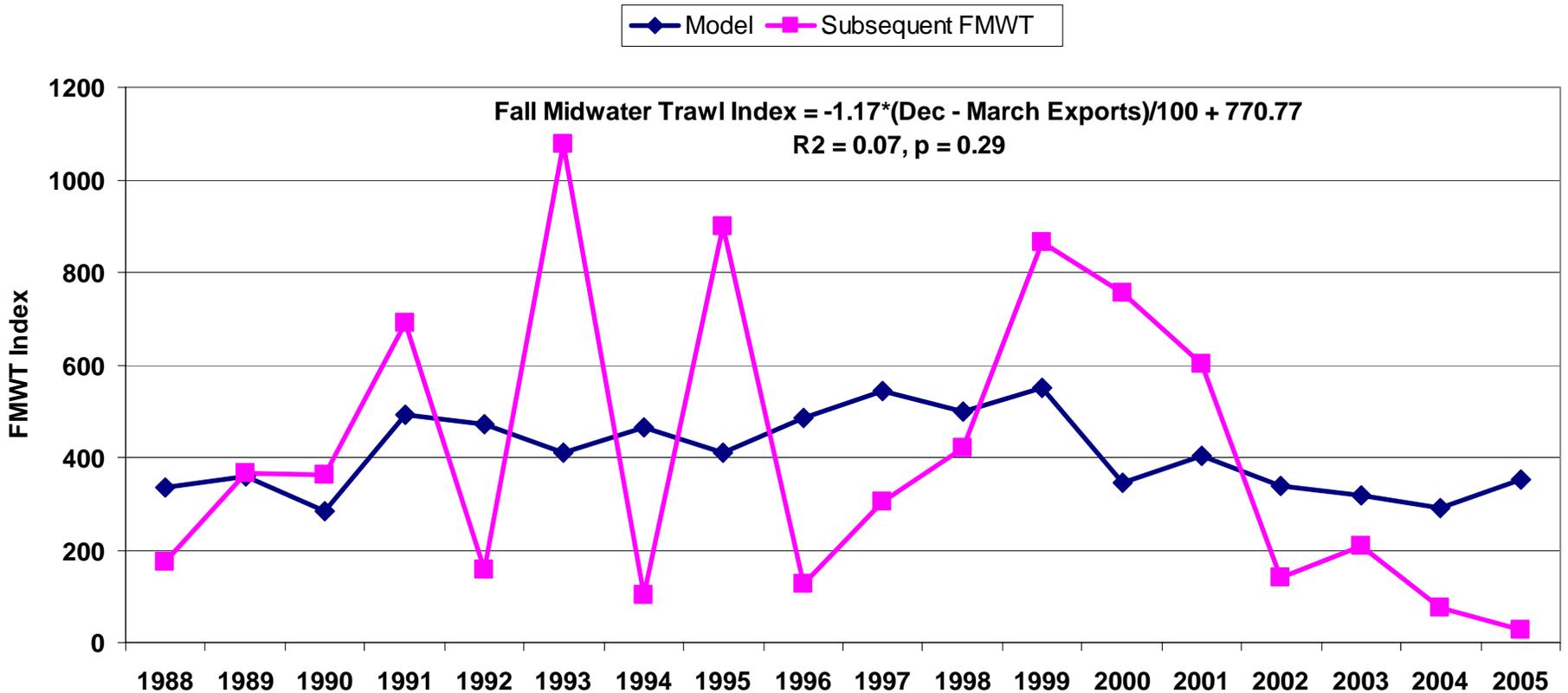
Factors considered

- Delta Smelt Abundance Indices:
 - Fall midwater trawl (FMWT)
 - Summer townet (STN)
- Exports
- Flows, salinity, clam density
- Range of time & spatial scales:
 - Decades, significant events
 - Year, season, month
 - System-wide to regional

Exports Do Not Predict Delta Smelt Abundance

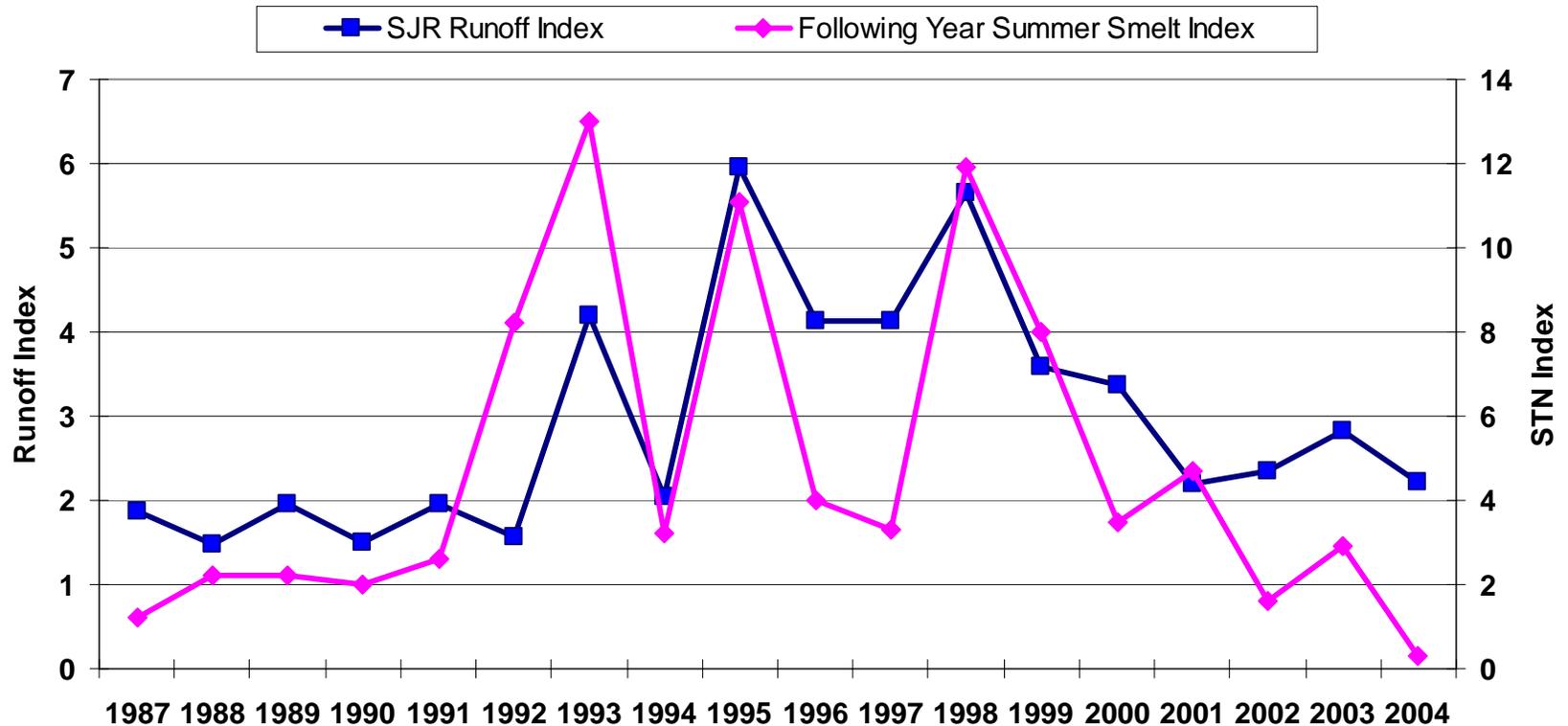
No significant relationships

Linear Regression: December - March SWP+CVP Exports Do Not Predict Subsequent Fall Delta Smelt Abundance

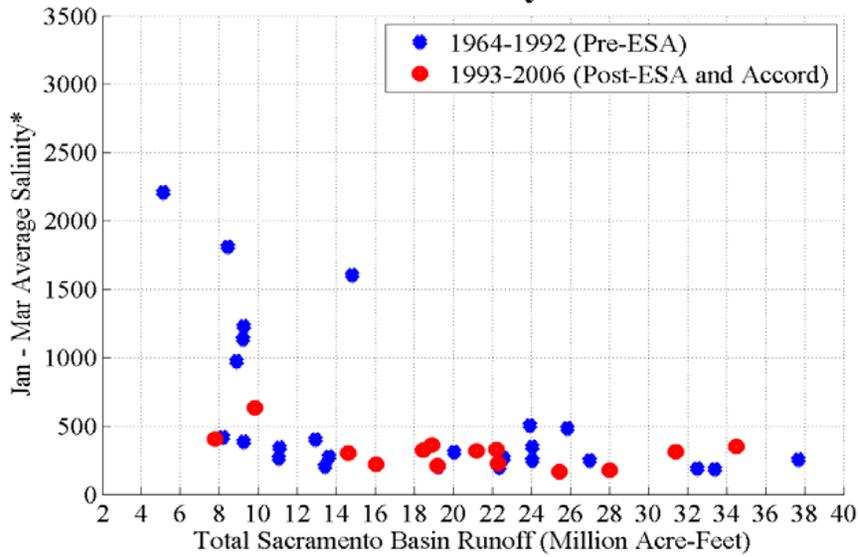


Summer Townet Index Tracks *Prior* Year Runoff Index!

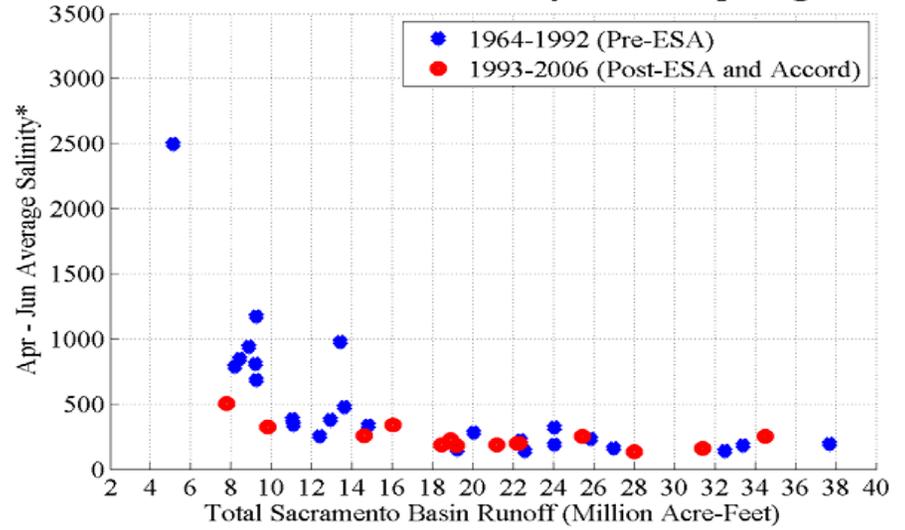
Post-Clam San Joaquin River Runoff Index and Following Year Delta Smelt Summer Townet Index (1988 - 2005)



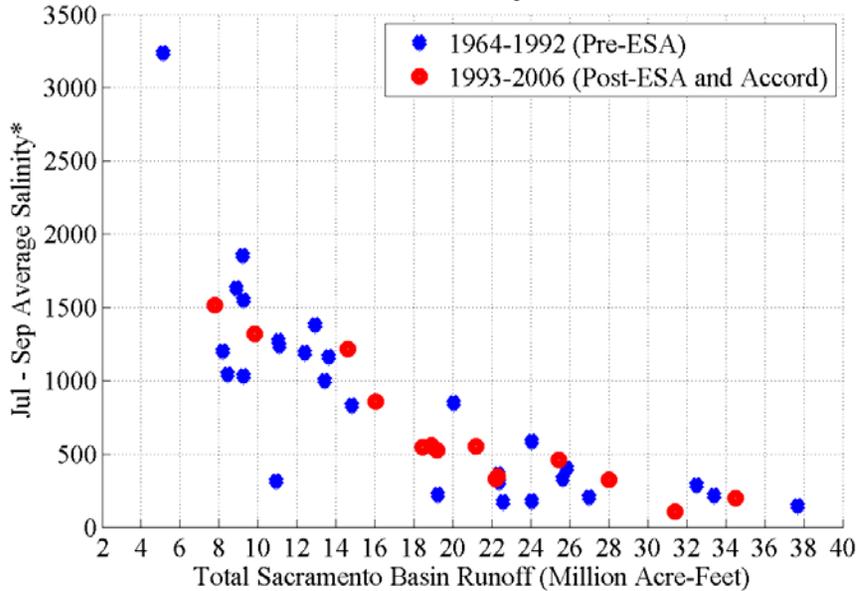
Western Delta Salinity in the Winter



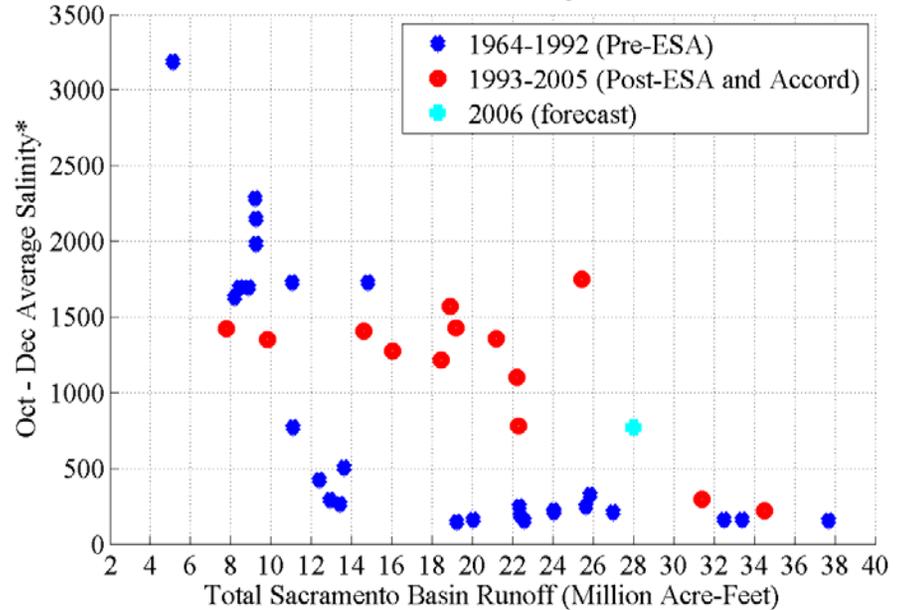
Western Delta Salinity in the Spring



Western Delta Salinity in the Summer



Western Delta Salinity in the Fall



* Salinity measured as Jersey Point electrical conductivity in microS/cm

vivaldi
27-Nov-2006

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vivaldi.m
27-Nov-2006 Iso



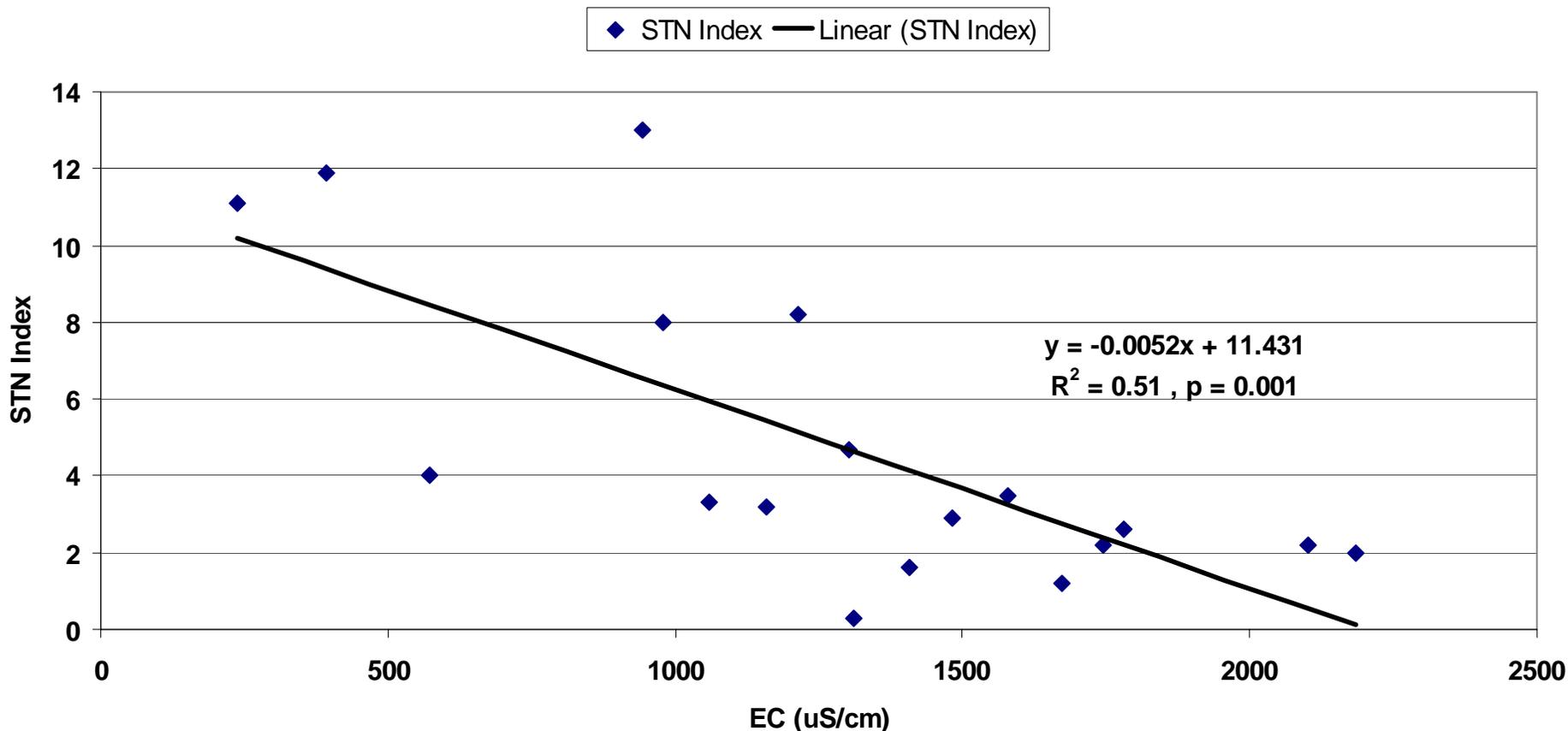
Western Delta salinity

Fall Salinity has increased since early 1990s (other seasons largely unchanged)

- Shift to summer flows for temperature control
- Rice fields flooded instead of burned
- Shift to fall pumping from spring
- Increased water use
- Decreased fall upstream flows (hydrology, diversions, power)

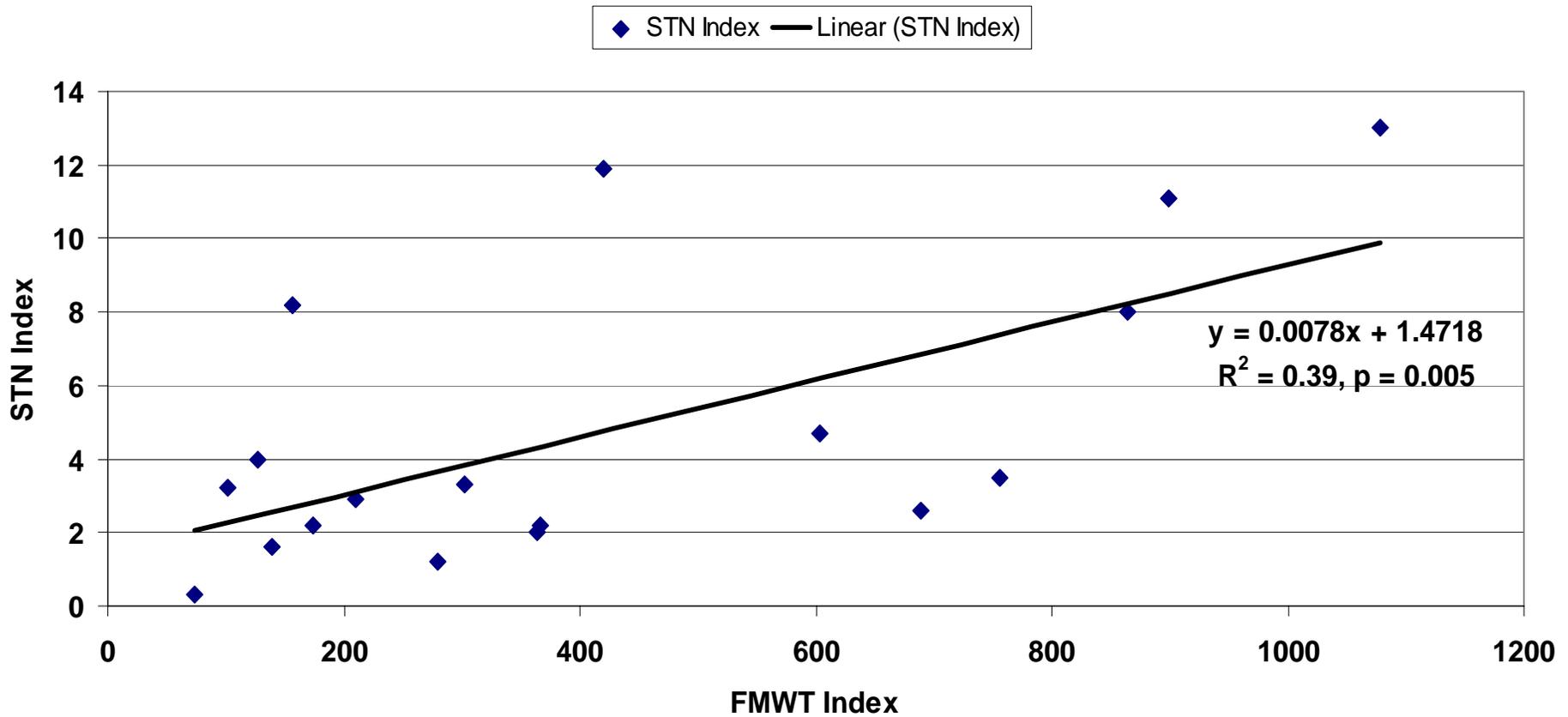
Post-Overbite Clam: Western Delta Salinity has a Very Good Correlation with Subsequent Summer Townet Index

Linear Regression: Fall Jersey Point Salinity with Subsequent Delta Smelt Summer Townet Index, 1988 - 2005: R-squared over 0.5!

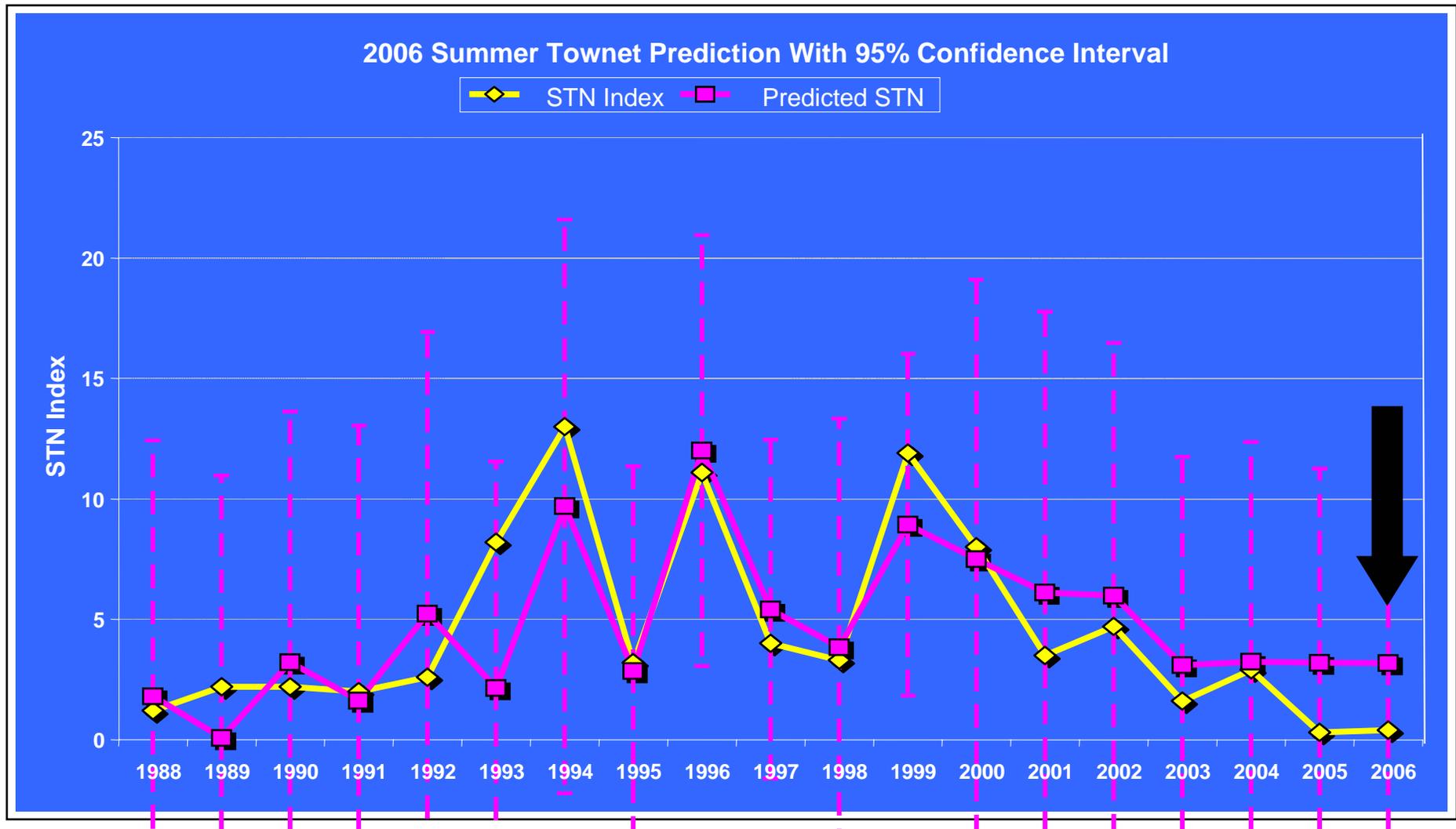


And, Summer Towntet Index Has a Good Correlation With Previous Fall Midwater Trawl Index

Delta Smelt Fall Midwater Index, 1987 - 2004, is Correlated with Subsequent Summer Towntet Index, R-squared is about 0.4!

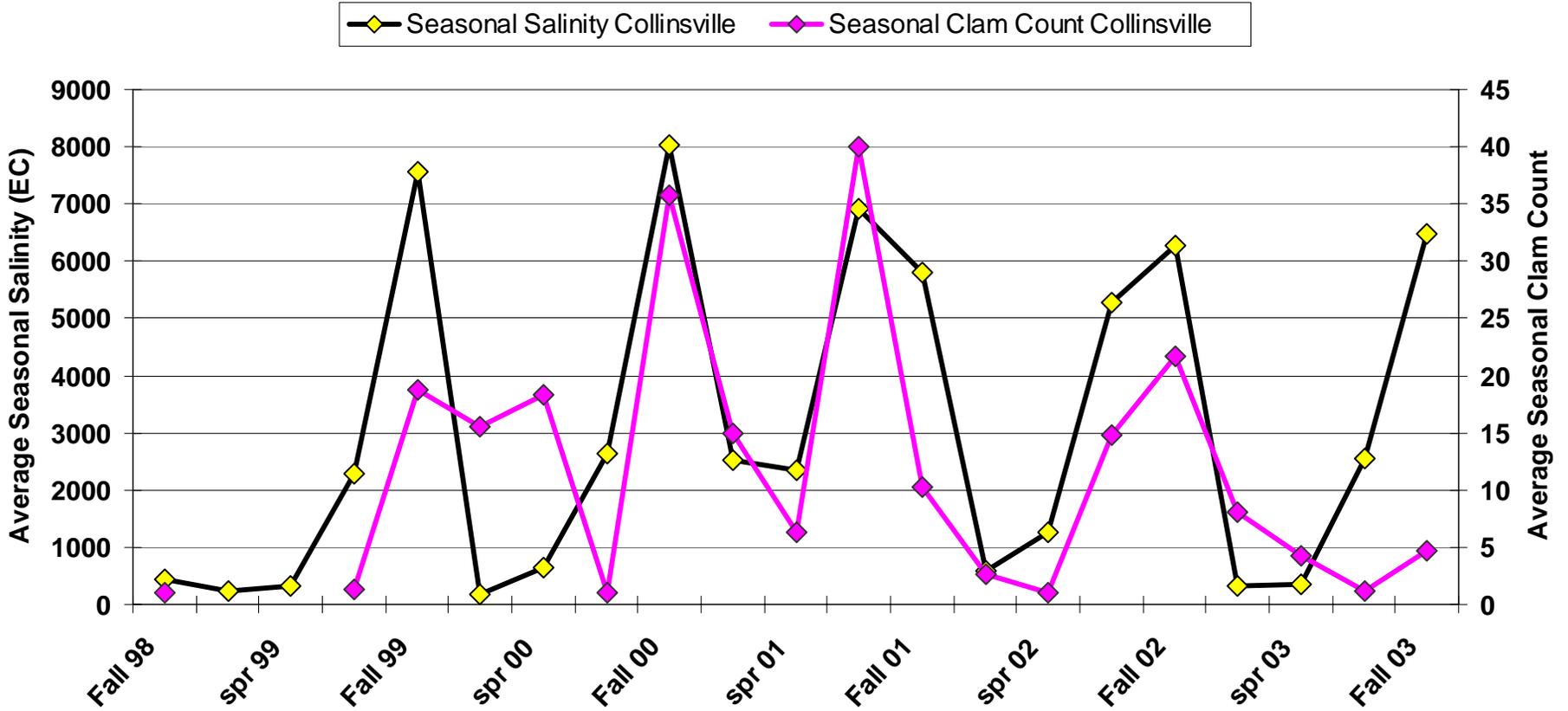


1987 – 2005, Previous FMWT and Fall Delta Salinity Relationship to Subsequent Summer Townet Index



Clam Numbers In Western Delta track Salinity!

Seasonal Clam Count and Salinity Near Collinsville, Western Delta

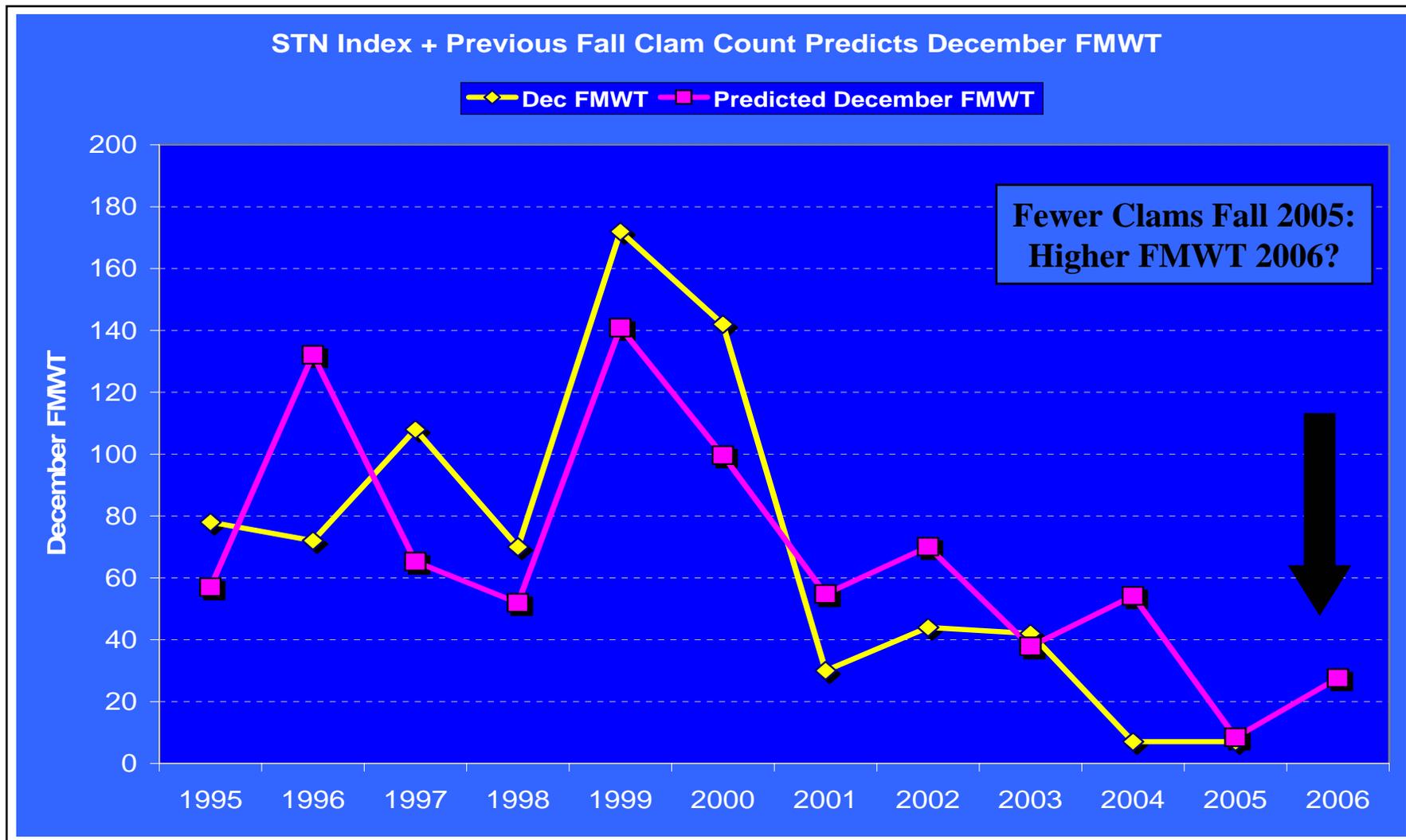


Possible Story – High Fall Salinity A Factor in Decline

- Delta salinity increases
- Overbite Clam shifts to fall recruitment
- *Food web disrupted fall, winter ?*
- *Habitat quality and size reduced in fall?*
- DWR results show Fall habitat quality declined
- Delta smelt develop gonads in fall (Bennett, 2005)
 - *Reproduction suffers ?*
 - *Result is lower STN Index ?*
- *Reduced or poor habitat results in greater susceptibility to other factors (toxics, exports)?*

STN Index + Prior Clam Count tracks Dec. FMWT

$$r^2=0.56, p = 0.009$$



Significant Correlations

- ***Salinity and runoff index are related***
 - *(fall regime has changed since early 1990's)*
- ***Clam biomass/numbers and salinity are related***
- ***FMWT and subsequent STN and spring salvage are all related***
 - *(high adult population in the fall results in high spring salvage and high summer population)*

Significant Correlations

- *STN related to prior year runoff index*
- *STN strongly related to prior fall salinity*
- *STN related to prior fall salinity/ FMWT (!)*
- *FMWT related to prior STN / clam density (!)*

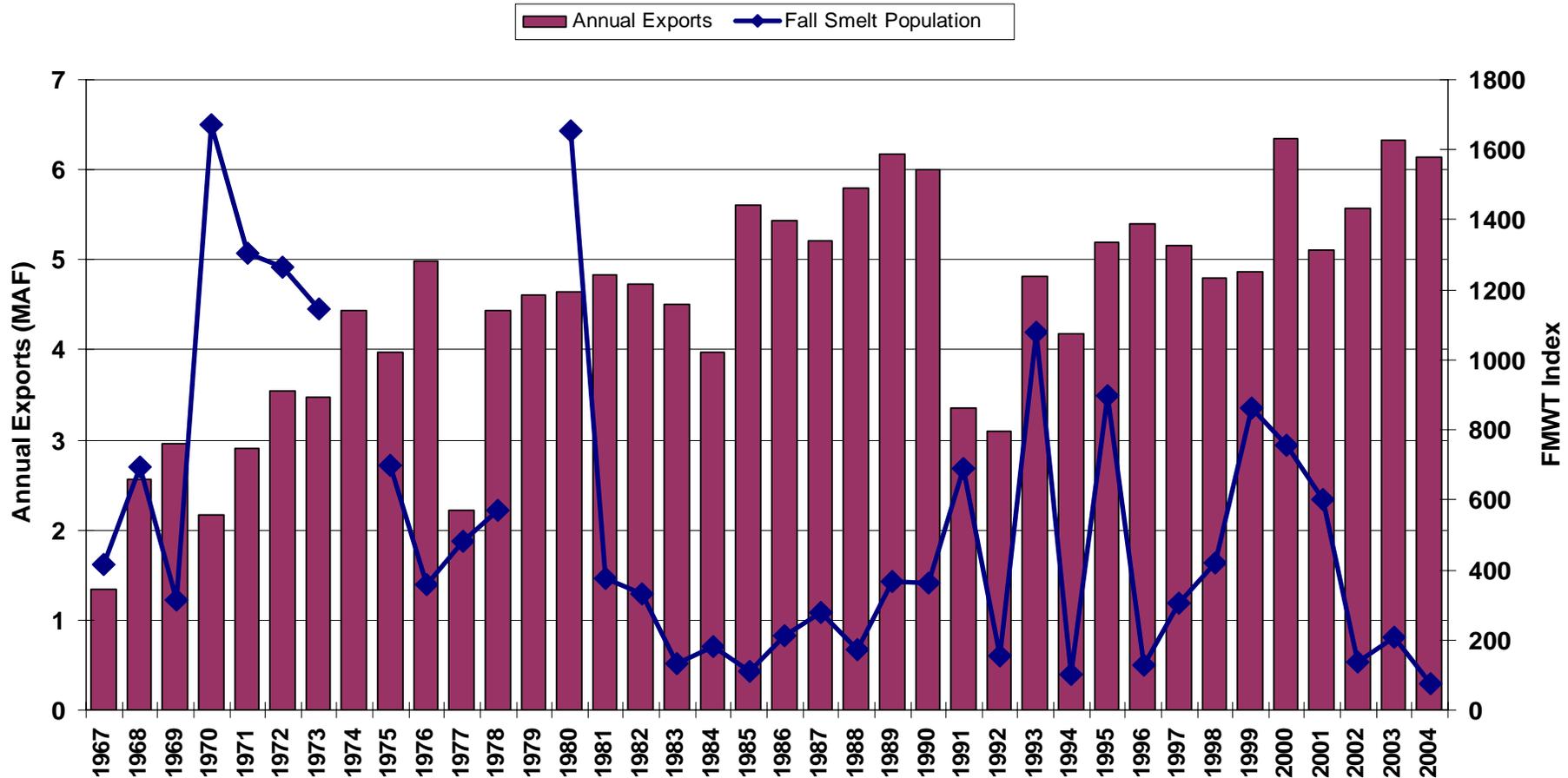
Summary:

- Western Delta salinity:
 - Fall Salinity has increased since 1990's
 - Other Seasons largely unchanged
- Delta smelt numbers correlated with salinity
 - Clams and Salinity strongly related
 - Fall salinity /FMWT index related to STN index
 - STN index/Clams related to December FMWT
- Export relationship is not significant
- Use EWA for salinity control, not just exports



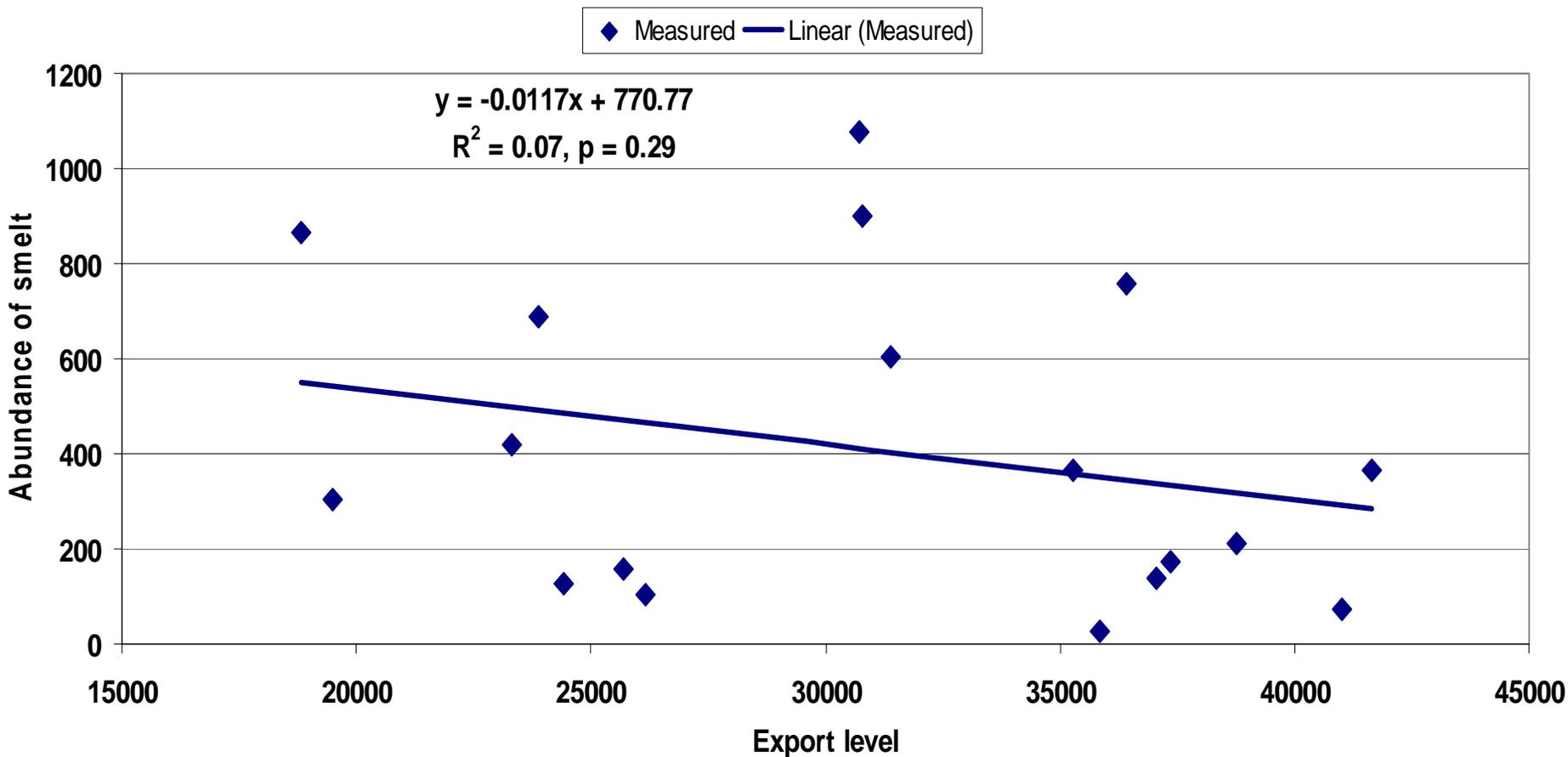
Since 1967, water exports from the Delta have increased while fish numbers decreased, but there is no pattern

Annual Exports and Delta Smelt Fall Midwater Trawl Abundance Index, 1967 - 2004

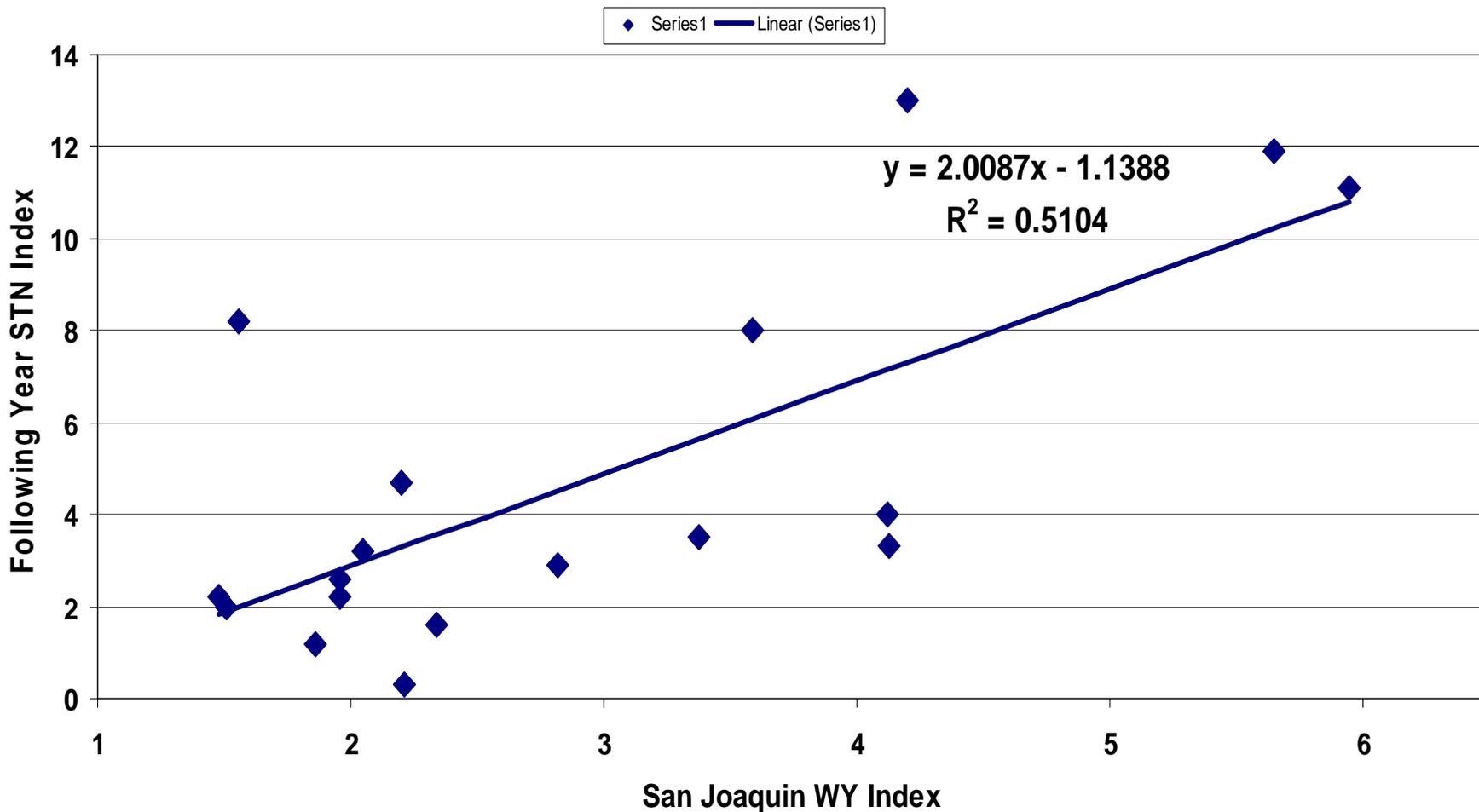


The relationship between exports and smelt abundance is very poor

Abundance of Delta Smelt compared to Winter Exports, 1988 - 2005

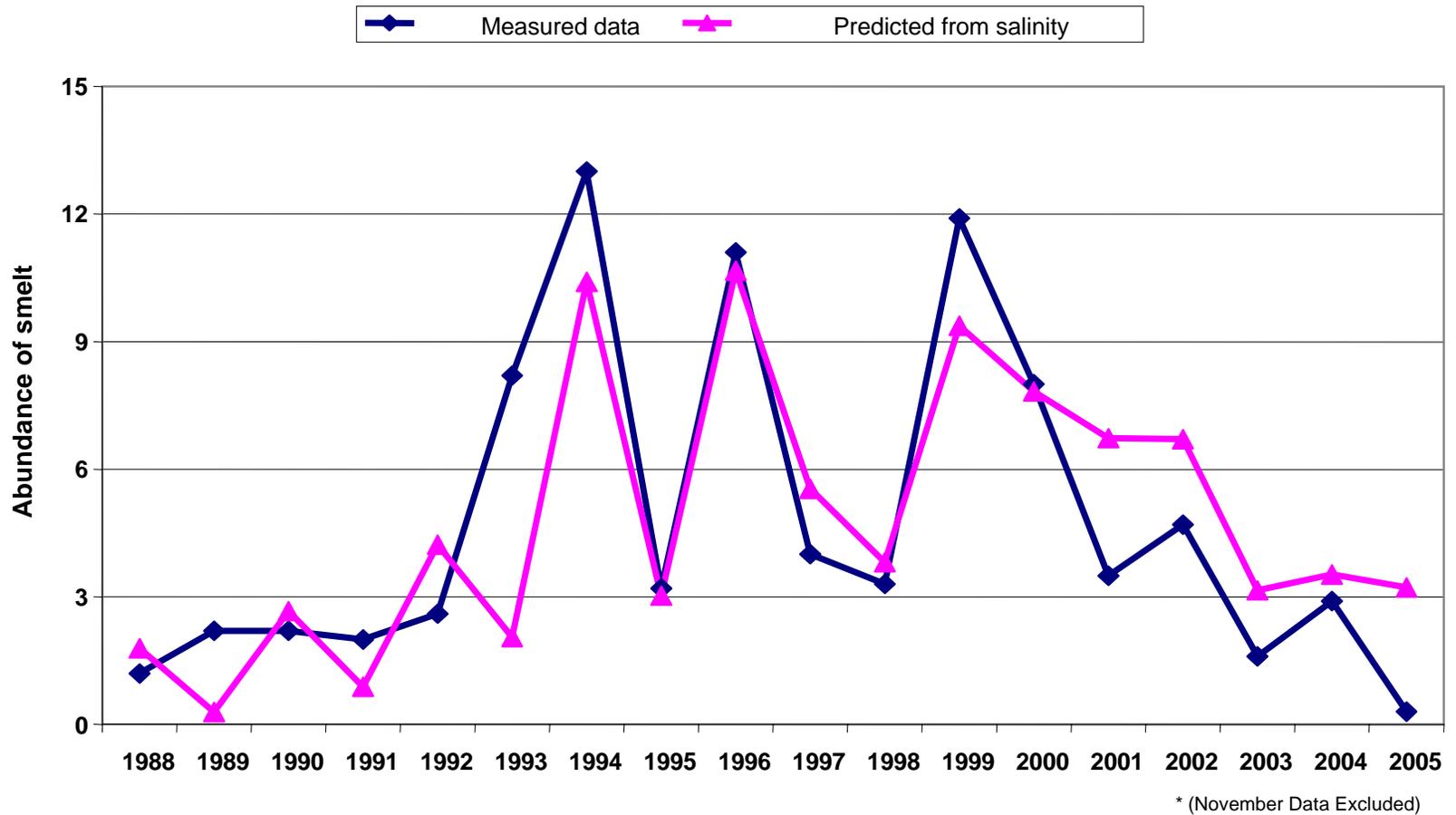


San Joaquin River Water Year Index (1987 - 2004) vs. Delta Smelt Summer Townet Index the Following Year

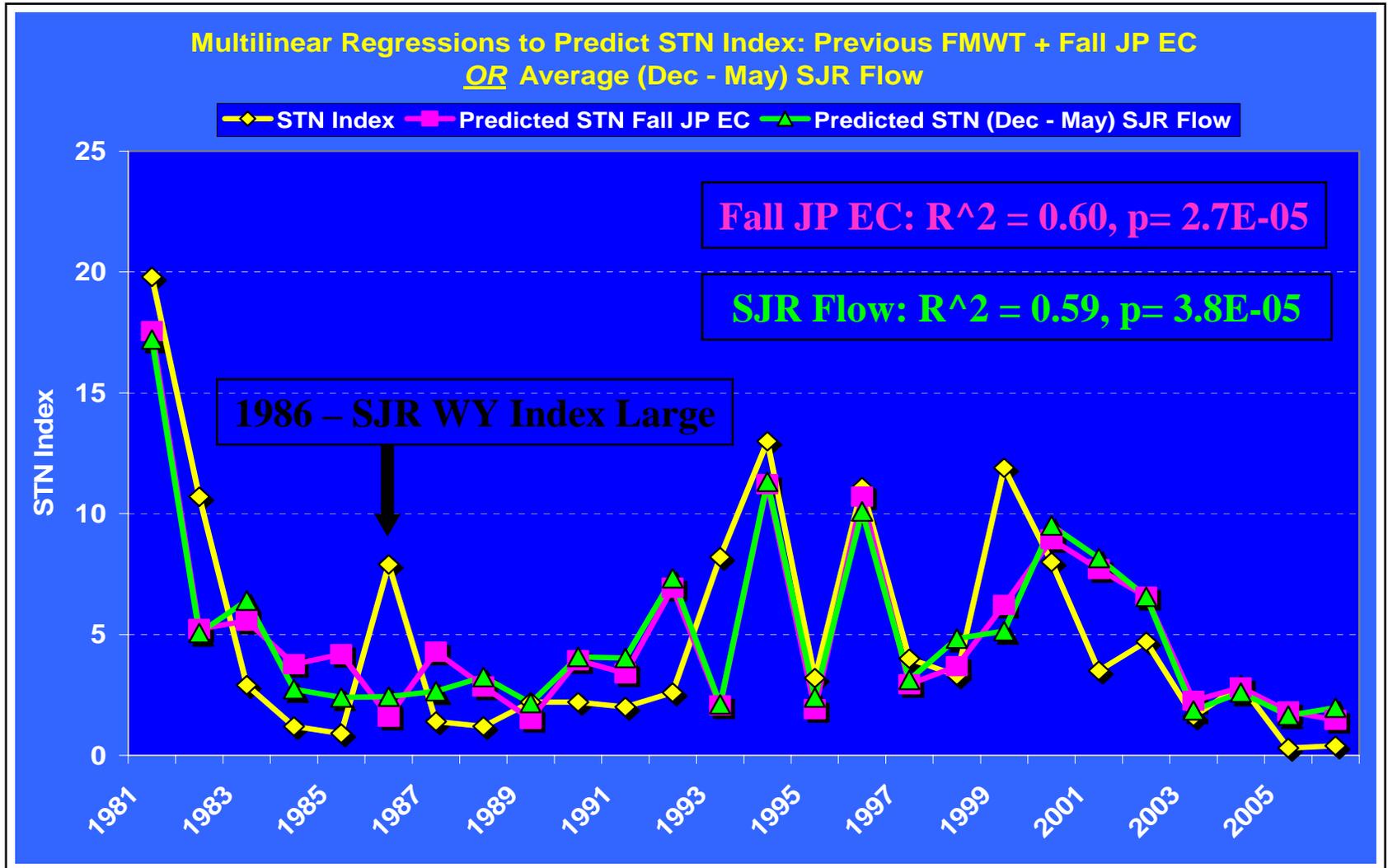


Delta Smelt Summer Abundance Can Be Predicted Closely Using Previous Fall Delta Salinity

Summer Townet Index Predicted From Previous Fall Salinity and Fall abundance



STN Index Predictions : Can Interchange Fall JP EC And Average (Dec – May) SJR Flow



Increases in Clam Numbers in western Delta Are Tracking Recent Increases in Fall Salinity

