SAV (Submerged Aquatic Vegetation) and Flow Rates in the Delta

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Egeria from South Coast Lakes Photo by Mary Pfauth Center for Lakes and Reservoirs, Portland State University

Questions

- What is the distribution of submerged aquatic vegetation in the Delta?
- Is SAV co-located with low water velocity?
- Is SAV co-located with clear water?
- Has the invasion of SAV decreased turbidity?

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Submerged Aquatic Species (SAV) in the Delta

Brazilian waterweed
Egeria densa

Eurasian watermilfoil
Myriophyllum spicatum

Curlyleaf pondweed
Potamogeton crispus

Carolina fanwort
Cabomba caroliniana

Dominant Invasive Species

Sago
Stuckenia pectinata

Coontail
Ceratophyllum demersum

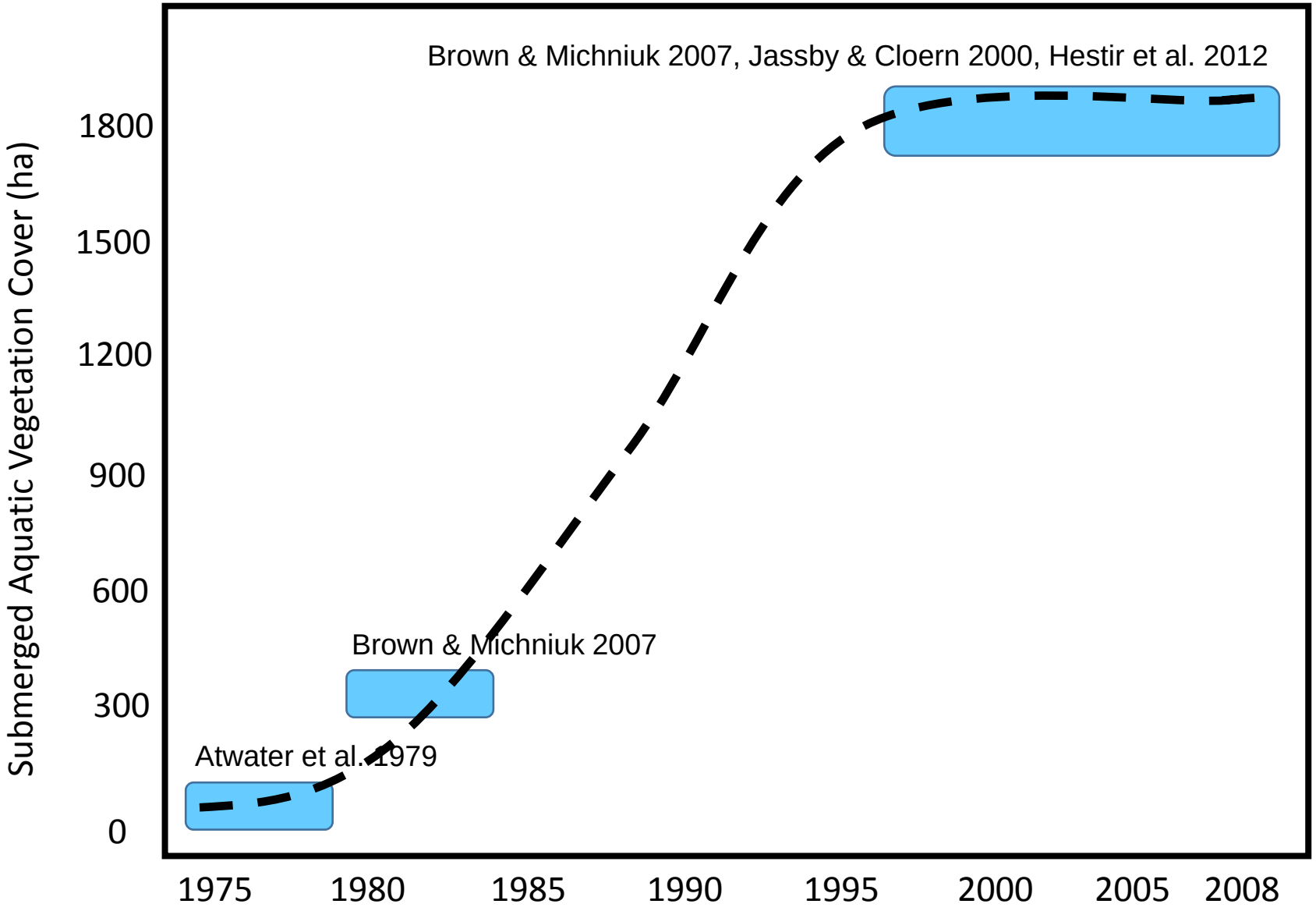
American pondweed
Potamogeton nodosus

Elodea
Elodea canadensis

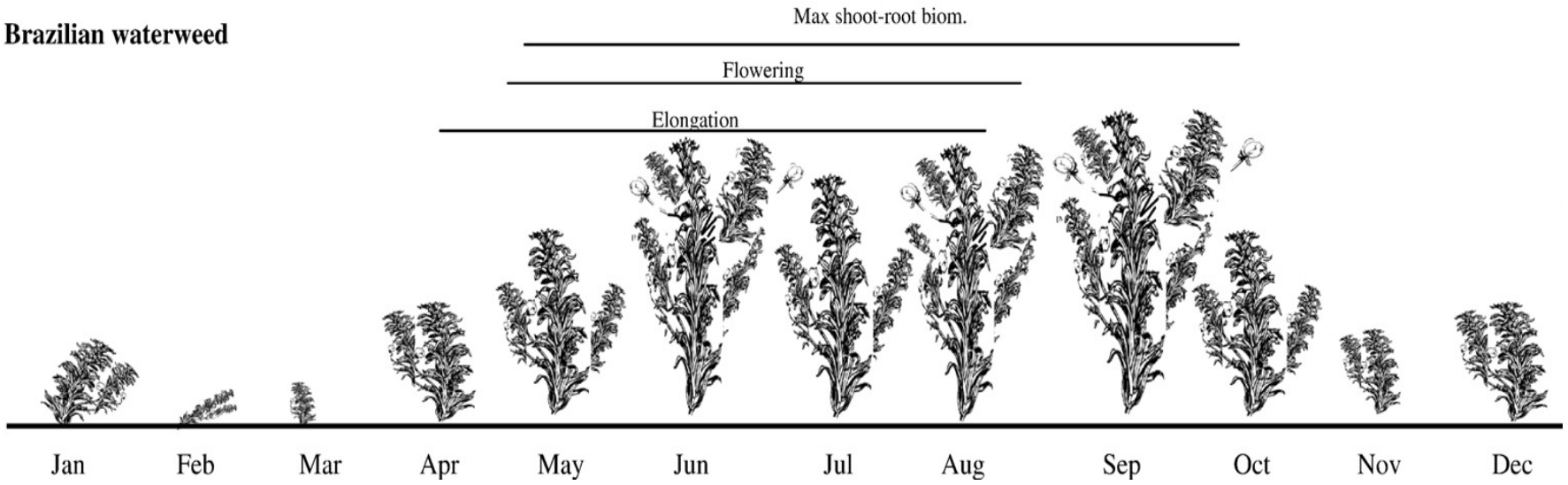
Dominant Native Species

Worst Weeds
Brazilian Waterweed
(*Egeria densa*)
Invaded in late 1980s
(Cohen and Carlton 1995)

Reconstructing the SAV Invasion Curve



What makes *Egeria densa* (Brazilian Waterweed) so competitive?



1. Year around growth; winter growth promotes early spring canopy development
2. Leaves distributed over full length of stems (maximize photosynthesis)
3. Bimodal summer growth peaking in June and September
4. Vegetative and flowering reproductive potential

What is the distribution of submerged aquatic vegetation?

Hymap airborne Hyperspectral data

126 bands, 400-2500nm range

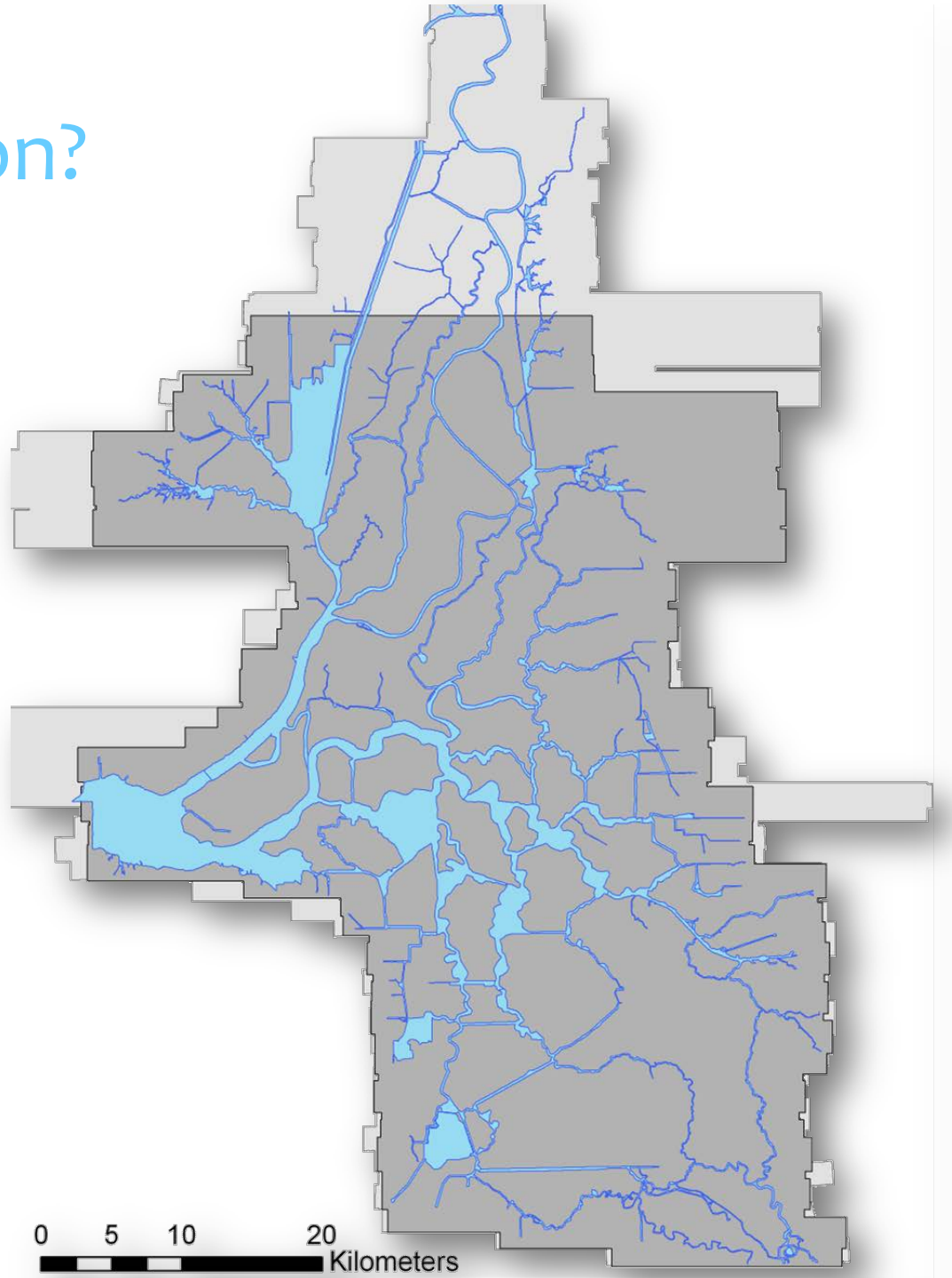
3m x 3m nominal pixel size

- June 2004-2007
- 64 flightlines

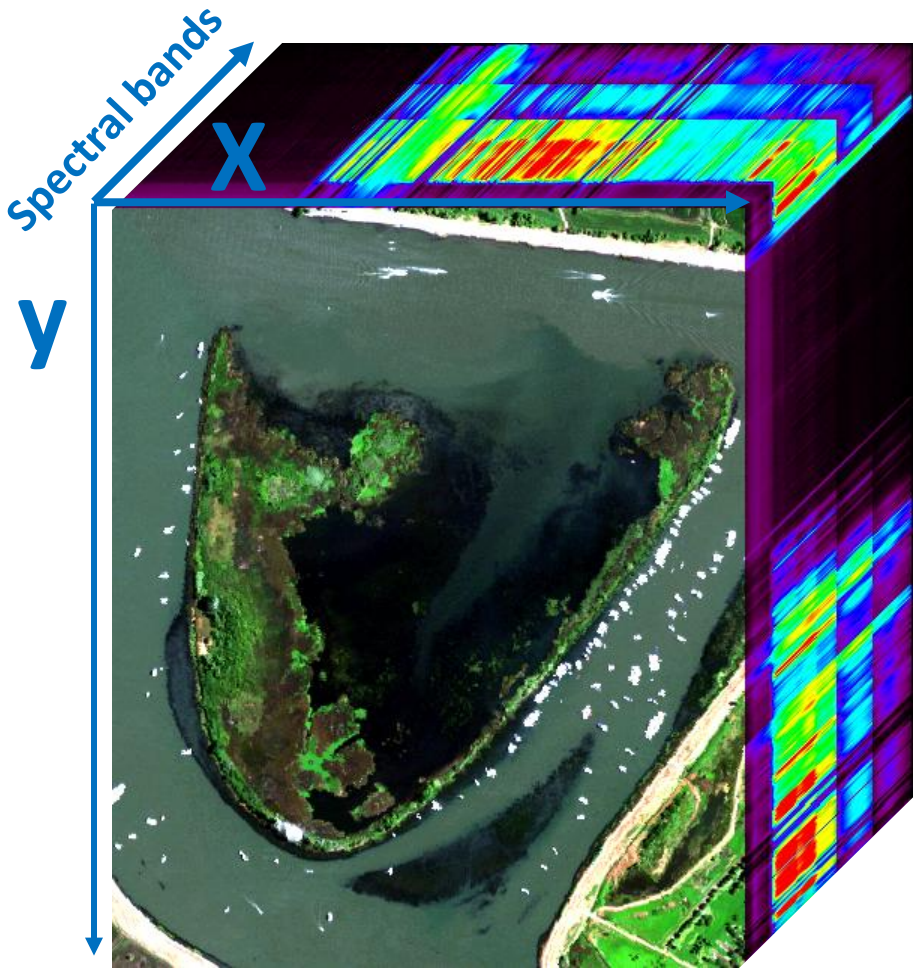
  ~3,000 km²
- June 2008

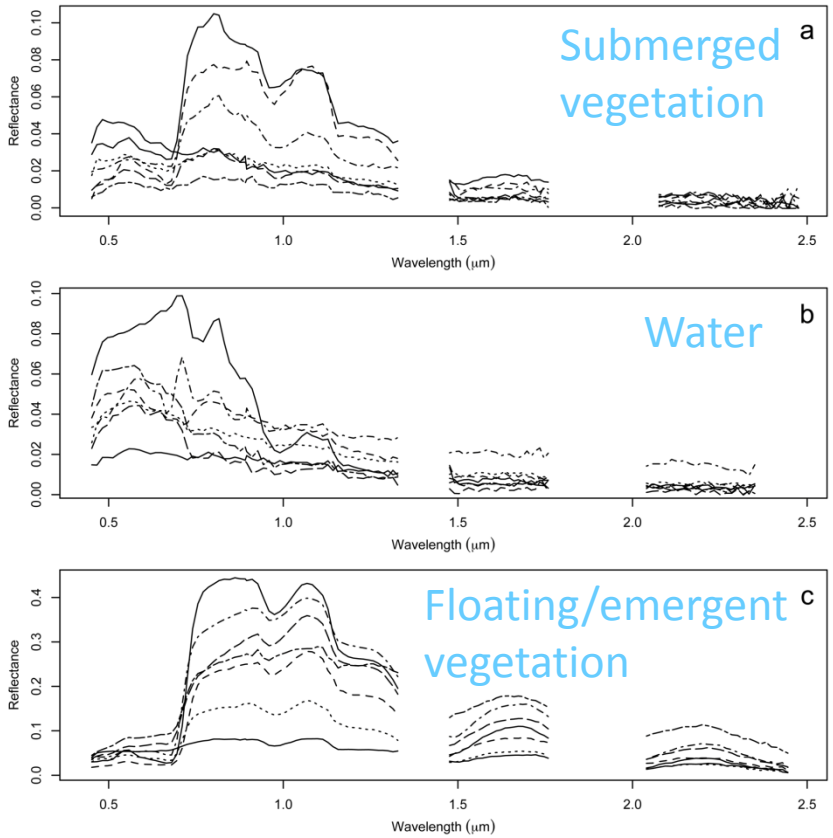
  47 flightlines

  ~2,400 km²



Mapping SAV: Why use hyperspectral remote sensing?



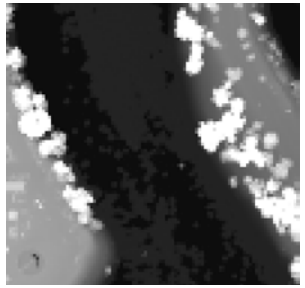


Hestir et al., 2012, *IEEE* JSTARS; Hestir et al., 2008, *RSE*

Mapping Methods

Data Collection

Hyperspectral flightline



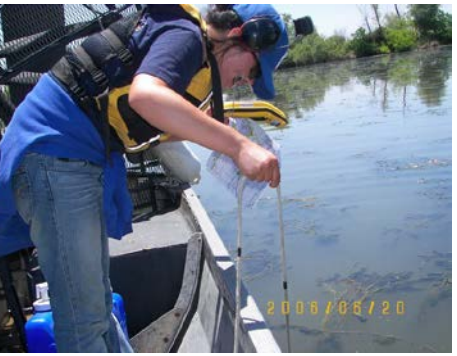
LiDAR First Return DEM

Ground Reference Data

Image processing and calibration

Classification
- *band indexes*
- *spectral mixture analysis*
- *spectral angle mapping*
- *continuum removal*

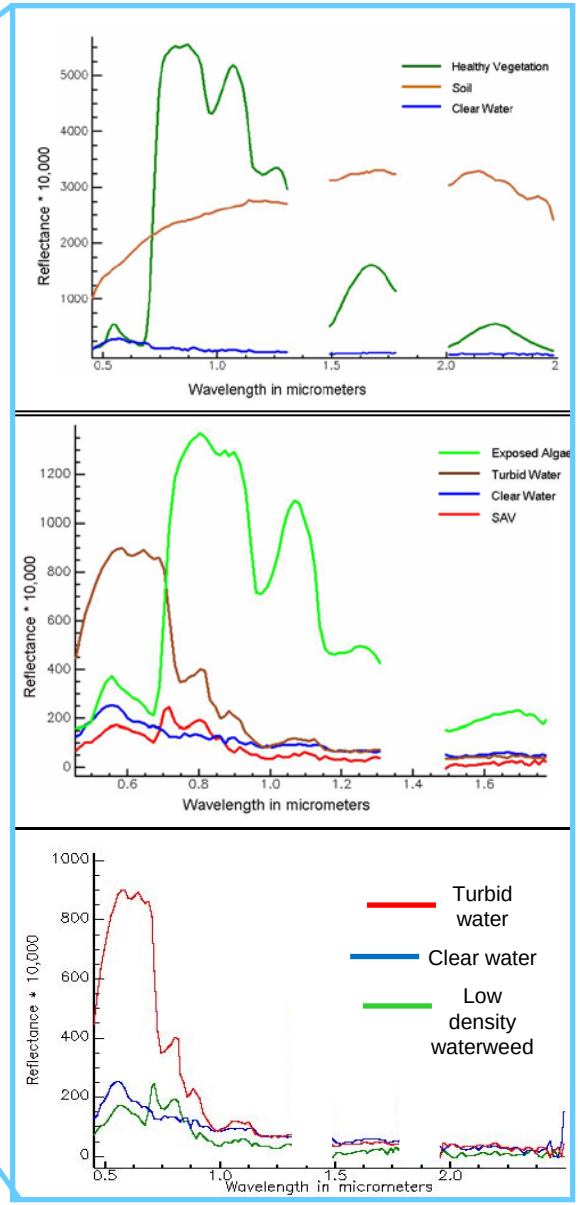
Ground Reference Data



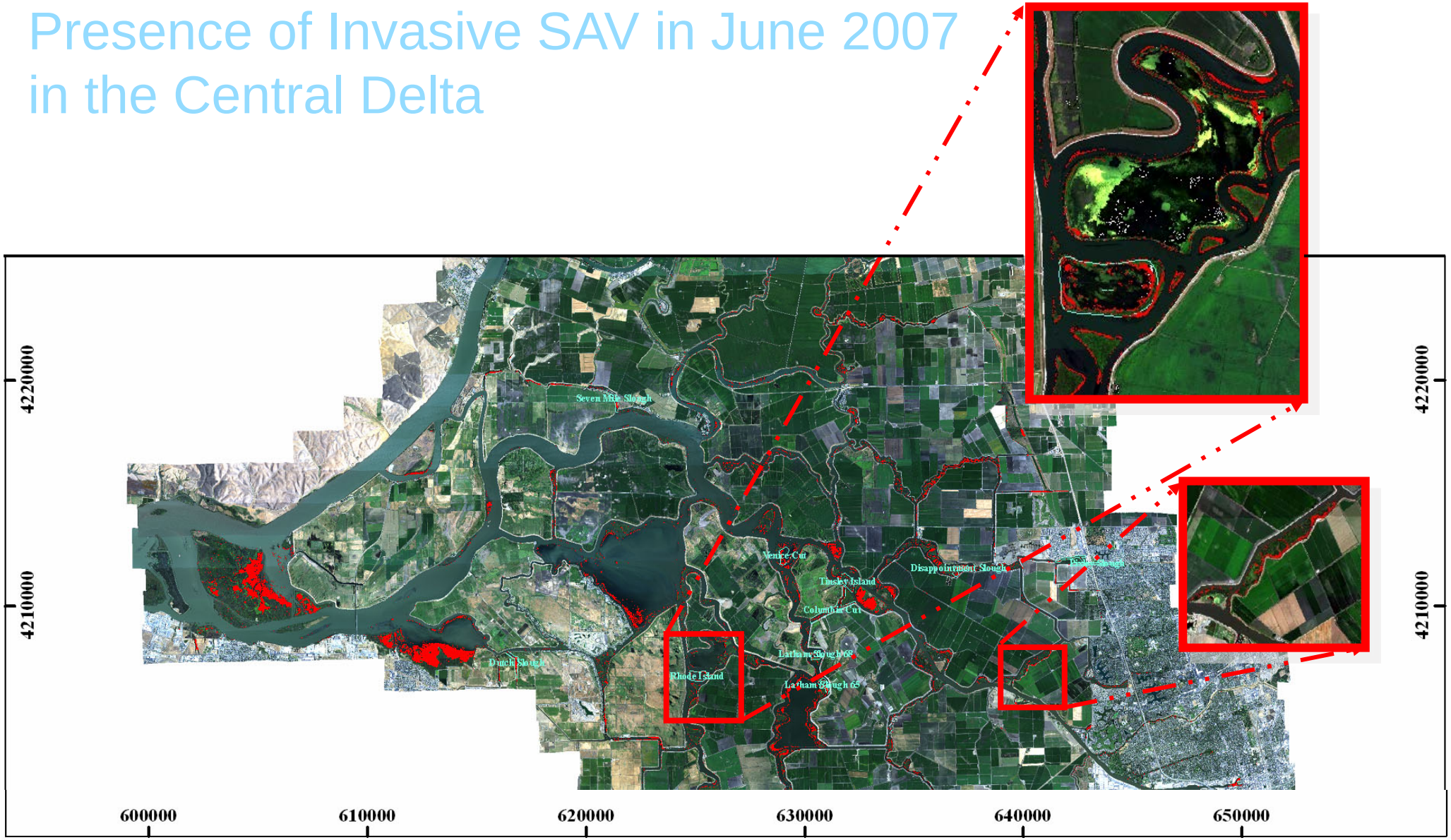
2004	2,103 points
2005	2,631 points
2006	3,285 points
2007	2,126 points
2008	1,334 points

Accuracy assessment

Spatial distribution & cover estimates

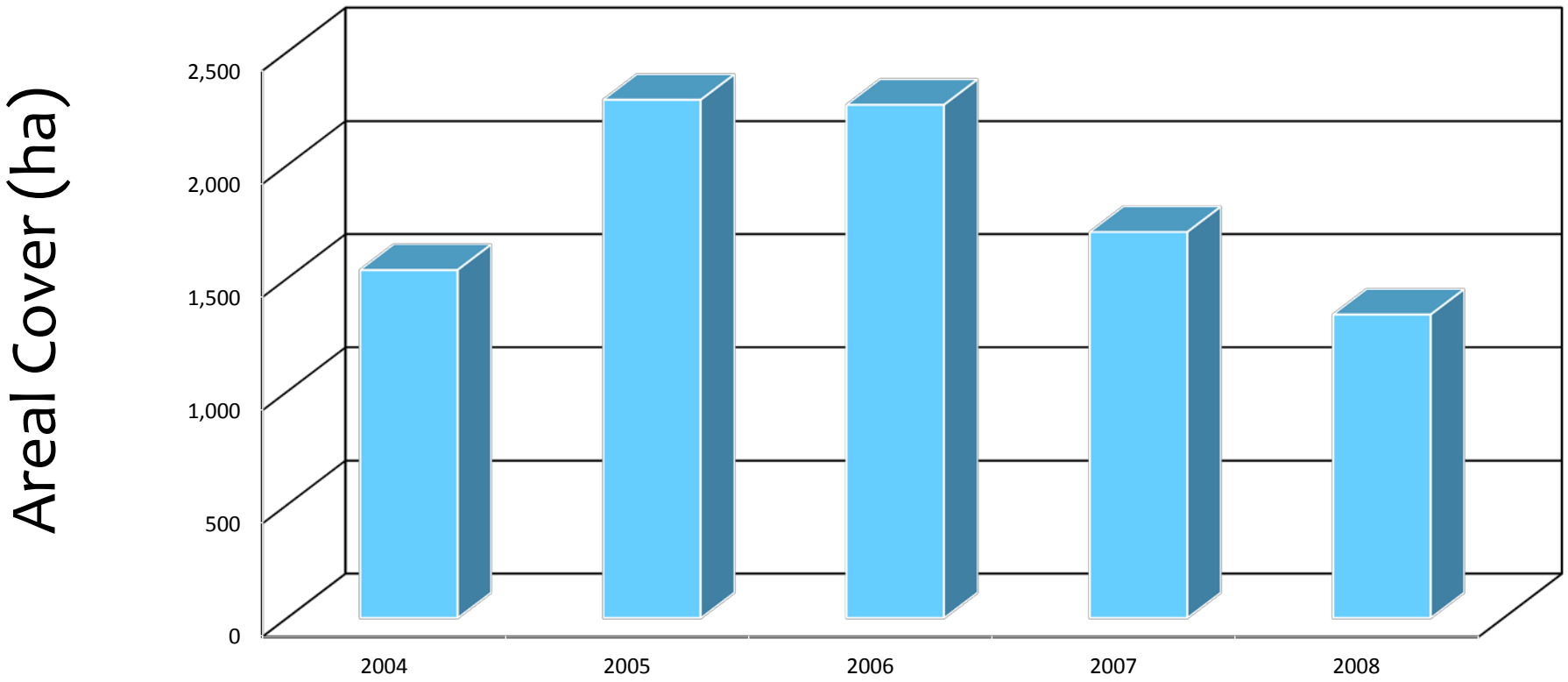


Presence of Invasive SAV in June 2007 in the Central Delta



SAV presence in:
Lantham Slough 68 and Lantham Slough 65

Remote Sensing SAV Mapping Results 2004-2008



Mean cover of 1817 ha over these years

	2004	2005	2006	2007	2008
Overall Accuracy	78.8%	84.7%	85.9%	79.6%	83.5%
Kappa (>0.6 is considered "very good agreement")	0.65	0.70	0.77	0.69	0.68

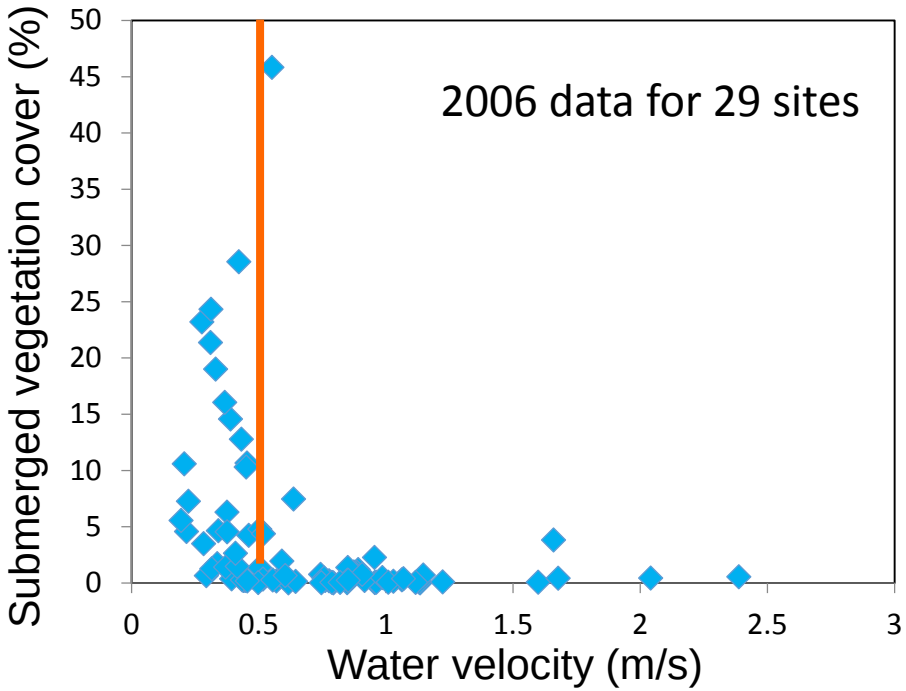
Hestir, E.L., J.A. Greenberg & S.L. Ustin 2012. Classification Trees for Aquatic Vegetation Community Prediction from Imaging Spectroscopy. IEEE JSTARS 5: 1572-1584.

Is SAV co-located with low velocity flows?

Approach

- Velocity station
- 1 km buffer

Does velocity control submerged vegetation cover?

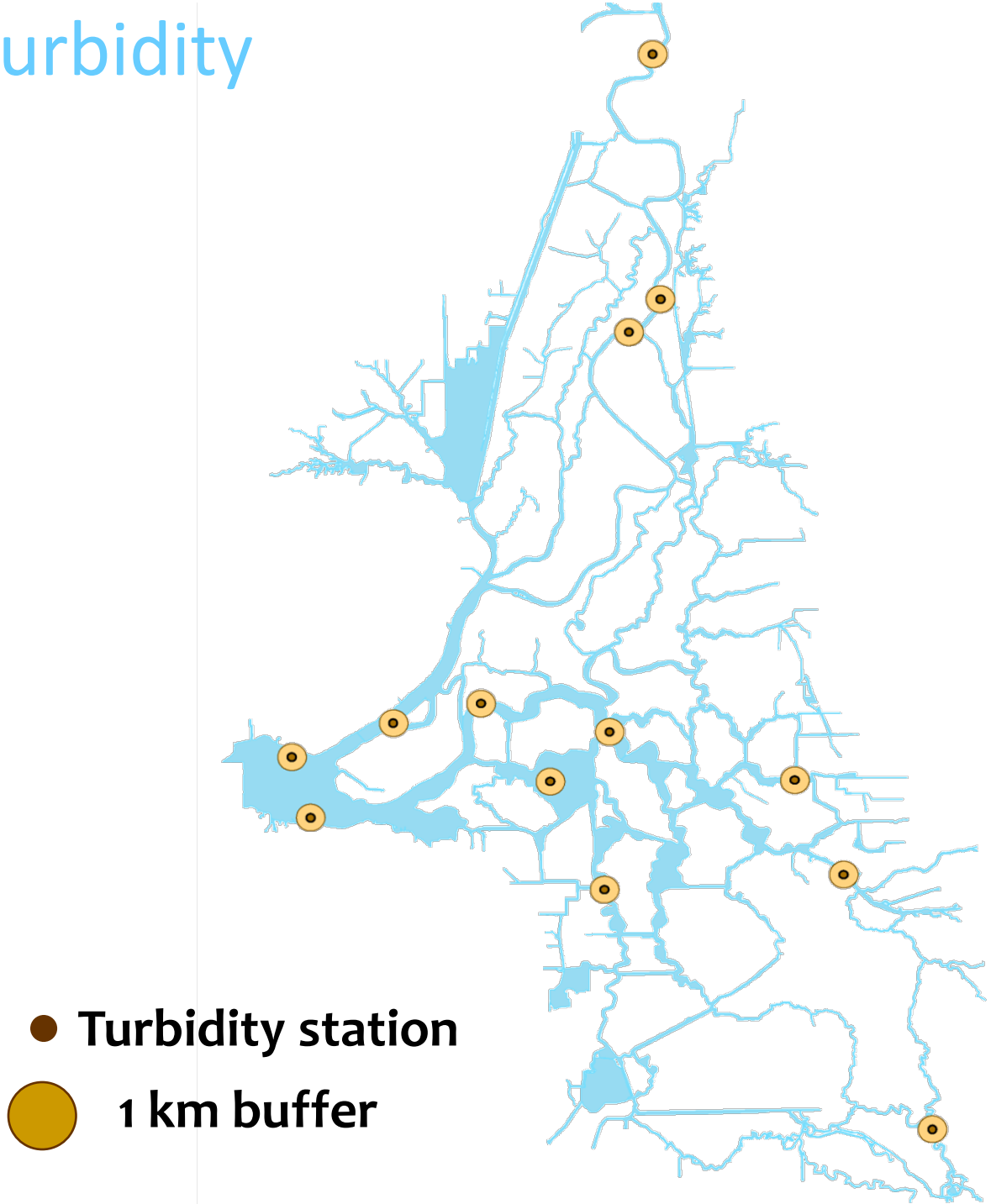


High velocity events control submerged vegetation cover

Is SAV co-located with low turbidity water?

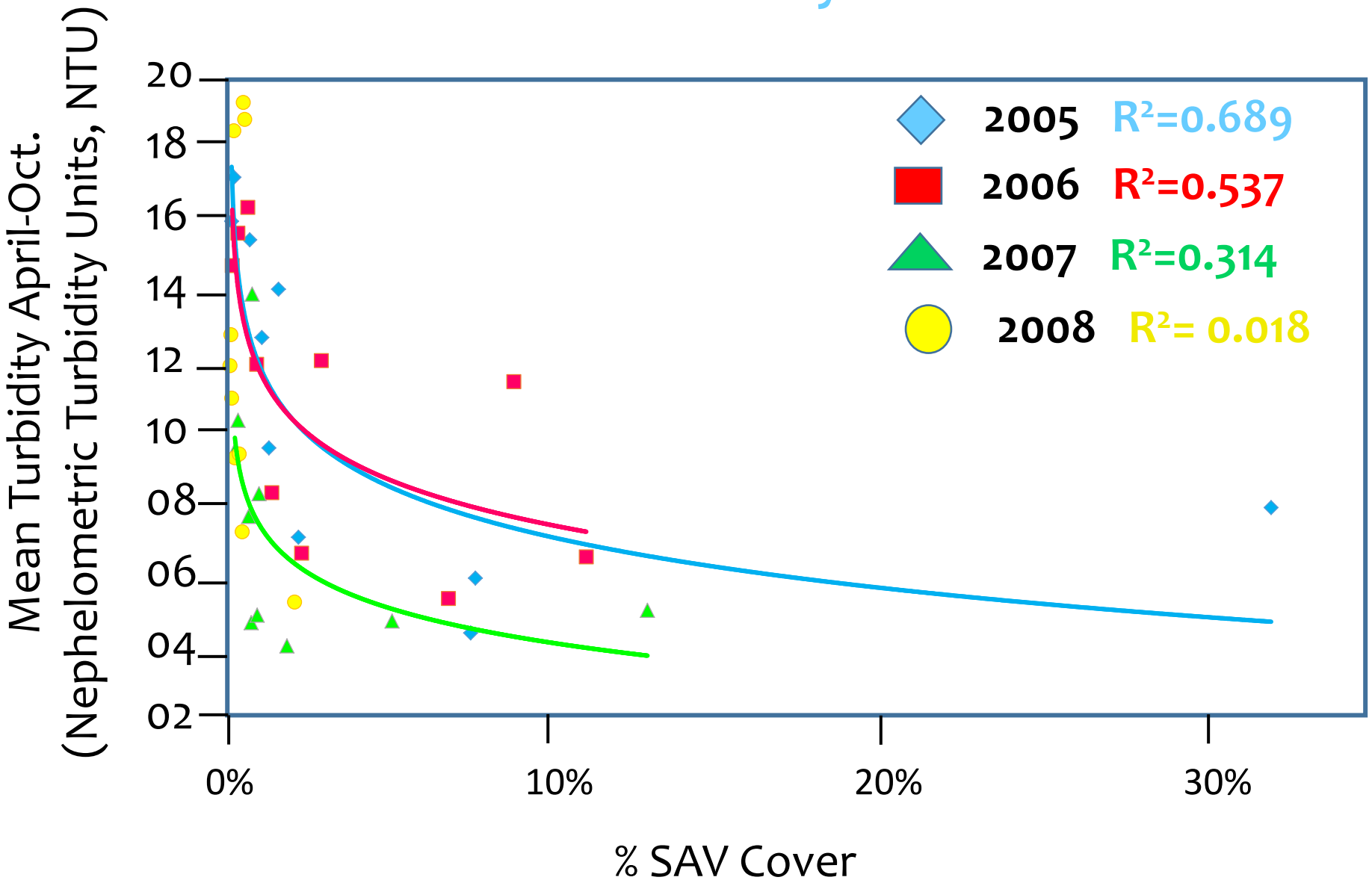
Approach

- 10 turbidity stations
  - Monthly data
- % SAV cover within 1 km of turbidity sites



Map Information
Velocity 1Km buffer
Velocity Stations
Photo Points
SAV within 1Km of station (2006)
Water Area with 1Km buffer (refined)
2006 Submerged Aquatic Vegetation
2006 remotely sensed Delta water mask
USGS
science for a changing world
2006/06/20

SAV and low turbidity water are co-located

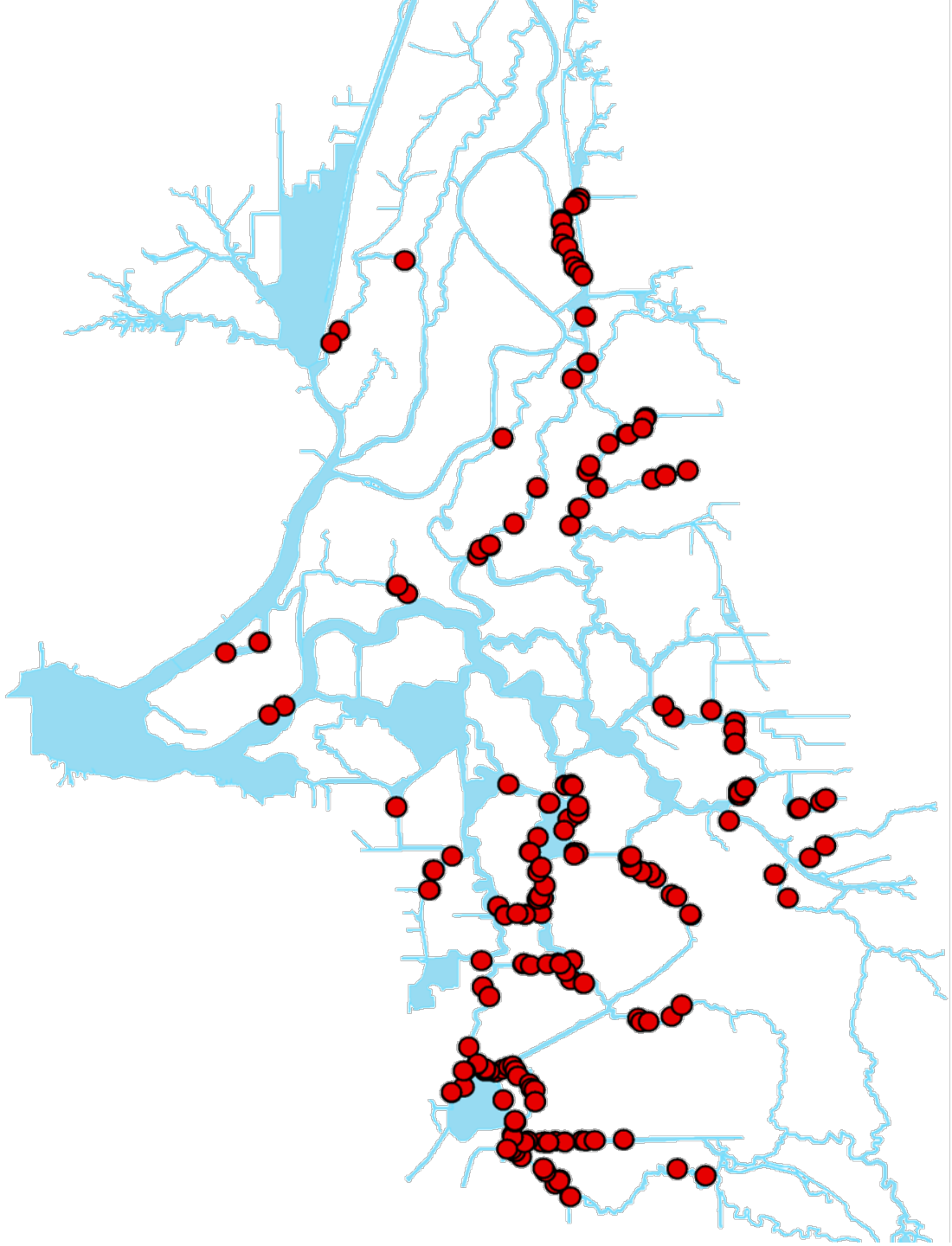


Channels with more SAV have low turbidity

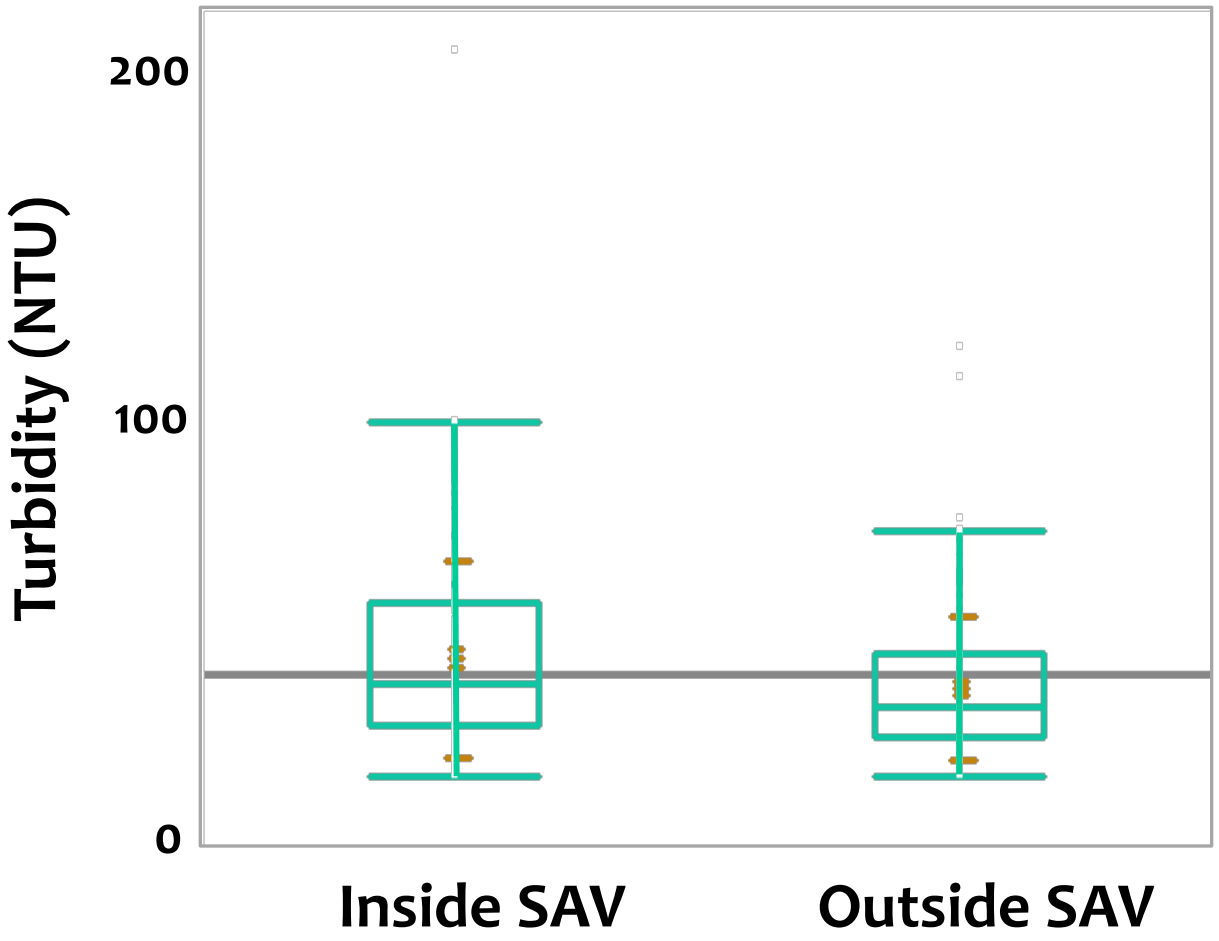
Why are SAV and low turbidity water correlated?

Approach

- 275 sites
- Inside/outside SAV patch
- Depth-averaged turbidity



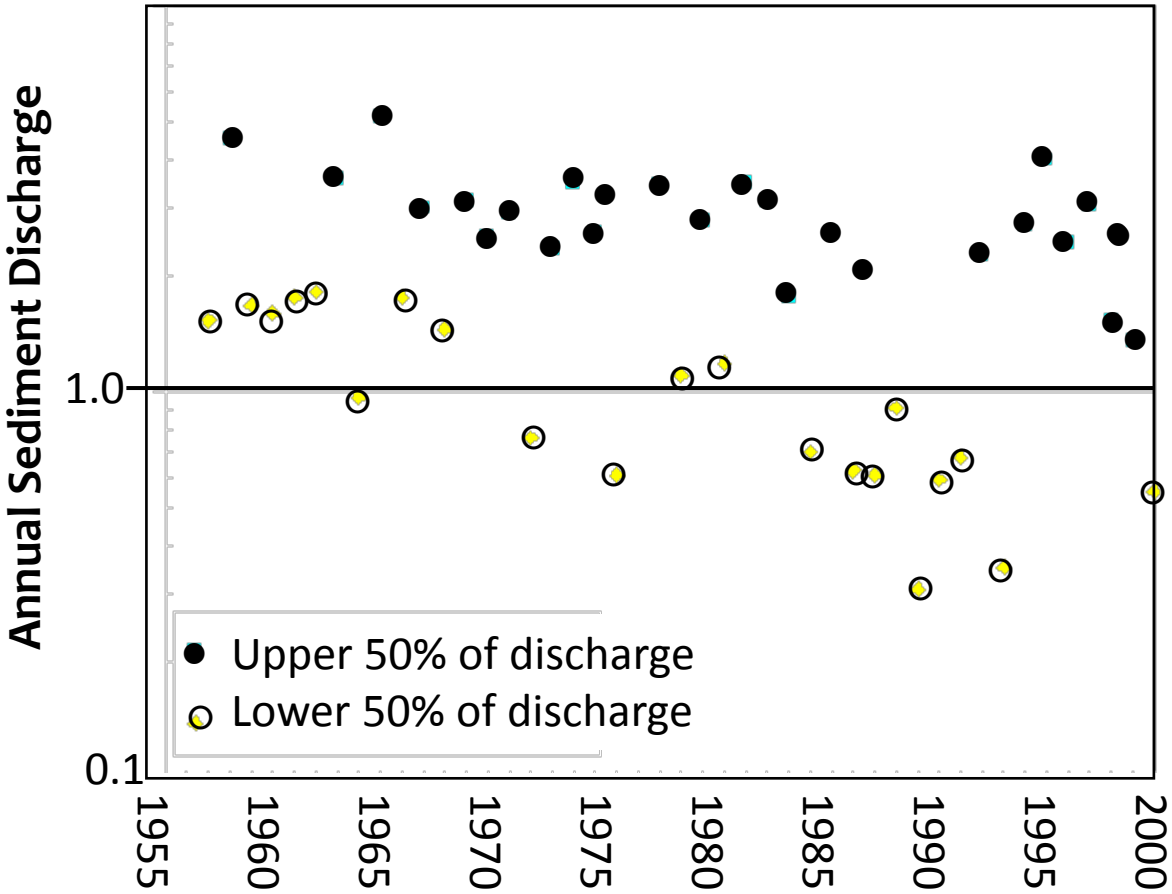
There is more sediment in SAV patches



Is SAV filtering sediment?

Has turbidity decreased in the Delta in the past 50 years?

- What are the trends in turbidity?
- Sediment supply to Delta decreased by 50% 1957-2001



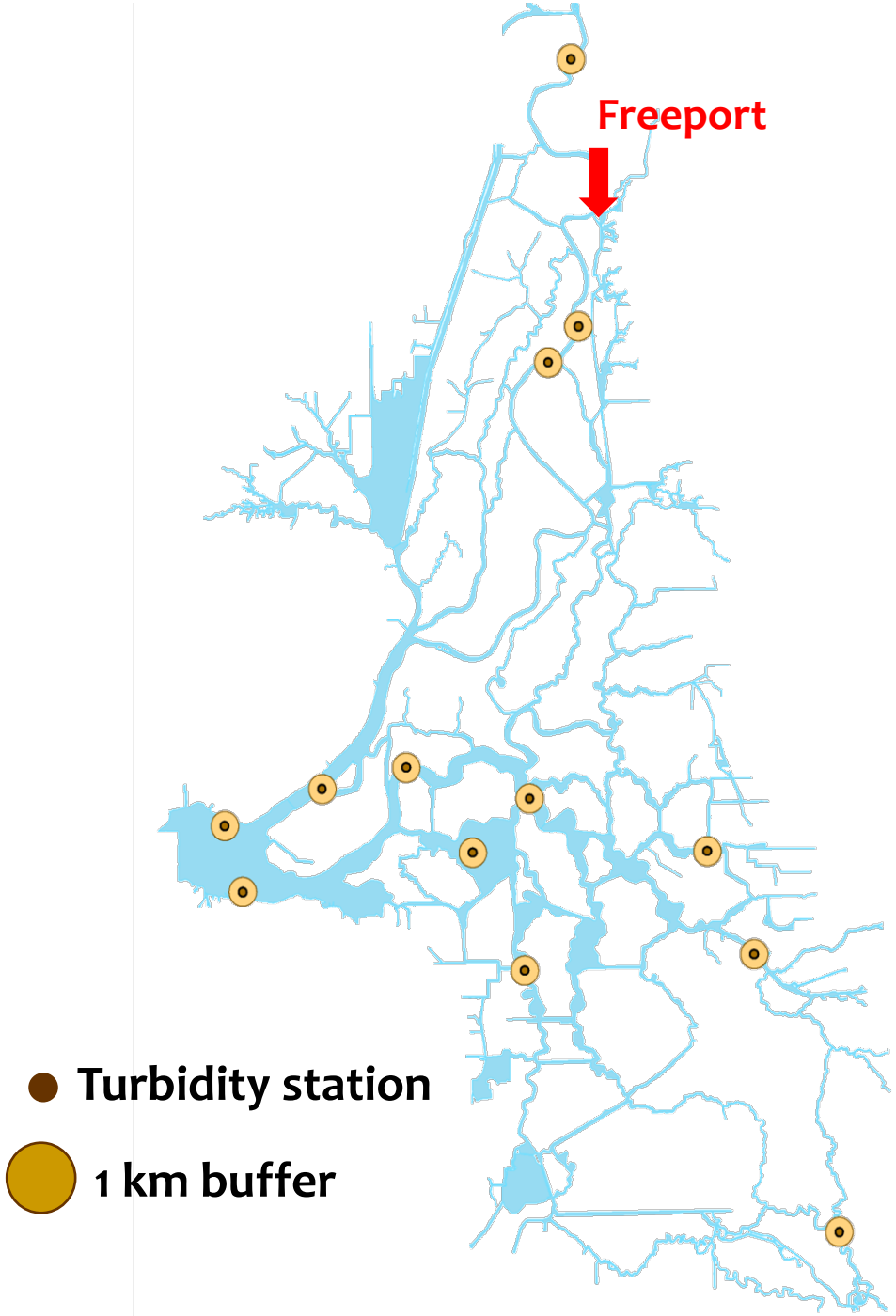
Hestir, E.L., D.H. Schoellhamer, T. Morgan-King, S.L. Ustin- 2013. A step decrease in sediment concentration in a highly modified tidal river delta following the 1983 El Niño floods. Marine Geology, 345: 304-313.

Changes in turbidity in the Delta between 1975 and 2006

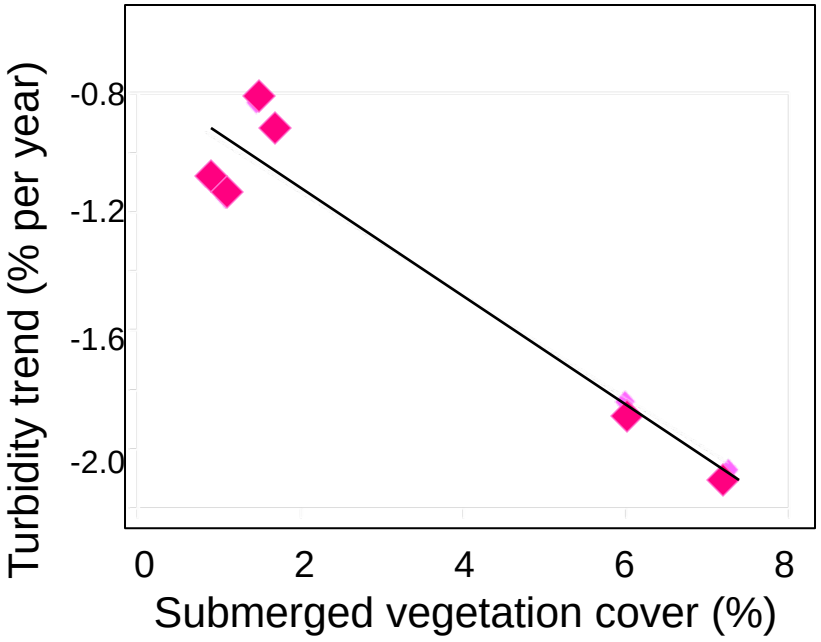
Approach

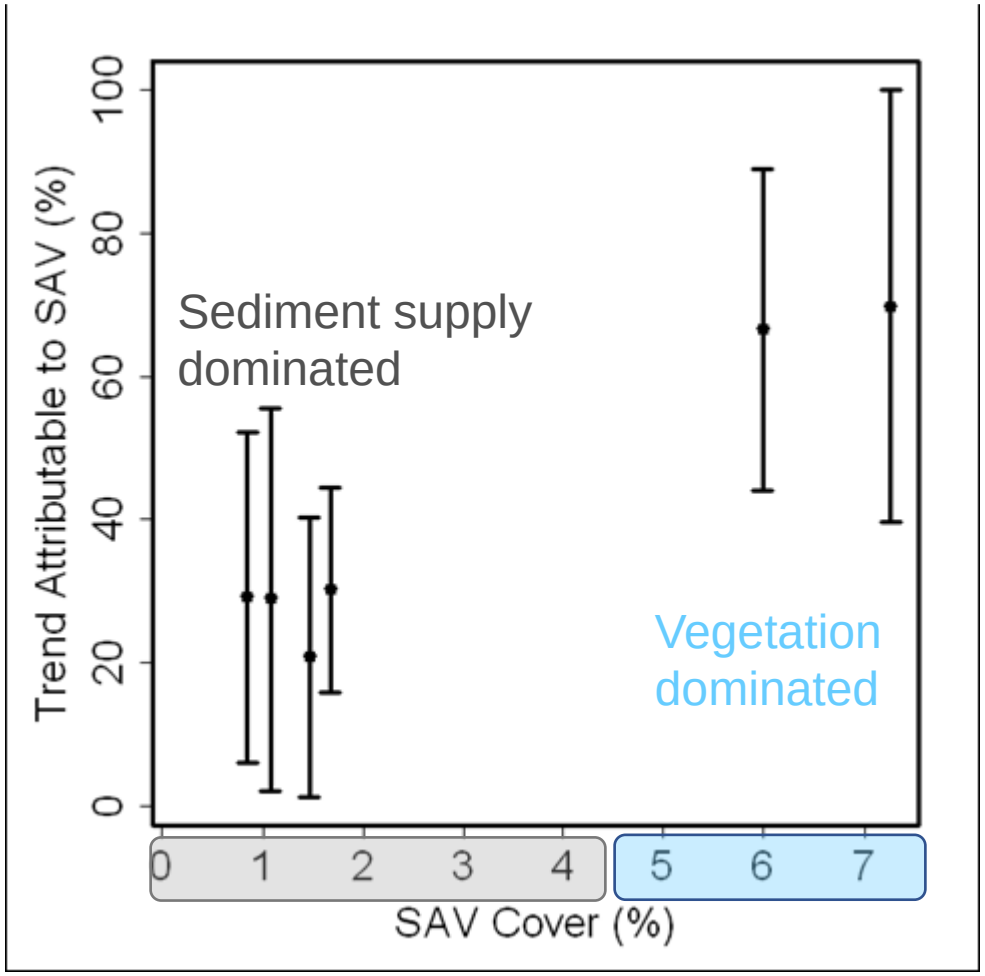
- Turbidity adjusted for daily suspended-sediment concentration in Sacramento River at Freeport

- Trend test 1975-2006



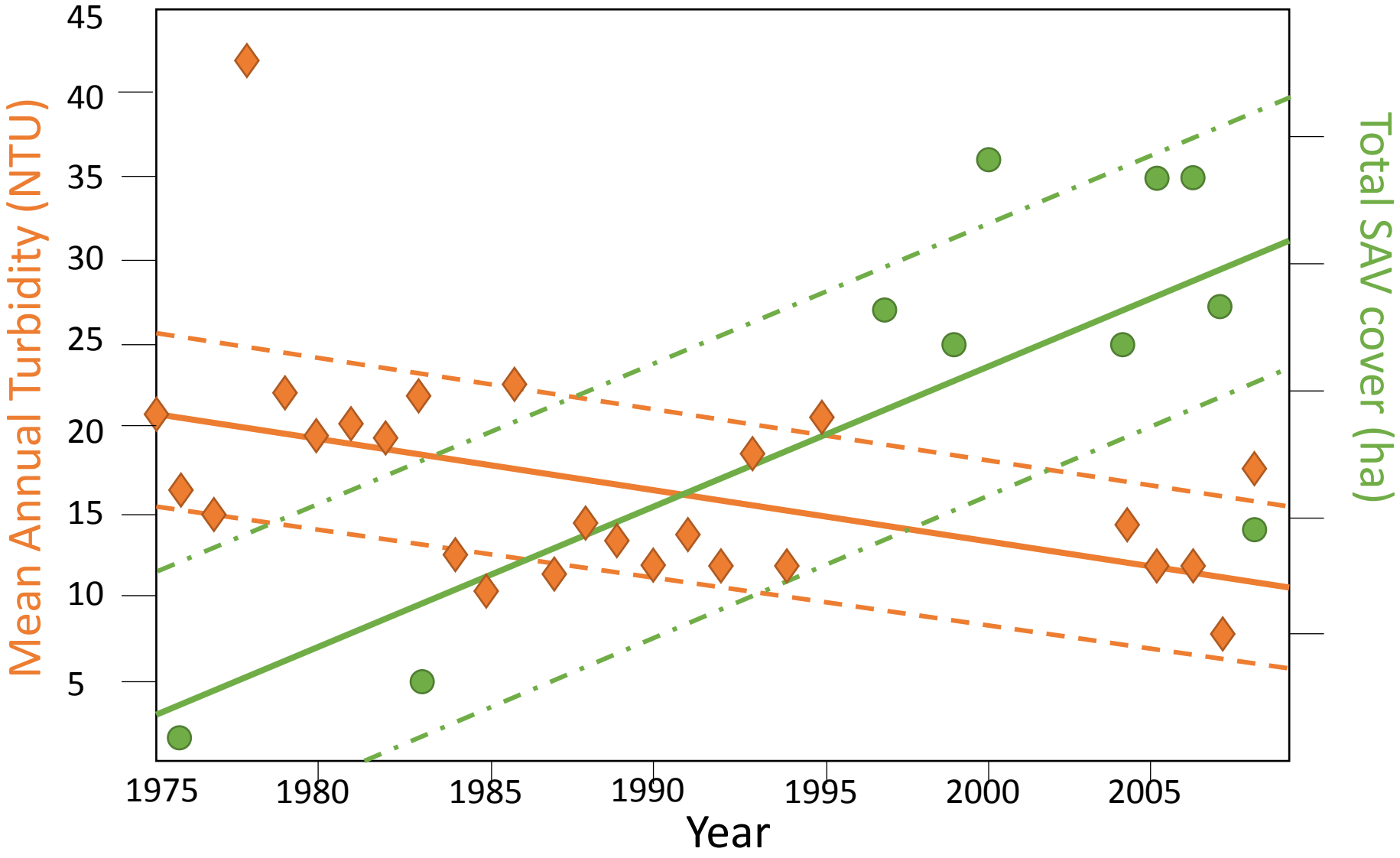
Does submerged vegetation contribute to the declining turbidity trend?

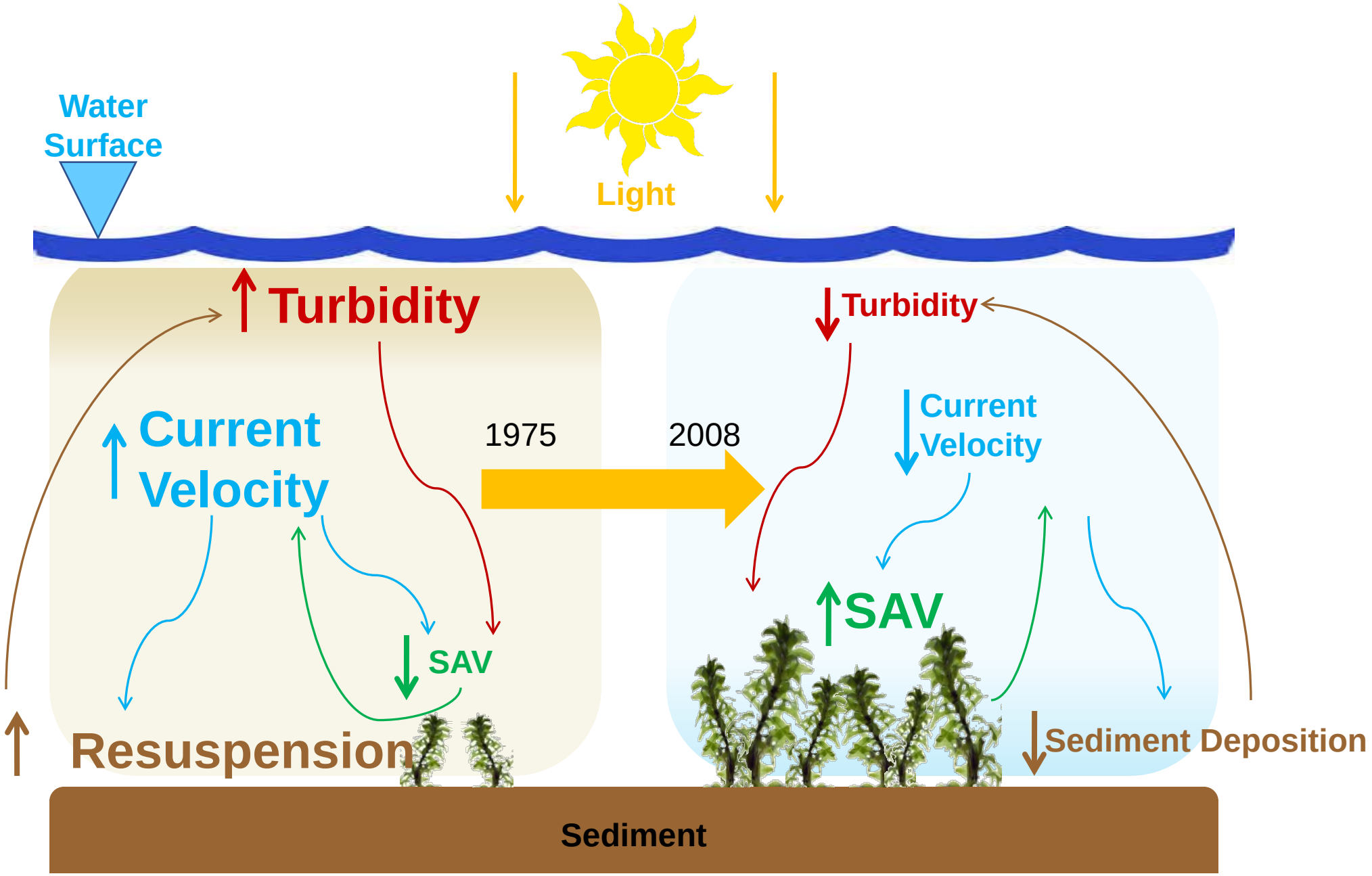




Submerged vegetation contributes 21-70% of the total trend

Modeling the SAV Invasion Curve




Water Surface
Light
Turbidity
Current Velocity
SAV
Resuspension
1975
2008
Turbidity
Current Velocity
SAV
Sediment Deposition
Sediment

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