Using remote sensing to monitor past changes and assess future scenarios for waterways in the Sacramento-San Joaquin Delta, California USA

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Introduction

Historically, **deltas** have been extensively affected both by natural processes and human intervention

Understanding drivers, predicting impacts and optimizing solutions to delta problems requires a holistic approach spanning many sectors, disciplines and fields of expertise

Deltas are ideal model systems to understand the effects of the interaction between social and ecological domains, as they face unprecedented disturbances and threats to their biological and ecological sustainability.

The challenge for deltas is to meet the goals of supporting biodiversity and ecosystem processes while also provisioning fresh water resources for human use

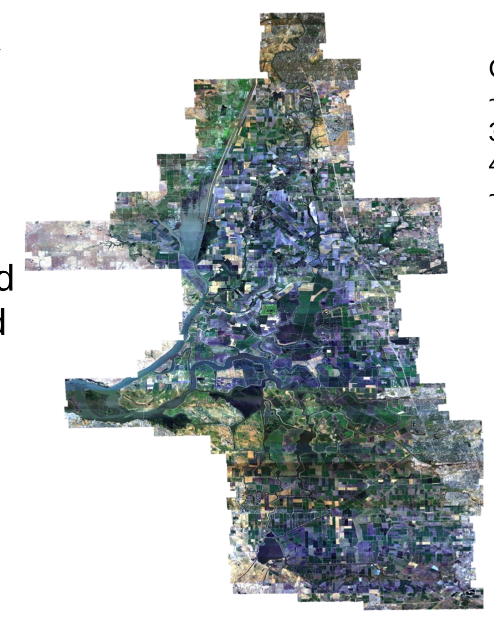
The Sacramento-San Joaquin Delta

1. $5.3 billion economic output
2. Declining sediment supply
3. Saline intrusion eastward
4. Marshland reclaimed for agriculture
5. Highly vulnerable to climate variability & change

Cohen & Carlton 1998; Luoma et al. 2015

1 Monitoring biological invasions and their cascading effects

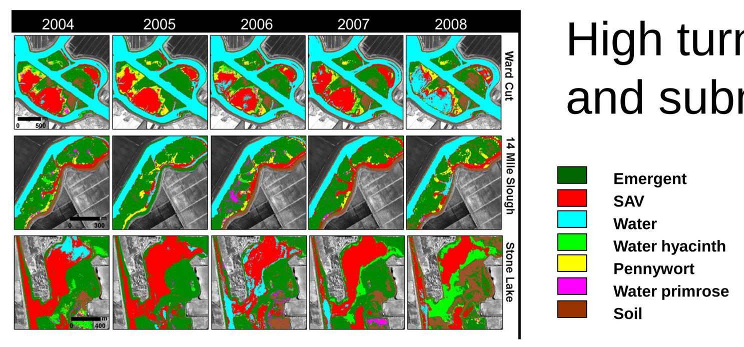
1. One of 25 global hotspots for biodiversity
2. 50 native species listed under the ESA
3. One of the most invaded ecosystems in the world



AVIRIS-ng
Collected Nov 2014 and Sep 2015
~2.5 m pixel resolution
380-2510nm
481 spectral bands at 5nm sampling
~61 flightline mosaic

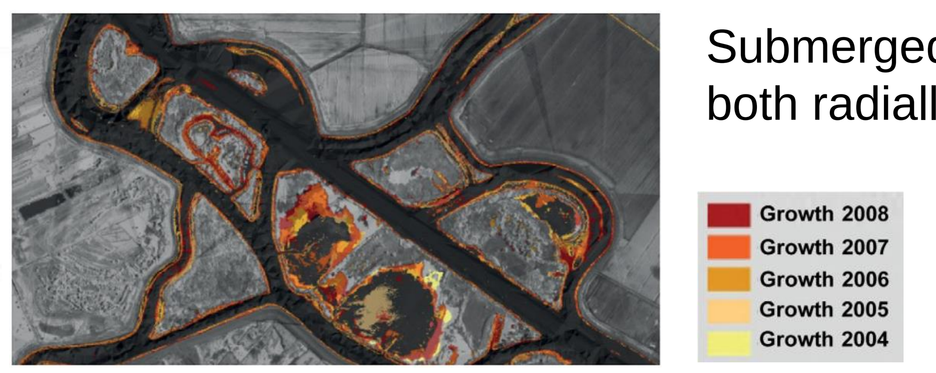
Extends the record:
HyMap Spectrometer
Collected Jun 2004 to Jun 2008
3m pixel resolution
400-2500nm
126 spectral bands at 10nm sampling
~65 flightline mosaic

Floating species occupy 1-8% of the waterways
classification accuracy>80% — Khanna et al. 2011

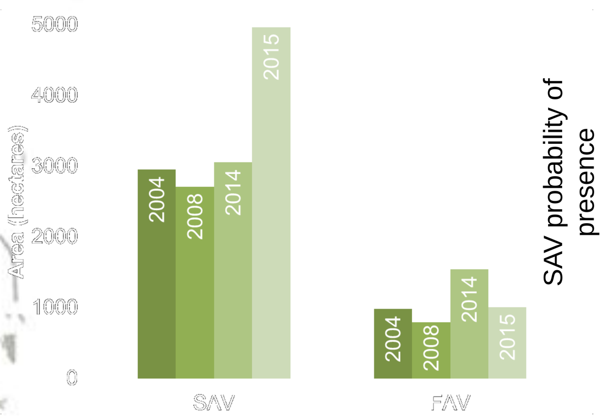


High turn-over between floating and submerged species — Ustin et al. 2014

Submerged species occupy 6-15% of the waterways
classification accuracy>90% — Hestir et al. 2012

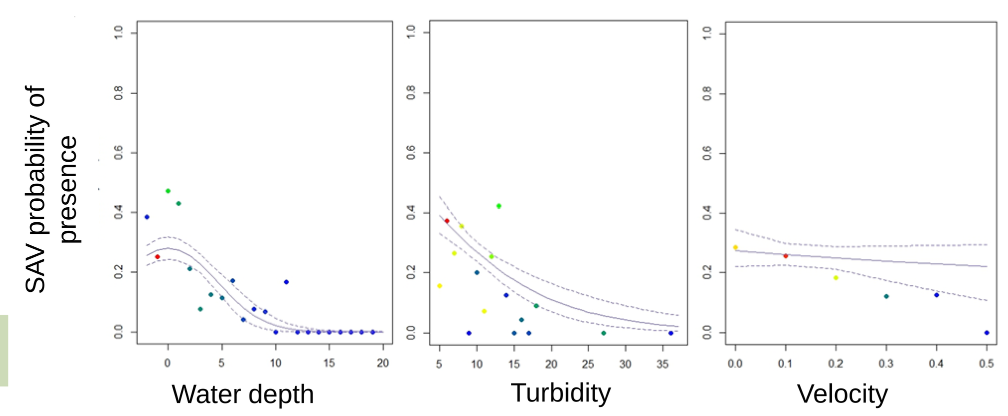


Submerged species disperse both radially and long distance — Santos et al. 2016

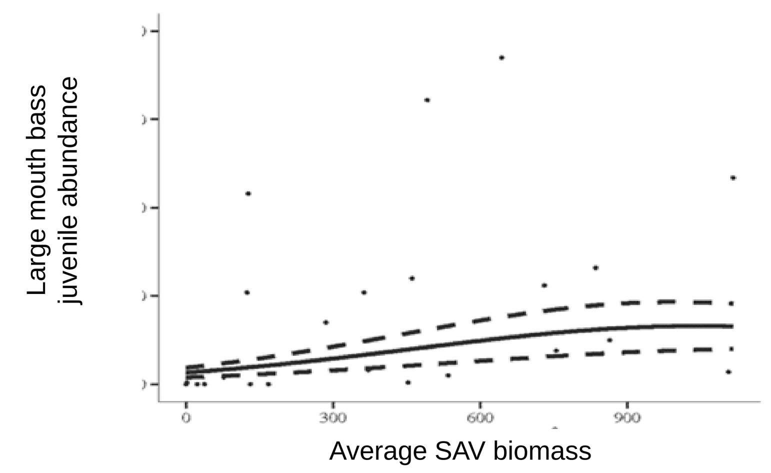


Submerged (SAV) and Floating (FAV) vegetation

Submerged species have increased in recent years



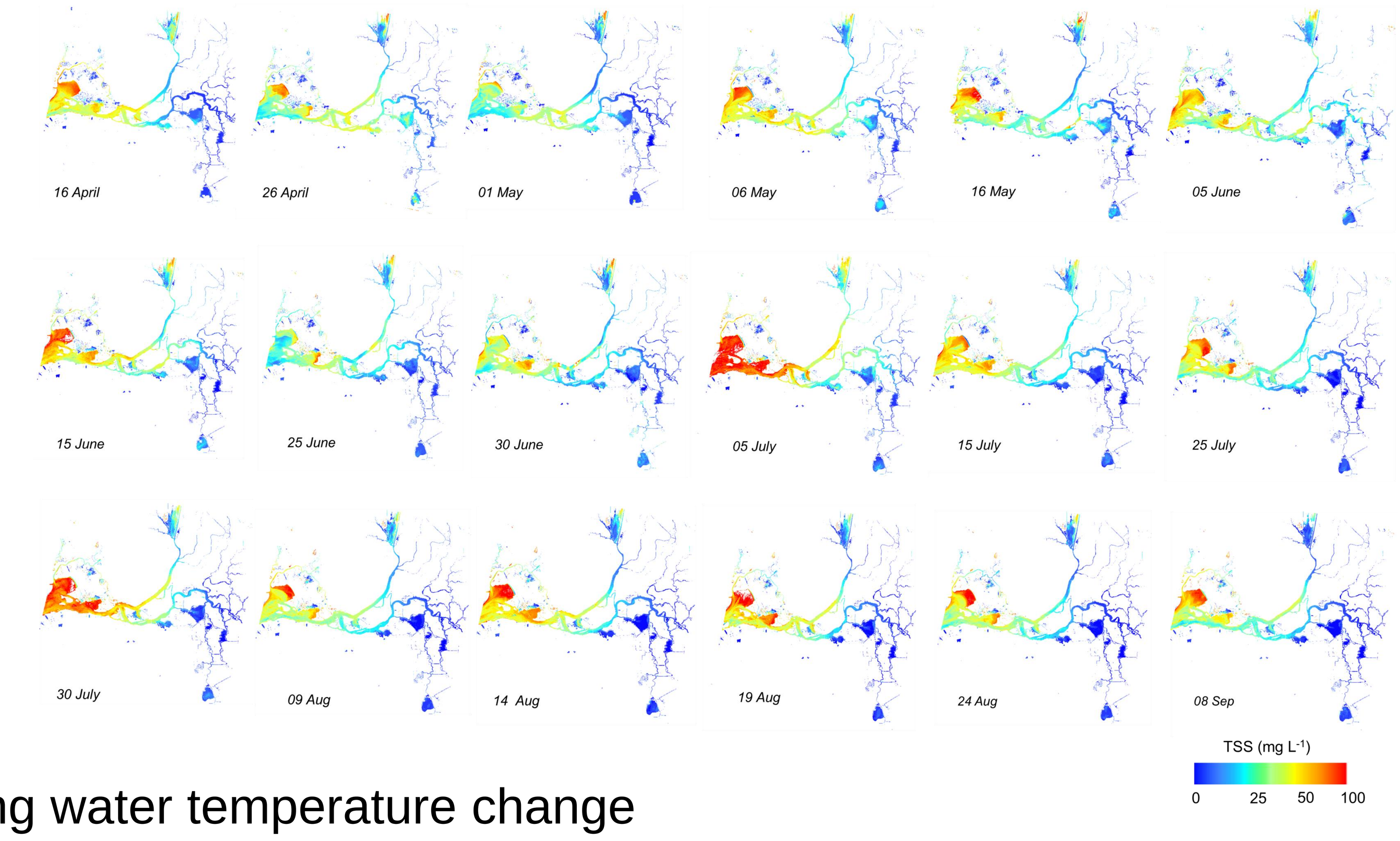
Submerged vegetation probability of presence is related to low turbidity and velocity — Durand et al. 2016



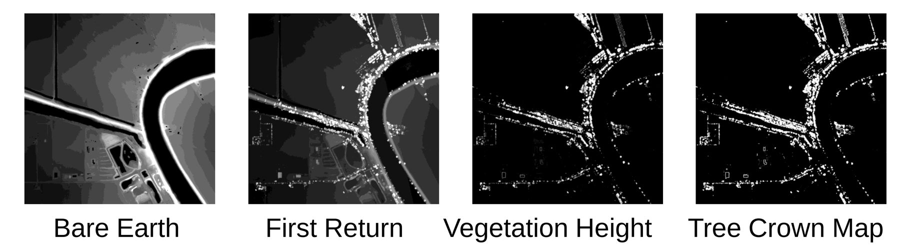
Submerged vegetation provides habitat for invasive fish who prey upon native endangered fish species — Conrad et al. 2016

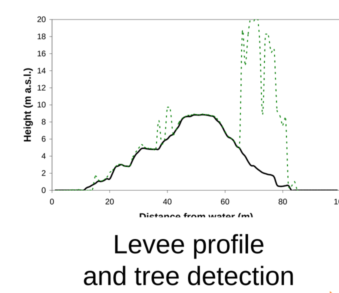
2 Monitoring changes in turbidity and sediments

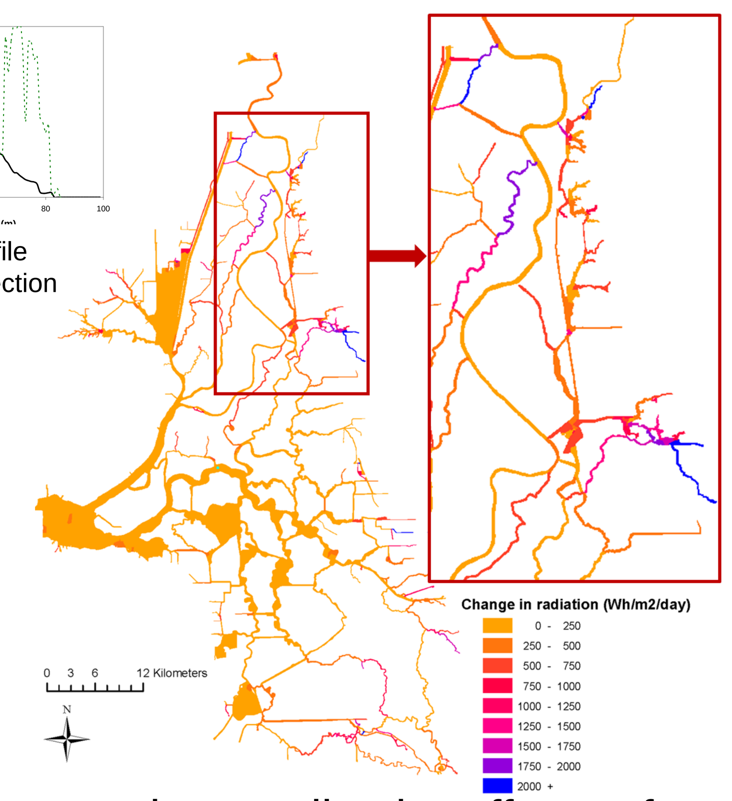
1. Sentinel-2 is a next generation satellite mission that will provide researchers with improved temporal (5 days revisit) and spatial (10m).
2. Monitoring inland water quality monitoring using the European Space Agency's Spot-5 Take-5 (S5T5) experiment as a proxy for full Sentinel-2 data. — Ade and Hestir 2016



3 Modeling water temperature change

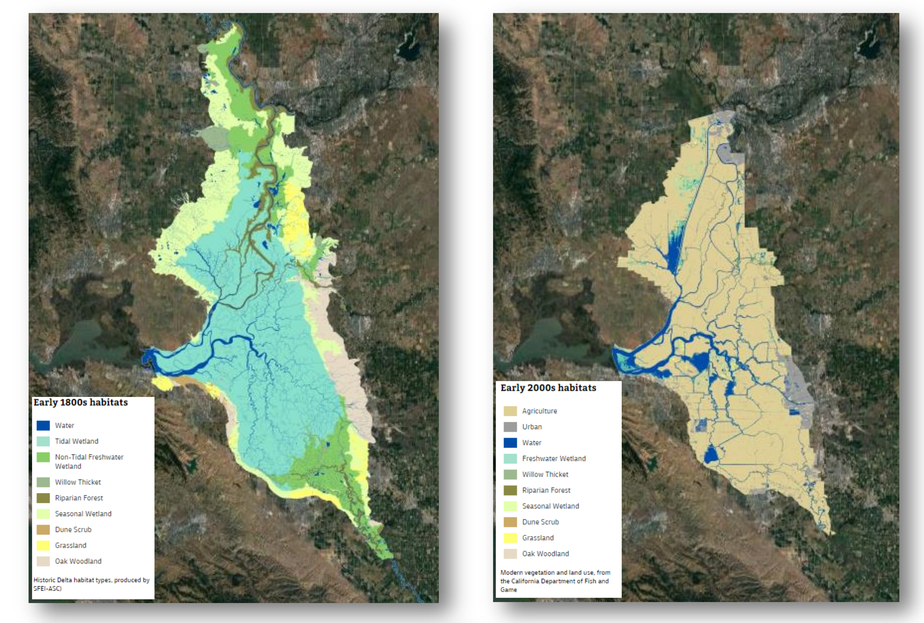






Lidar data used to predict the effects of tree removal on water temperature — Greenberg et al. 2012

4 Land use/land cover change



Envisioning California's Delta as it Was
KQED Science
http://web.stanford.edu/group/west/cgi-bin/projects/delta/map/index.html

The **SSJ Delta** has undergone a process of land reclamation for agriculture

Conclusions

Deltas will be further affected both by ongoing land cover and climate changes.

We show some examples of remote sensing applications to study biodiversity, ecology, water quality and land use/land cover changes, which benefits from existing data and sensors.

New missions and sensors expand upon the capacity exemplified in here: higher spatial, temporal and spectral resolution.

Remote sensing offers an enormous potential to detect, predict and monitor the processes of change and the drivers of change in deltas and their social-ecological interactions

Acknowledgements

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