Science to support management of the APPLS

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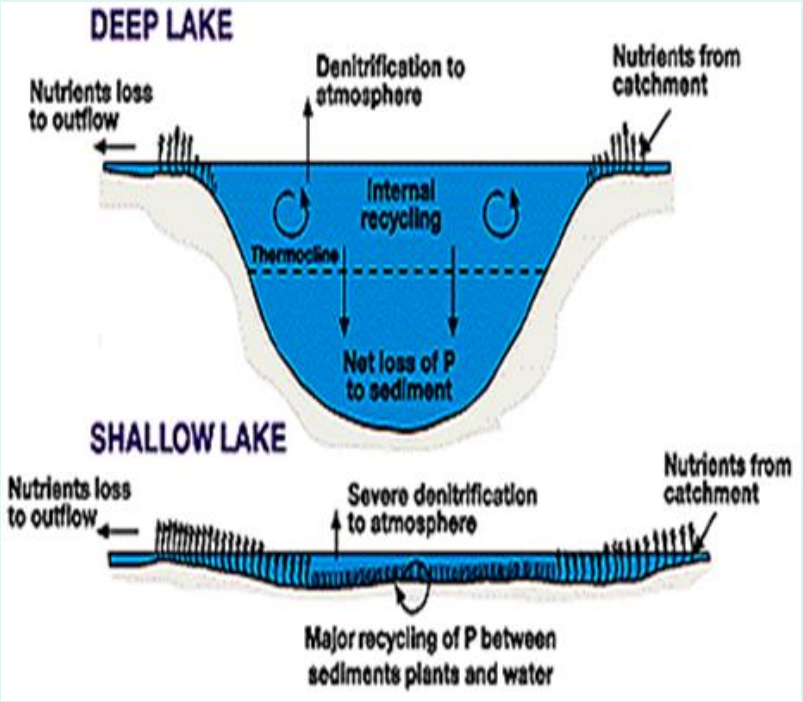
Phelps Lake
Lake Pungo
New Lake
Lake Mattamuskeet
0 3 6 12
Kilometers

Shallow Lake Limnology

- Less than 3 m deep
- Frequent Mixing
  - Resuspension
  - phosphorus
- High Primary Productivity
  - Macrophytes- Aquatic Plants
  - Algae



The tale of the tape…

Lake	Average Depth Sampled (m)	Secchi Depth (m)	DOC (mg/L)	SUVA (abs@254/ DOC)	Chlorophyll- a (ug/L)
Phelps	1.5	1.5	1.5	0.009	1.19
Mattamuskeet					
East	1	1	14	0.015	17.3
West	1	0.4	18	0.022	36.4
Pungo	1	0.003	20	0.037	18.5

Lake Phelps

Lake Mattamuskeet

Pungo Lake

More tale of the tape…

Nutrients

Lake	$N\text{-}NO_x$ (ug/L)	$N\text{-}NH_4$ (ug/L)	$P\text{-}PO_4$ (ug/L)	TN (ug/L)	ON (ug/L)
Phelps	0.03	7.98	1.3	36.68	28.66
Mattamuskeet					
East	1.46	12.88	4.71	761.5	747.17
West	7.04	28.13	2.3	993	957.83
Pungo	495.75	20.52	23.71	1097.5	581.23

Lake Phelps

Lake Mattamuskeet

Pungo Lake

Why Mattamuskeet first?

(a lesson in media relations)

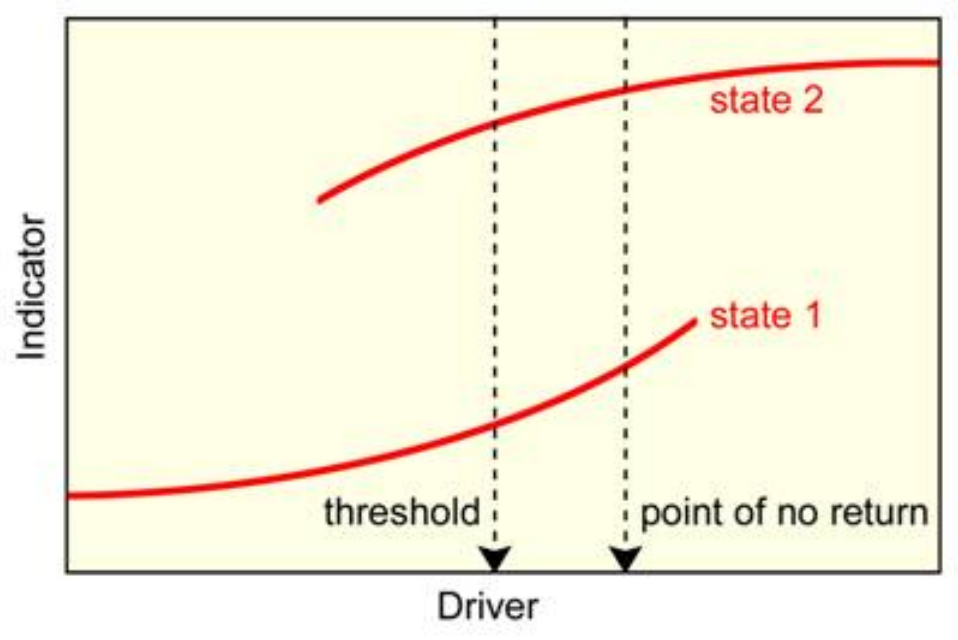
Pulitzer Prize Winning

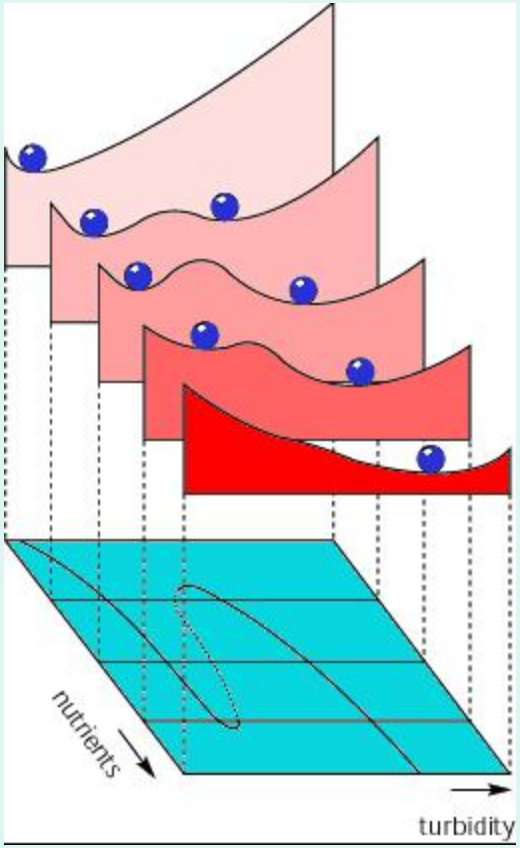
WASHINGTON DAILY NEWS

The Voice of the Pamlico

"It's just big," said Piehler. "We were all sitting around the office one day looking at a map and said, 'Wow, that's a huge lake.' Also, it's a major fish and waterfowl habitat."

But really, Why Mattamuskeet?





"Are understanding and incorporating ecological thresholds the key to successful environmental management, or are they an important and appealing conceptual way of looking at ecosystems with no real potential for practical application?"

Groffman and others 2006

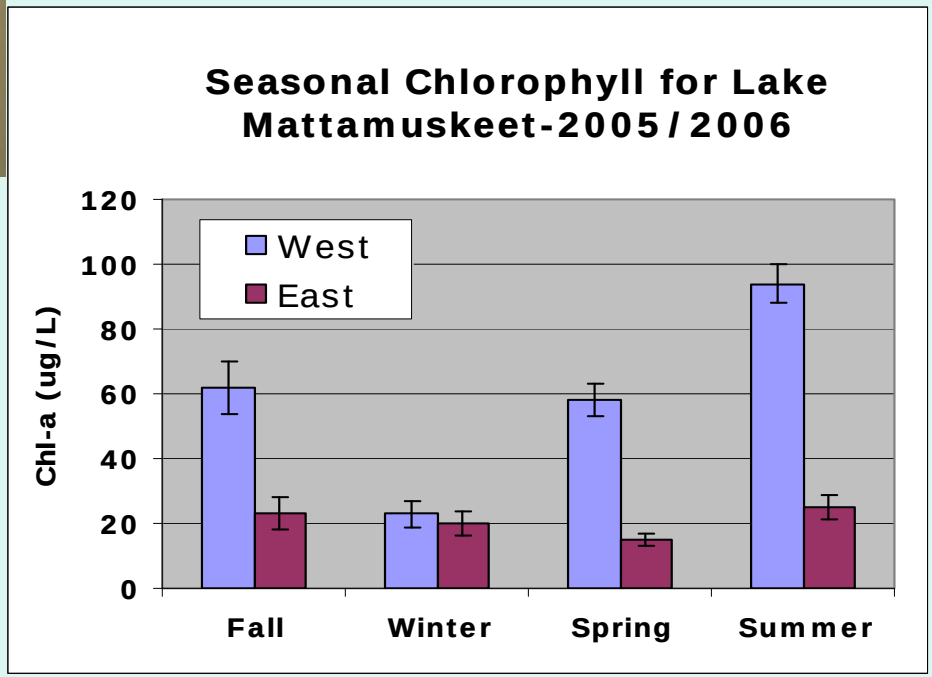
Sampling Stations


First the
phytoplankton

Tale of two lakes

West

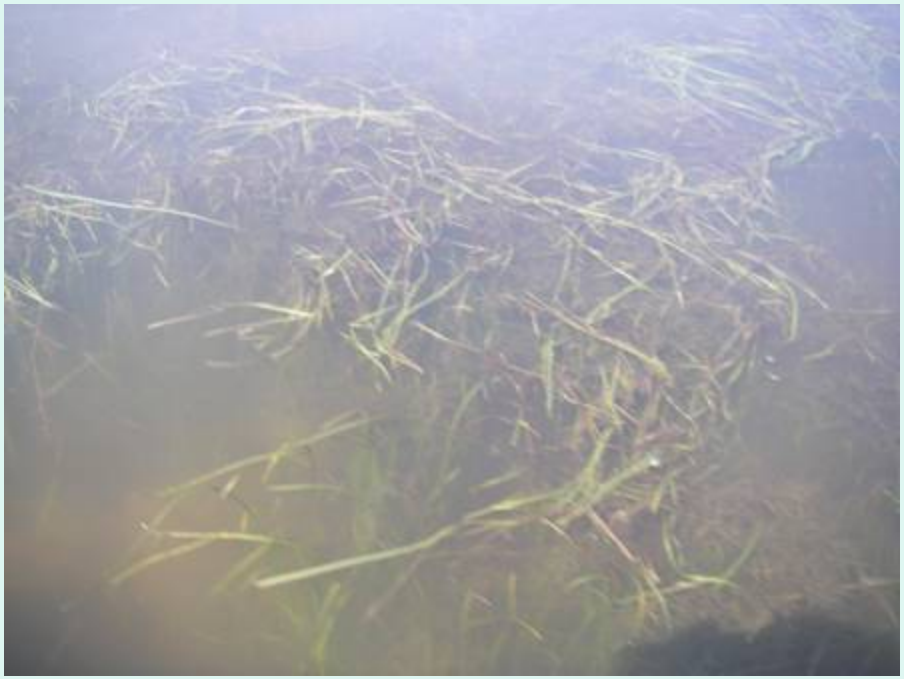
- Algal Dominated
- Low Water Transparency



East

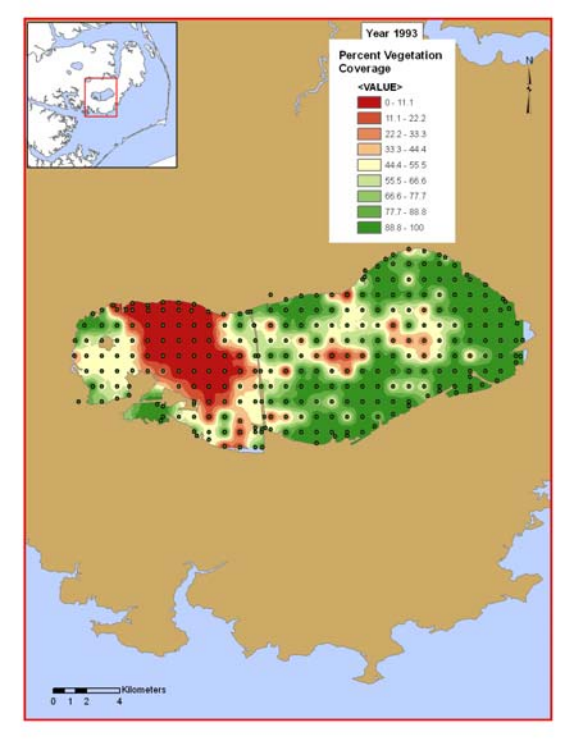
- Low algal biomass
- High Water Transparency

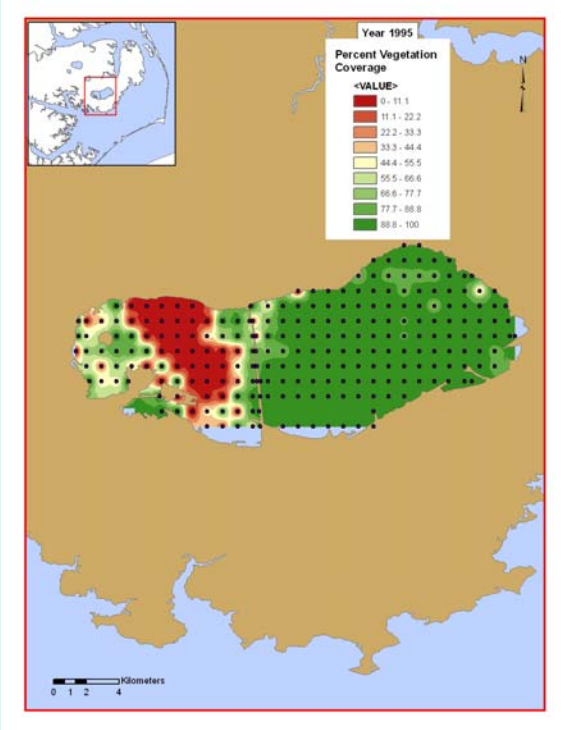
What about the plants?

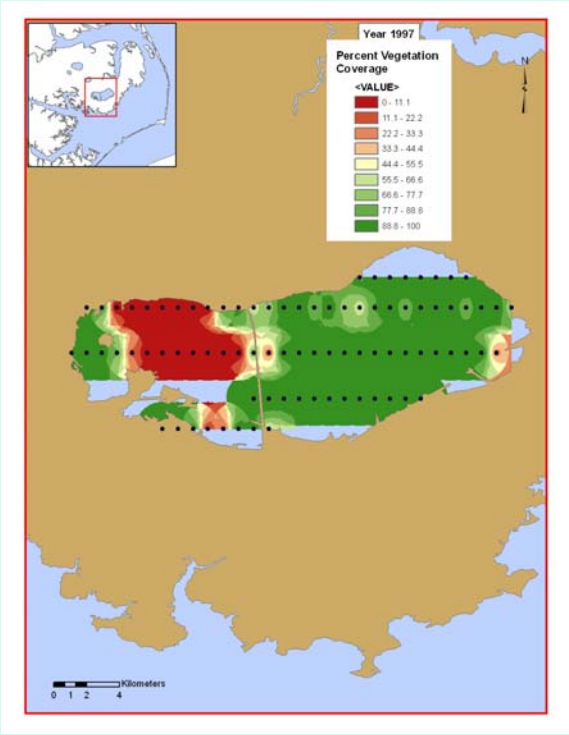


….and how stable is stable?

Macrophyte coverage in the 1990s

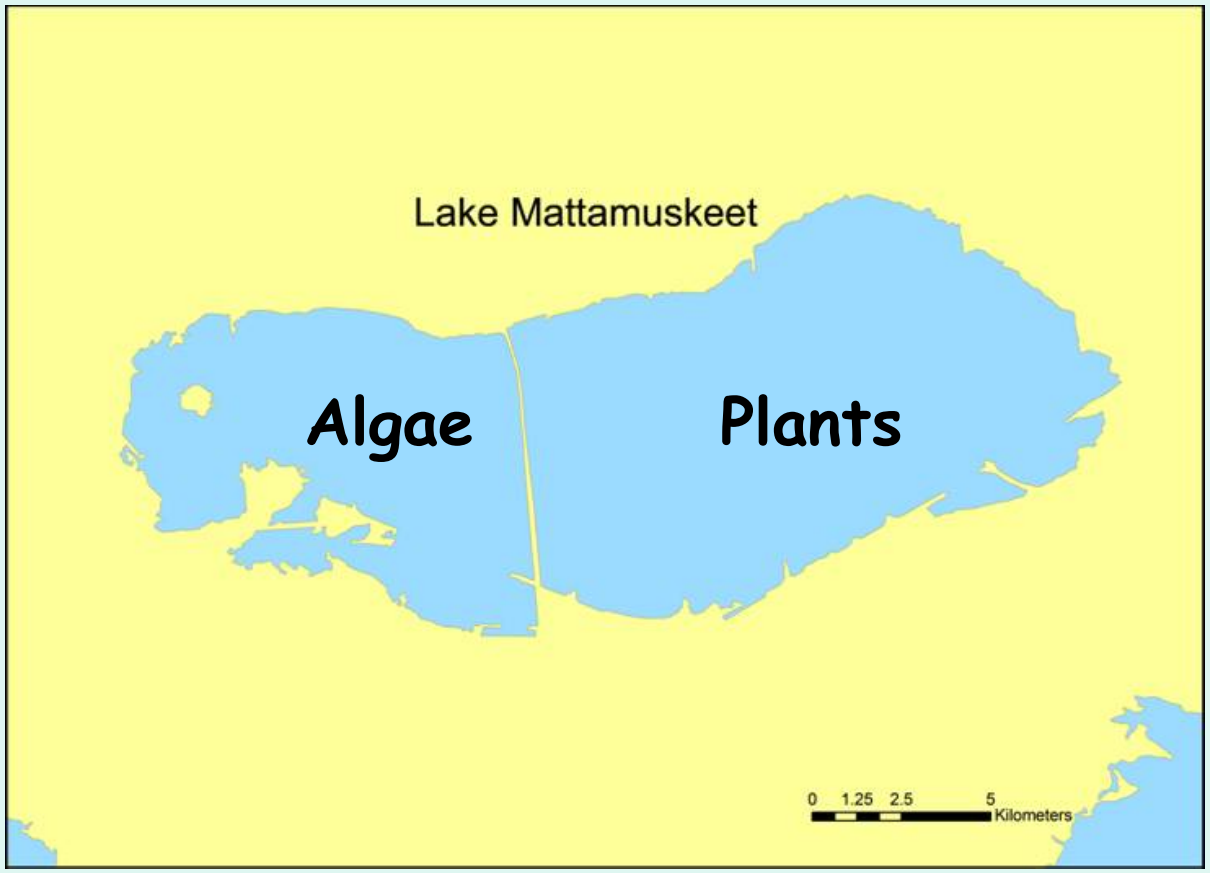






Green = Plants
Red = No Plants

Potential drivers in change of ecosystem state



Nutrient addition bioassays

Bioassay design (4 replicates/treatment):

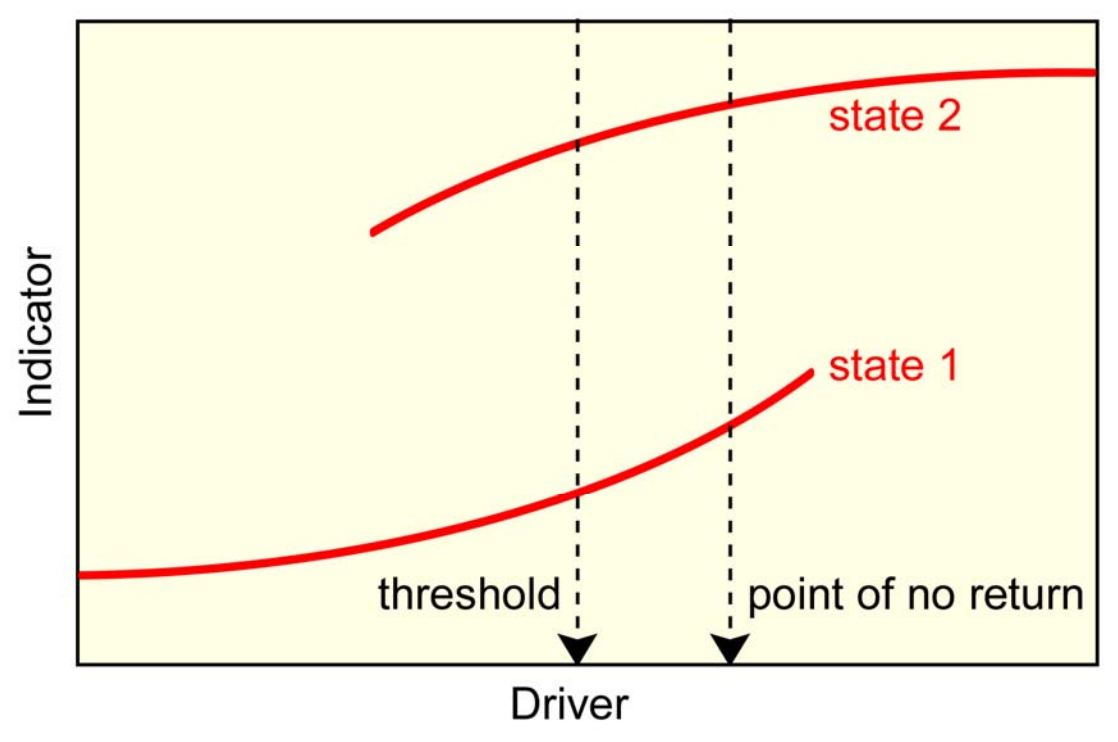
- **West Side, East Side**

  Control
  Nitrogen (20uM NH_4^+-N)
  Phosphorus (5uM PO_4^+-P)
  Nitrogen+Phosphorus

- **Data presented are for 2 day incubations**

Spatial and temporal changes in phytoplankton nutrient limitation

Shallow Lakes Can Flip



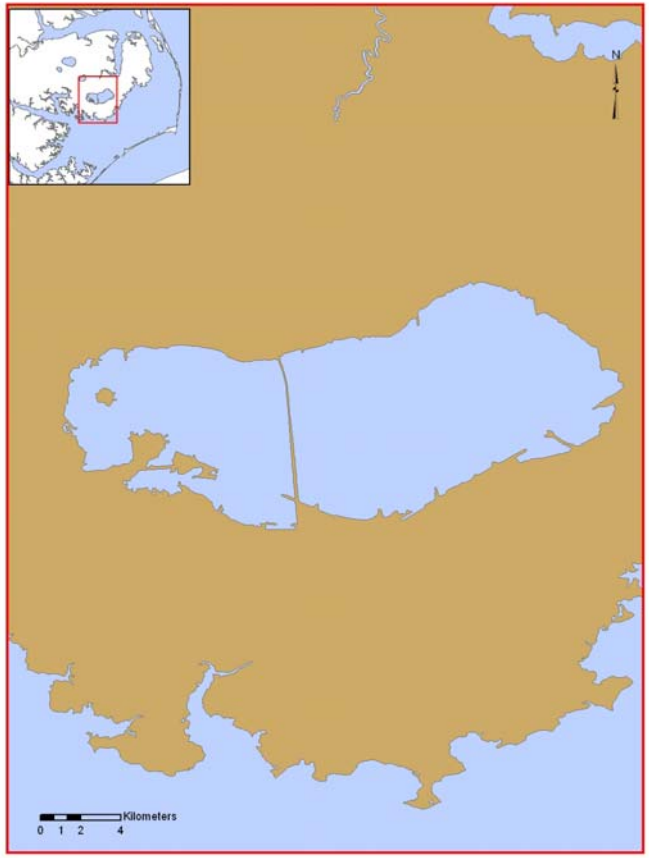

Chlorophyll *a*
Nitrogen
Image © 2006 MDA EarthSat
Image © 2006 DigitalGlobe
©2005 Google
Pointer 35° 29'37.59"N 76° 11'21.92"W elev 0 ft
Streaming 100%
Eye alt 16.30 mi

Other contrasts East v. West

- Nutrient cycling
- Greenhouse gas fluxes
- Zooplankton

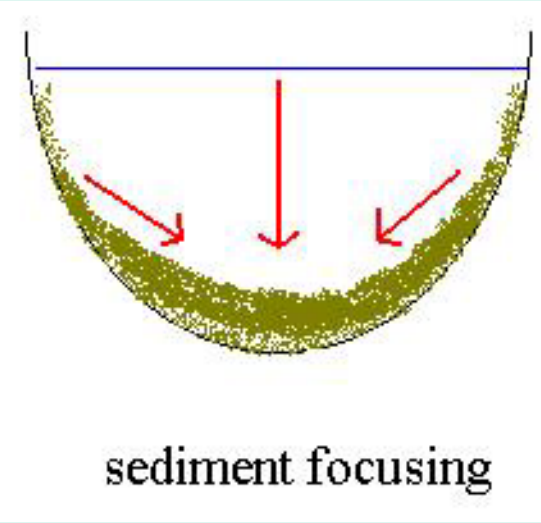
Important events in the history of Lake Mattamuskeet

- 1585: John White painted the lake
- 1850's: 1st canal dug
- 1915-1932: lake was drained and farmed
  - Southern 12,000 acres
- 1932: NWR
- 1942: Highway 94
- 1950's: removed carp and catfish
- 1985: replaced water control structures

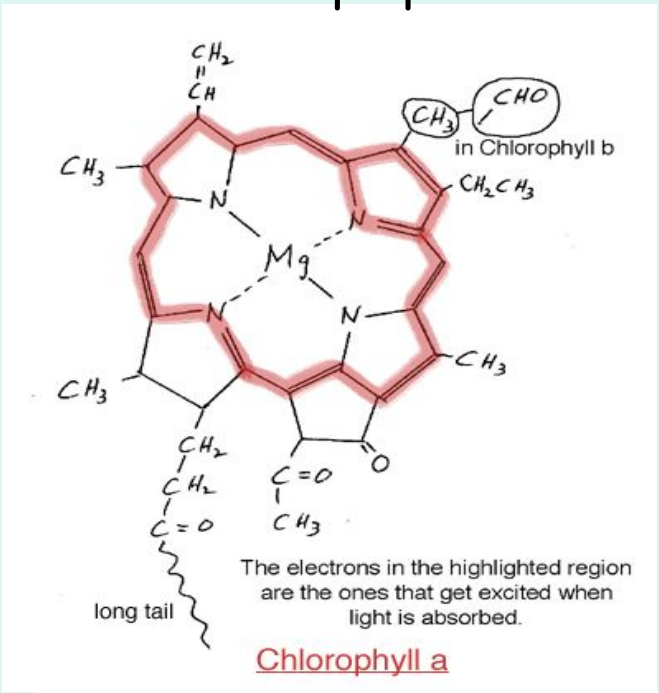


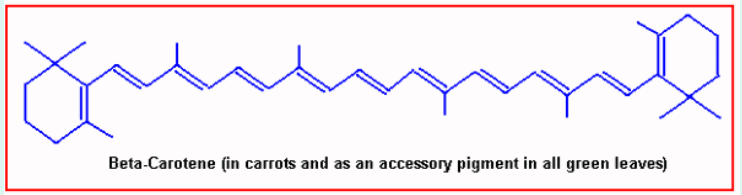
Paleolimnology

- Sediment Record
- Proxies
  - Organic Matter (LOI)
  - Solid-Phase Elements
    - P, S, AL, Fe and others
  - Dating ^{210}Pb, ^{14}C
  - Photosynthetic Pigments

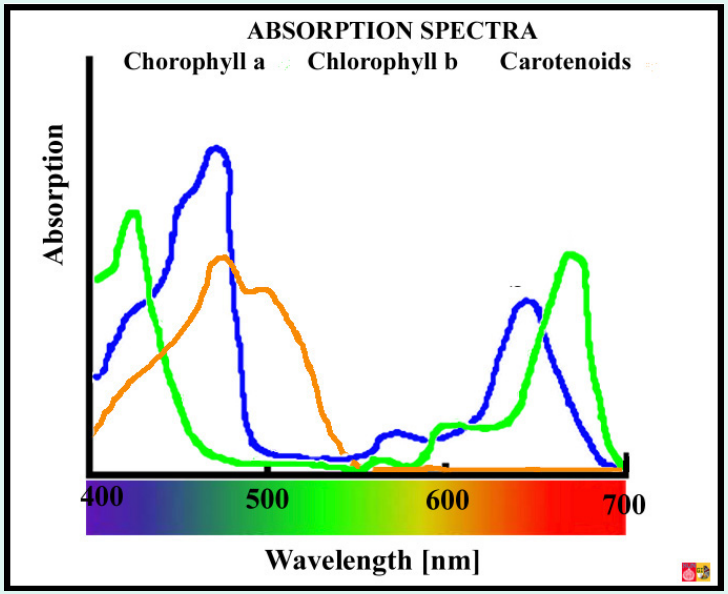


- Pigment Types
  - Chlorophylls
    - Chl-a and b
  - Carotenoids
    - Group specific

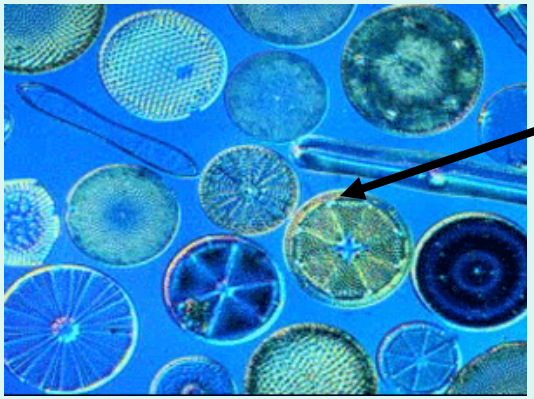




- Analysis
  - -HPLC-photodiode array detector
  - -Retention time and spectra
- Degradation
  - -Light, oxygen, temperature
  - -Chlorophylls and pheopigments

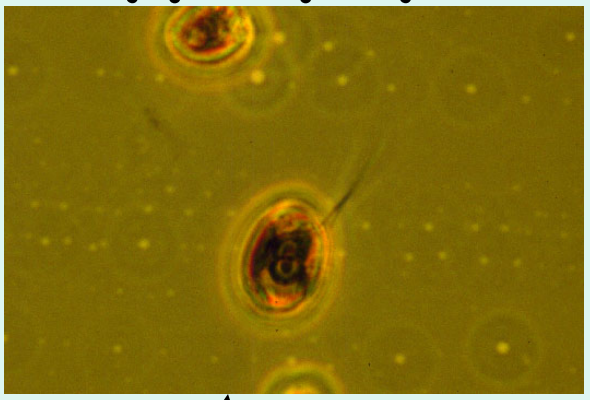


Diatoms



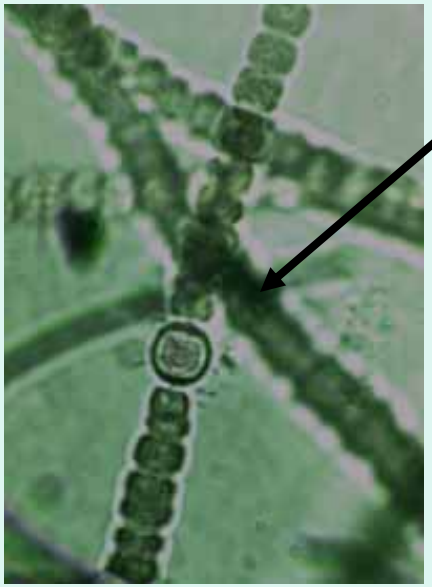
Fucoxanthin
Diatoxanthin

Cryptophytes

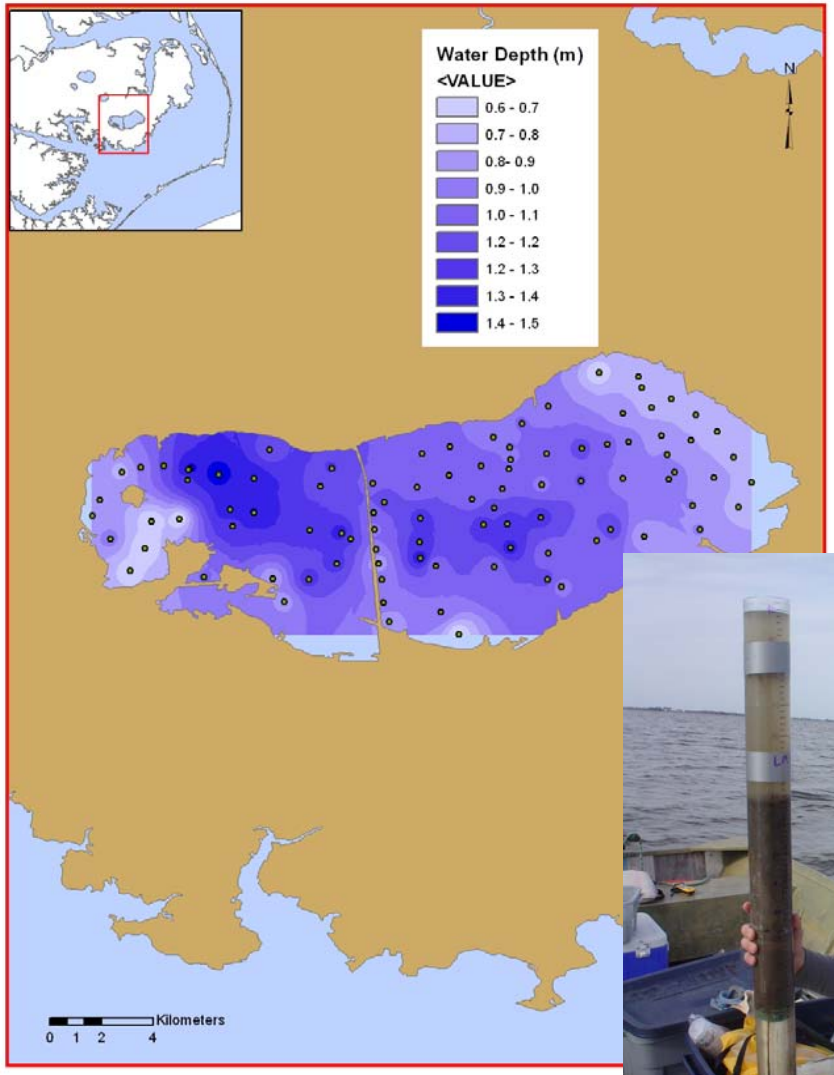


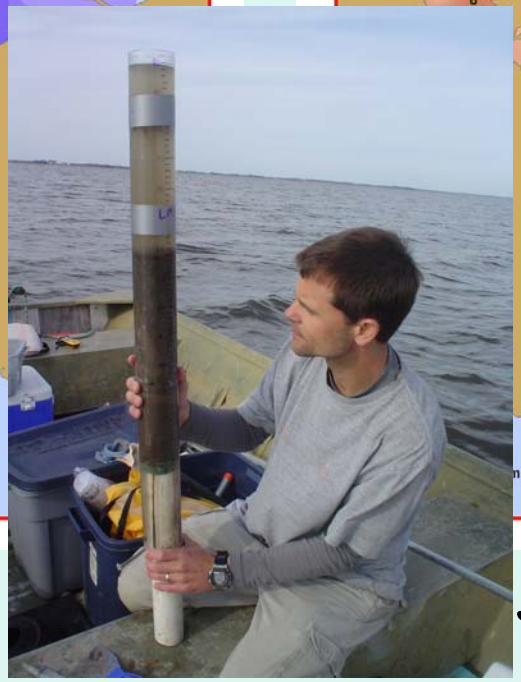
Alloxanthin

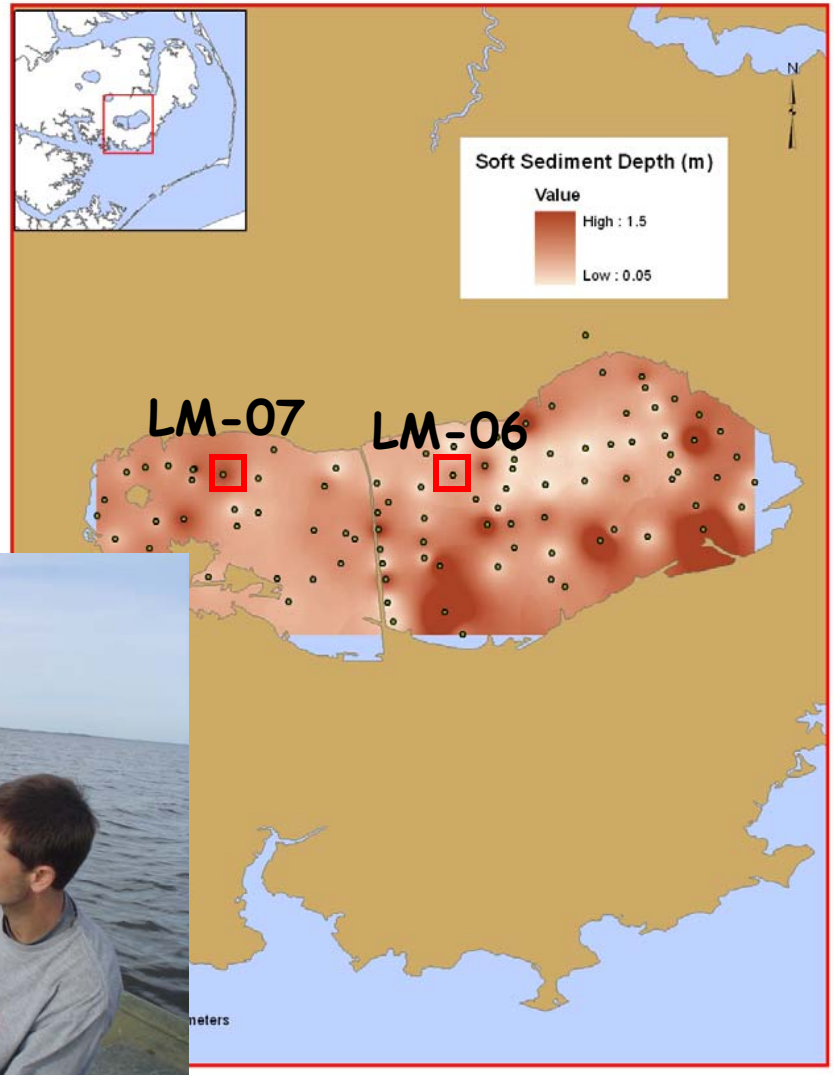
Cyanobacteria



Myxoxanthophyll
Echineone
Canthaxanthin
Aphanozophyll



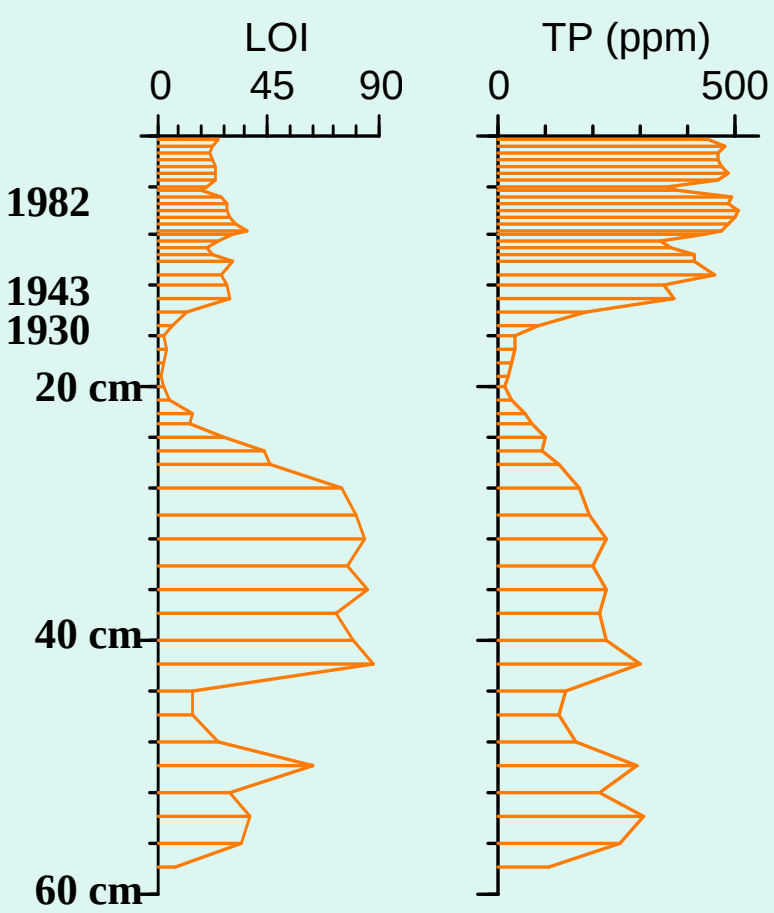




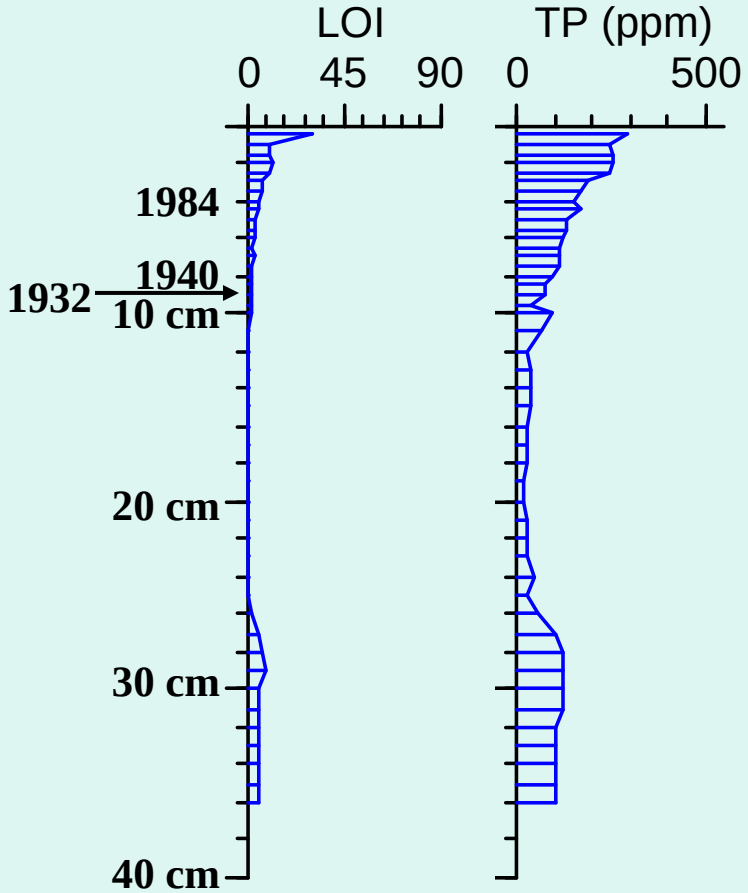
Water Depth

Soft Sediment

LOI and Phosphorus

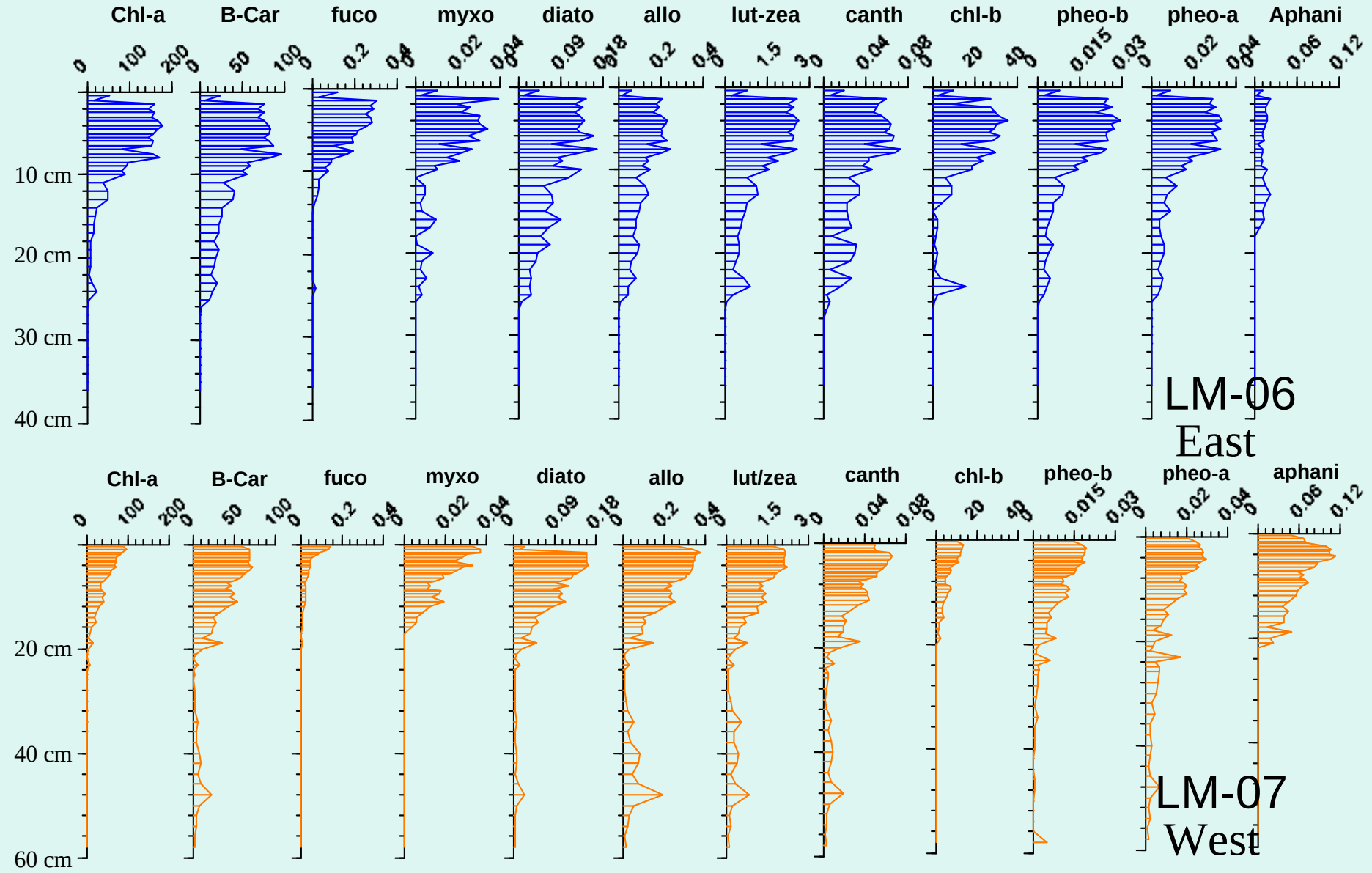


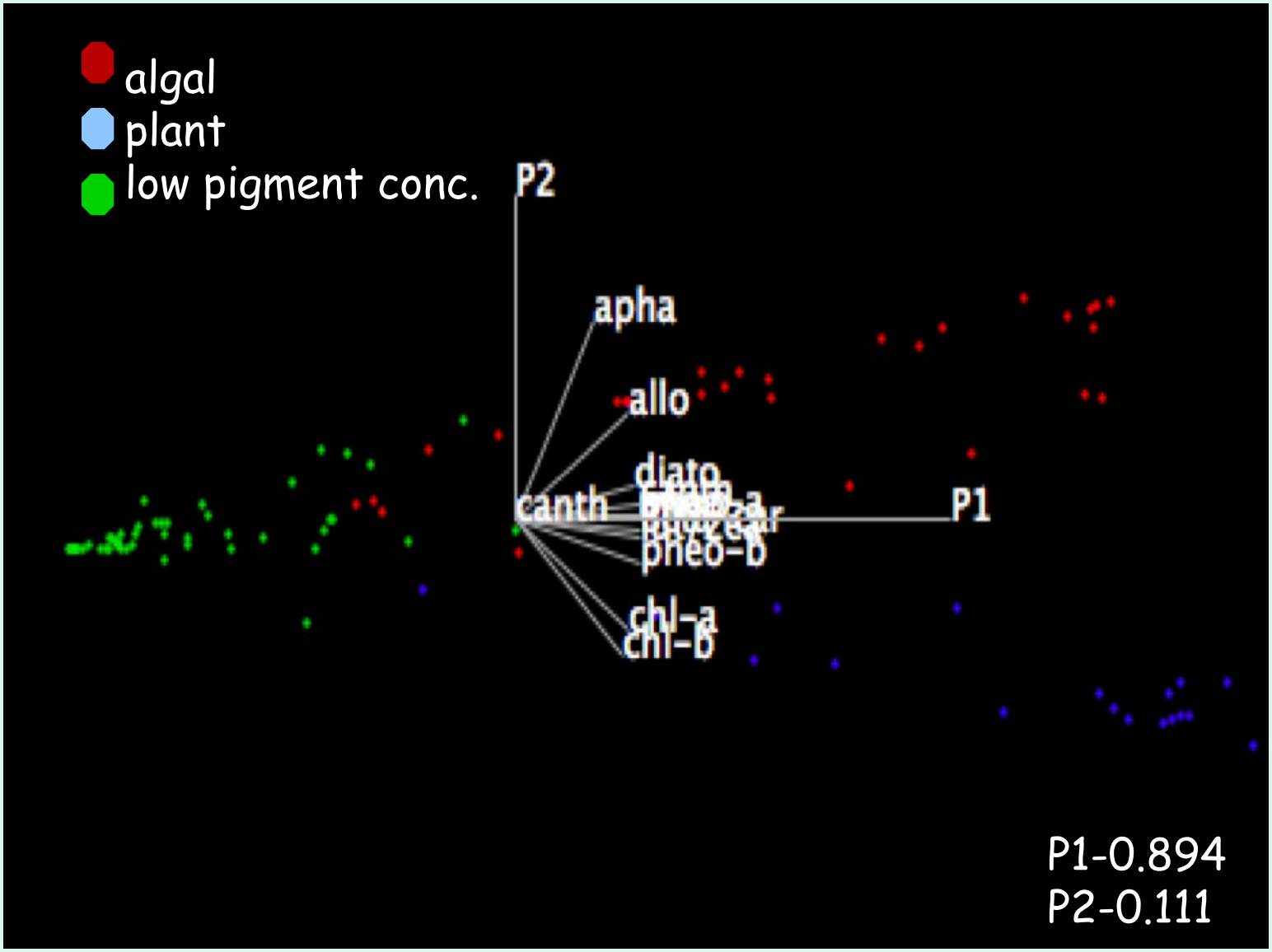
LM-07-West Side



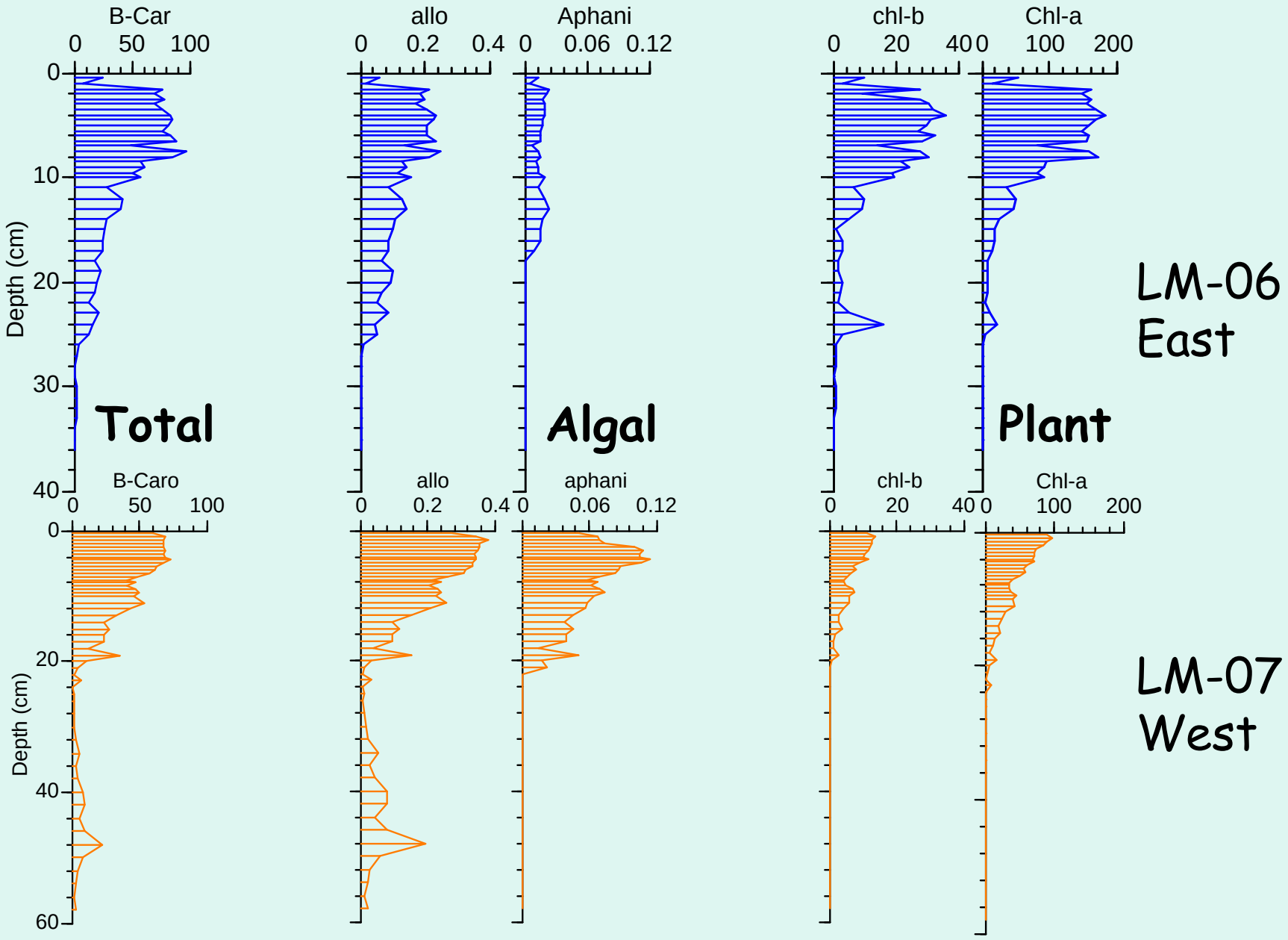
LM-06-East Side

Pigments (ug pigment/g org.)

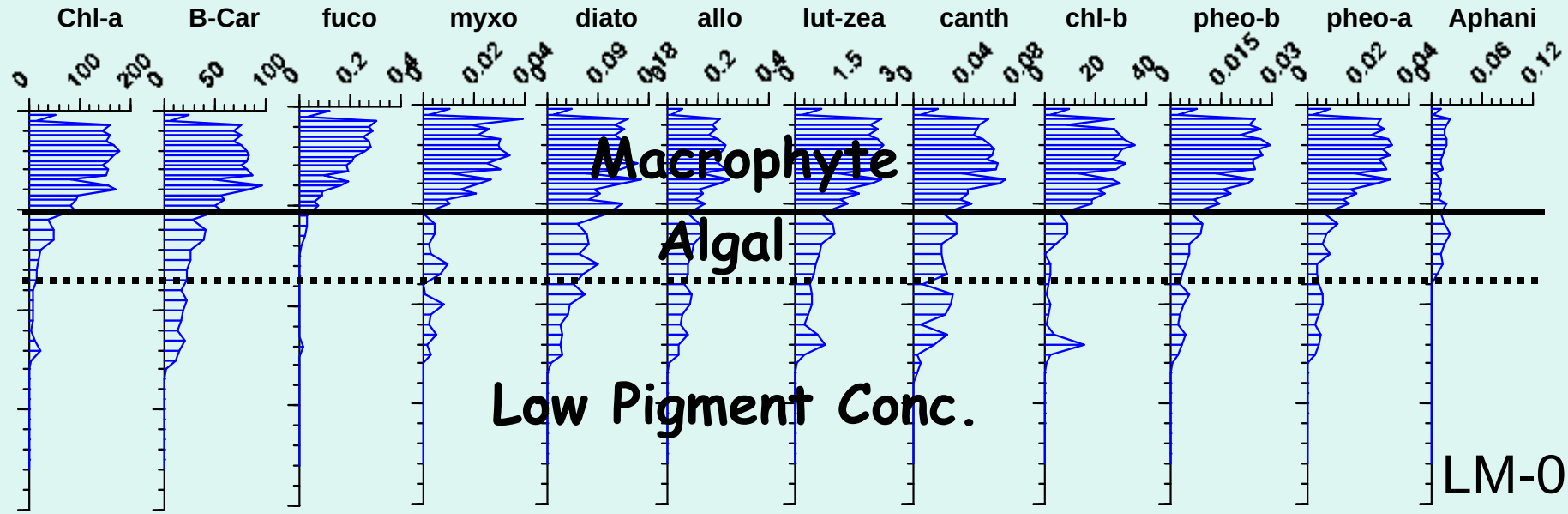


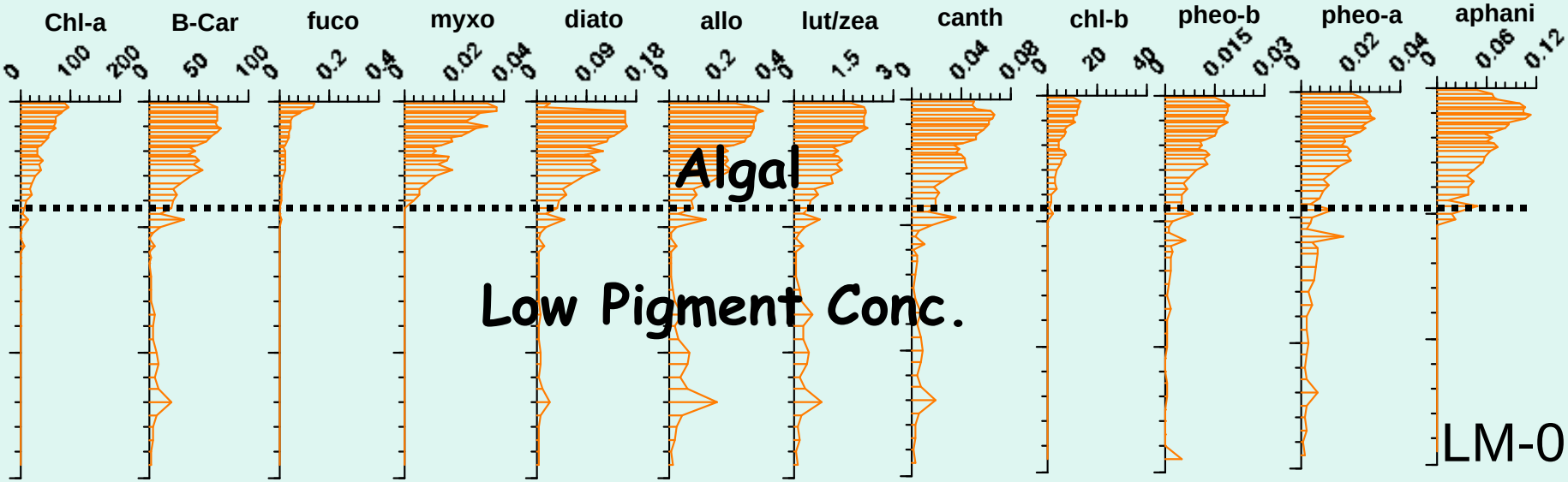


Principal components P1 and P2 using all pigments except fuco. Sediment clusters (colors) determined by k-means cluster analysis


B-Car
0
50
100
allo
0
0.2
0.4
Aphani
0
0.06
0.12
chl-b
0
20
40
Chl-a
0
100
200
Depth (cm)
0
10
20
30
40
Total
Algal
Plant
LM-06
East
B-Caro
0
50
100
allo
0
0.2
0.4
aphani
0
0.06
0.12
chl-b
0
20
40
Chl-a
0
100
200
Depth (cm)
0
20
40
60
LM-07
West

Pigments (ug pigment/g org.)

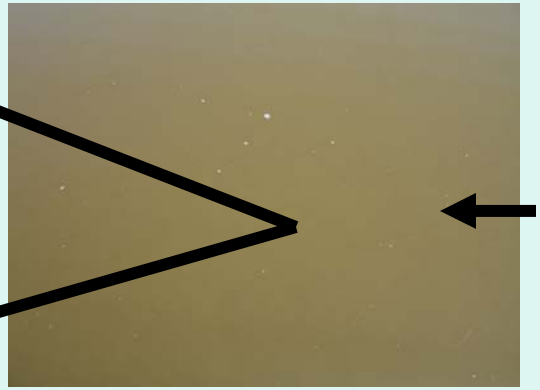




What do we know?

- Before 1940 the entire lake was phytoplankton dominated
- The east side shifted to plant dominance soon after 1940

1940

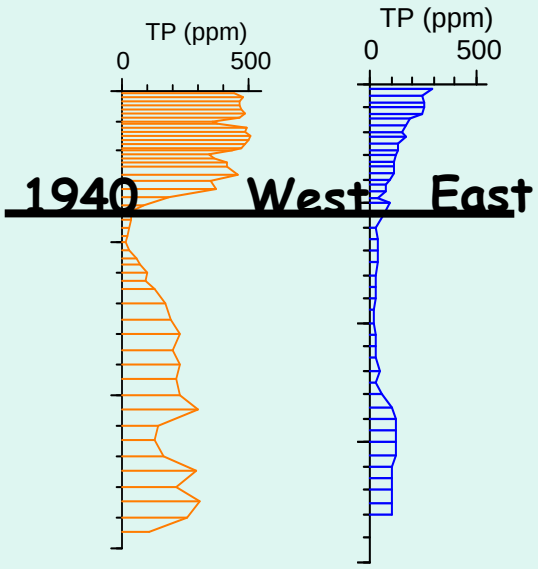


1850 ← ?

1st Canal

Possible Mechanisms

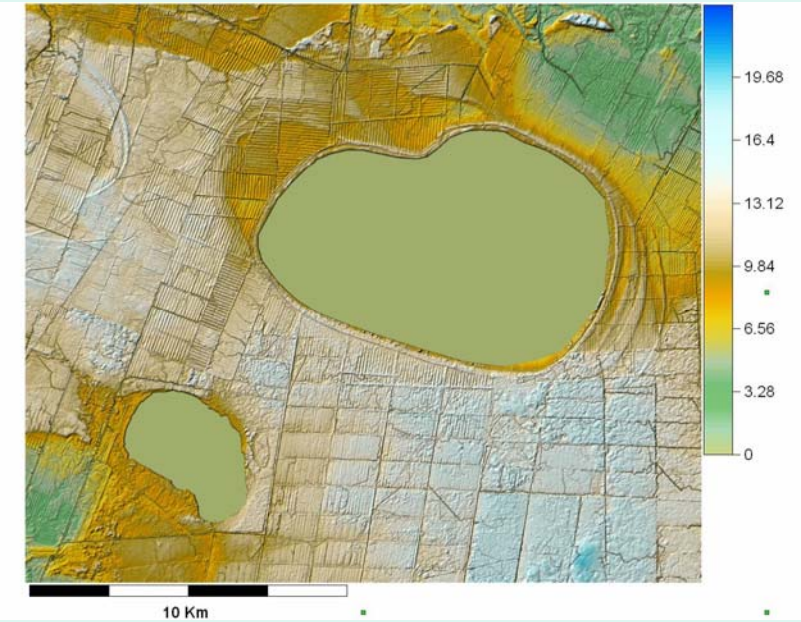
- Nutrients
  - East-low P storage
  - West-high P storage

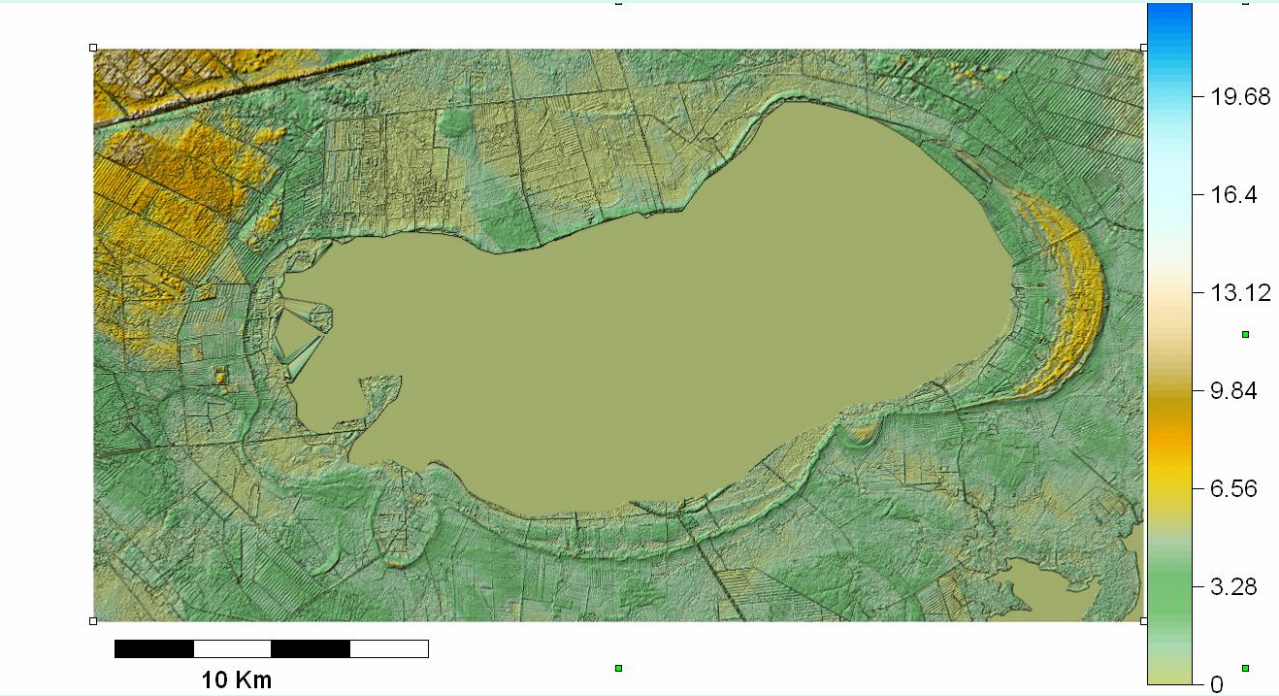


- Lake size and water depth
  - Fetch
  - 1850 water depth change

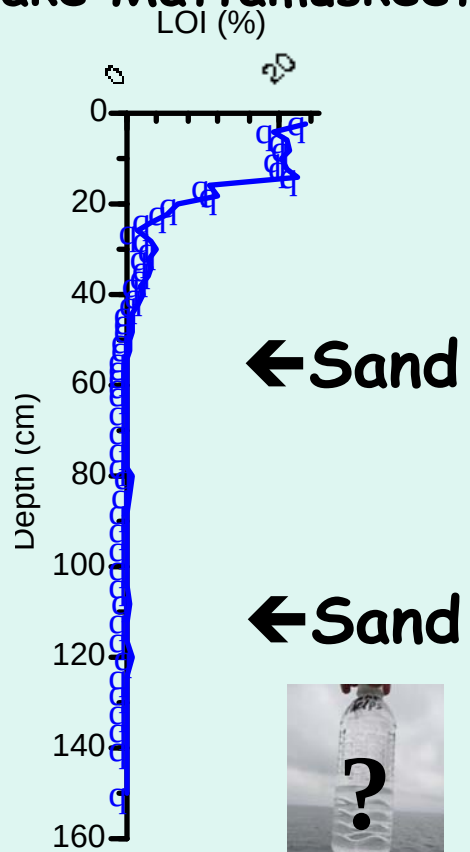
- Trophic Structure
  - Waterfowl
  - Fish and zooplankton

The APPLS landscape

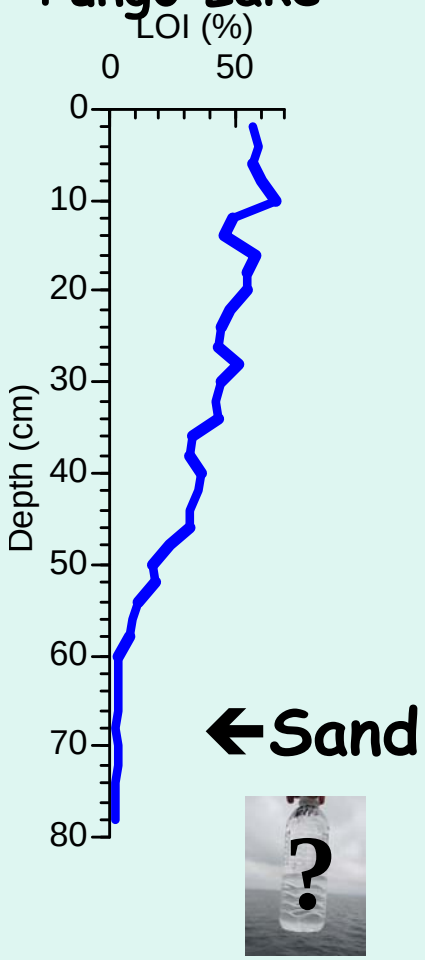




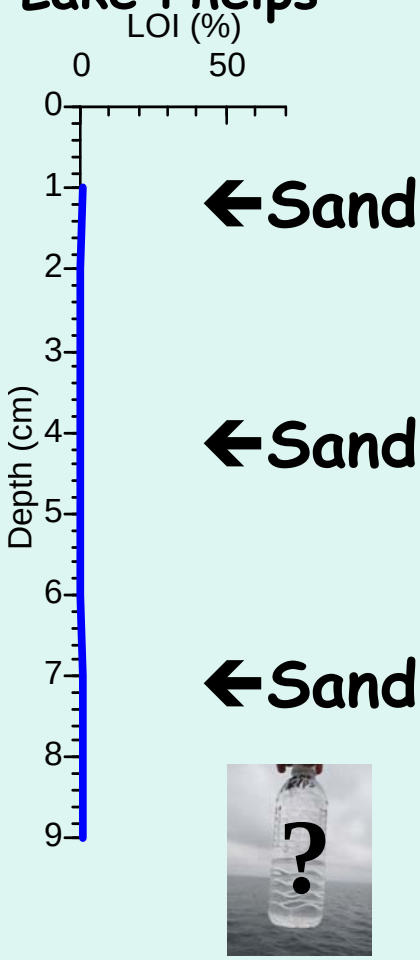
Lake Mattamuskeet



Pungo Lake



Lake Phelps



Big changes underway…

Many to thank…

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