The Role of Lake Depth in Regulating Water Quality and Fish Assemblages in Oxbow Lakes of the Yazoo River Basin.

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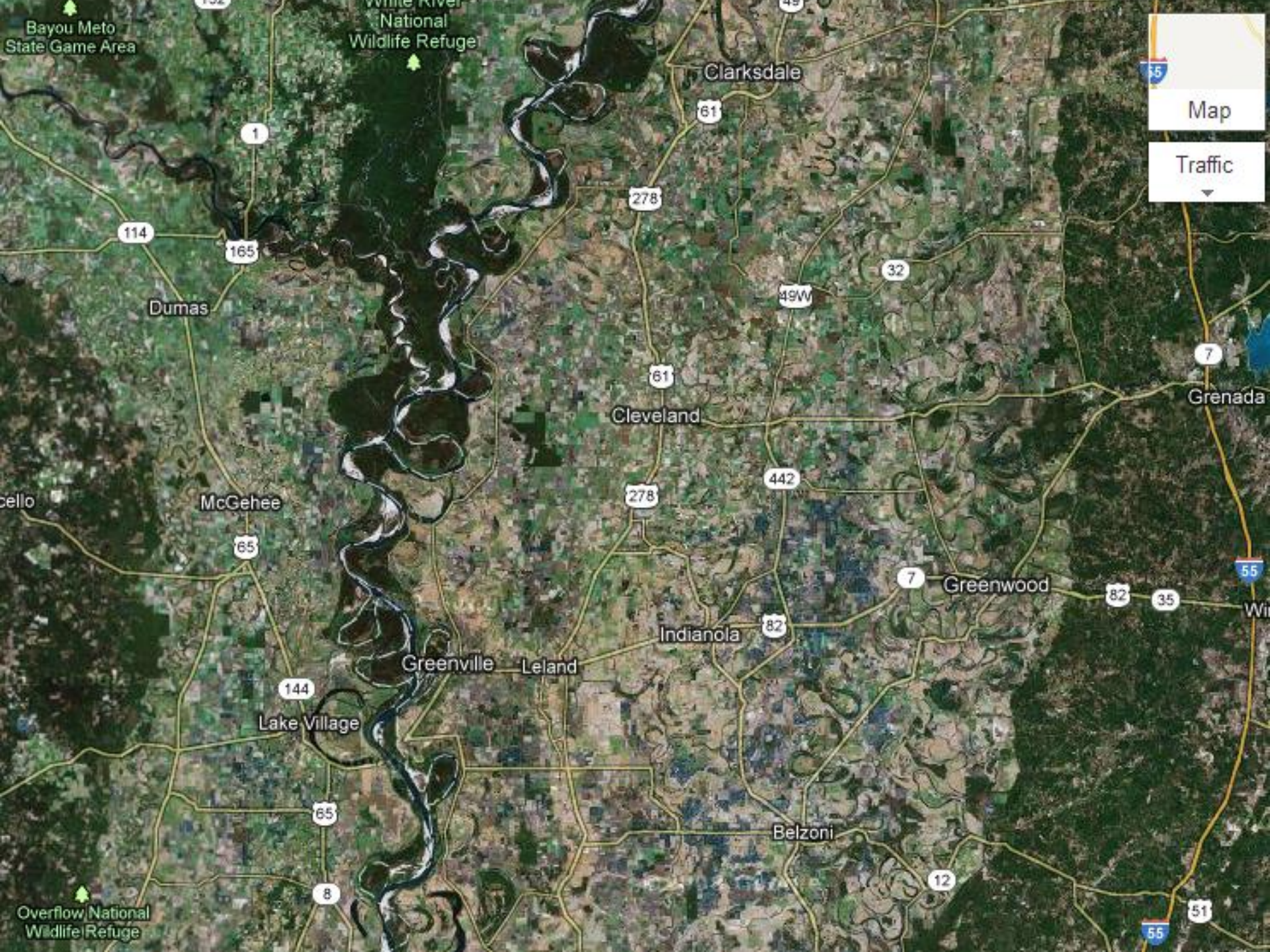
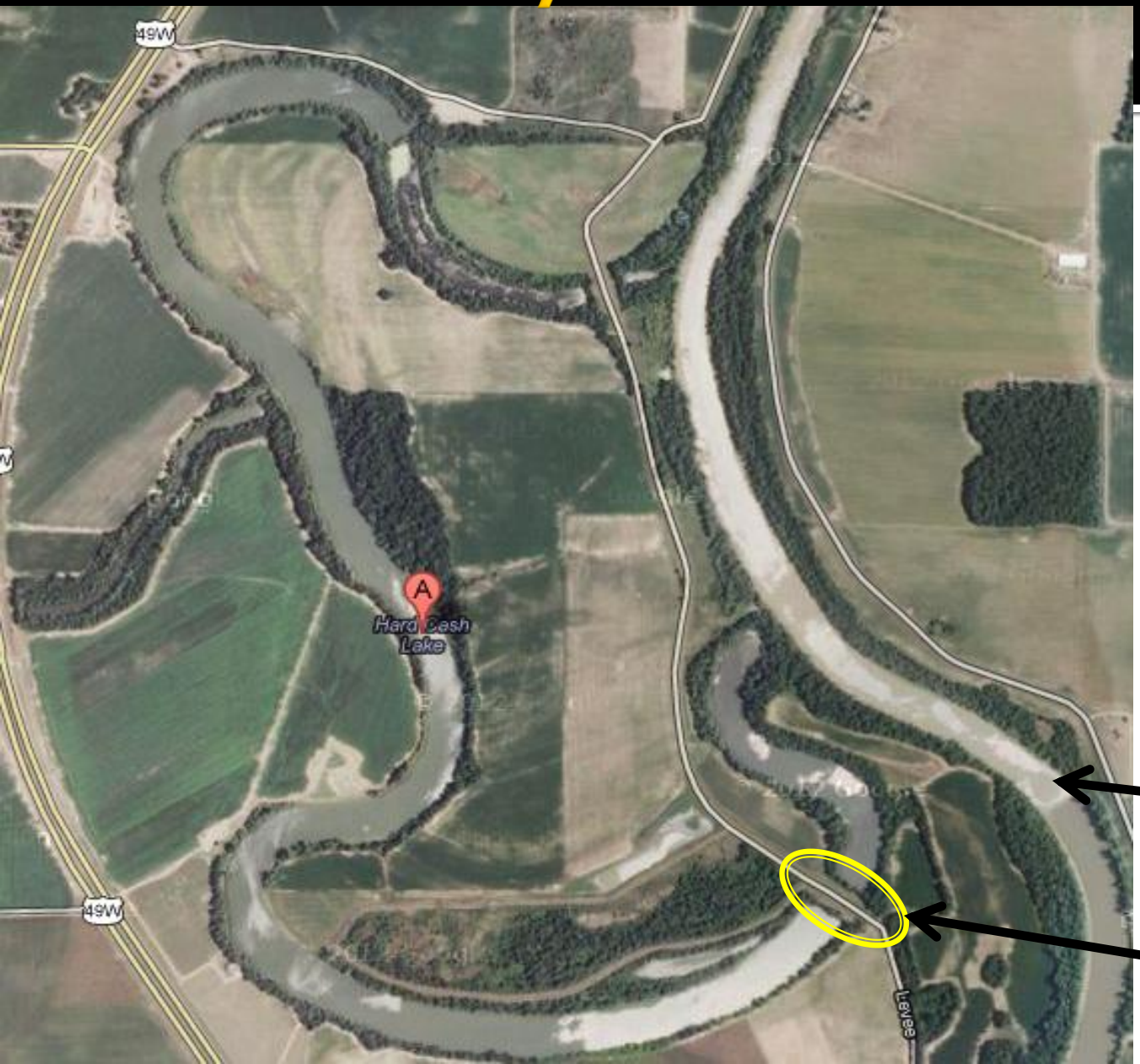

Bayou Meto
State Game Area
White River
National
Wildlife Refuge
Clarksdale
61
1
278
114
165
32
49W
Dumas
61
Cleveland
7
Grenada
442
278
McGehee
65
7
Greenwood
82
35
55
Indianola
82
Greenville
Leland
144
Lake Village
65
Belzoni
12
8
51
55
Overflow National
Wildlife Refuge
Map
Traffic

Lake Perturbations

- Lakes in MS delta are severely degraded.
  - Levee construction
    - Isolation of lakes - function like a farm pond
    - Loss of riverine fauna
  - Agriculture
    - Loss of riparian buffers

Case Study: Hardcash Lake



Yazoo River

Levee

Lake Perturbations

- Lakes in MS delta are severely degraded.
  - Levee construction
    - Isolation of lakes - function like a farm pond
    - Loss of riverine fauna
  - Agriculture
    - Loss of riparian buffers
    - Nutrient inputs
    - Eutrophication
  - Suspended solids
    - Shallowing of lakes
      - 2 - 4 cm/year
    - Loss of diversity
- Notable changes in fish communities

Lake Perturbations

Hypereutrophication
Excess phytoplankton = high Chl *in vivo*

High suspended solids

Questions

- Are fish assemblages different between deep and shallow lakes?
- Is water quality different between deep and shallow lakes?

Methods

- Fish collection
  - Electrofishing
  - Water quality
    - Diel fluctuations
      - Hach hydrolabs near deepest part of lake
    - In-situ
      - Took composite sample from lake surface
      - Turbidity Hach 2100p Turbidmeter

Model MS5 © 2005 Campbell Scientific (Canada) Corp.

Methods

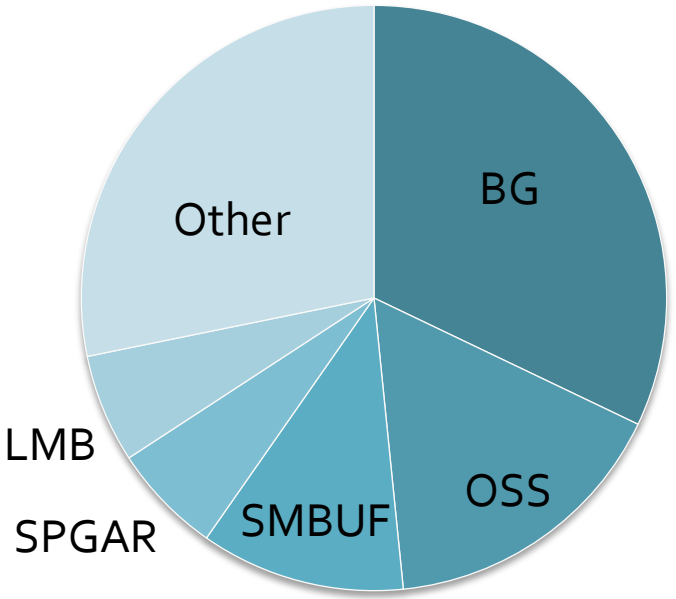
- Chlorophyll *in vivo*
  - Important predictor of phytoplankton, eutrophication, and diel fluctuations in oxygen
  - Traditionally analyzed in laboratory: time consuming
  - Simplified by use of *Aqua*fluor handheld fluorometer (Turner Designs, Sunnyvale, California) .
    - Able to record chl *in vivo* quickly in the field

Results

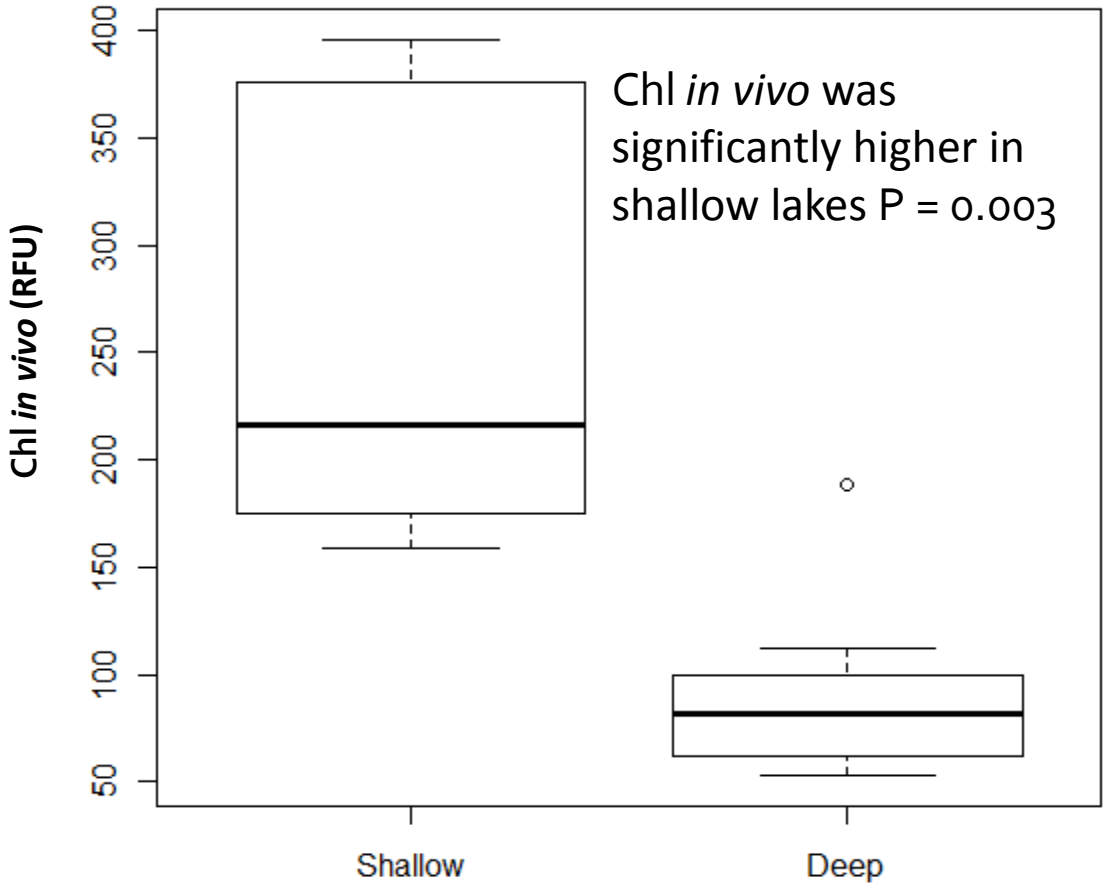
Results

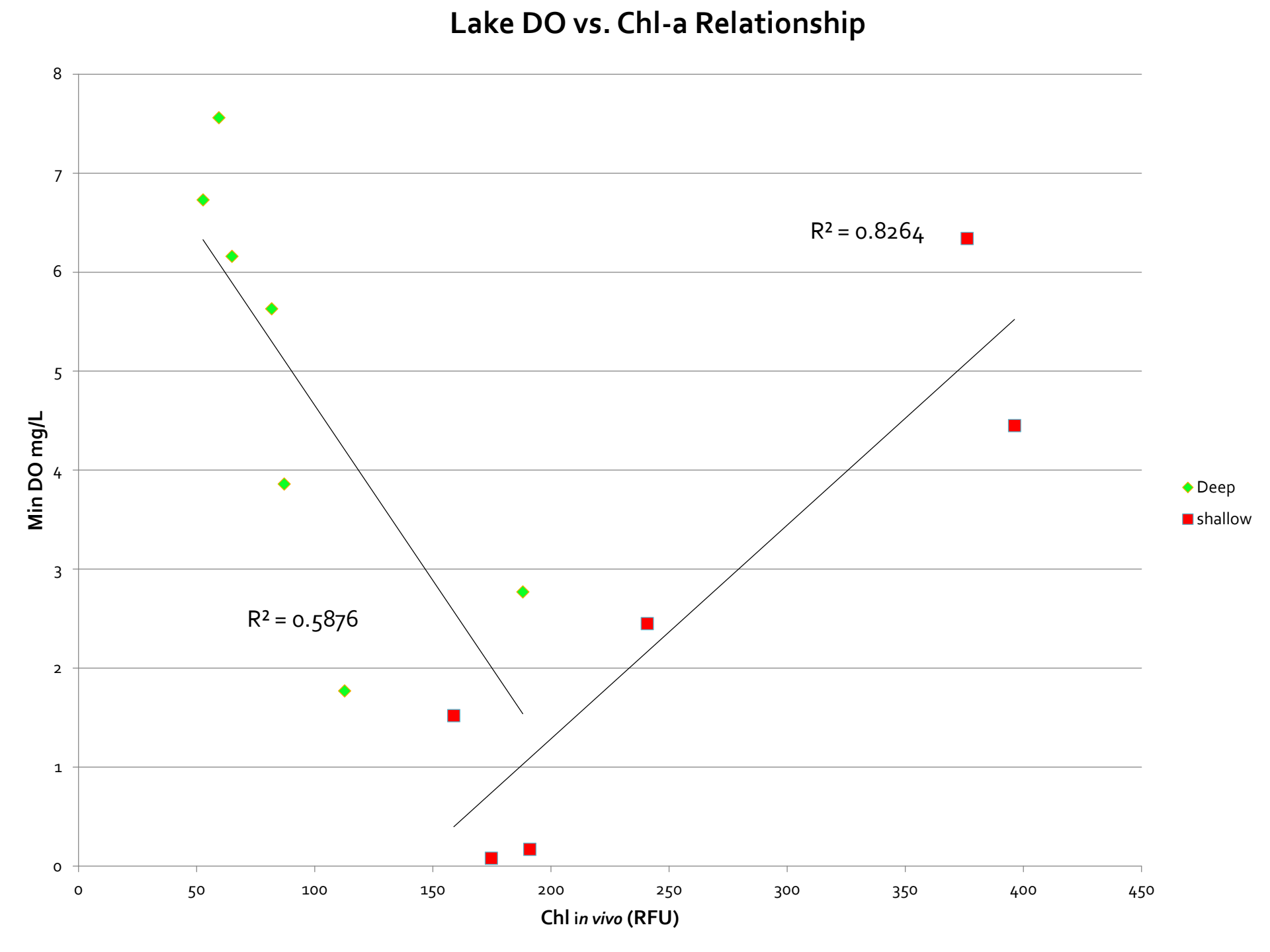
- 10,869 fish representing 31 species.
- Total catch dominated by;

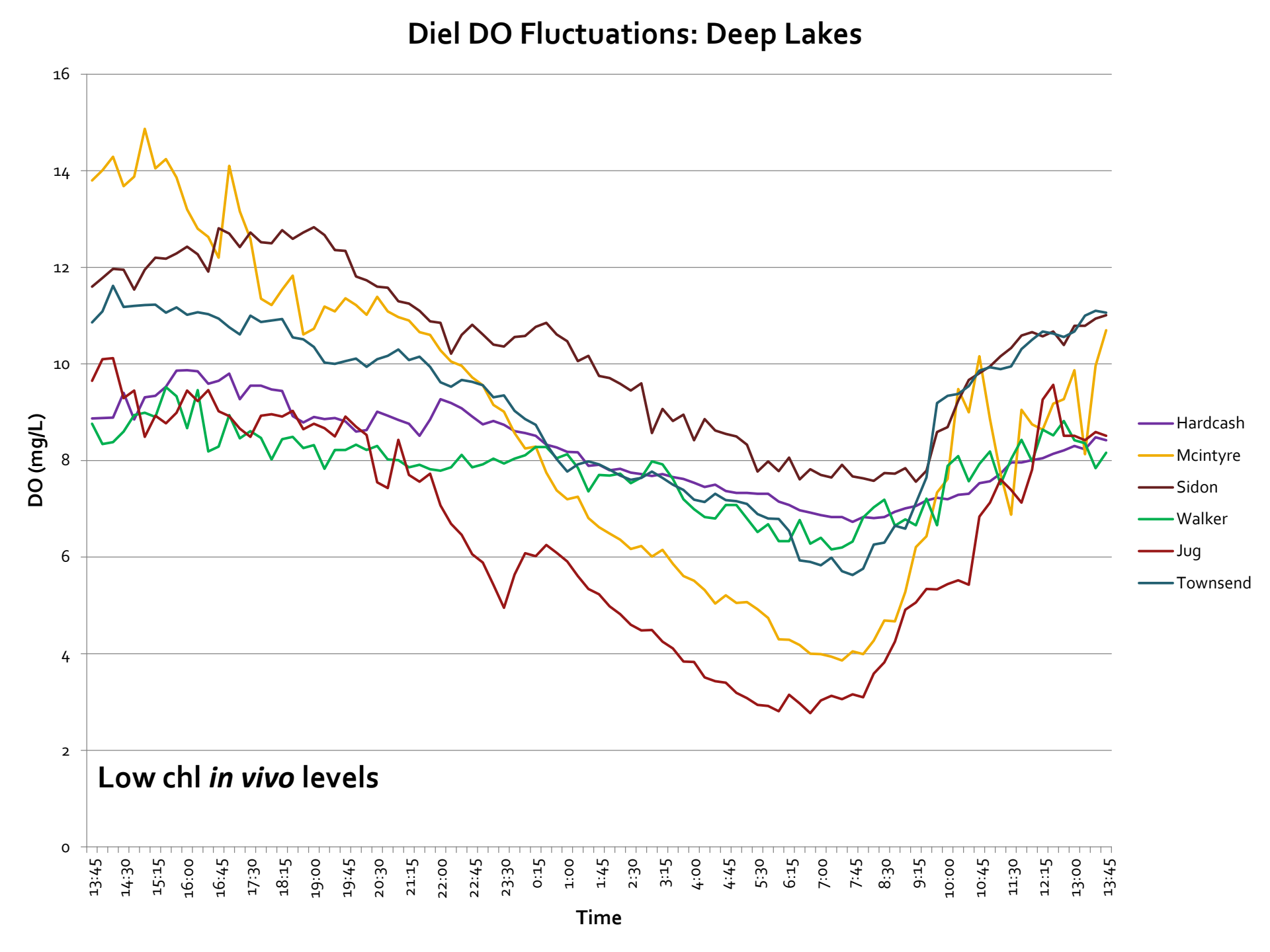
Bluegill	32 %
Orange spotted sunfish	16%
Smallmouth buffalo	11%
Spotted gar	6%
Largemouth bass	6%

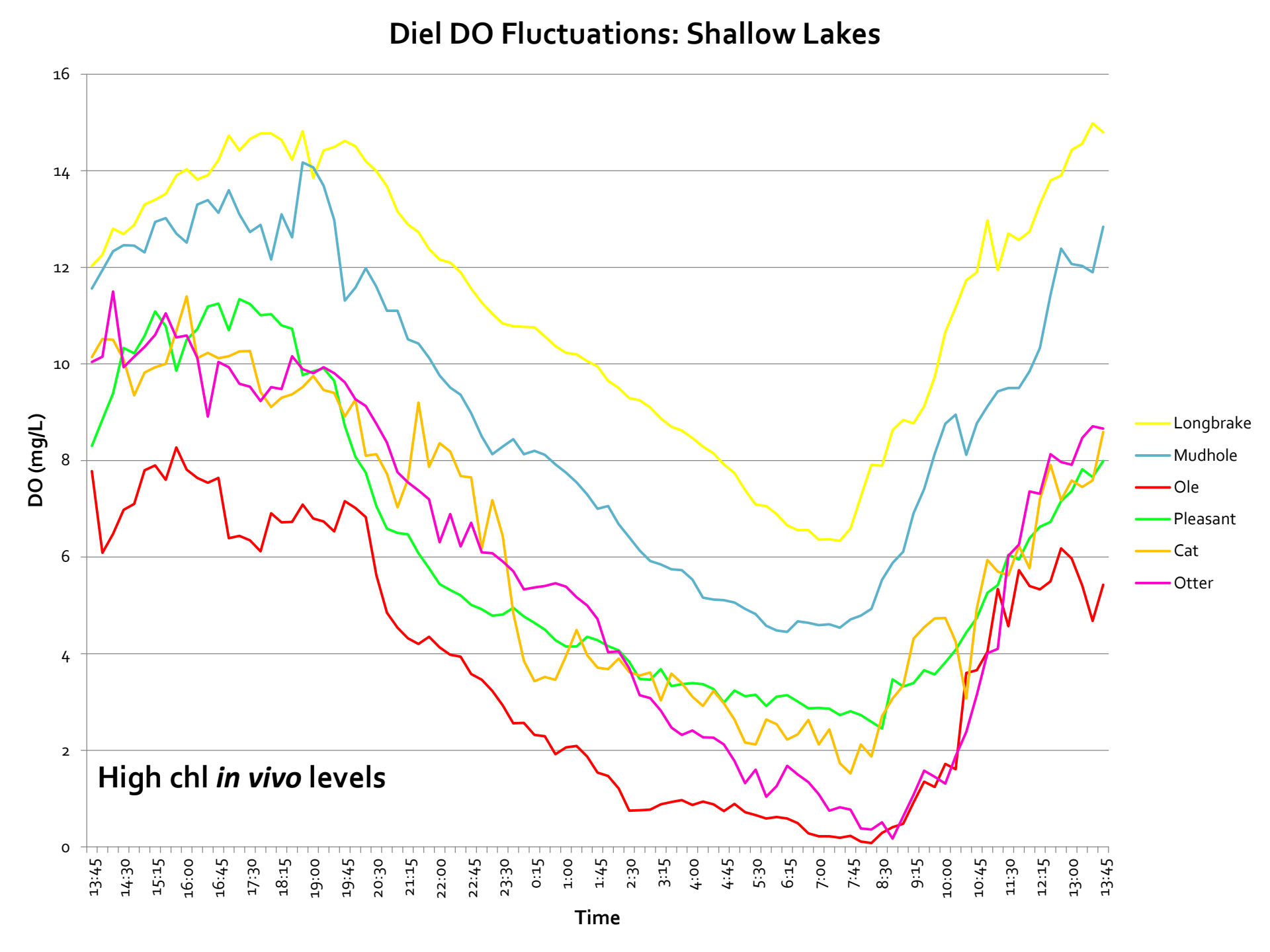


Results

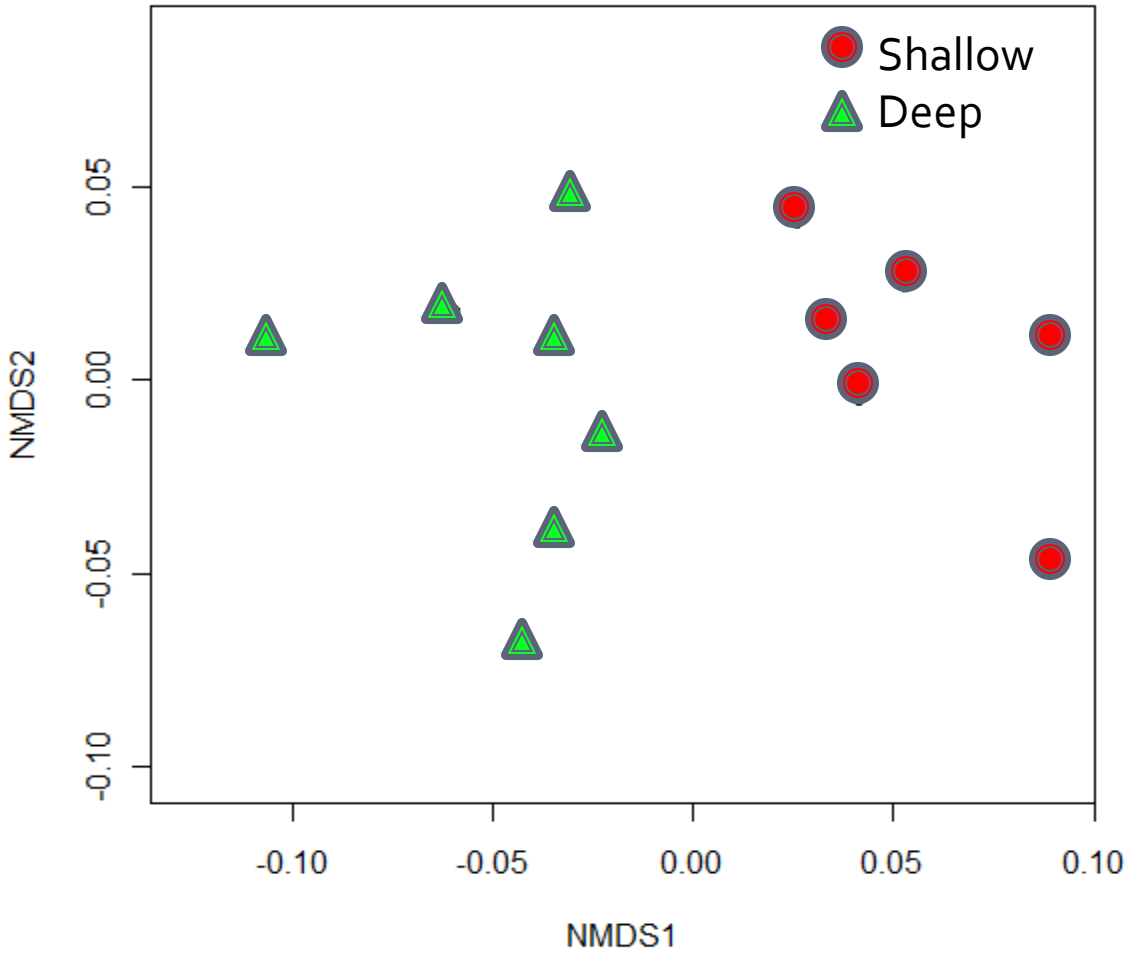

Chl *in vivo* was significantly higher in shallow lakes P = 0.003
Chl *in vivo* (RFU)
400
350
300
250
200
150
100
50
Shallow
Deep


Lake DO vs. Chl-a Relationship
Min DO mg/L
Chl in vivo (RFU)
R² = 0.8264
R² = 0.5876
Deep
shallow
0
1
2
3
4
5
6
7
8
0
50
100
150
200
250
300
350
400
450

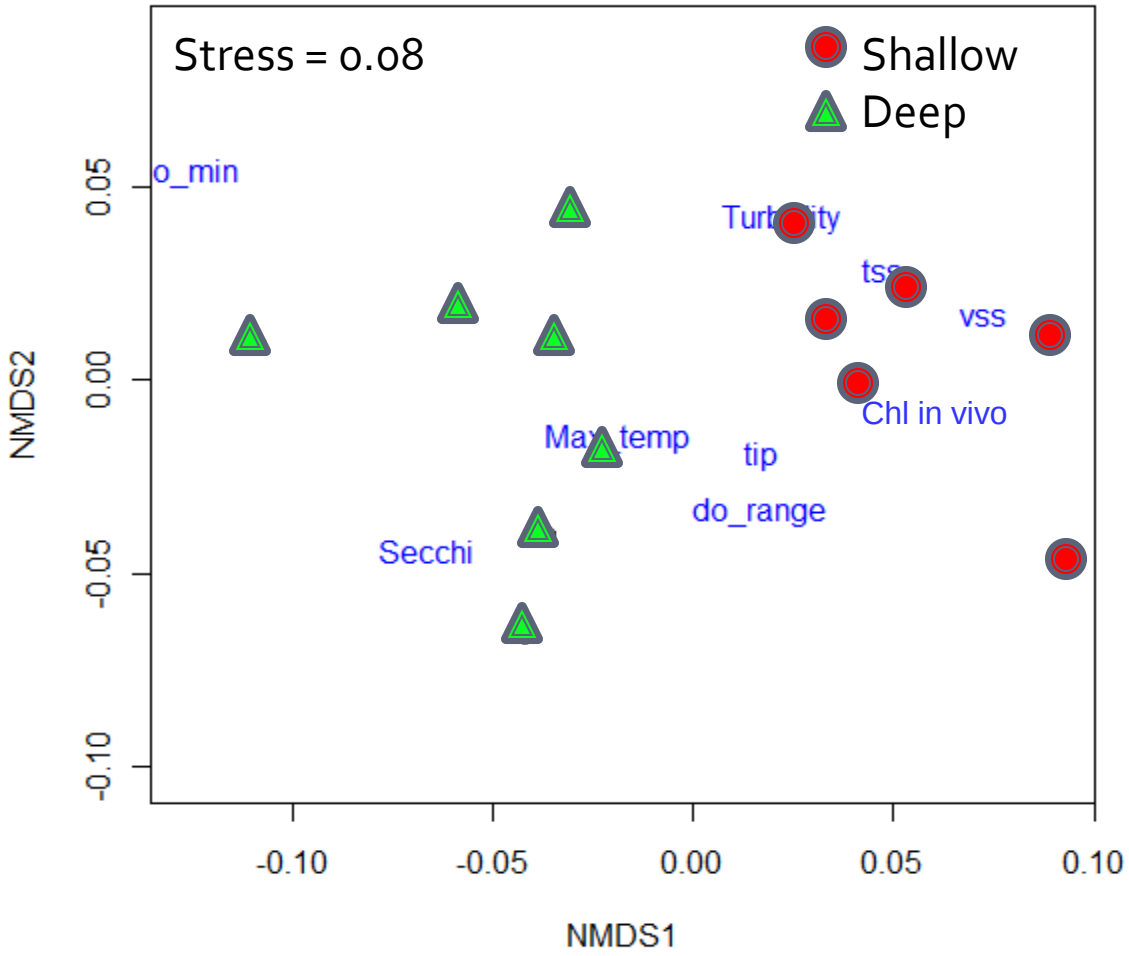

Diel DO Fluctuations: Deep Lakes
DO (mg/L)
16
14
12
10
8
6
4
2
0
13:45
14:30
15:15
16:00
16:45
17:30
18:15
19:00
19:45
20:30
21:15
22:00
22:45
23:30
0:15
1:00
1:45
2:30
3:15
4:00
4:45
5:30
6:15
7:00
7:45
8:30
9:15
10:00
10:45
11:30
12:15
13:00
13:45
Time
Hardcash
Mcintyre
Sidon
Walker
Jug
Townsend
Low chl *in vivo* levels


Diel DO Fluctuations: Shallow Lakes
DO (mg/L)
16
14
12
10
8
6
4
2
0
13:45
14:30
15:15
16:00
16:45
17:30
18:15
19:00
19:45
20:30
21:15
22:00
22:45
23:30
0:15
1:00
1:45
2:30
3:15
4:00
4:45
5:30
6:15
7:00
7:45
8:30
9:15
10:00
10:45
11:30
12:15
13:00
13:45
Time
Longbrake
Mudhole
Ole
Pleasant
Cat
Otter
High chl *in vivo* levels

NMDS:WQ



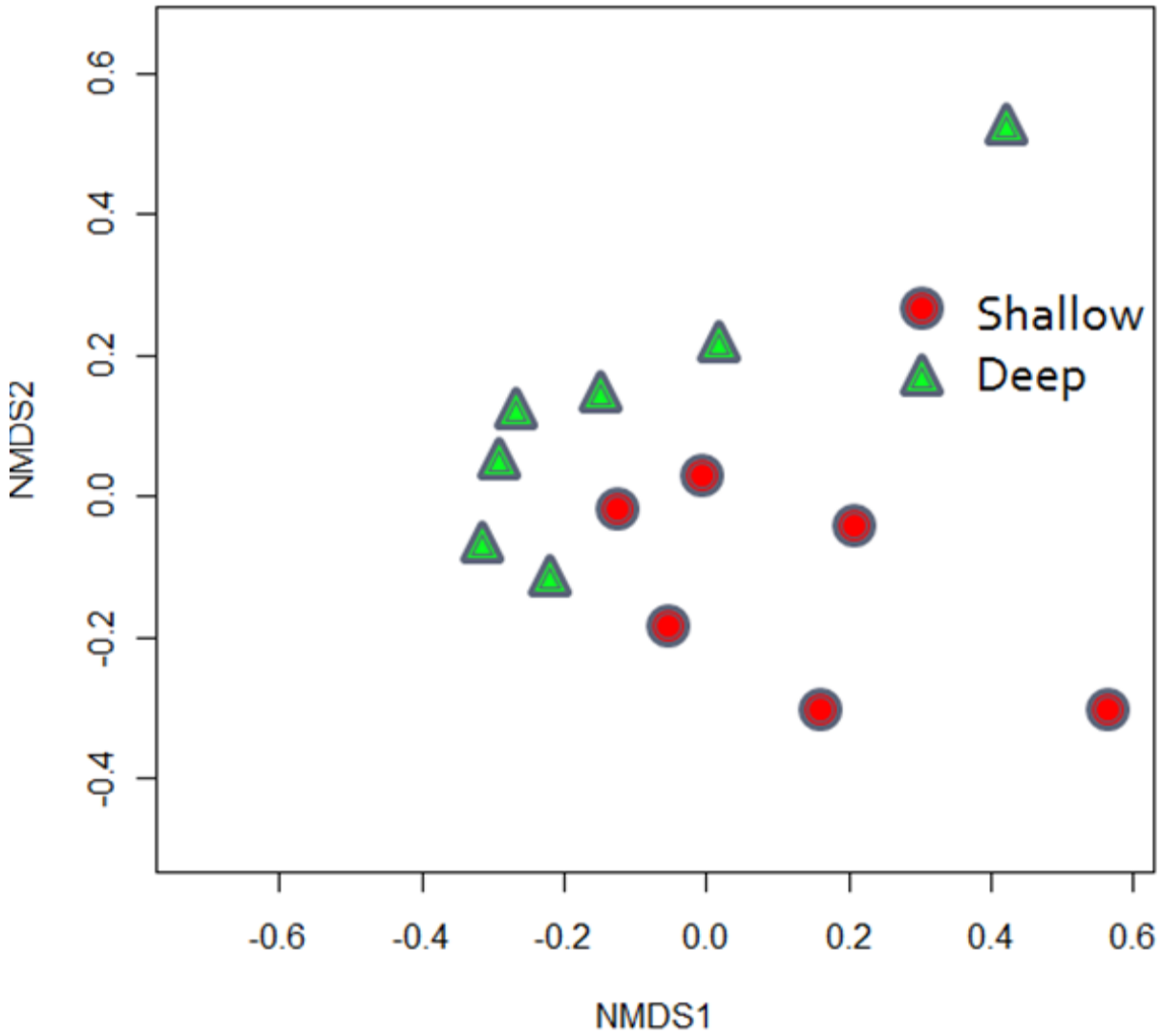
NMDS:WQ


Stress = 0.08
Shallow
Deep
o_min
Turbidity
tss
vss
Chl in vivo
Max temp
tip
do_range
Secchi
NMDS2
NMDS1
0.05
0.00
-0.05
-0.10
-0.10
-0.05
0.00
0.05
0.10

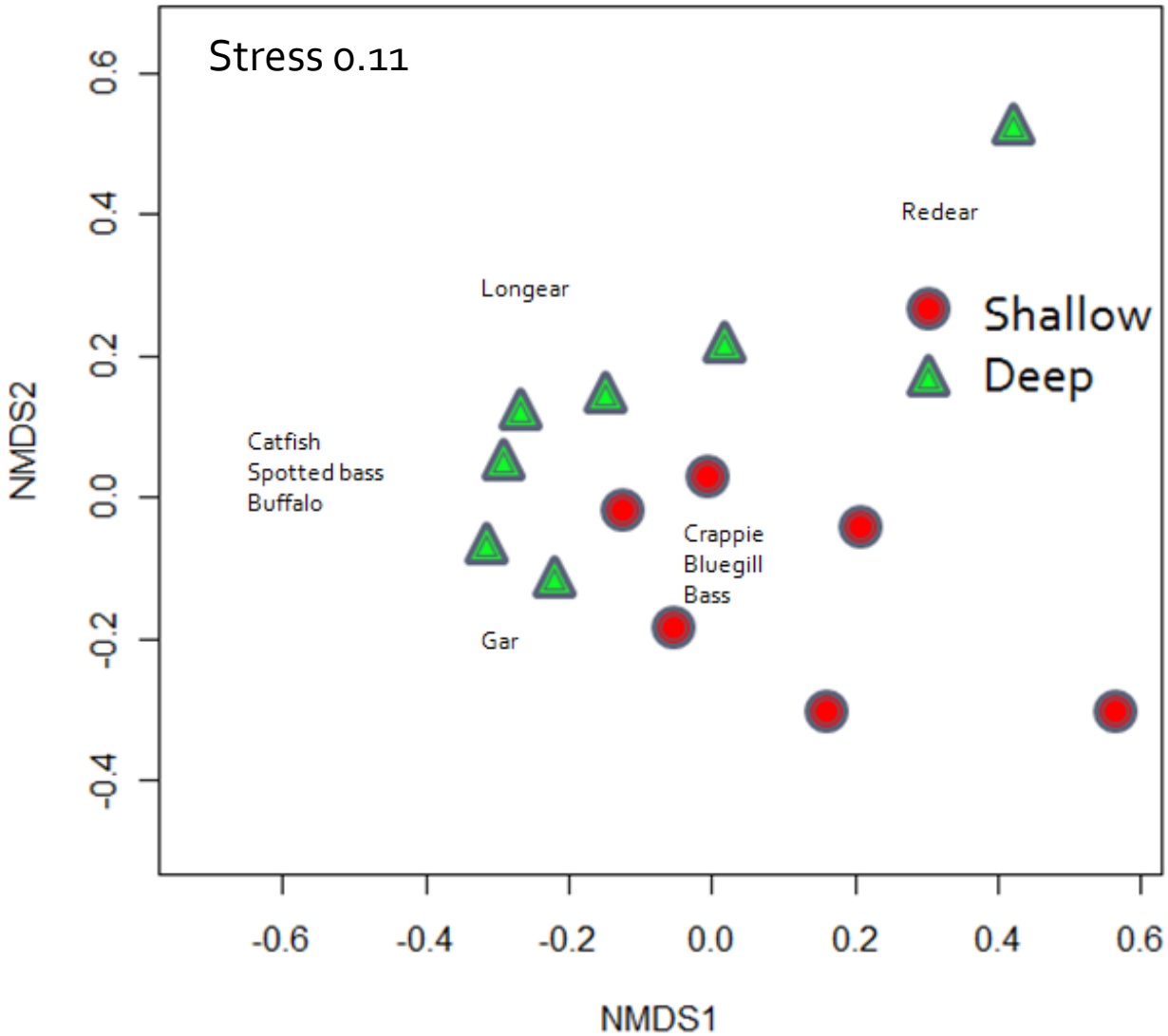
Results

- Water quality
- Euclidean distance similarity matrix
- 10000 permutations
- PERMANOVA H_0: Deep = Shallow
  - P = 0.005 reject H_0

NMDS: FISH



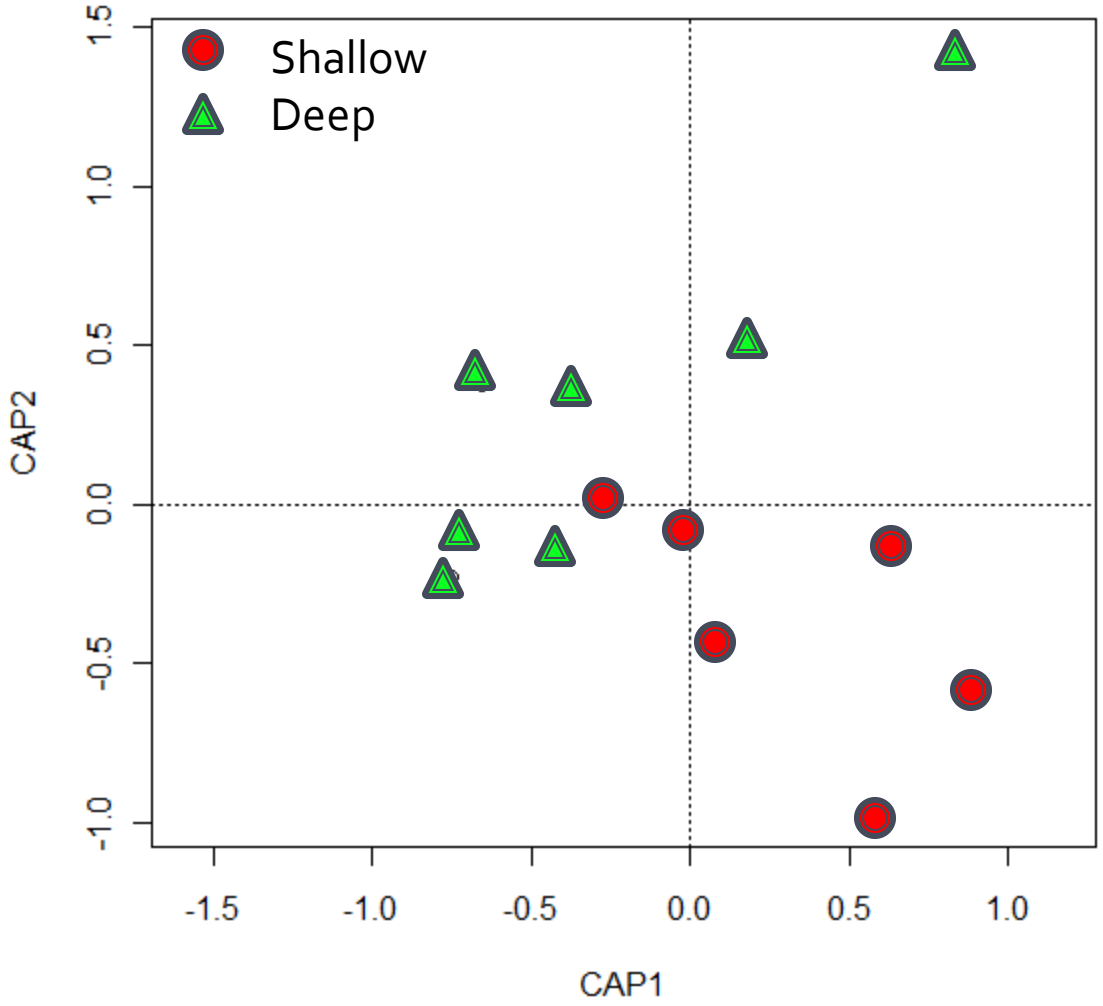
NMDS: Fish


Stress 0.11
Redear
Longear
Shallow
Deep
Catfish
Spotted bass
Buffalo
Crappie
Bluegill
Bass
Gar
NMDS2
NMDS1
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6

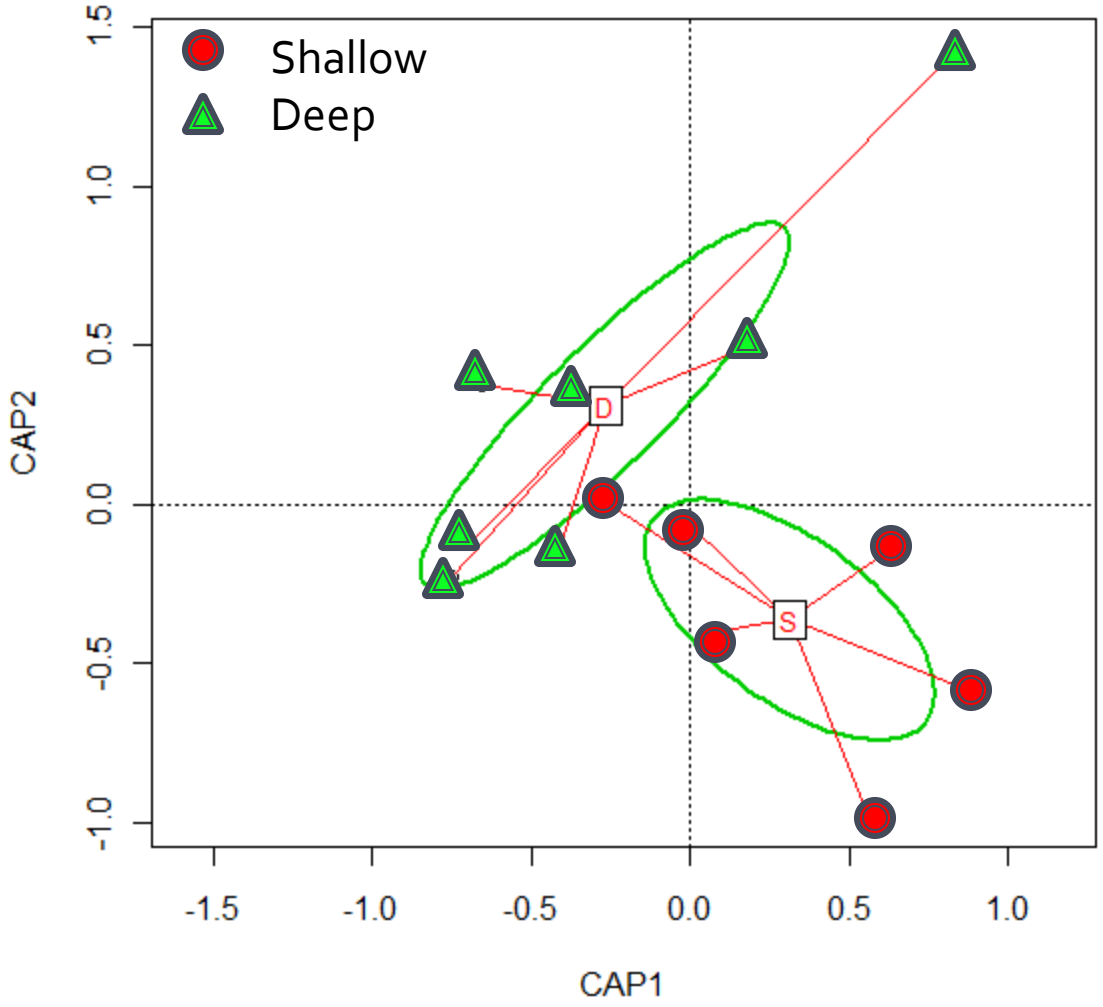
Results

- Log -1 transformation
- Bray Curtis similarity matrix
- 10000 permutations
- PERMANOVA H_0: Deep = Shallow
- P = 0.028 reject H_0

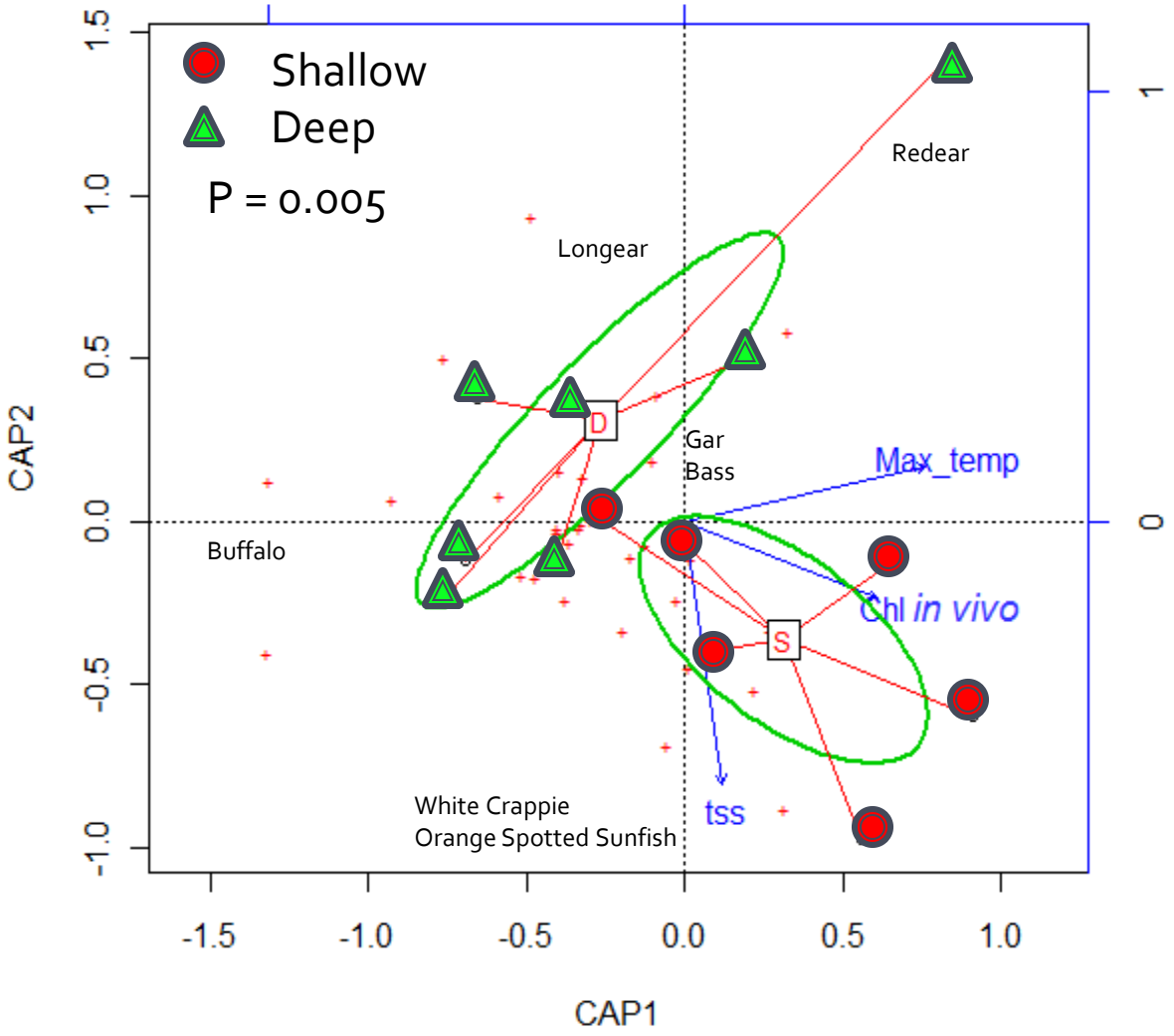
CAP



CAP



CAP


Shallow
Deep
P = 0.005
Redear
Longear
Gar
Bass
Max_temp
Buffalo
Chl in vivo
tss
White Crappie
Orange Spotted Sunfish
D
S
CAP1
CAP2
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1
0

CAP

- Used ordistep in R{VEGAN} to select most significant variables for CAP model.
  - Retained TSS, Chl *in vivo*, and maximum temperature.
  - All of which have higher levels in shallow lakes.
  - Overall model significance p = < 0.001

SIMPER Statistics

Fish	Depth	Percent contribution
White Crappie	S	87
Emerald Shiner	S	89
Western Mosquitofish	S	89
Black Crappie	S	90
Taillight Shiner	S	90
Orange Spotted Sunfish	S	92
Longear	D	86
Brook Silverside	D	86
Flathead Catfish	D	90
Black Buffalo	D	91
Blue Catfish	D	100
Spotted Bass	D	100

Conclusions

- Shallow lakes create harsher environments for intolerant fish species.
  - As indicated by low DO and high chl- in vivo levels.
  - High chl *in vivo* levels are indicative of wide diel swings in oxygen:
    - High DO during day, low DO during evening due to respiration of organic matter (i.e. phytoplankton)

Conclusions

- Water depth is significant contributor to fish community composition and water quality.
- Important for fisheries management
  - Deeper lakes harbor more desirable sport fish
    - Improve local economy
  - Deeper lakes provide more stable water quality conditions
    - Meet MS water quality guidelines
- Lake remediation efforts
  - Dredging
  - Install weirs to raise water level.
  - Riparian buffer

Acknowledgements

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- Caroline Andrews
- Water Wizards

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Acknowledgements

Questions?