Hyperspectral & Lidar Remote Sensing of the Delta

Susan L. Ustin and Erin L. Hestir

Center for Spatial Technologies & Remote Sensing (CSTARS)

UC Davis

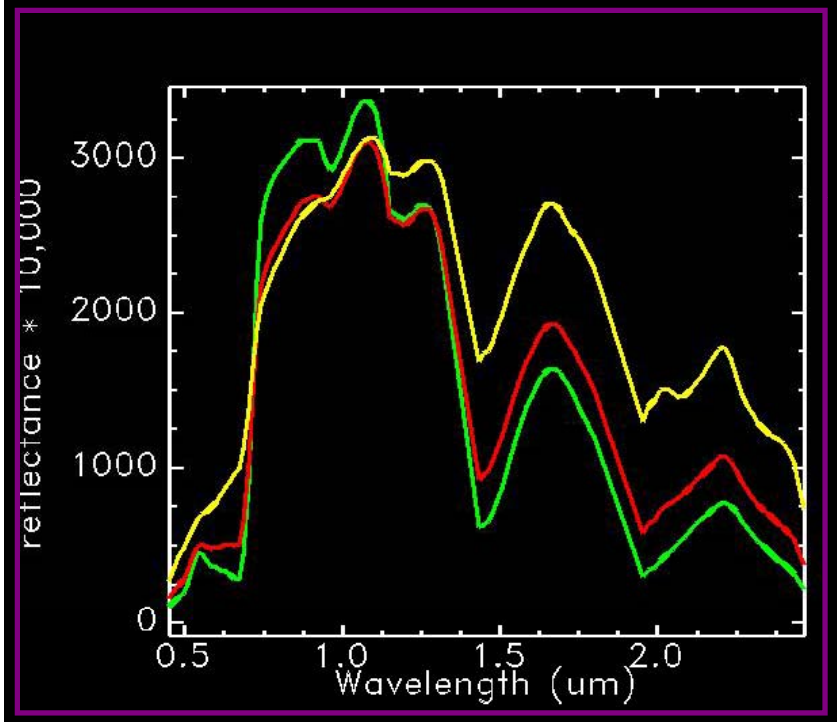
Outline

1. What is it and why?
2. Terrestrial applications
    a. *Lepidium*
    b. Trees
    c. Land use change
3. Wetland applications
    a. Succession dynamics in water hyacinth
    b. Scaling biogeochemical process models
4. Aquatic applications
    a. Species detection and mapping
    b. Trends in turbidity and velocity
    c. Assessing management efficacy
    d. Radiative transfer modeling for water quality monitoring

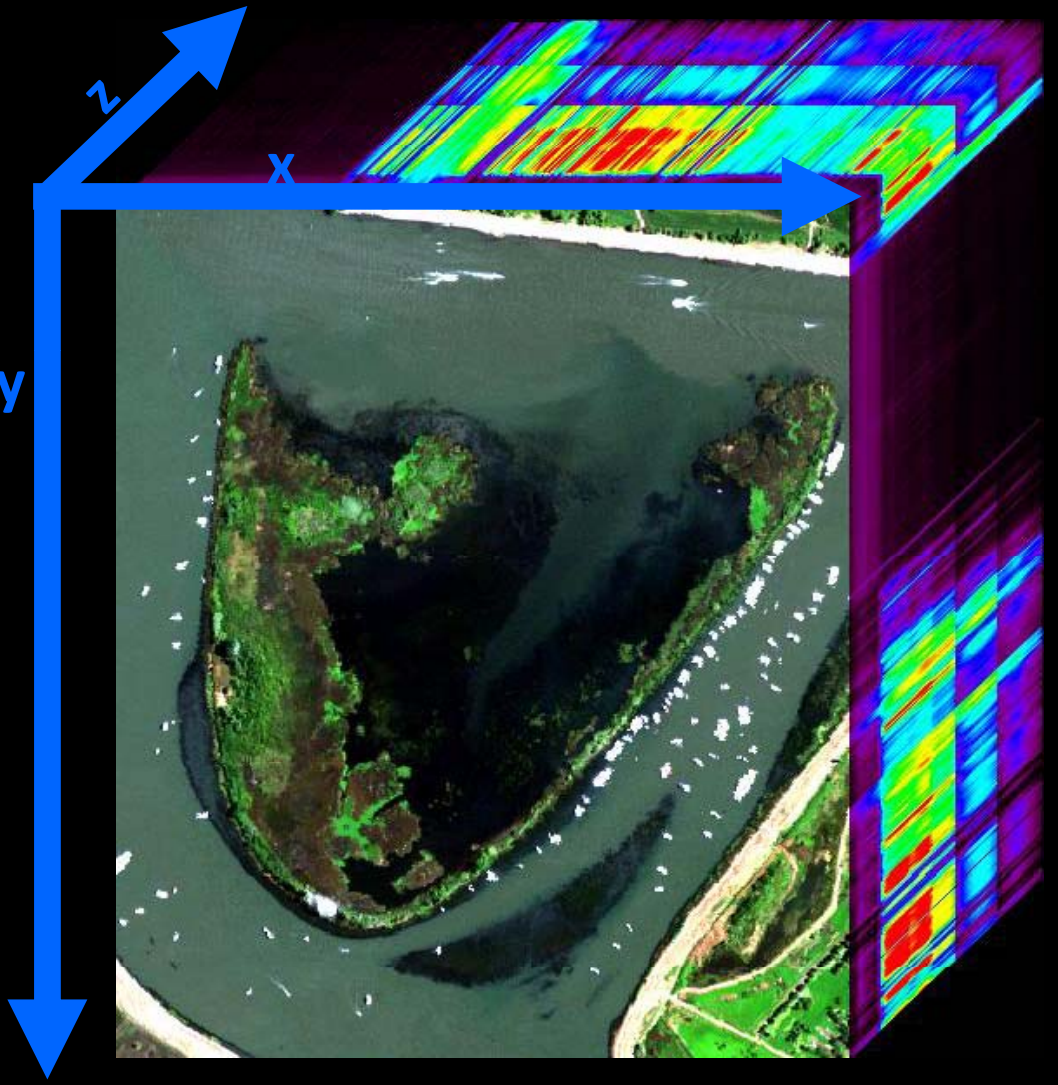
Why Monitor Using Remote sensing?

- Permanent Record
  - physical measurement: electromagentic energy
- Direct mapping of biophysical processes
  - Environmental analysis
- Geospatial Information; wall-to-wall sampling
  - Samples difficult to reach locations
- Can be acquired at multiple time scales
  - critical for monitoring change

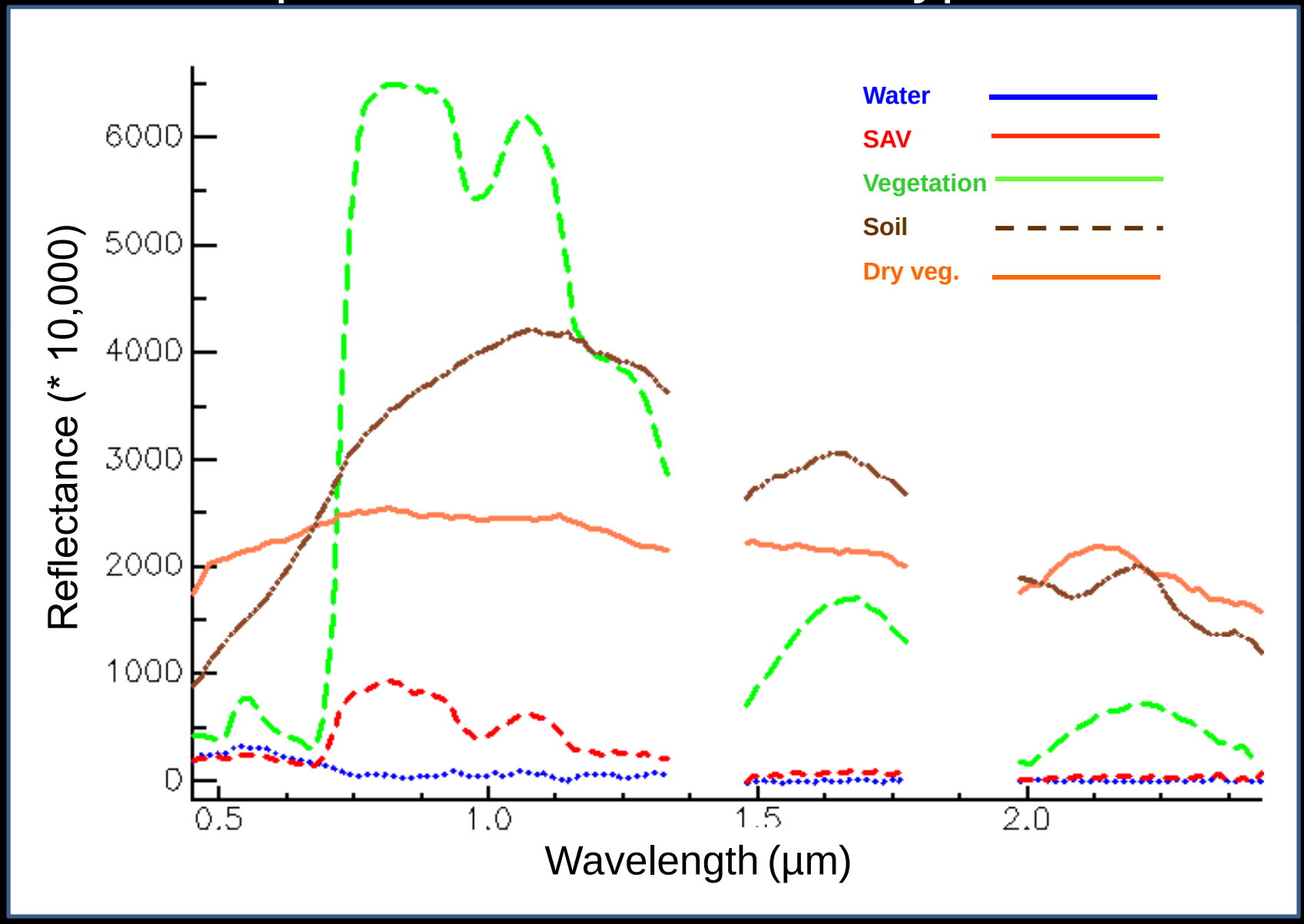
What is hyperspectral remote sensing?



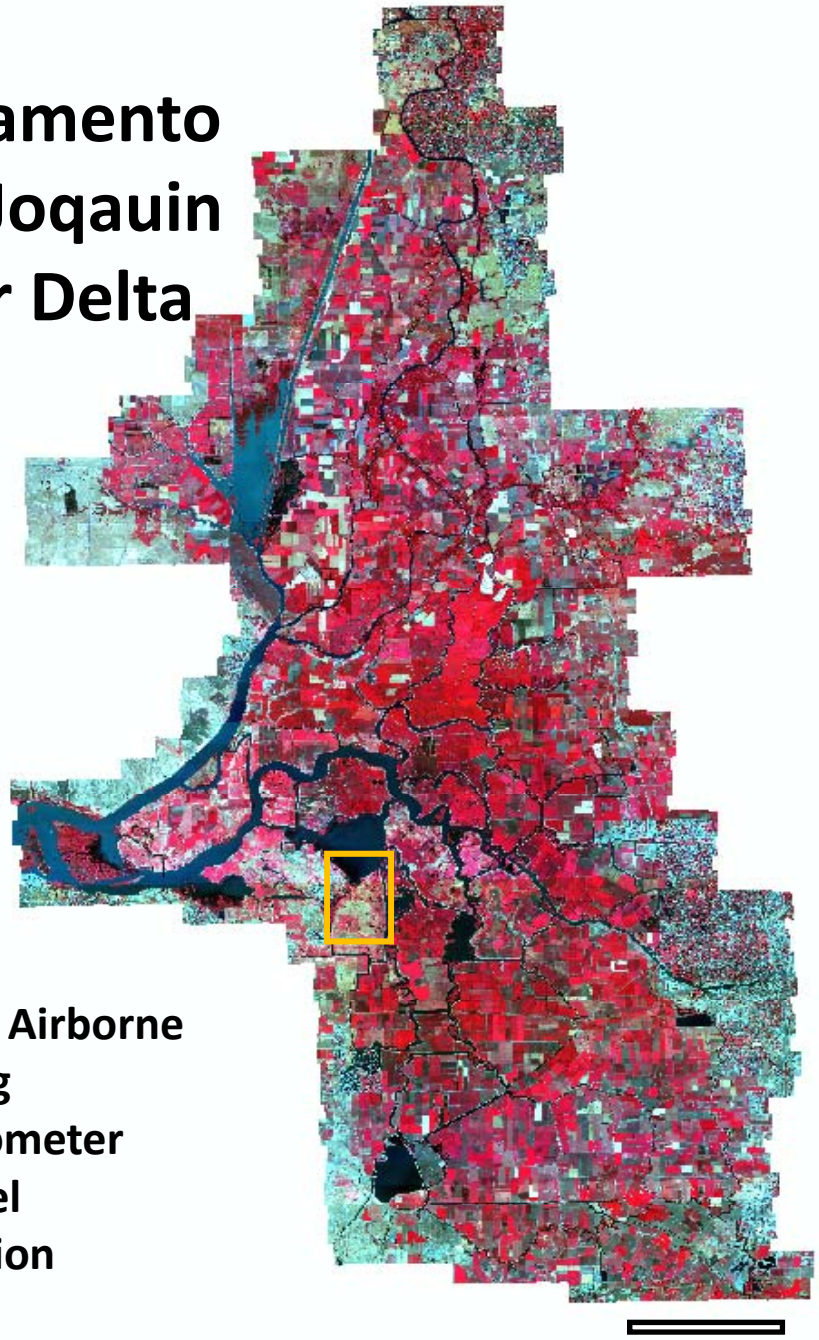
Vegetative Lepidium
Senescent Lepidium
Flowering Lepidium



Spectral Differences Can Be Used To Identify Species and Land Cover Types



The Sacramento San Joqauin River Delta



HyMap Airborne Imaging Spectrometer 3m pixel resolution

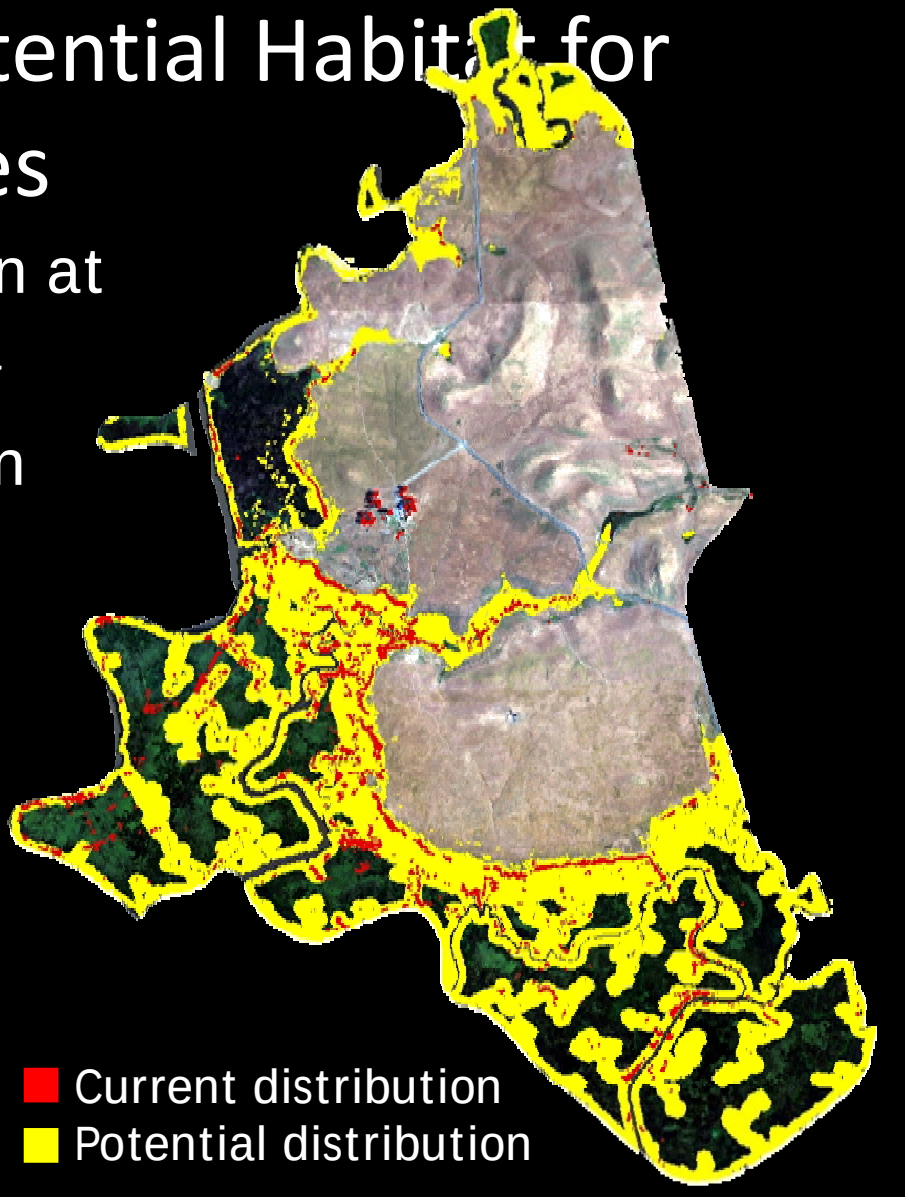
Terrestrial applications

1. Estimating Potential Habitat for Invasive Species

- Lepidium distribution at Rush Ranch =12.6 ha
- potential distribution

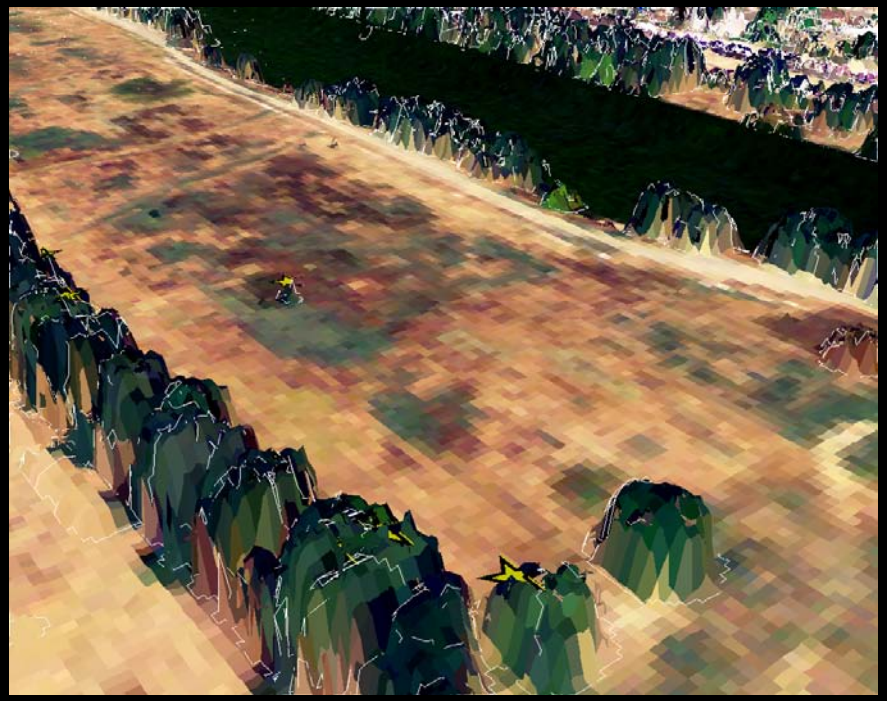
  = 219 ha

  = 25% of land area
- Only 5% of suitable habitat is currently occupied

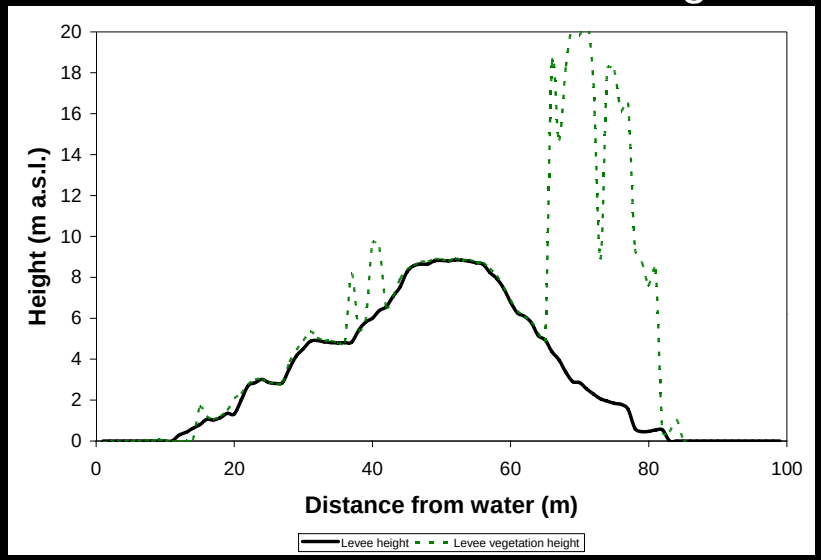


Terrestrial applications

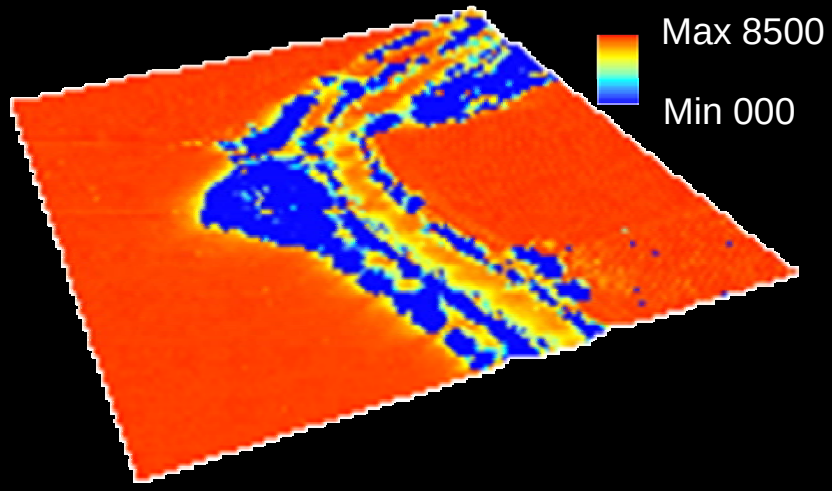
2. Levee Stability, Trees & LiDAR Data



Vertical Profile of levees and Vegetation

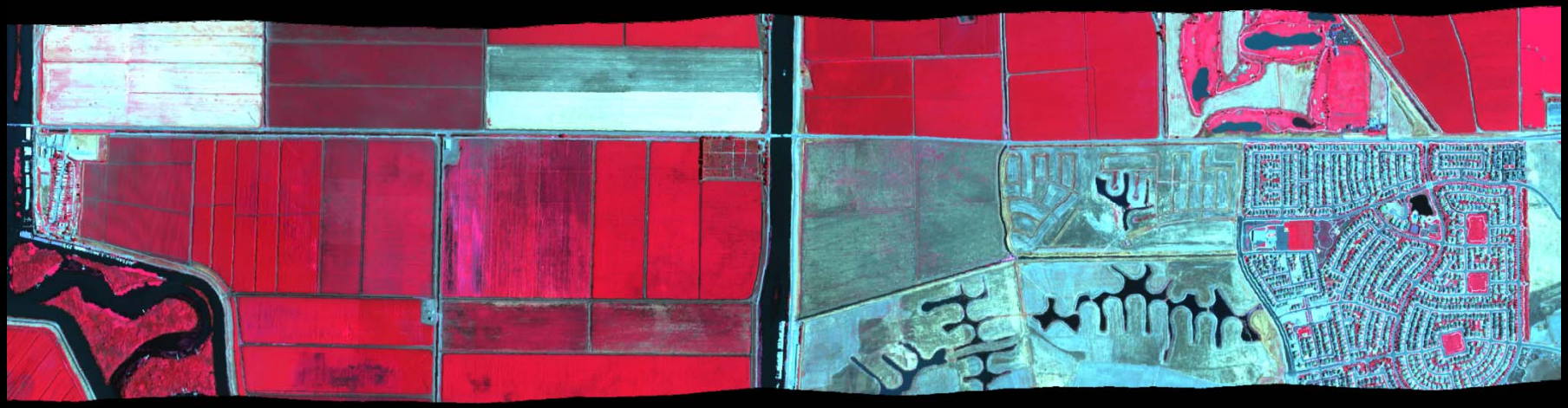


Total Daily Irradiation (W/m^2/day)



Terrestrial applications

3. Land use change

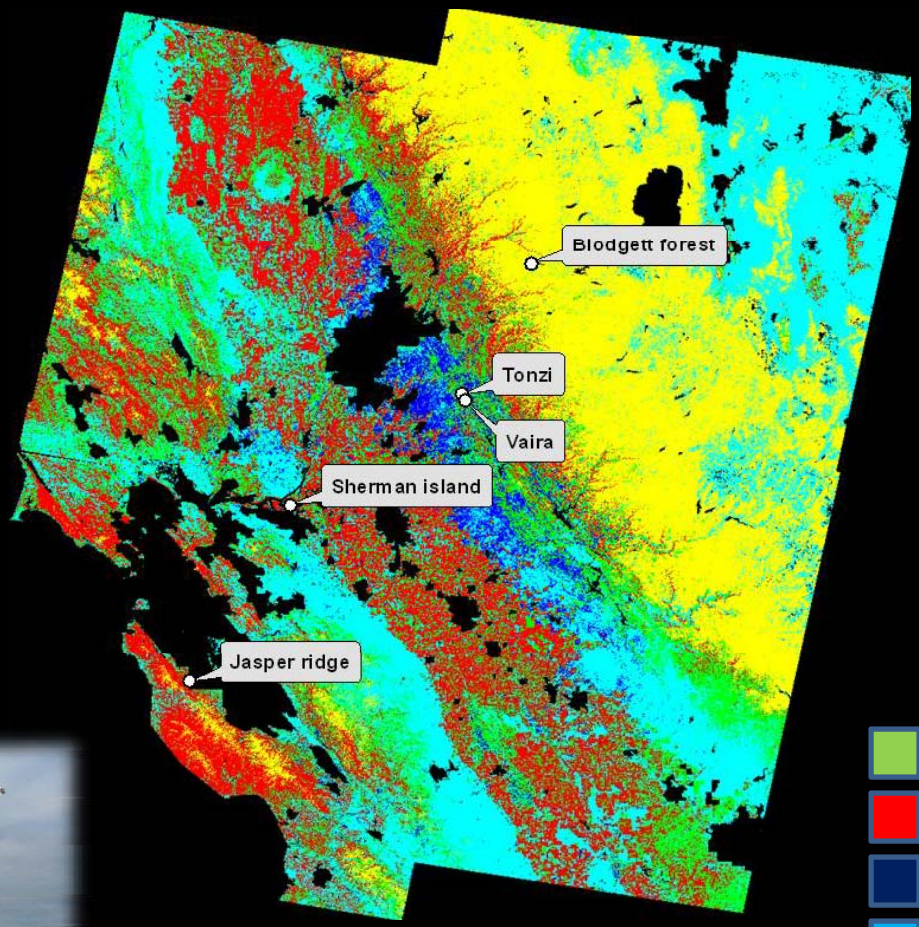


Agricultural land conversion

2004 to 2008; Northern Stockton (Fourteen Mile Slough)

Terrestrial applications

4. Scaling biogeochemical process models



Pixels with spectral properties of tower footprint

Scaling from high spatial resolution hyperspectral imagery to region

August 2007
5 eddy towers

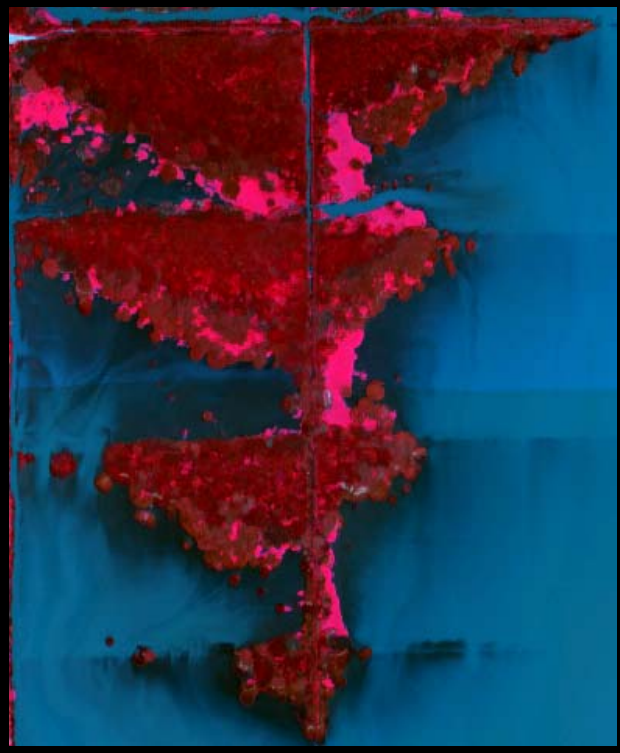
- Jasper Ridge
- Sherman Island
- Tonzi
- Vaira
- Blodgett

Wetland applications

1. Wetland Recovery after flooding; Succession processes

Liberty Island

2004

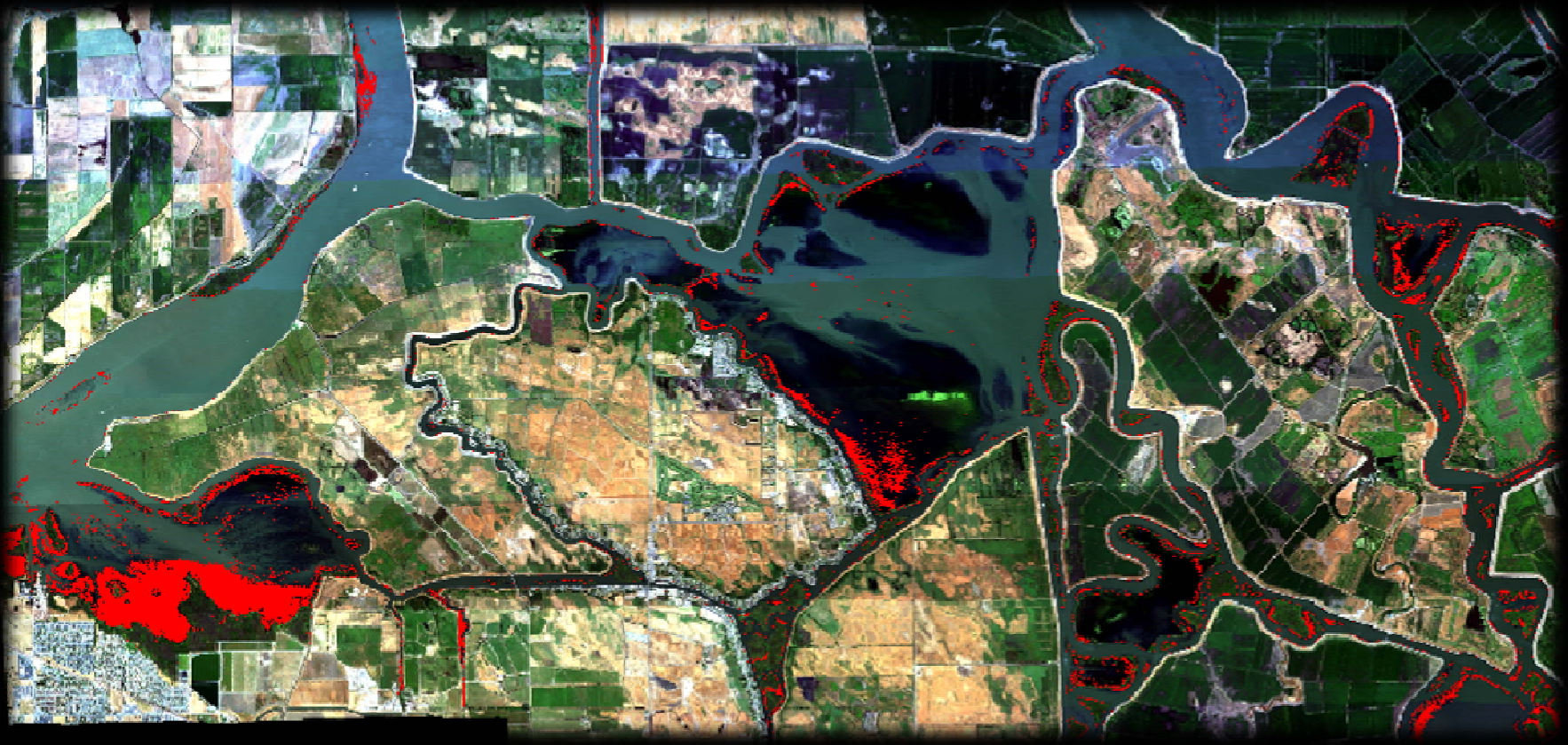


2008

- Tule Expansion

Aquatic applications

1. Species detection and mapping

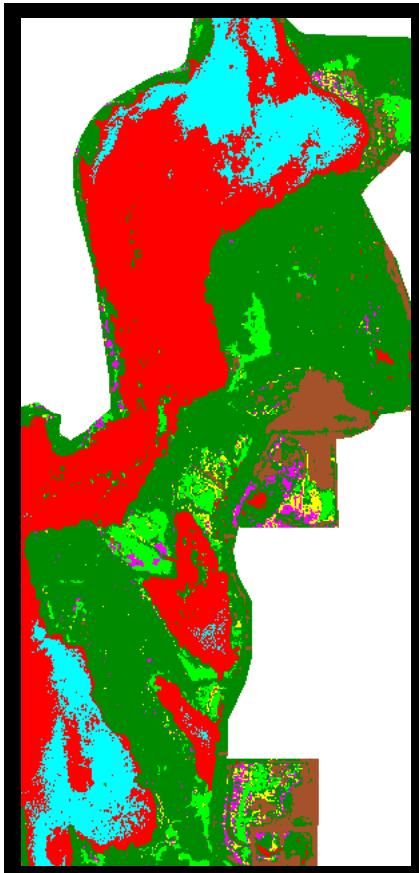


- Submerged Aquatic Vegetation

Aquatic applications

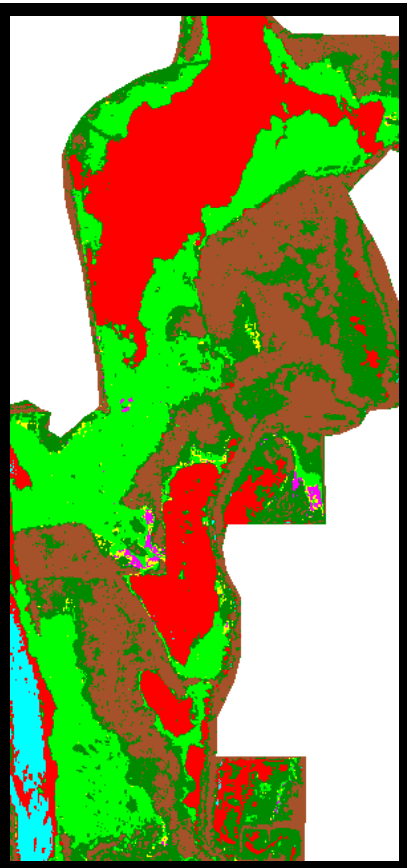
2. Water hyacinth management

Succession from submerged to floating species and response to management

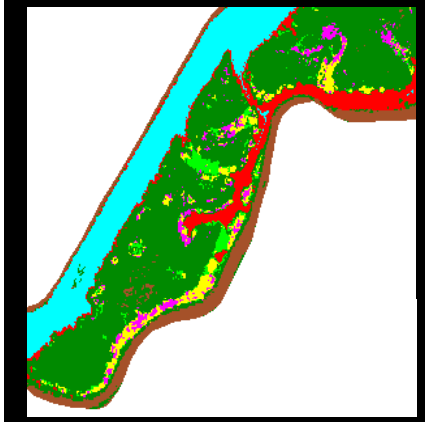


(a) Stone Lake in 2004

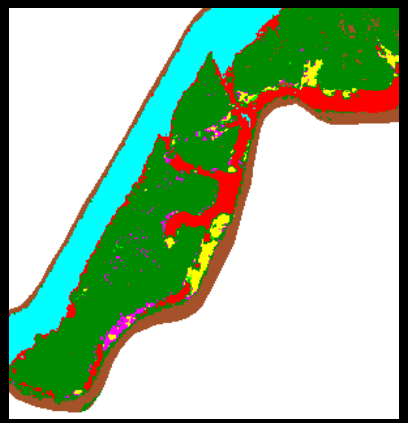
(b) Stone Lake in 2007



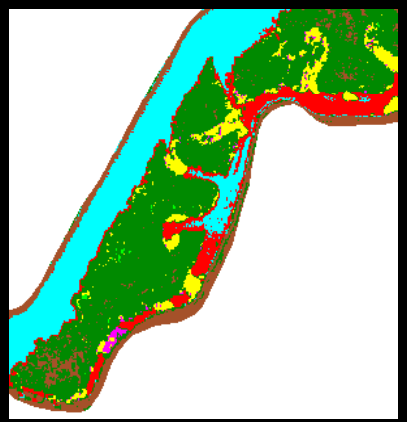
(c) Stone Lake in 2008



(d) FM Slough in 2004

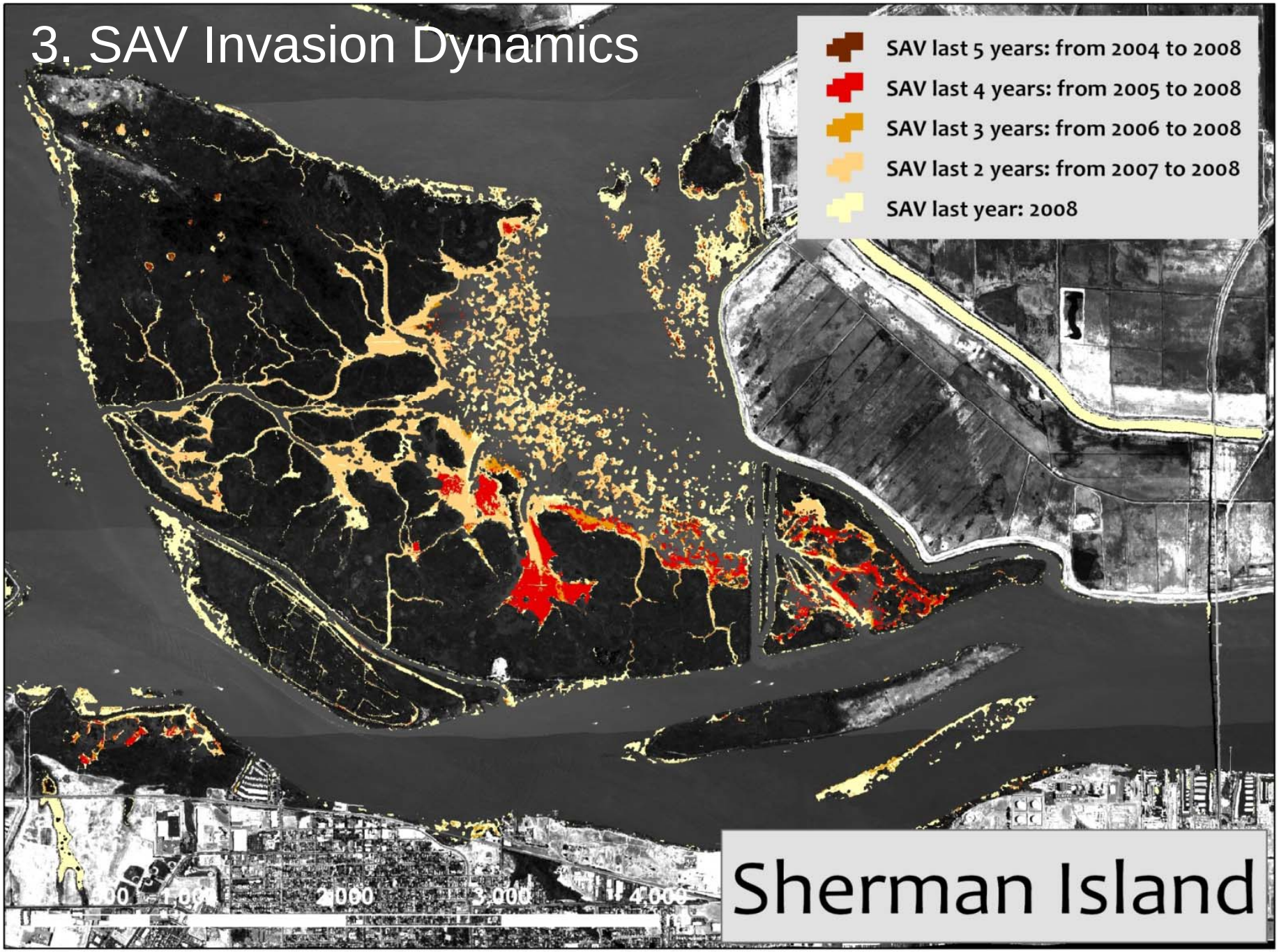


(e) FM Slough in 2007

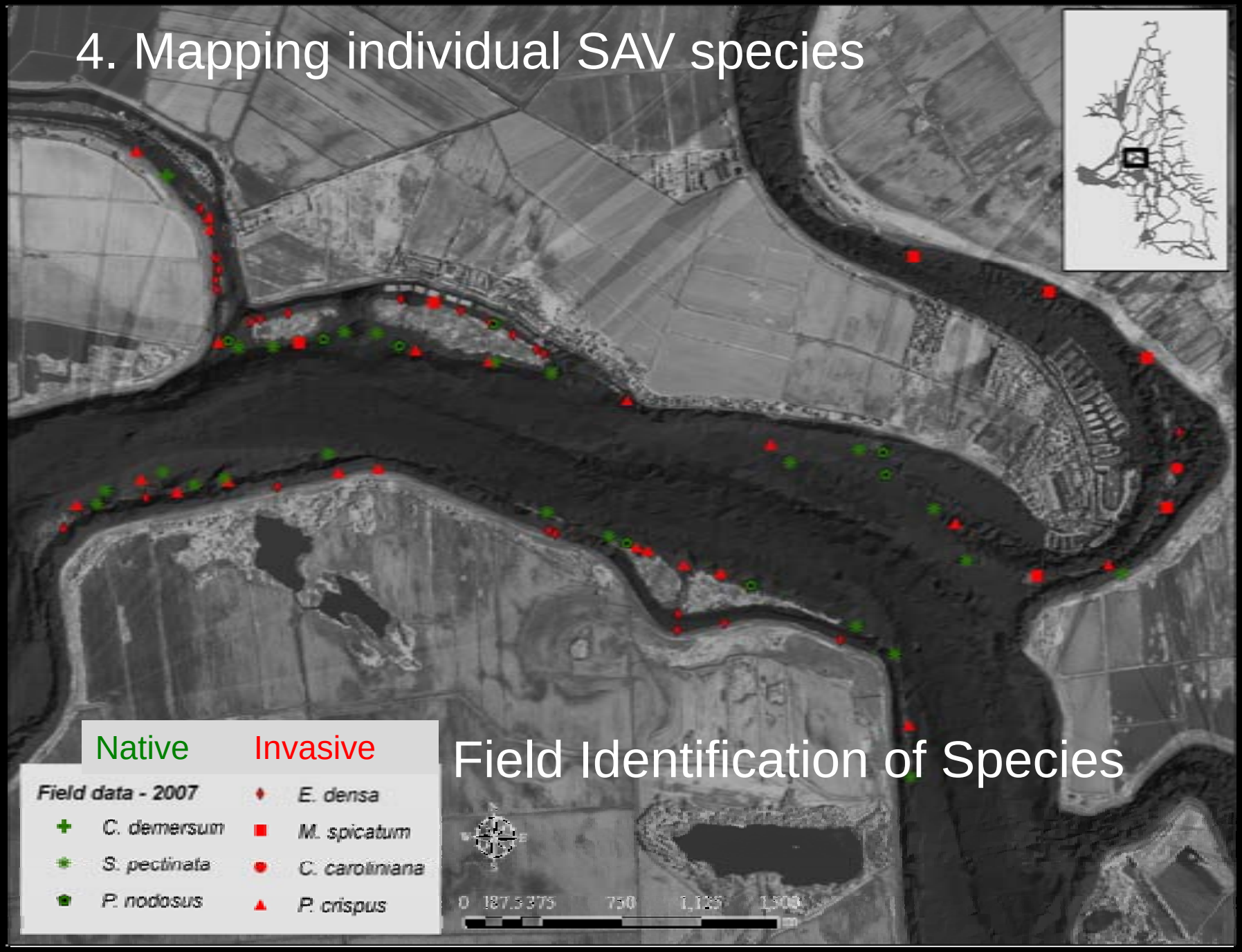


(f) FM Slough in 2008

- Water
- Submerged Aquatic Plants
- Emergent / Riparian
- Soil / Dry Vegetation
- Water Hyacinth
- Pennywort
- Water Primrose

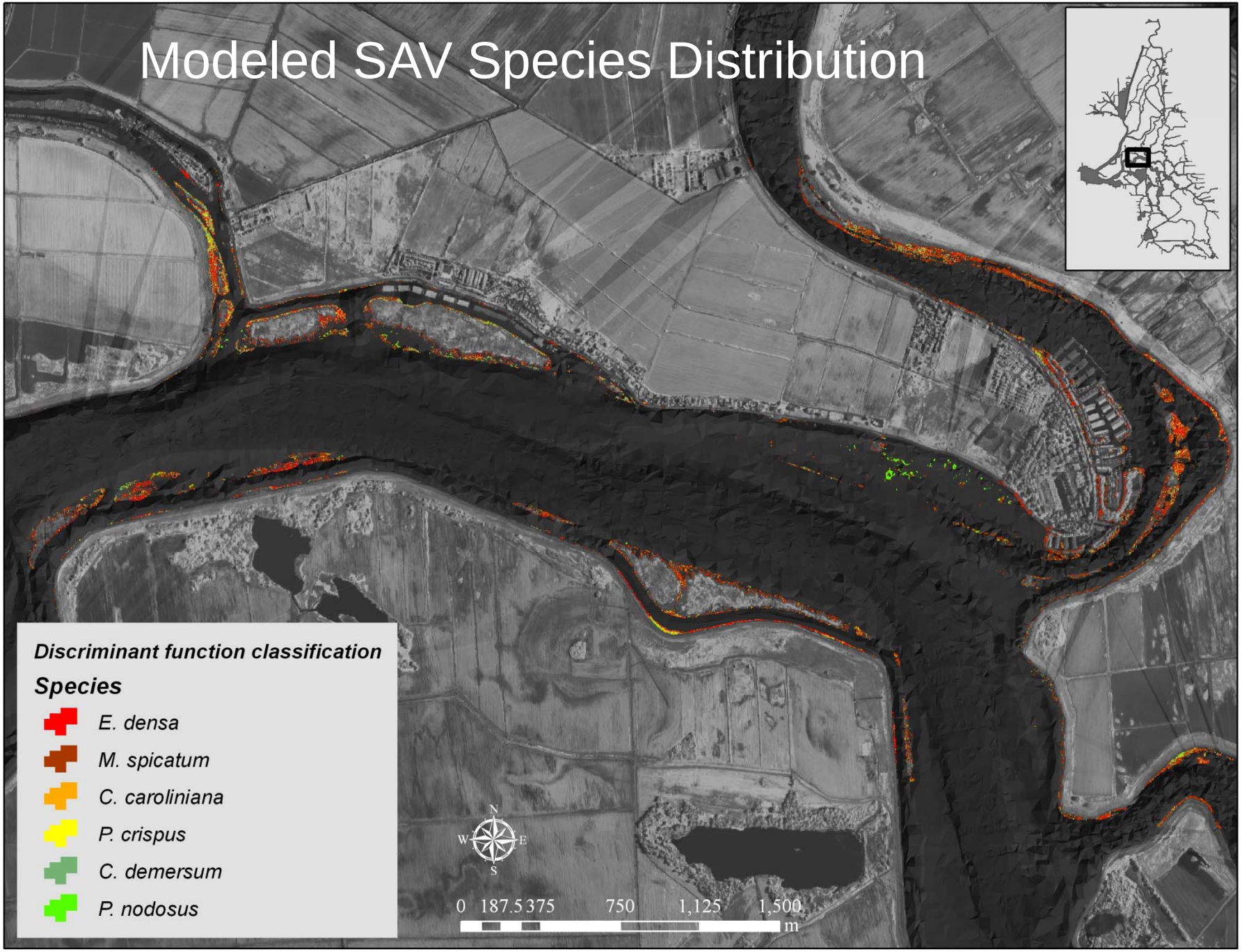

3. SAV Invasion Dynamics
SAV last 5 years: from 2004 to 2008
SAV last 4 years: from 2005 to 2008
SAV last 3 years: from 2006 to 2008
SAV last 2 years: from 2007 to 2008
SAV last year: 2008
0
1,000
2,000
3,000
4,000
Sherman Island

4. Mapping individual SAV species



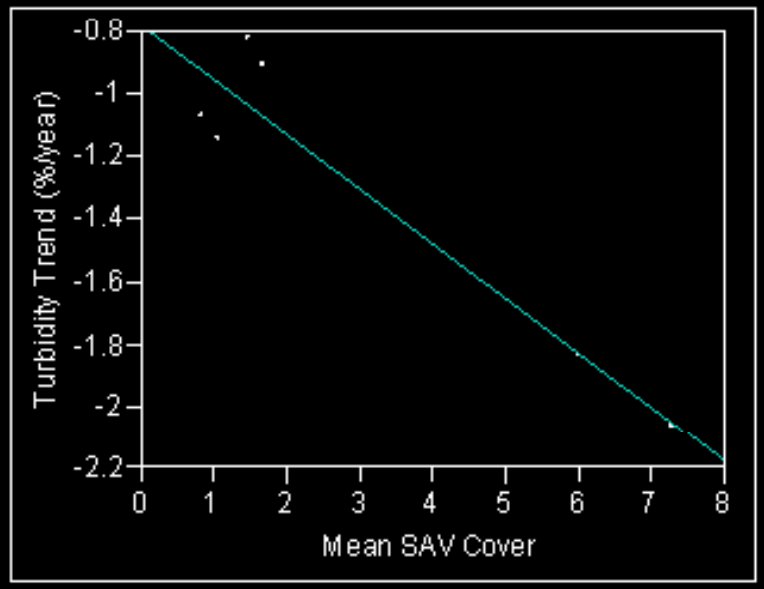
Field Identification of Species

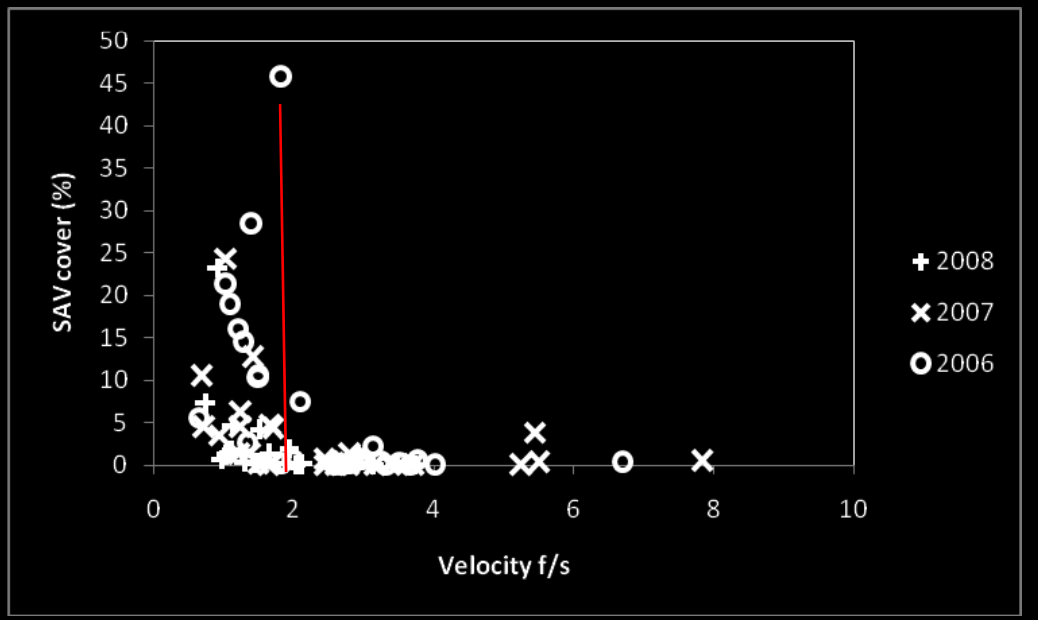
Modeled SAV Species Distribution



Aquatic applications

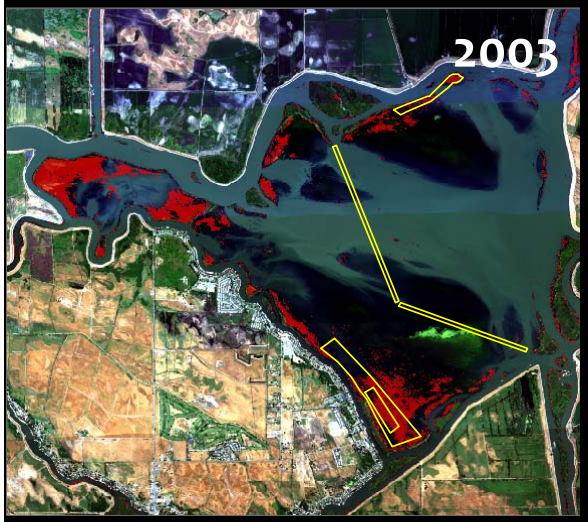
5. Trends in SAV, turbidity and velocity

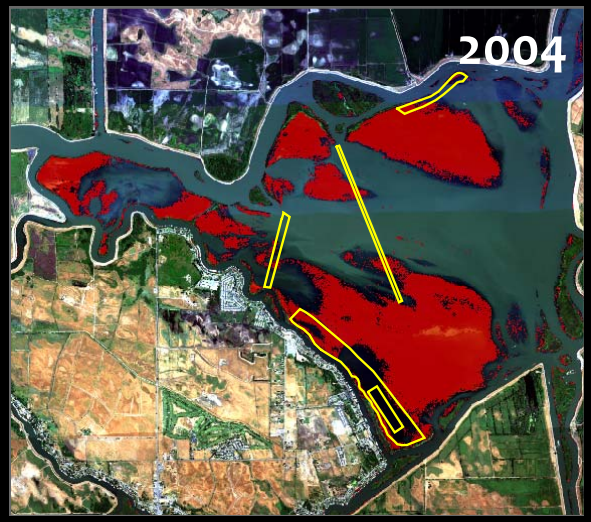


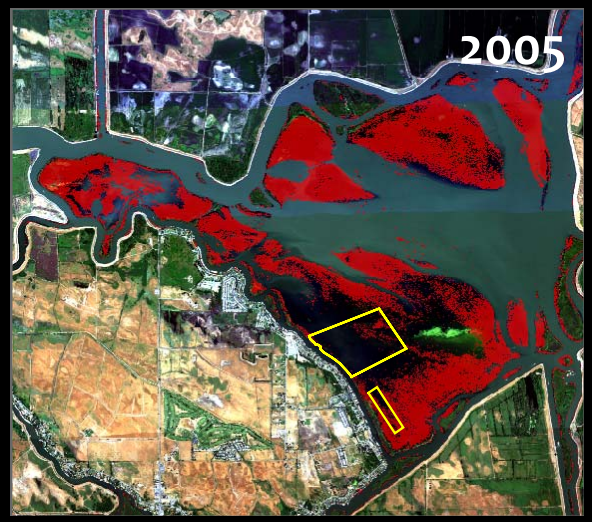


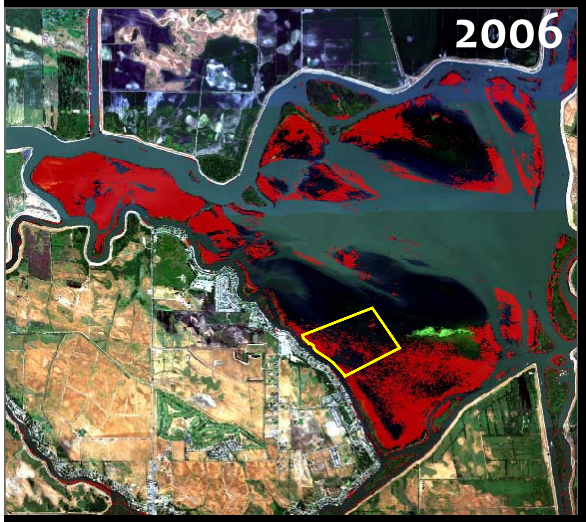
Aquatic applications

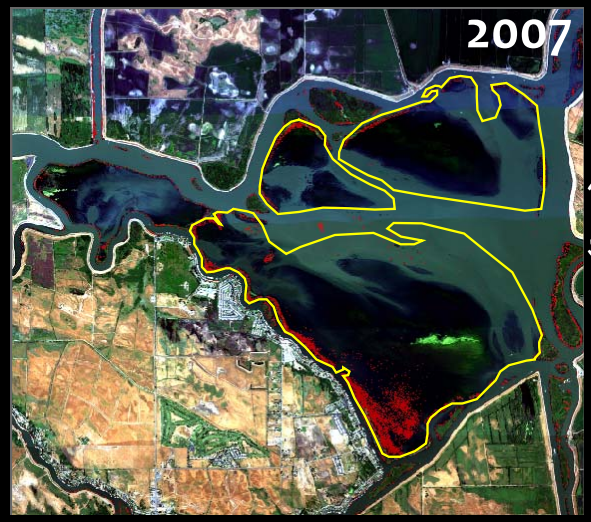
6. Management Efficiency





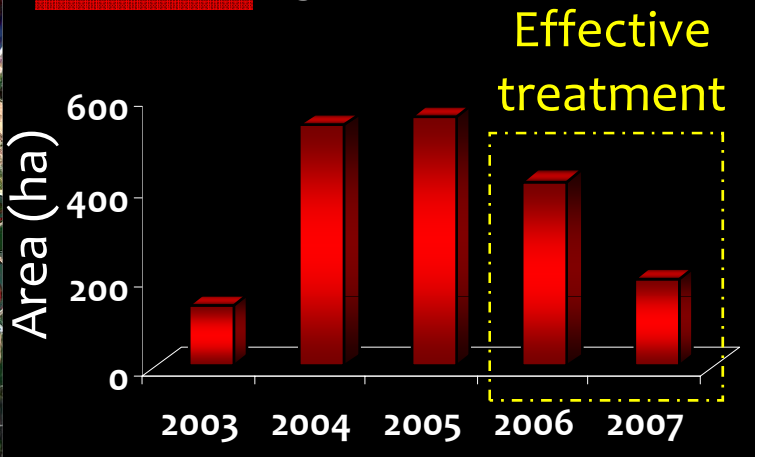






Herbicide treatment areas

SAV



Aquatic applications

6. water quality monitoring using radiative transfer modeling

$$R(0-) = f\frac{b_b(\lambda)}{a(\lambda)+b_b(\lambda)}$$

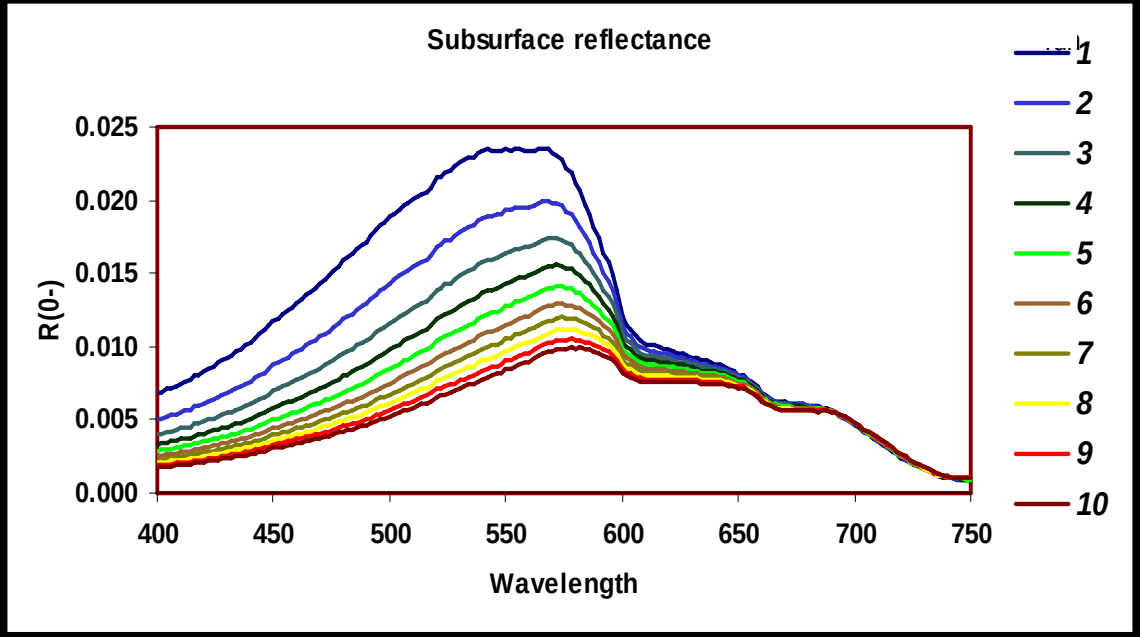
Interaction at surface

Apparent optical properties

$$R(0-) = \frac{r_1 b_b}{(a+b_b)}$$

Inherent optical properties

Absorption coefficients still must be determined for CHL, CDOM, and TSM.



Many more applications…

These are just a few of the potential applications using hyperspectral data and Lidar

What can hyperspectral do for you?