From Salt Ponds to Wetlands

Cargill Salt sells back 15,000+ acres of shoreline to nature

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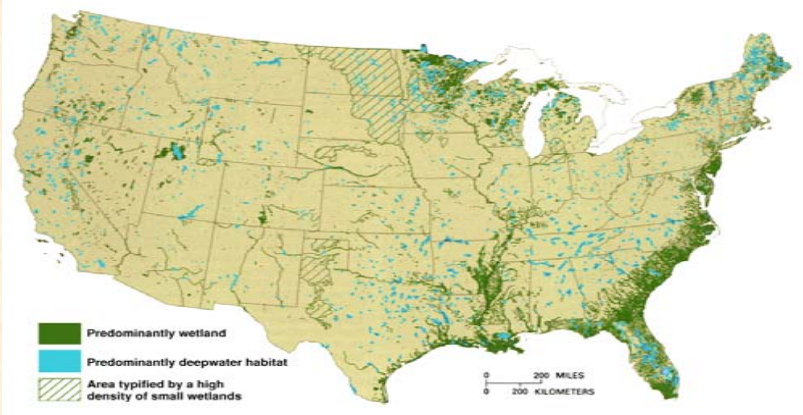
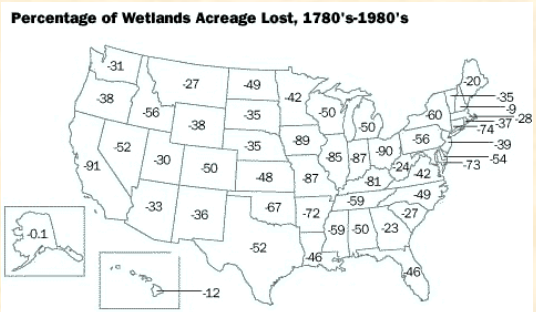
Wetlands in the U.S.





Twenty-two states have lost at least 50 percent of their original wetlands. Seven states—Indiana, Illinois, Missouri, Kentucky, Iowa, California, and Ohio—have lost over 80 percent of their original wetlands. Since the 1970's, the most extensive losses of wetlands have been in Louisiana, Mississippi, Arkansas, Florida, South Carolina, and North Carolina.
Source: Mitch and Gosselink. Wetlands. 2nd Edition, Van Nostrand Reinhold, 1993

- What is a wetland?
- Marsh, bog, pit, swamp
- Coastal or inland and including watersheds
- Diverse systems
- Incredibly productive

http://geochange.er.usgs.gov/sw/impacts/hydrology/wetlands/

Wetlands in the South Bay

- Tidal Marsh
- Mud Flats
- Seasonally Dry Wetlands
- Upland


Tidal Marsh

Mudflat at high tide

Mudflat at low tide

Seasonally Dry Wetlands

Upland

Importance of Wetlands

- Habitat/Nursery
- Flood Control
- Filter
- Recreation
- Education

Burrowing owls

Endangered California Clapper rail

Endangered salt marsh harvest mouse

Ducks, geese, heron, egret, pelicans and turns

Habitat

Flood Control

Eastern Diked Marsh

Western Diked Marsh

Marsh owned by Mid-Pen

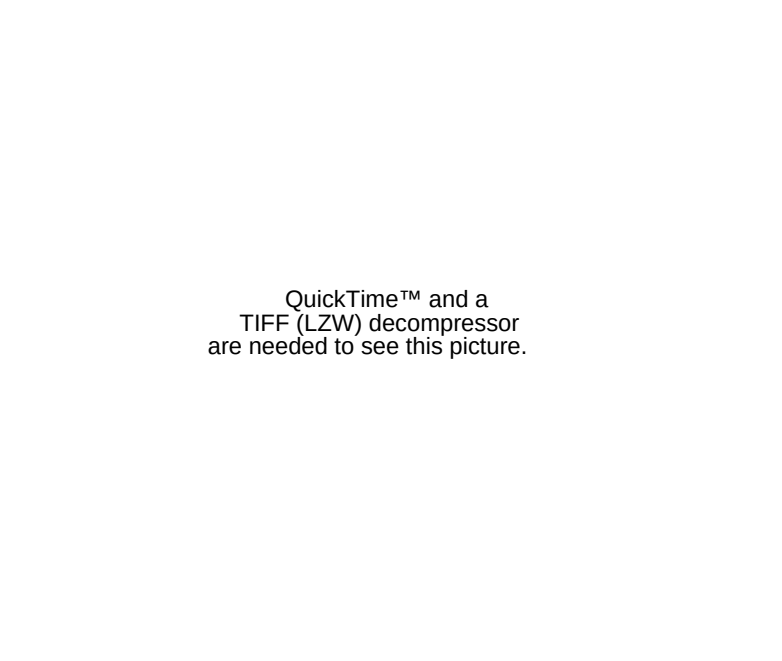
Storm water run-off & flood control

Flood Control

http://pedrocreek.org/

- San Pedro Creek, Pacifica, CA
- Agriculture/flood control land early/mid-1900's
- 1950's urban buildup
- 1960's flooding problems

Natural Filter



- Mudflats soak up harmful chemicals
- Plants are adapted to utilize excess material
- Trash deposition

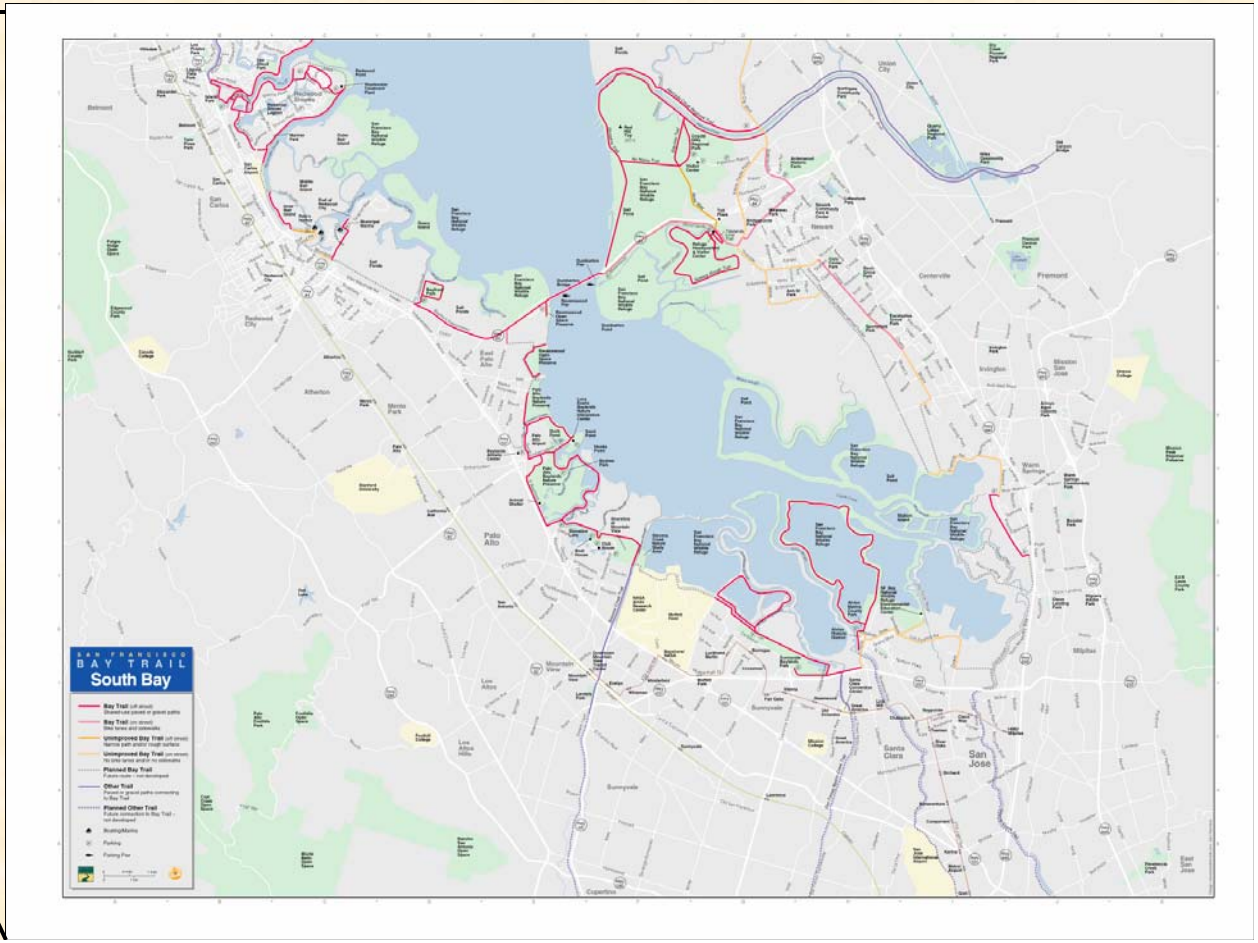
http://www.melbourewater.com.au/content/library/water_cycle/waterways/wetlands/Wetlands_Natures_Filter.pdf

Recreation

Maintained recreation trails for running, roller blading, biking, bird watching, etc…

Duck blinds for hunters

Recreation



- San Francisco Bay trail
- http://baytrail.abag.ca.gov/map.html

Education

- Non-profit organizations -- educational programs throughout SF Bay

→ Save the Bay - Oakland, CA

-- Canoe programs through wetlands (East, North and Peninsula)
-- www.savesfbay.org

→ Marine Science Institute - Redwood City, CA

-- Ship and land-based biology/ecology programs throughout the Bay
-- www.sfbaymsi.org

→ Bay Model Association - Sausalito, CA

-- Ship and land-based programs in Marin County
-- www.baymodel.org

→ CA Explorations - San Mateo, CA

-- Individualized environmental education programs around SF Bay
-- www.caexplorations.com

San Francisco Bay - The Past

- pre-contact-1769 Indigenous
- 1850s--Gold Mining
- 1900s--Salt Works
- 1920s-1960s--Agriculture
- 1933-1994--Military use of Land
- 1950s-1990s--Urban Buildup

- **Early salt gathering from naturally occurring salt ponds around the Bay**

Ohlone Indians

The Muwekma Ohlone

home

1850’s - Gold Mining

- Sierra Nevada hydraulic mining
- This is what made Central California so popular
- Where did the runoff go?

1942--Leslie Salt—Consolidation of the Bay's Business

1978--Cargill purchases Leslie Salt

Moffett Field, CA

Navy Base 1933-35

US Army Air Corp 1935-42

Naval Air Station 1942-1994

Decommissioned after 1994

Past vs. Present Conditions of SF Bay Wetlands

~ 95% original wetlands have disappeared

http://www.sfei.org/ecoatlas/Habitat/maps/SFBay/pastpres1.html

1800's

present

Acquisition of 15,000+ Acres of Land from Cargill Salt Co.

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

NBC 6 o’clock news July 2003

Look How Much Land We Have to Work With!

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Cargill property along Stevens Creek recreation path

Will we be able to access this area?

Pond A2W

- Intake pond
- Brackish water (15 - 30ppt)
- Levees opened summer ‘04

Pond A7

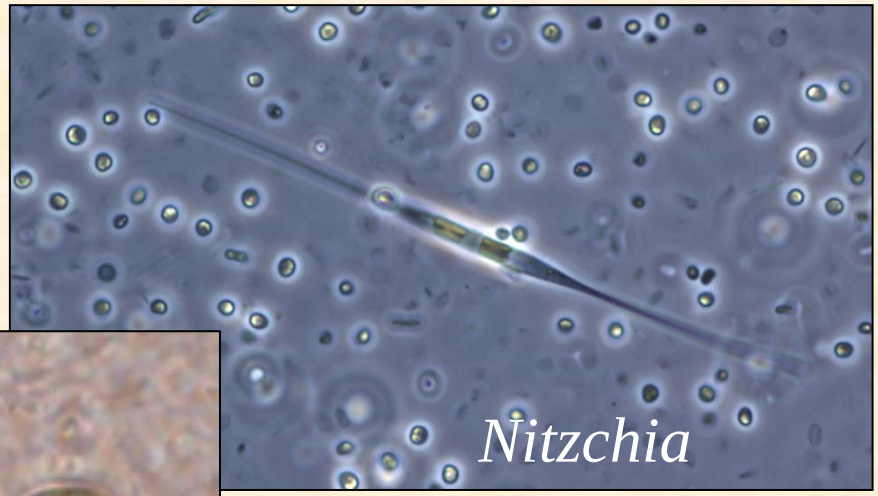
- Mid-salinity (65 - 80ppt)
- Bird habitat
- Excess organic material
- Managed saline pond?

Pond A23

- High salinity (>300ppt)
- Halophile habitat
- Bird habitat
- Mars/Europa-like

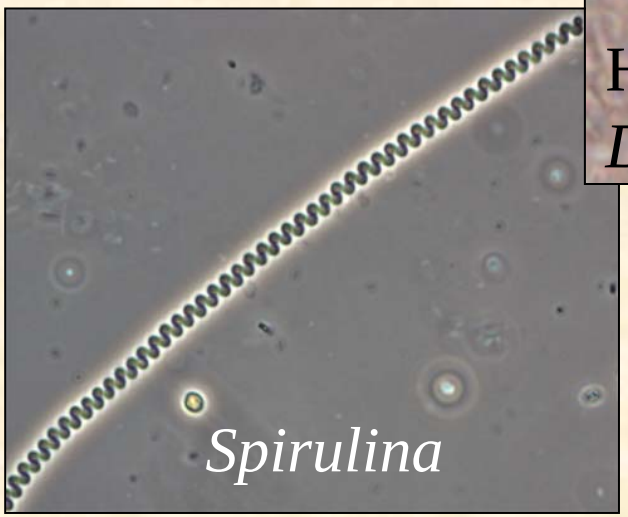
Microbes Give Ponds their Color

Dinoflagellate



Nitzchia

Halophiles and
Dunaliella



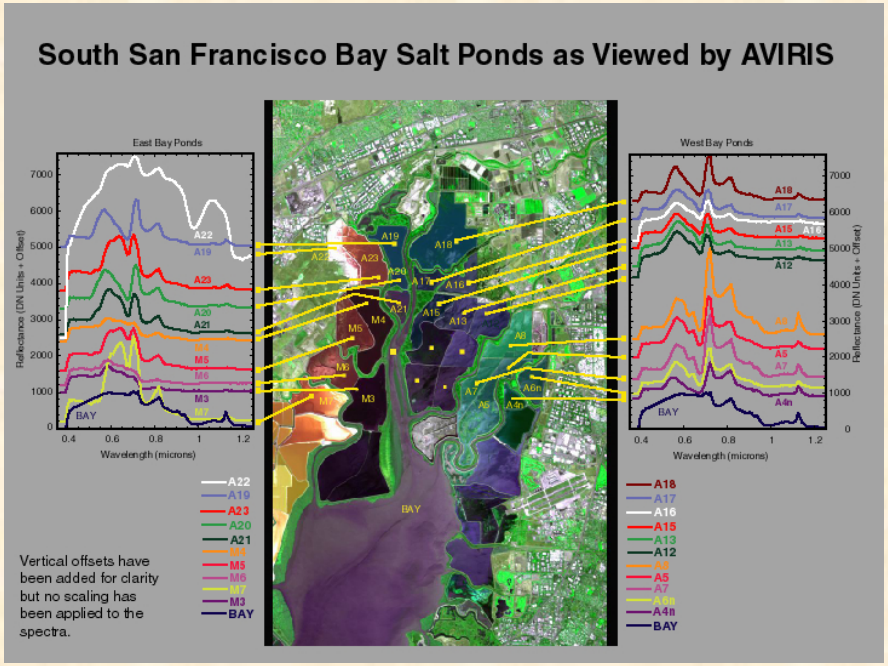
Spirulina

Noctiluca

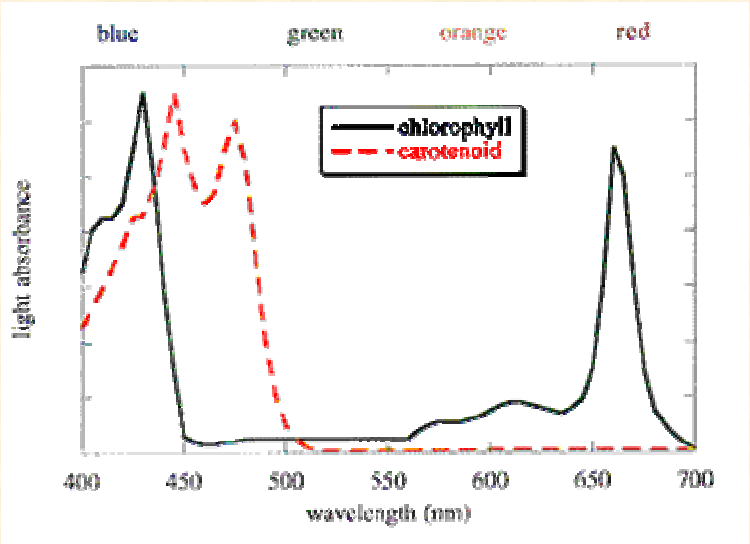
Using Remote Sensing to Monitor Restoration

Spectral characteristics from satellites - AVIRIS, LandSat, MODIS, etc.

and compare to…



Courtesy of Dr. James Brad Dalton

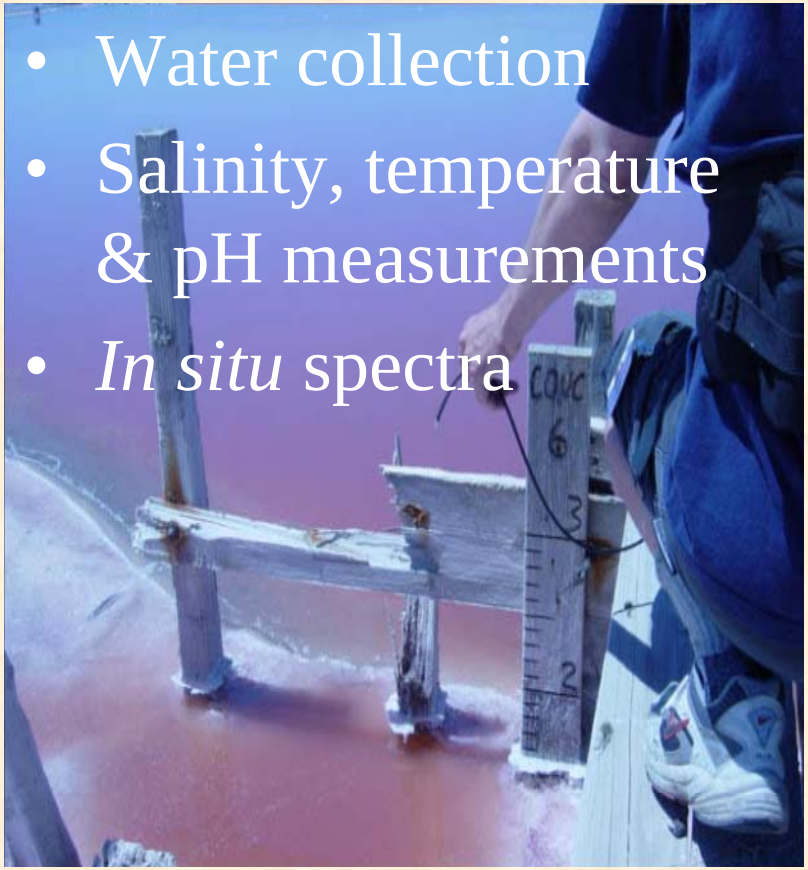


http://www.rain.org/~mkummel/stumpers/03nov00a.html

Spectral characteristics from pigment - chl a, carotenoids (435 & 665nm), (400 - 500nm)

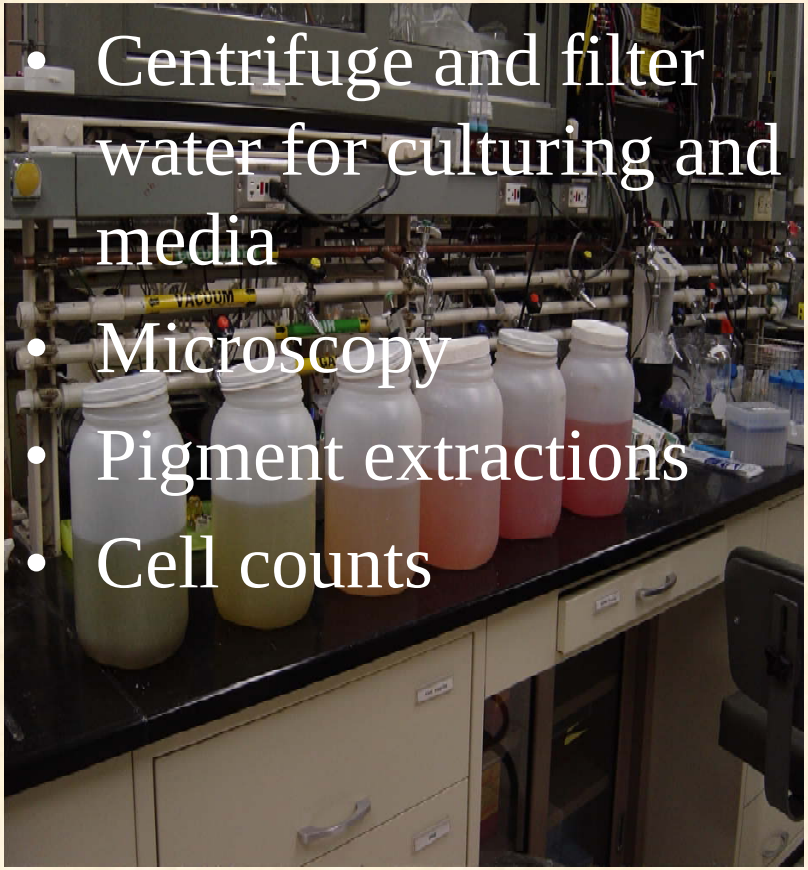
Methods

In the field…



- Water collection
- Salinity, temperature & pH measurements
- *In situ* spectra

In the lab…



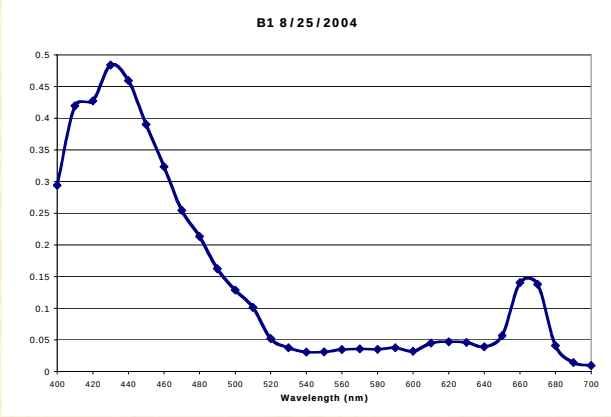
- Centrifuge and filter water for culturing and media
- Microscopy
- Pigment extractions
- Cell counts

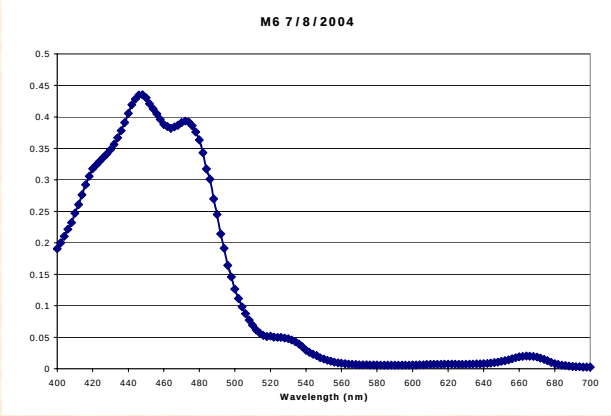
Results so far…

POND	DATE	SALINITY (ppt)	CILIATE	FLAGELLATES	ALGAE	DINO-FLAGELLATE	PENNATE DIATOM *Nitzchia* sp	EXTREME EUKARYOTE *Dunaliella* sp	ARCHAEA *Halobacter* sp
A1	2/11/04	20		100%					
A2W	2/11/04	20		80%		20%			
B2	2/11/04	22.5		95%					
A2E	2/11/04	25		100%					
A3W	2/11/04	25	5%	95%					
B1	2/11/04	25		95%			5%		
A3N	2/11/04	35		100%					
A12	8/13/03	65	20%	20%		10%	50%		
A13	8/13/03	85	10%	35%	5%		50%		
A15	8/13/03	85		80%		5%	15%		
A16	8/13/03	110		90%			10%		
M4	8/8/03	210						20%	80%
M6	7/1/03	260						10%	90%
A23	6/23/03	310						10%	90%

- Common eukaryotes found up to ~100ppt
- Extreme eukaryote and Archaea found > 200ppt

Low salinity vs. High salinity





- B1 salinity = 20ppt

→ notice less absorbance in 400 - 500nm range

→ notice large 665nm chl a peak

- M6 salinity = 265ppt

→ notice more absorbance in 400 - 500nm range

→ notice smaller peak at 665nm

Our Conclusions…

- …to come someday
- Still need to sort through data on both ends
- Compare pigment and spectral data and recognize trends

Extra Information

- South Bay Salt Pond Restoration Project
  http://www.southbayrestoration.org/
- San Francisco Estuary Institute
  http://www.sfei.org/
- California Coastal Conservancy
  http://www.coastalconservancy.ca.gov/