Seasonal Water Quality Patterns in Curly Leaf Pondweed Plots

William F. James
Engineer Research and Development Center
Eau Galle Aquatic Ecology Laboratory
W500 Eau Galle Dam Rd
Spring Valley, WI 54767

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Unique Life Cycle

- Turions (vegetative structures) sprout in late summer through late winter
- Plants can overwinter under the ice
- Explosive growth occurs shortly after ice out
- Peak biomass and turion development occur in early June to mid-July (and beyond)
- Populations senesce rapidly in mid-summer

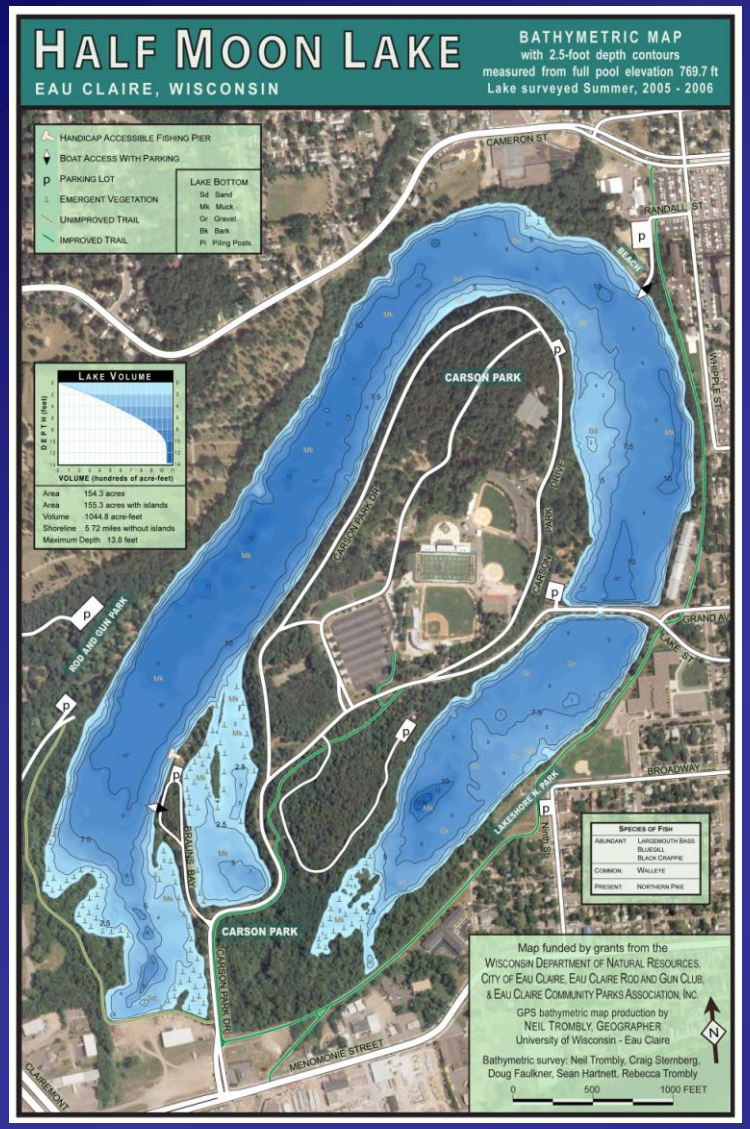
Water Quality Issues

- Phosphorus in macrophyte tissue leaches back into the water for algal uptake during senescence
- Decomposition of large mats may exert an oxygen demand at the sediment-water interface
- Curly leaf senescence usually coincides with later development of noxious blue-green algal blooms

Linkages Between Curly Leaf Senescence, Water Quality, and Algal Blooms

- The contribution of curly leaf senescence to the phosphorus budget and algal uptake depends on:
  - Lakewide biomass and tissue P
  - Proportion of lake that is infested
  - Timing of senescence
  - Importance relative to other P sources
- Can management of curly leaf result in improved water quality?
  - Depends on above
  - Early season herbicide application can limit curly leaf P input
- Direct transfer of P from curly leaf to algae is difficult to pinpoint
  - More research is needed
  - Tracer studies

Half Moon Lake, Eau Claire, WI



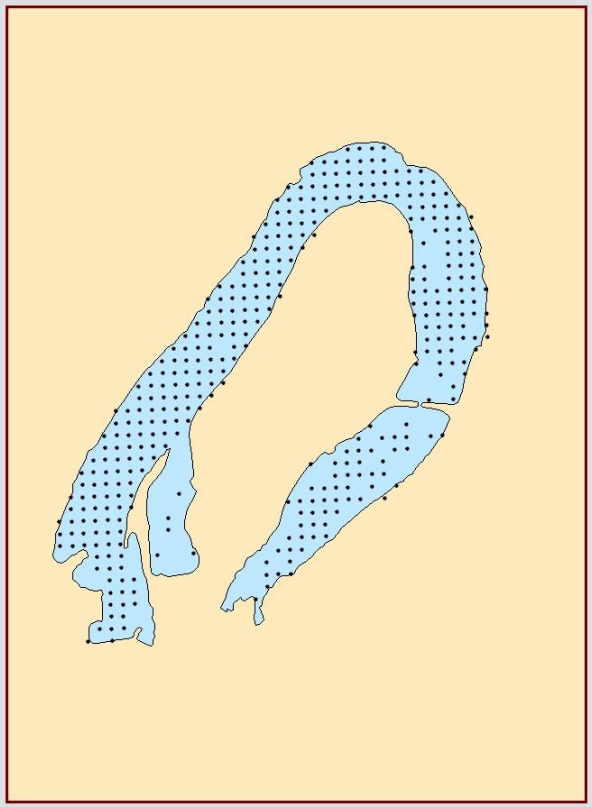
Source: N. Trombley, WI-DNR

- Urban oxbow lake of the Chippewa River
- Important recreational and wildlife resource
- Located in the City of Eau Claire, WI
- Population ~ 65,000
- Rich history as a holding pond during the lumber industry of the late 1800s

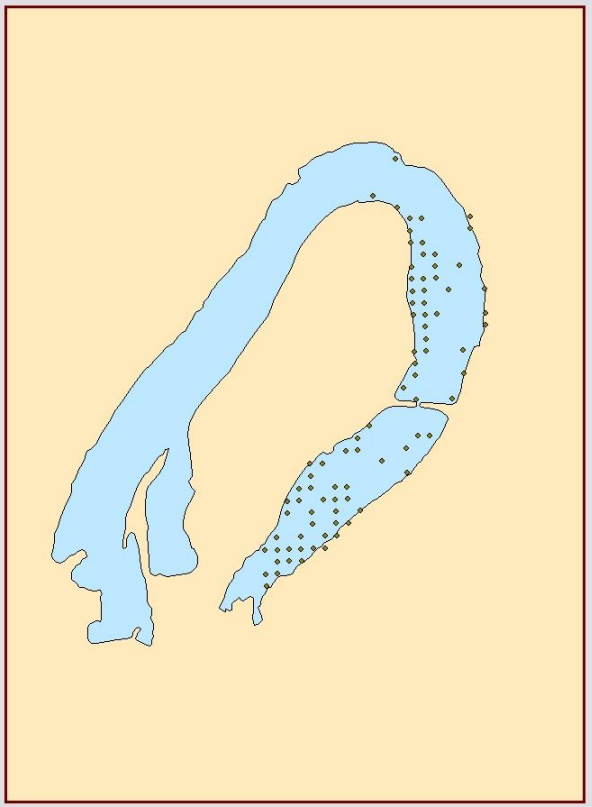
Water Quality Impairment

- *Potamogeton crispus* and *Myriophyllum spicatum*
- Eutrophic
  - TSI = 74
  - > 0.10 mg L^{-1} phosphorus
  - > 80 mg m^{-3} chlorophyll
  - < 1.0 m Secchi transparency
- Phosphorus budget
  - Sediment internal loading (42%)
  - *P. crispus* decomposition (20%)
  - Motor boat activity (17%)
- Beach closure

P. crispus



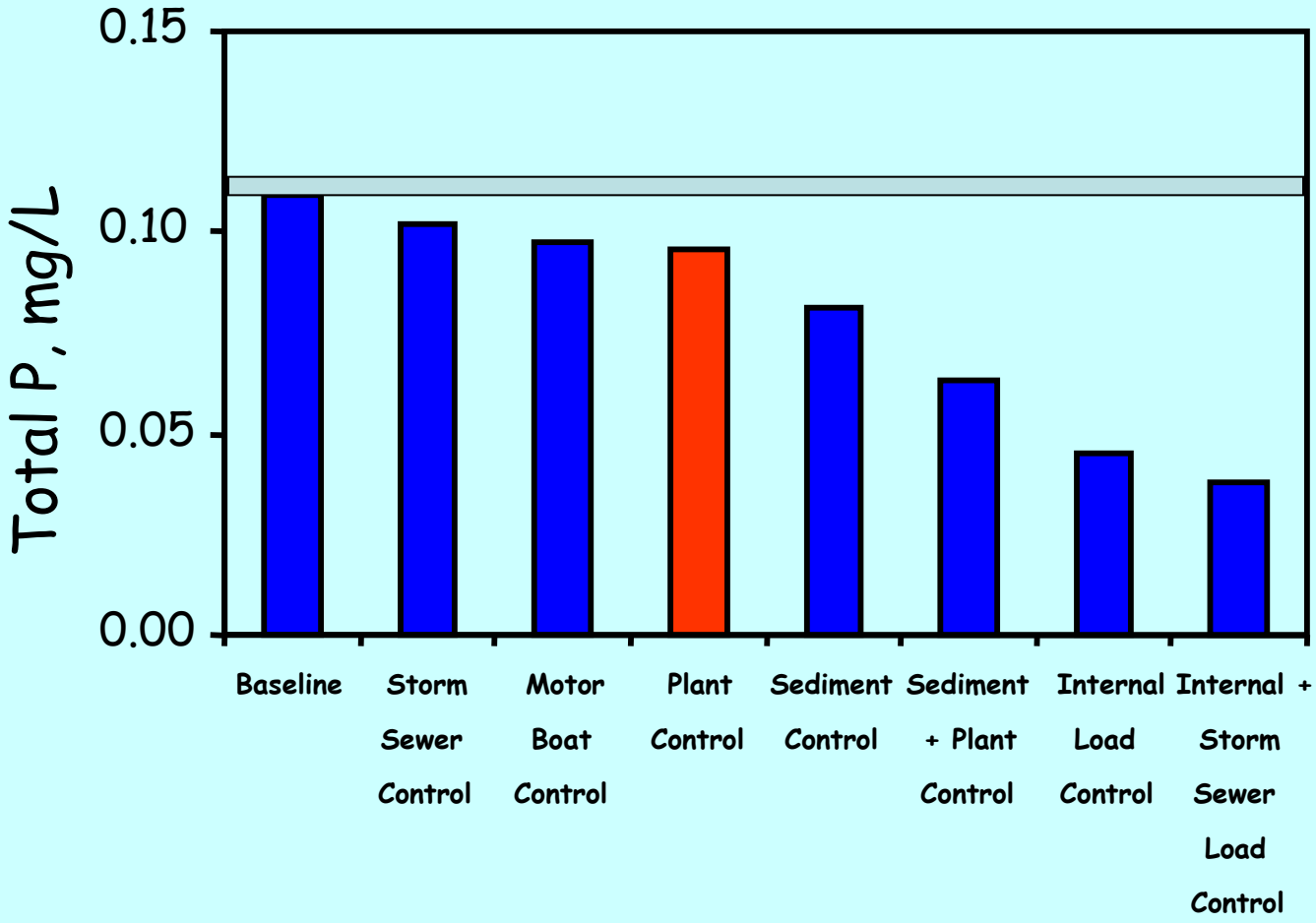
M. spicatum

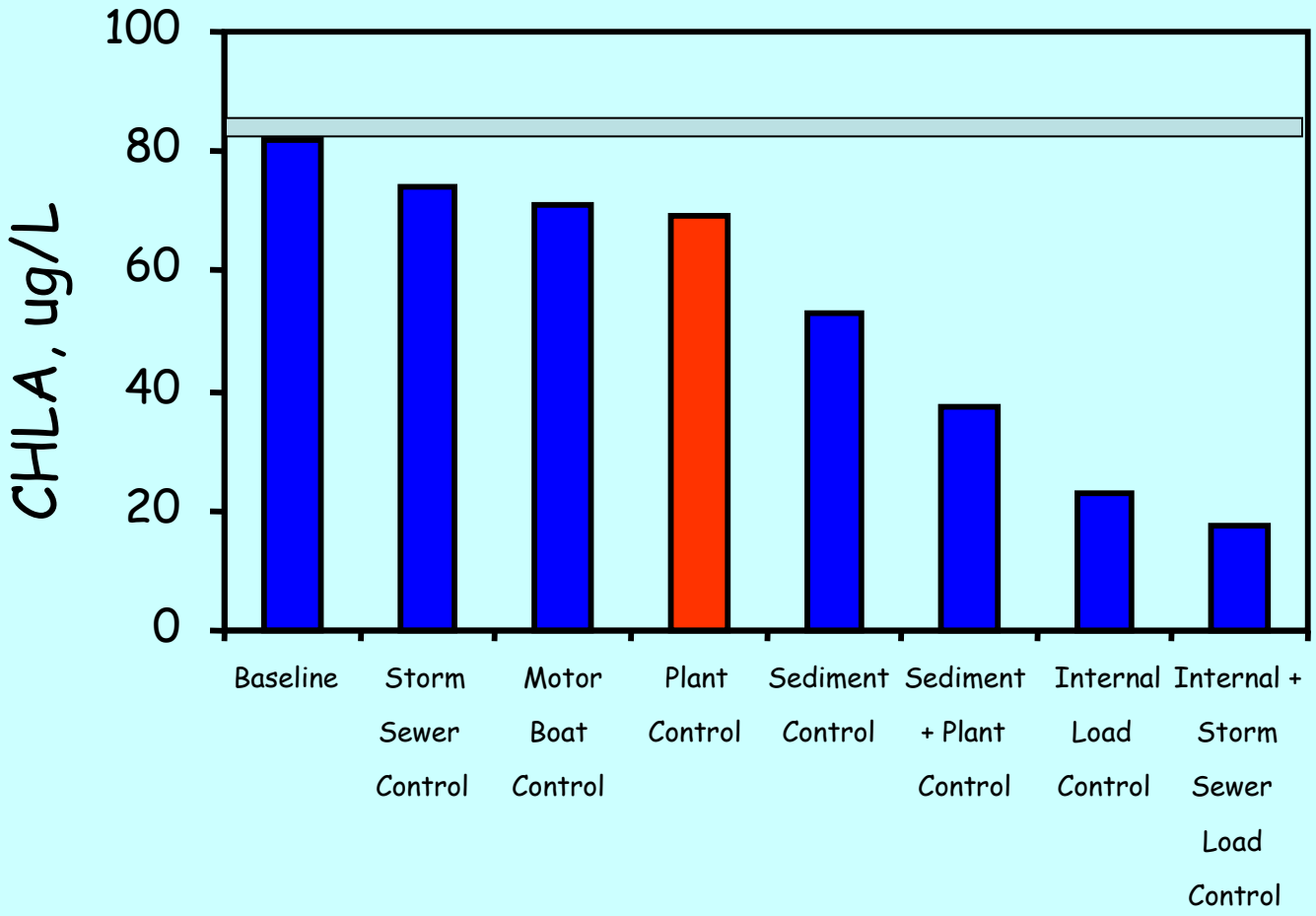


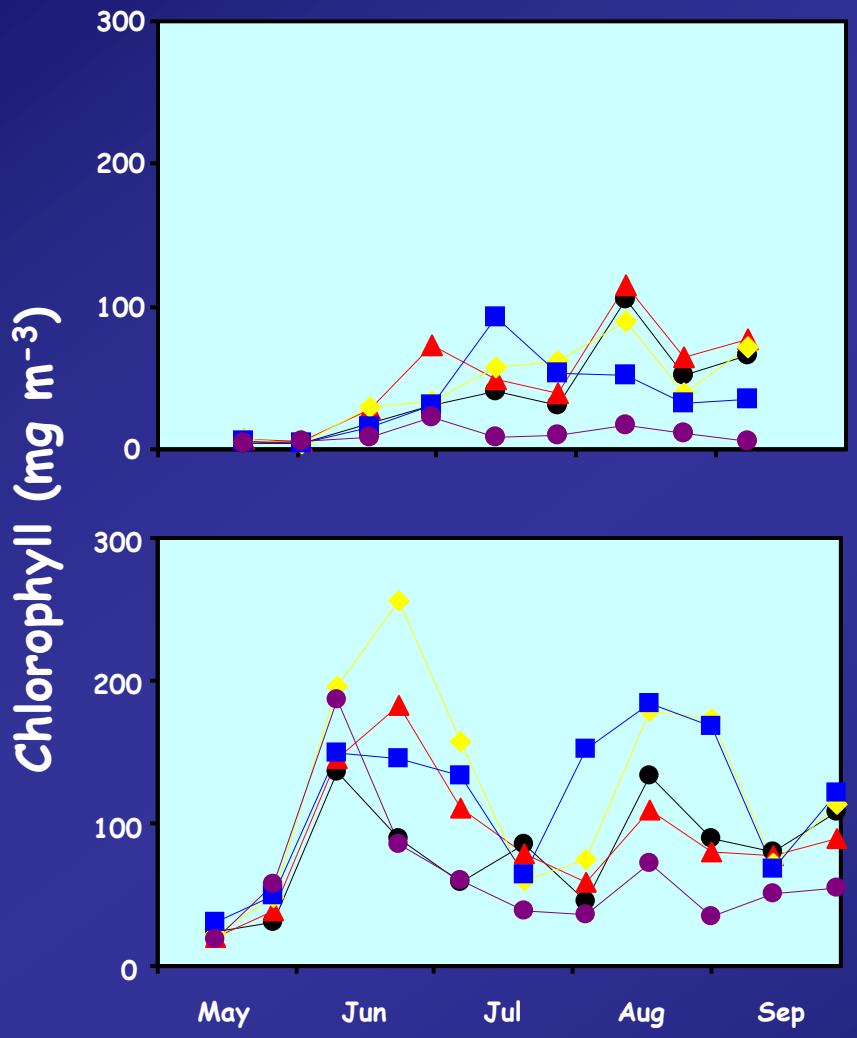
2008

Phosphorus Budget

Loading Variable mg m^{-2} d^{-1}	Source	Rate	Percent
External P Load	Storm Sewers	**0.3**	**5**
	GW Pumps	**0.4**	**7**
	Precipitation	**0.5**	**9**
Internal P Load	Sediment	**2.5**	**42**
	P. crispus	**1.2**	**20**
	Motor Boats	**1.0**	**17**
Total		**5.9**	**100**


0.15
0.10
0.05
0.00
Total P, mg/L
Baseline
Storm Sewer Control
Motor Boat Control
Plant Control
Sediment Control
Sediment + Plant Control
Internal Load Control
Internal + Storm Sewer Load Control

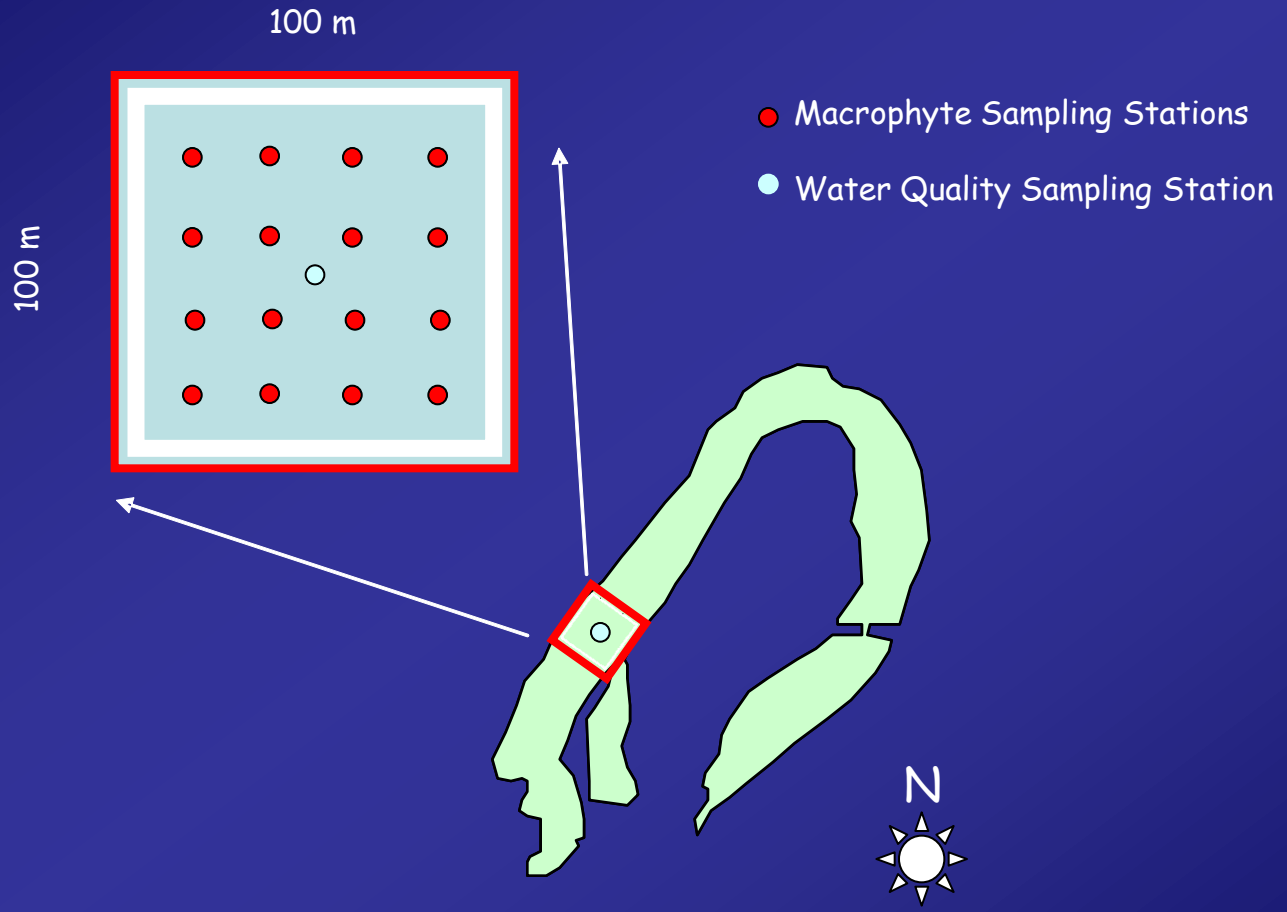

CHLA, ug/L
100
80
60
40
20
0
Baseline
Storm Sewer Control
Motor Boat Control
Plant Control
Sediment Control
Sediment + Plant Control
Internal Load Control
Internal + Storm Sewer Load Control


Chlorophyll (mg m-3)
300
200
100
0
300
200
100
0
May
Jun
Jul
Aug
Sep

Objectives

- Examine detailed water quality patterns in a large plot setting in Half Moon Lake, Wisconsin

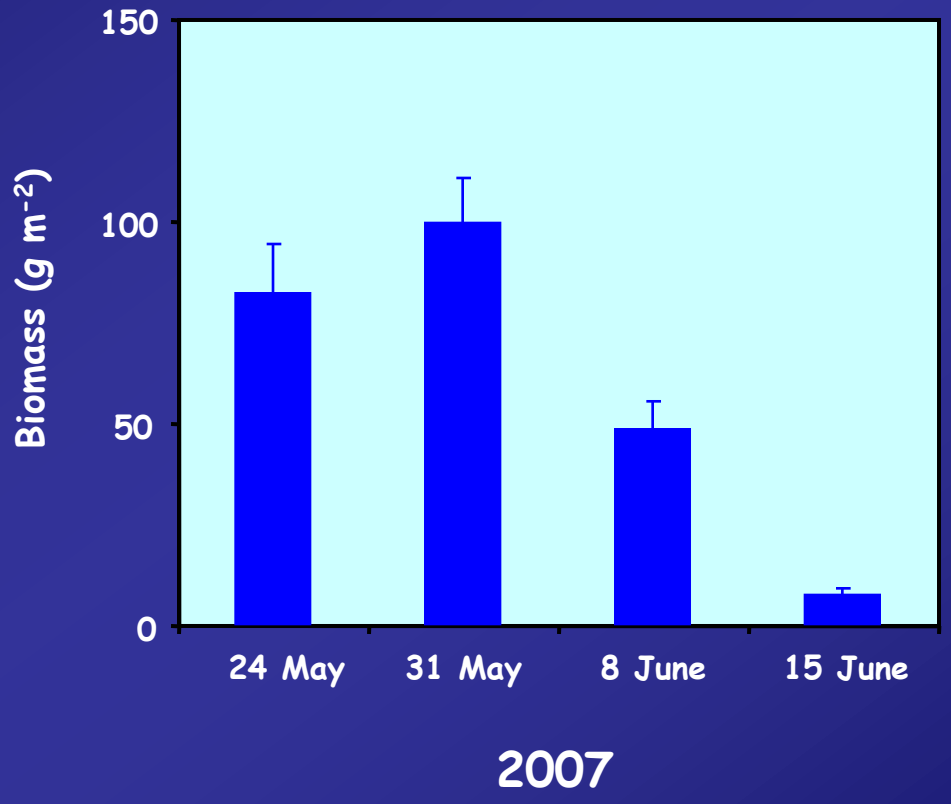
- Explore linkages between curly leaf senescence and later development of algal blooms


100 m
100 m
Macrophyte Sampling Stations
Water Quality Sampling Station
N

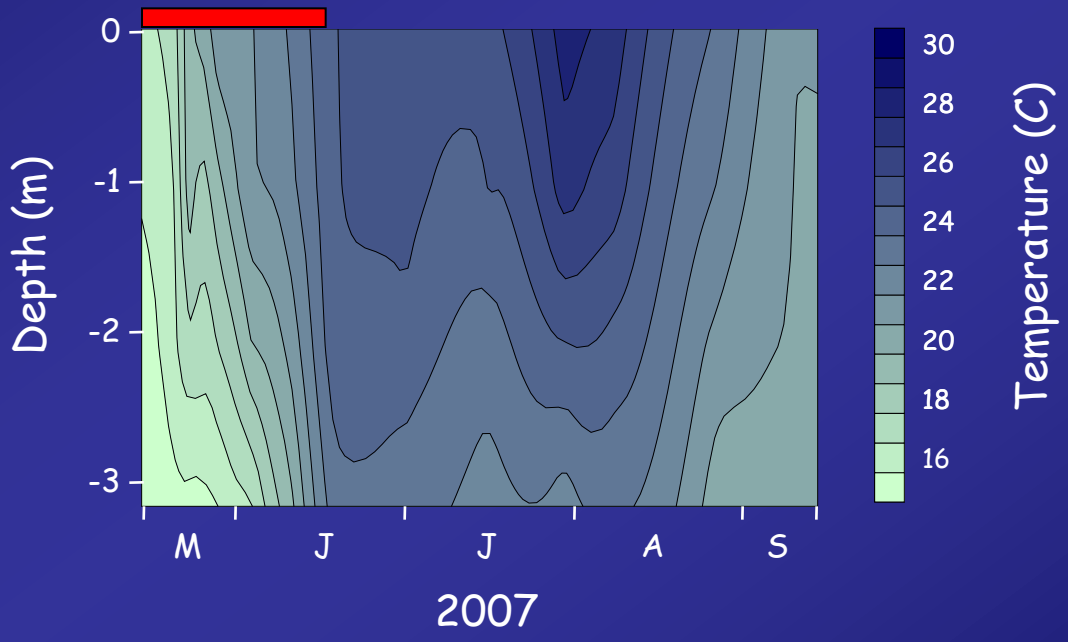
Why a Study Plot

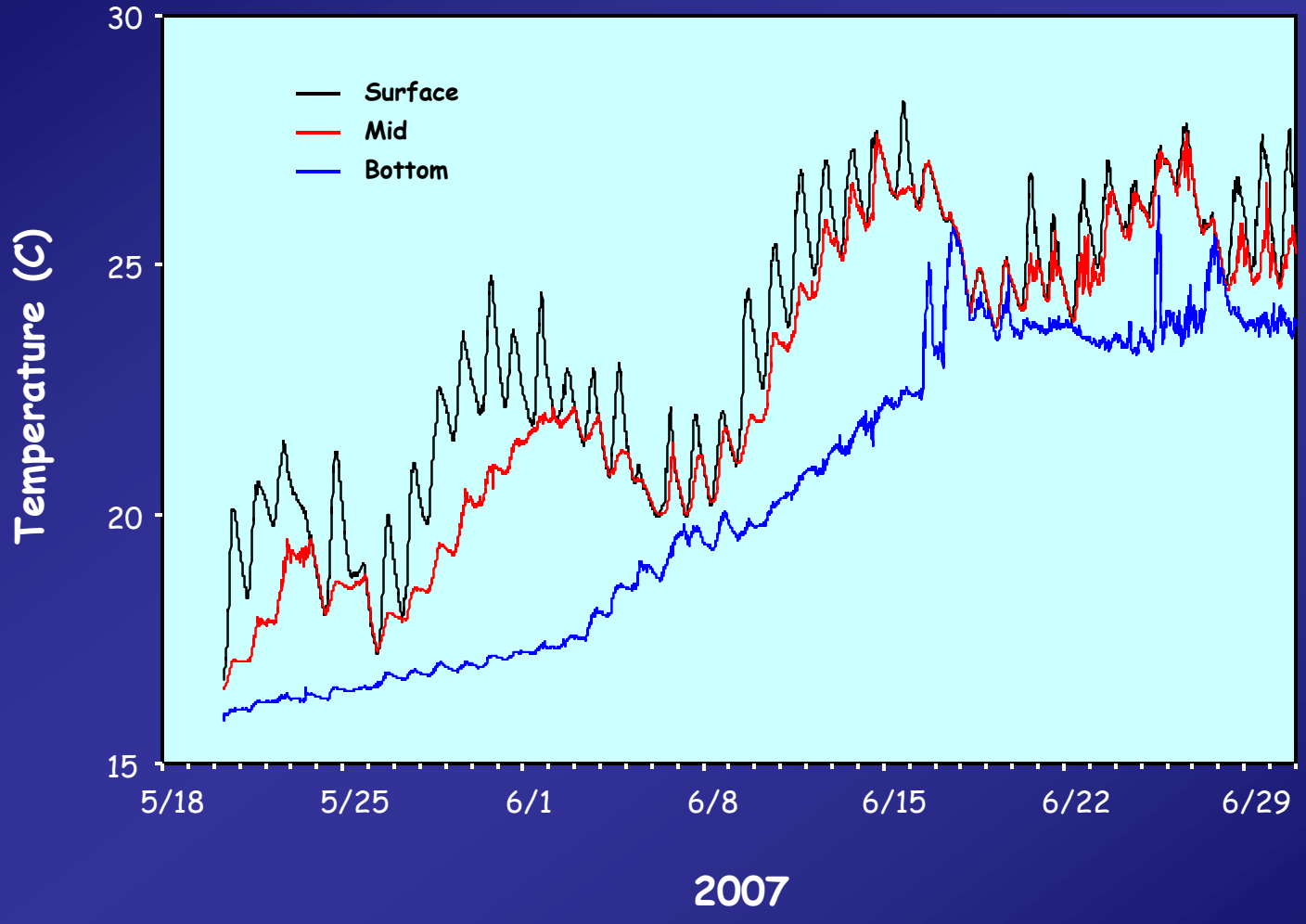
- Mechanical harvesting is used to manage curly leaf
- No harvesting in plots

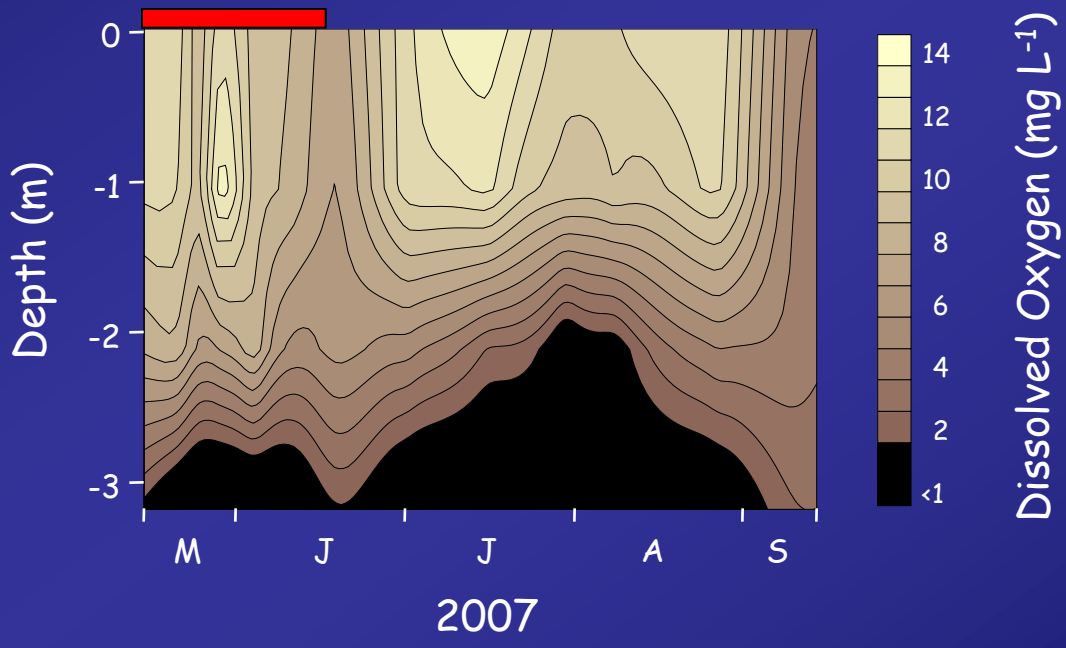
Curly Leaf Biomass

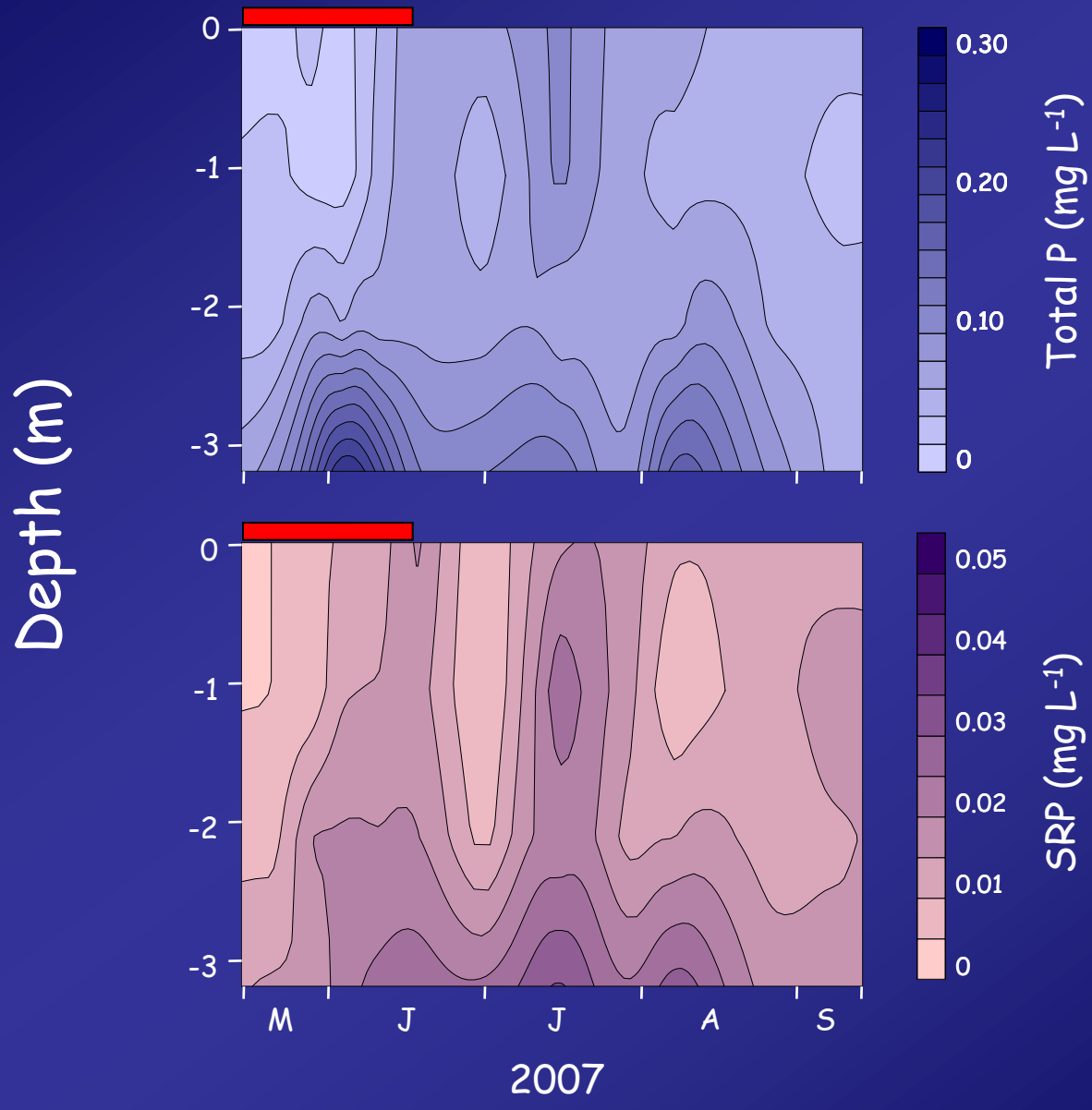


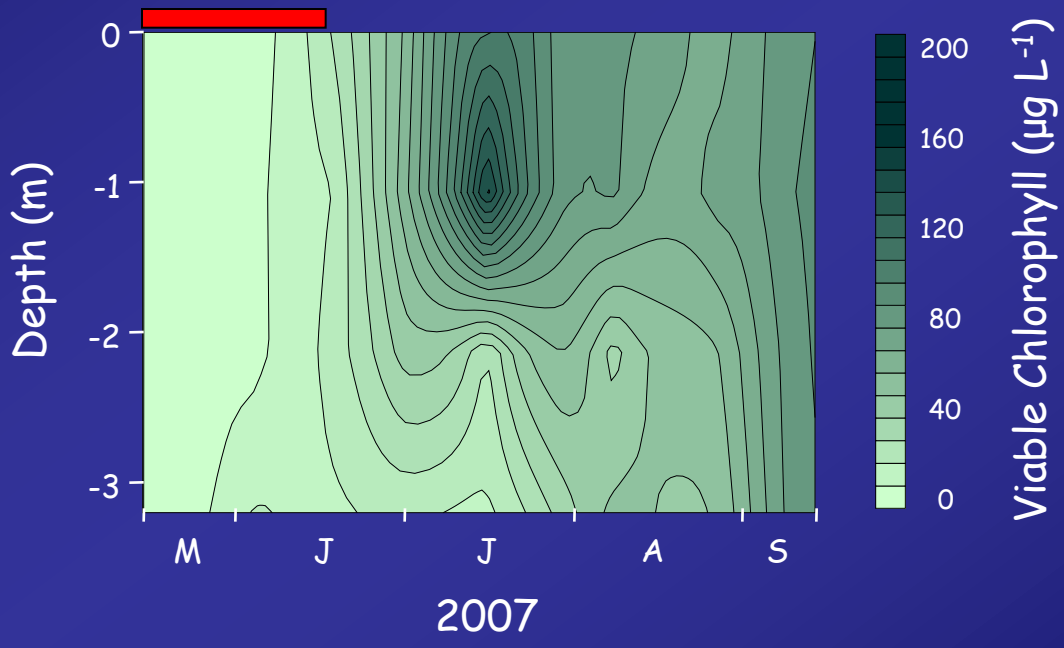

JUN 4 2007

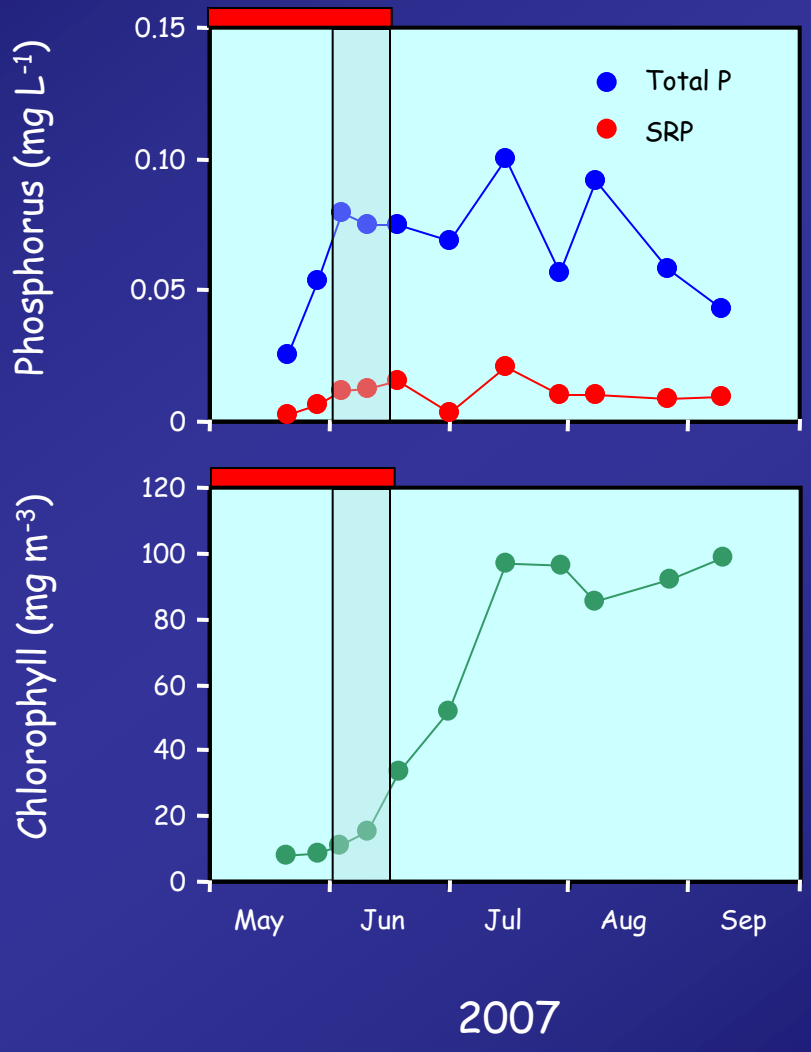

0
-1
-2
-3
Depth (m)
M
J
J
A
S
2007
30
28
26
24
22
20
18
16
Temperature (C)


Surface
Mid
Bottom
30
25
20
15
Temperature (C)
5/18
5/25
6/1
6/8
6/15
6/22
6/29
2007


0
-1
-2
-3
Depth (m)
M
J
J
A
S
2007
14
12
10
8
6
4
2
<1
Dissolved Oxygen (mg L-1)


Depth (m)
0
-1
-2
-3
0.30
0.20
0.10
0
Total P (mg L-1)
0.05
0.04
0.03
0.02
0.01
SRP (mg L-1)
M
J
J
A
S
2007


0
-1
-2
-3
Depth (m)
M
J
J
A
S
2007
200
160
120
80
40
0
Viable Chlorophyll (µg L-1)

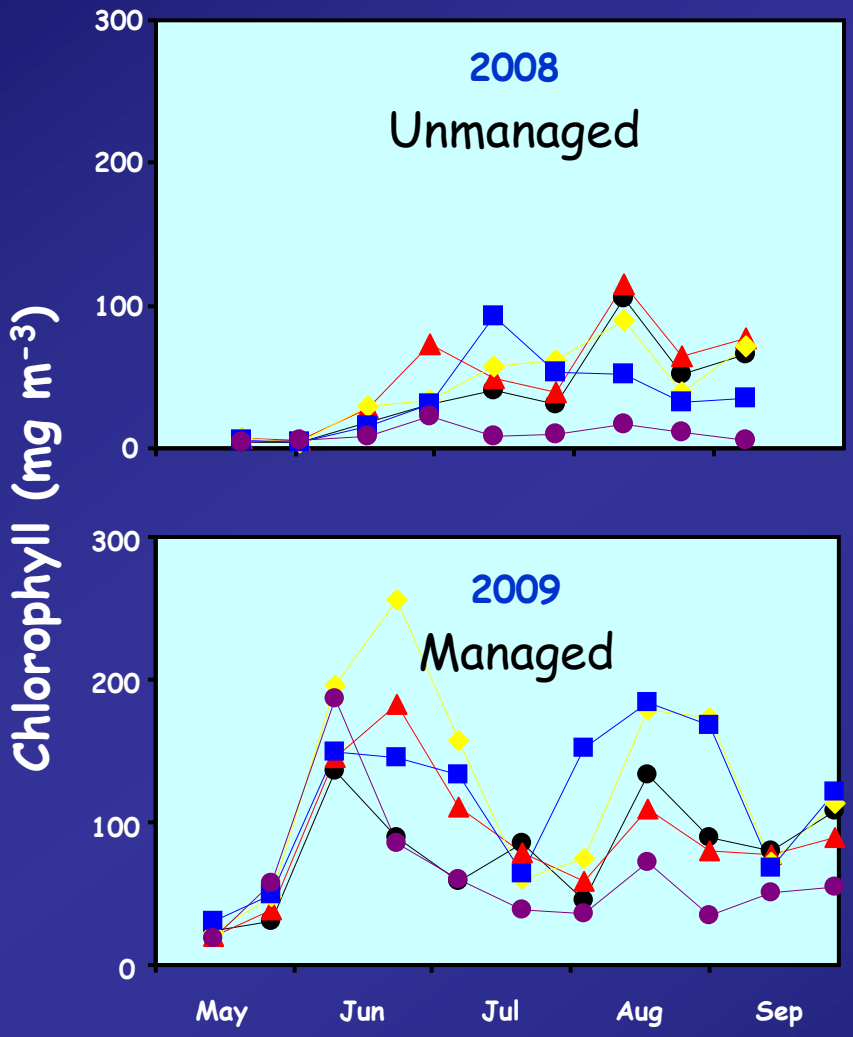

Phosphorus (mg L-1)
0.15
0.10
0.05
0
Total P
SRP
Chlorophyll (mg m-3)
120
100
80
60
40
20
0
May
Jun
Jul
Aug
Sep
2007

Early Summer P Budget (Mid-May to Mid-June)

Source	kg P
Curly leaf tissue P	60-90
Sediment flux	20
Total P increase	70

Summary and Knowledge Gaps

- Curly leaf senescence accounted for much of the total P increase in early June
- Algal biomass increased tremendously after senescence, with peaks occurring in July – September
- Unknowns
  - How much of the curly leaf P was taken up by algae for growth
  - Luxury uptake and storage as polyphosphates in algal cells
  - versus sediment P flux in July through September


Chlorophyll (mg m-3)
300
200
100
0
2008
Unmanaged
300
200
100
0
2009
Managed
May
Jun
Jul
Aug
Sep

Acknowledgments

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ERDC Aquatic Plant Control Research Program