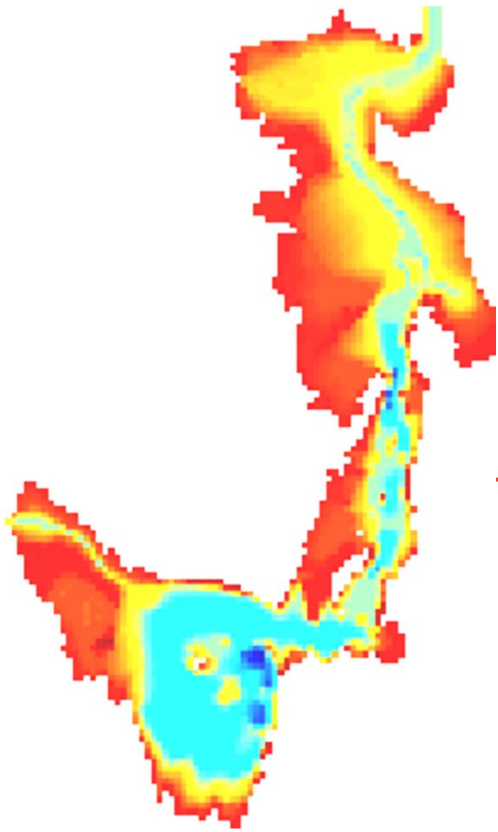


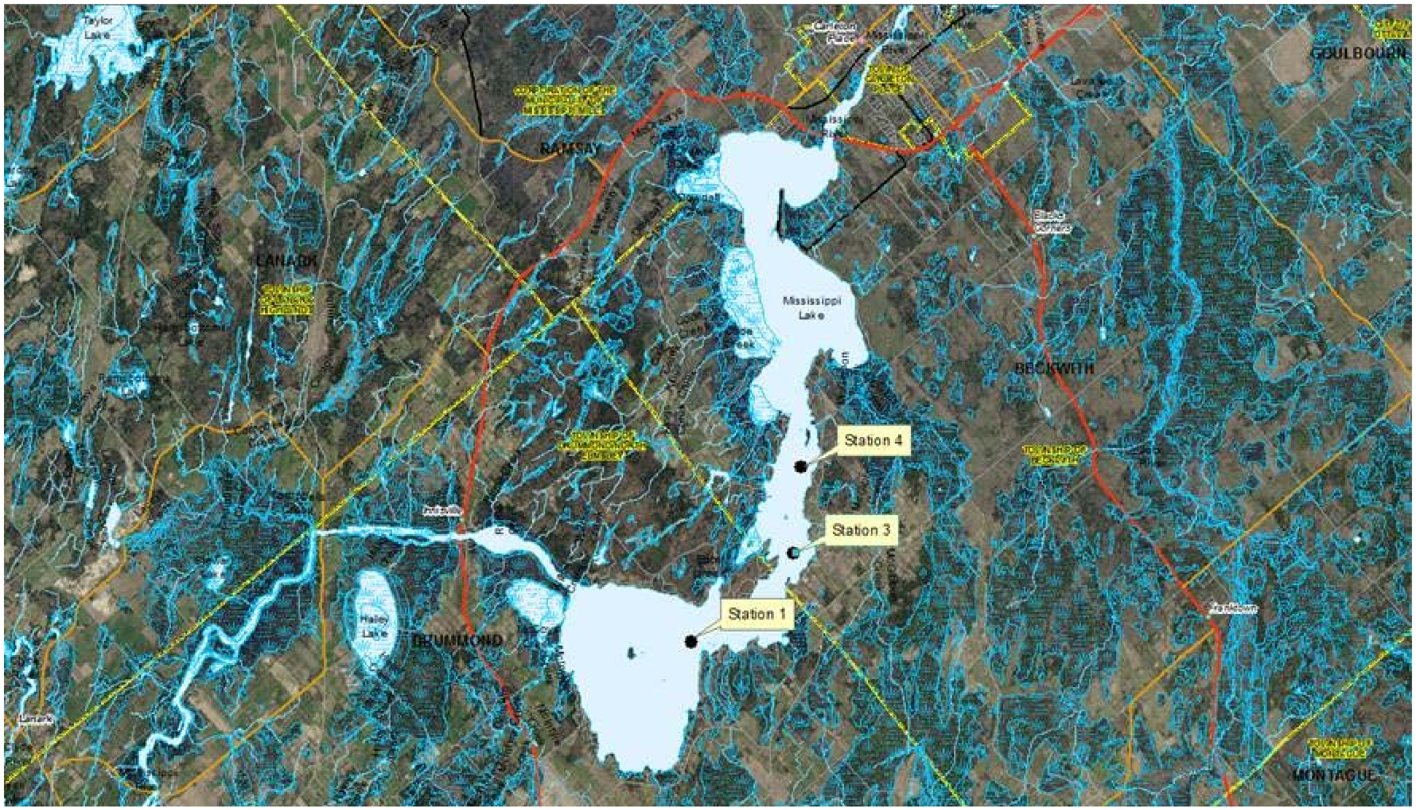
Mississippi Lake Hydrodynamic & Biogeochemical Modelling

Dr. Nader Nakhaei — *MVCA*
Dr. Leon Boegman — *Queen’s University*
Dr. Geoffrey Hall — *Queen’s University*

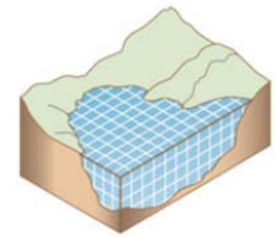
➢Objectives

- To determine main causes of water quality issues in Mississippi Lake by hydrodynamic & biogeochemical modeling

- To evaluate impact of different scenarios on the water quality



Model

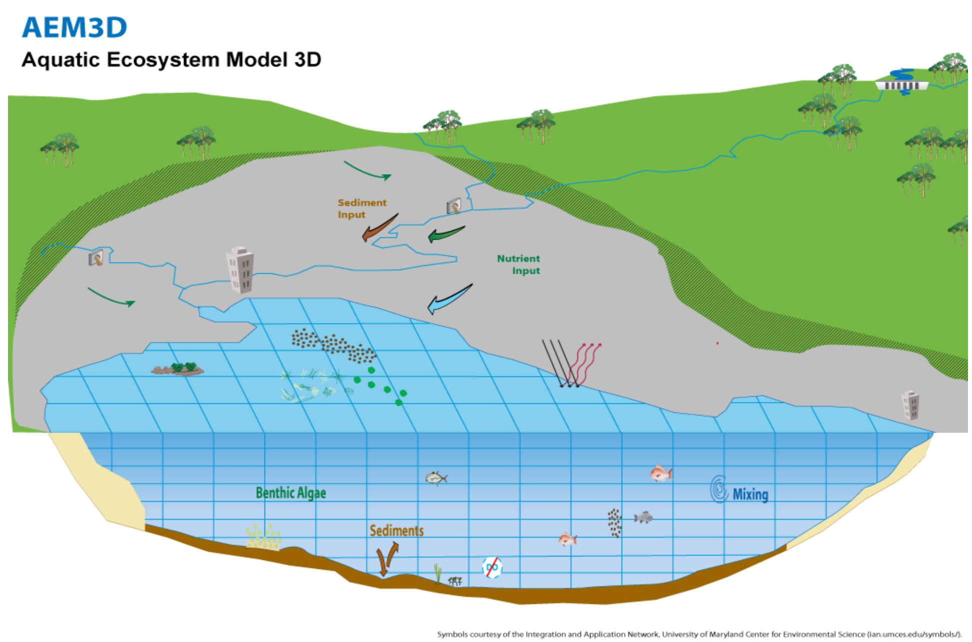


AEM3D

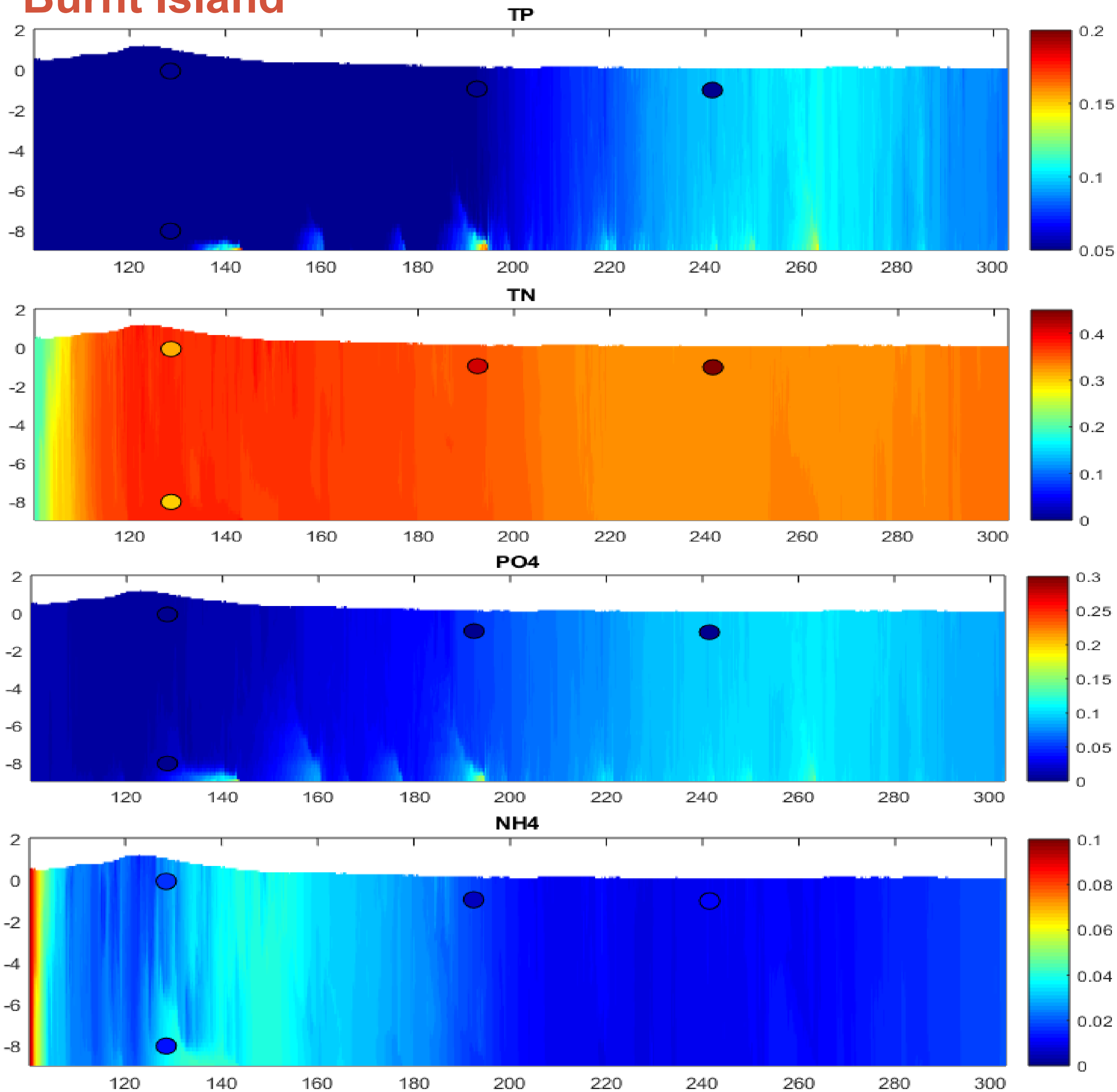
3D coupled Hydrodynamic-Aquatic Ecosystem Model

Nitrogen, Phosphorus, Oxygen, Phytoplankton, Zooplankton, fish, bacteria & …

- Initial condition & inflow water quality
- Parameters calibration
- 7even groups of Algae
- Remediation scenarios



Burnt Island



RMSE TP < 0.05

RMSE TN < 0.12

RMSE PO4 < 0.05

RMSE NH4 < 0.03

Creeks Inflow

Based on watershed area

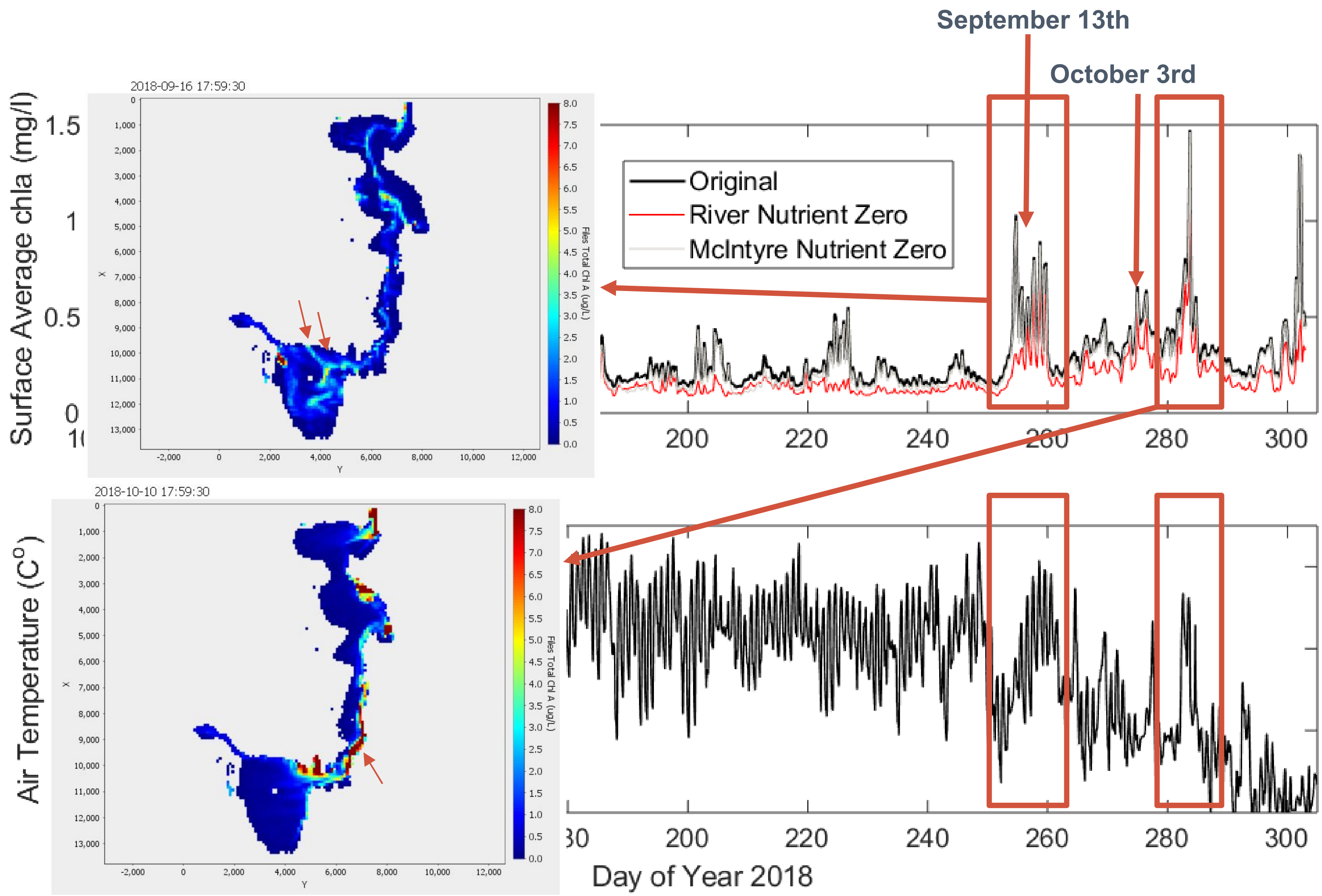
- Creeks Inflow ≈ 6% to 8% of the River inflow

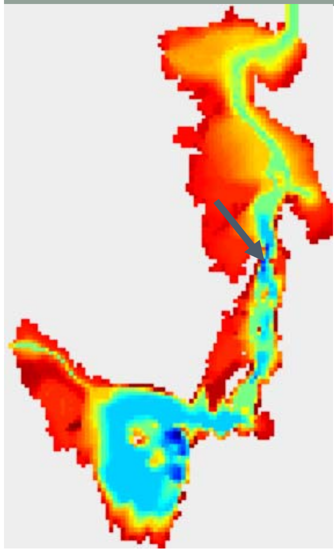
- But total TP contribution ≈ 20% of the River TP contribution
- total TKN contribution ≈ 23% of the River TKN contribution

- McIntyre responsible for more than 50% of the nutrients from the creeks

- Scenarios
  - River Nutrient ZERO
  - McIntyre Nutrient ZERO
  - Internal Nutrient Release ZERO

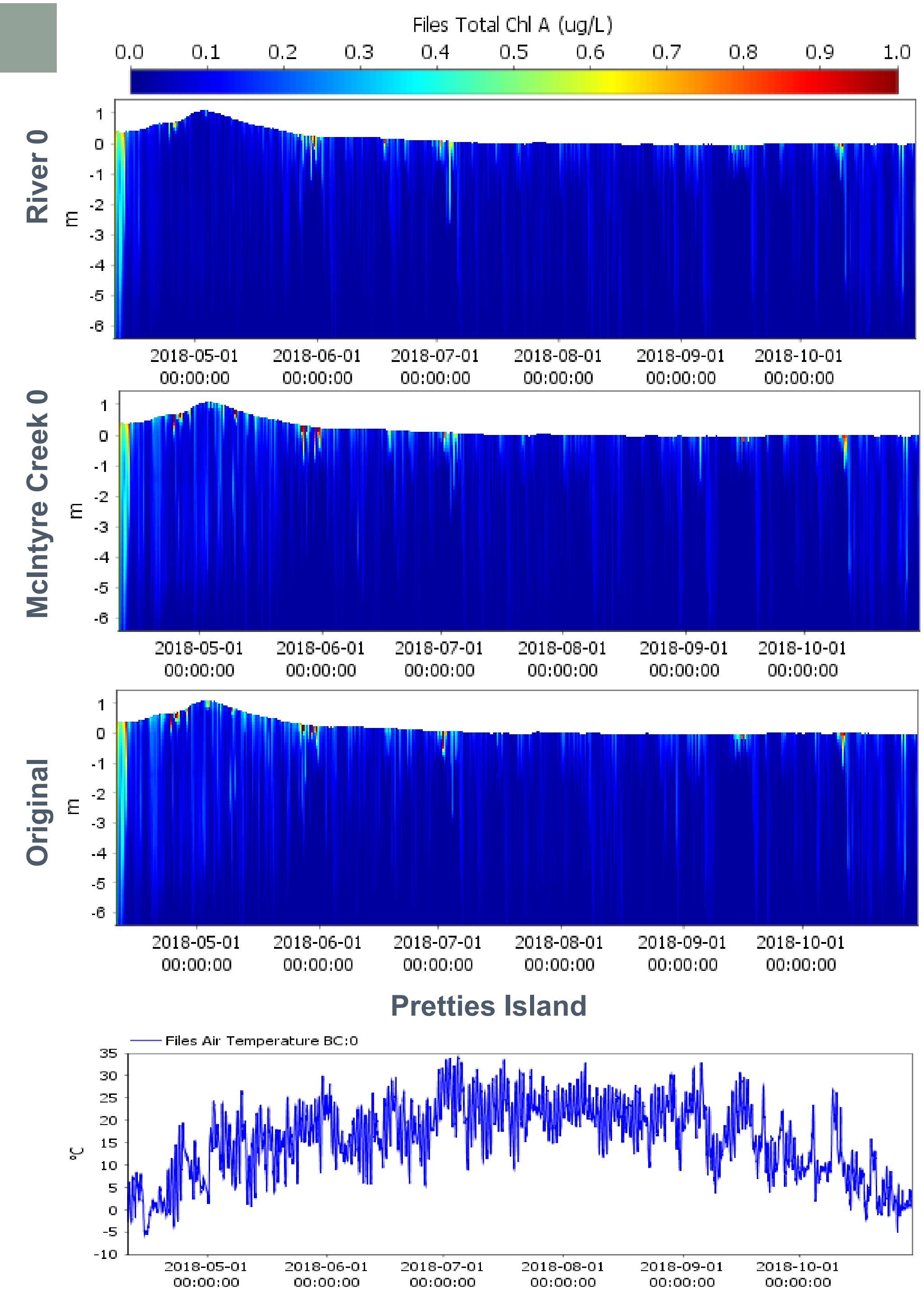
- 9% surface chla reduction McIntyre
- 38% surface chla reduction Mississippi River
- < 1% surface chla reduction Internal Loading

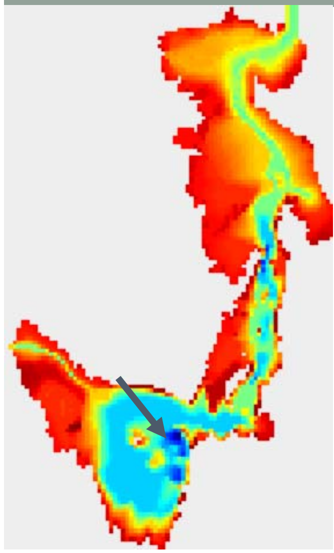


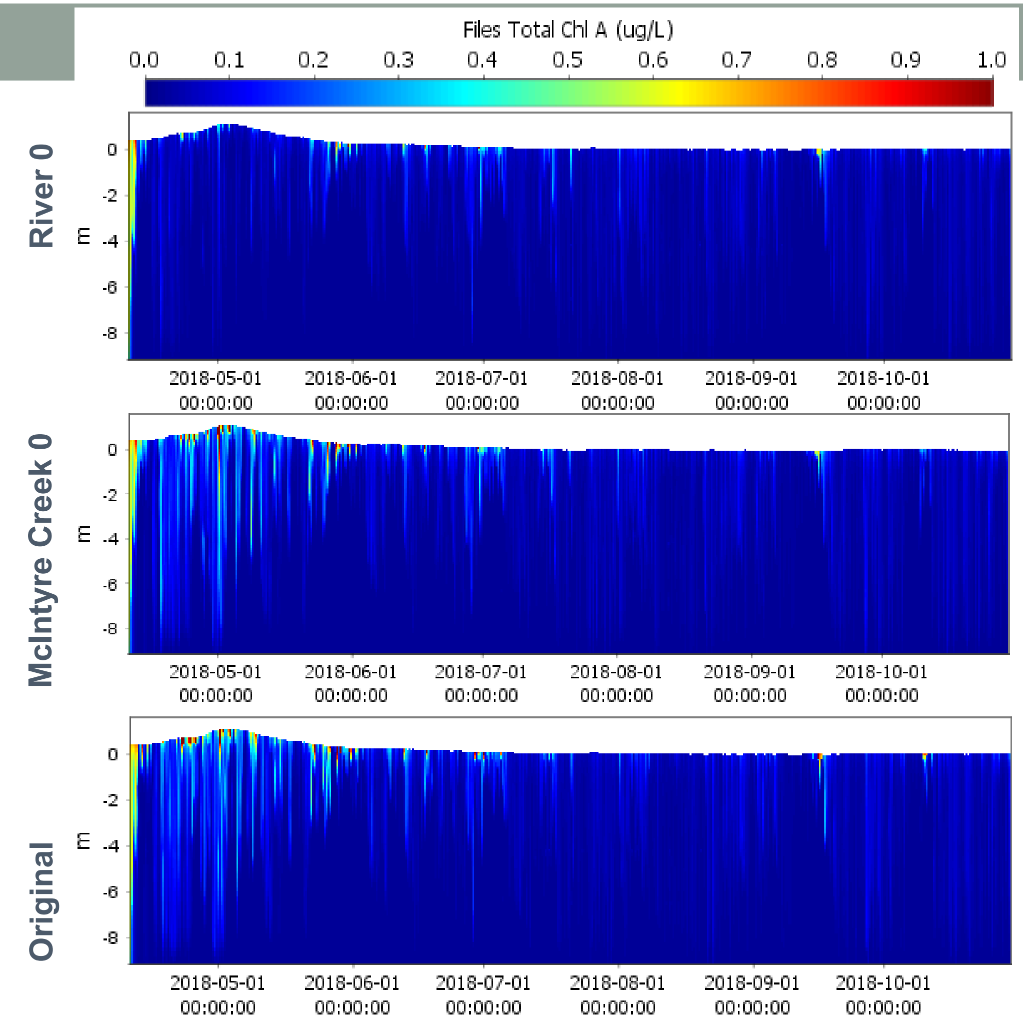


- 0.8% chla reduction
- 18% chla reduction

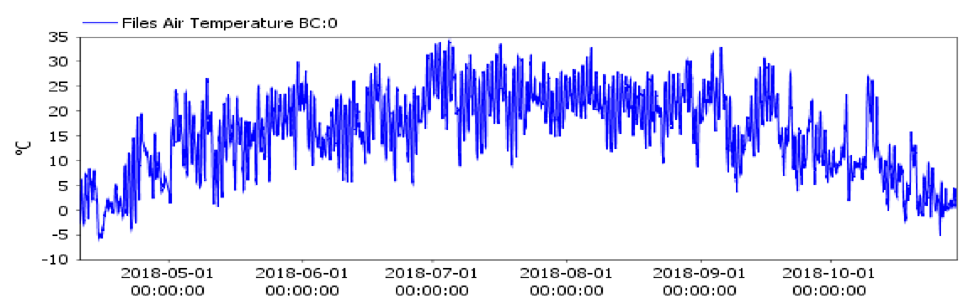
McIntyre
River



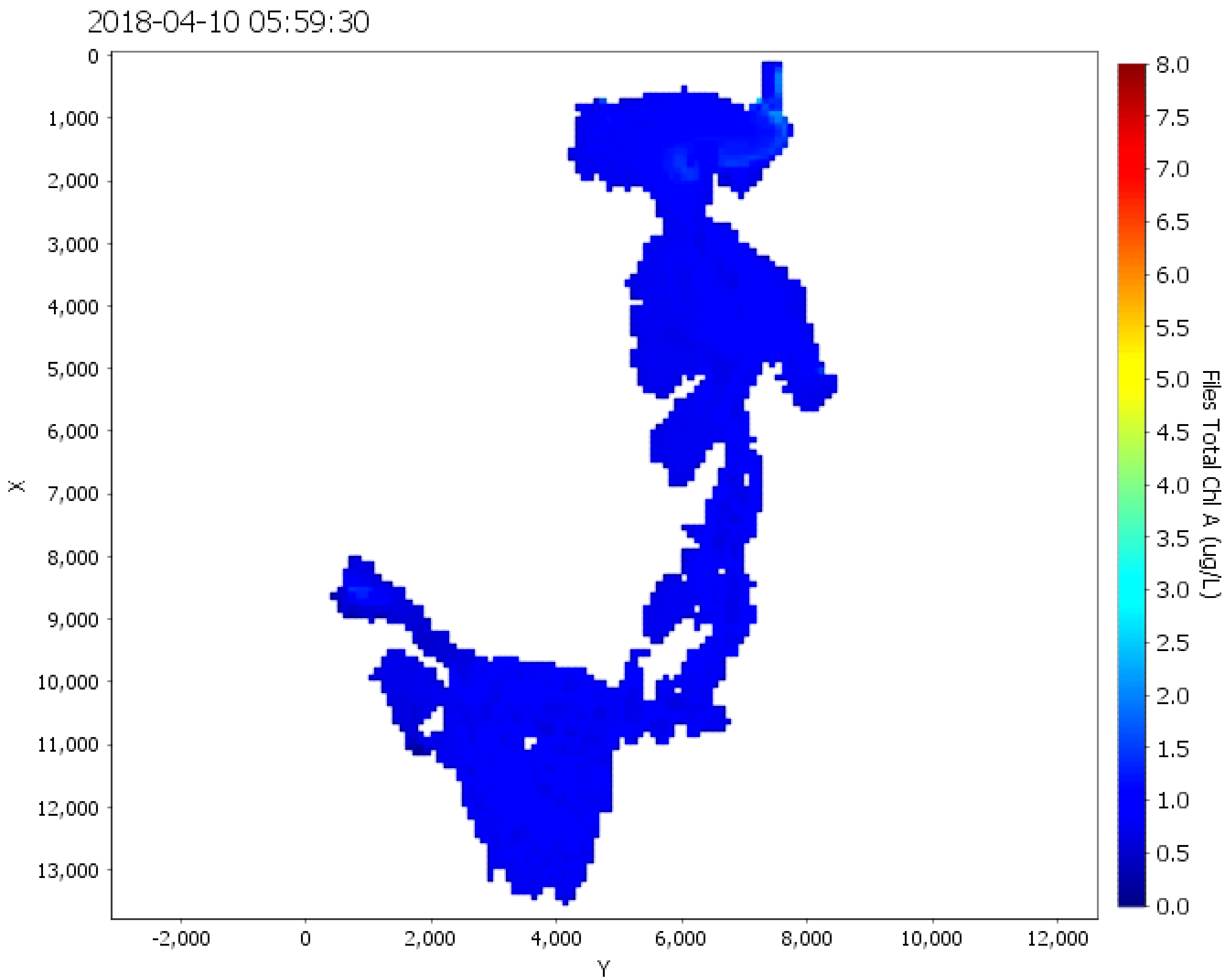




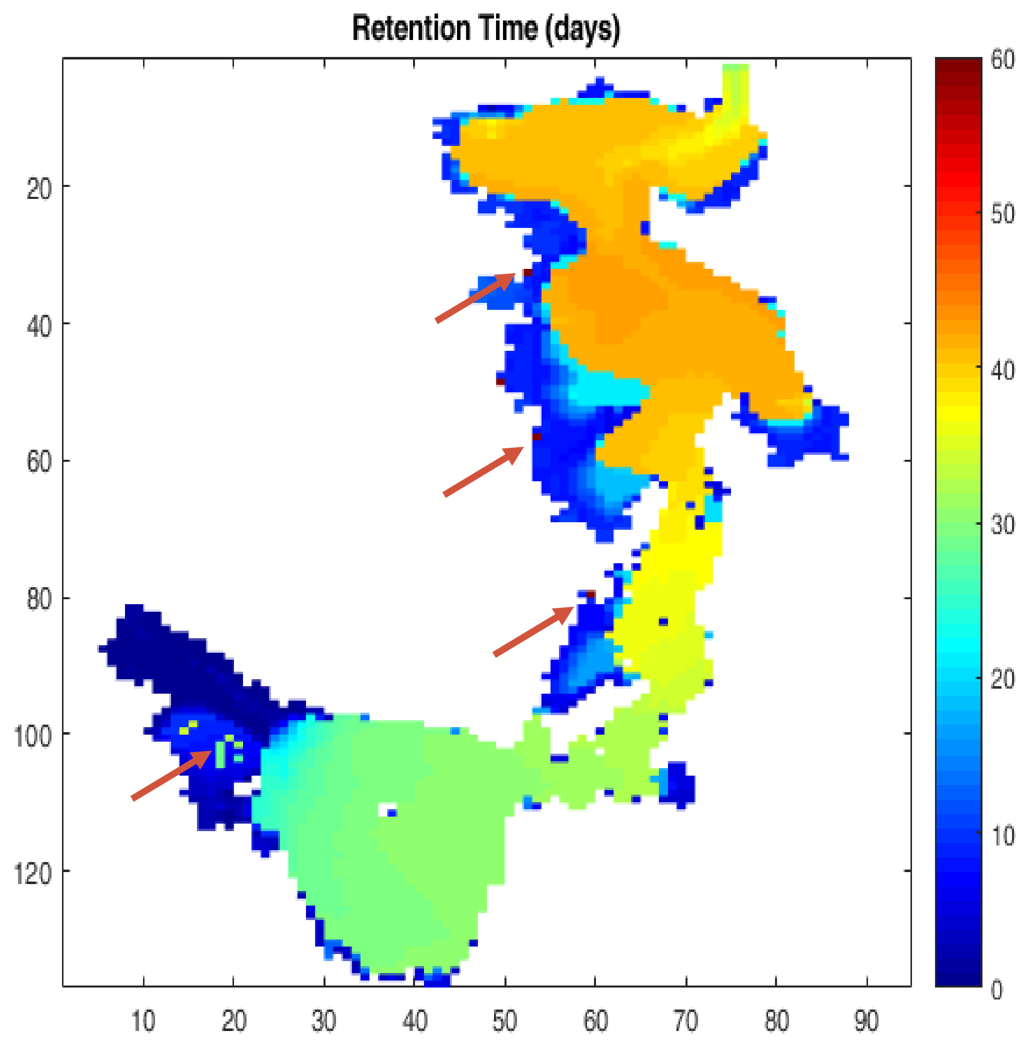
Burnt Island



- **1% chla reduction** **McIntyre**
- **31% chla reduction** **River**



2018-04-10 05:59:30
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
X
-2,000
0
2,000
4,000
6,000
8,000
10,000
12,000
Y
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Files Total Chl A (ug/L)


Retention Time (days)
20
40
60
80
100
120
10
20
30
40
50
60
70
80
90
60
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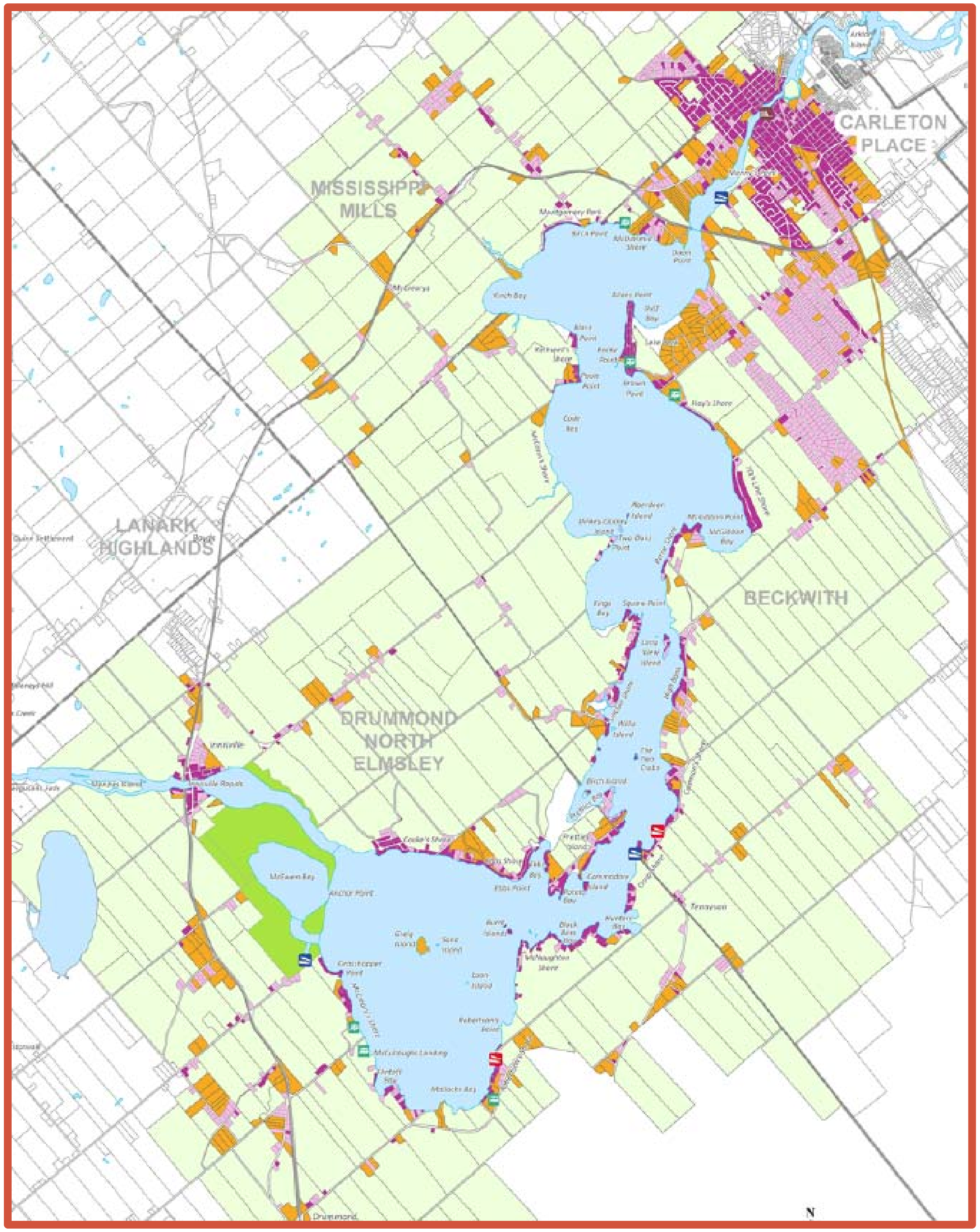
40
30
20
10
0



Thank you for your attention!

Acknowledgment

MITACS

Dr. Leon Boegman

Alyson Symon, Paul Lehman, Robert Betcher, Kelly Stiles, Elora Oades, Stephen Miller

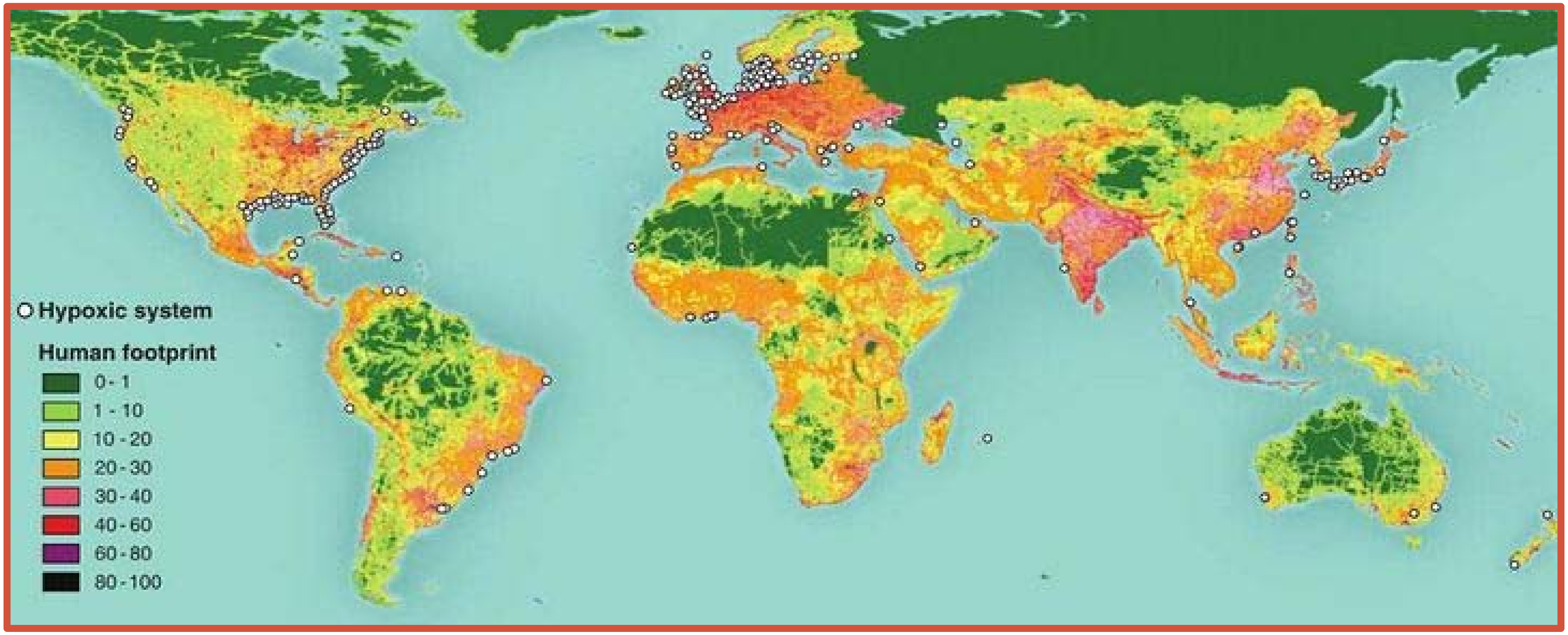
MLA - Rob Bell

And all MVCA staff

…

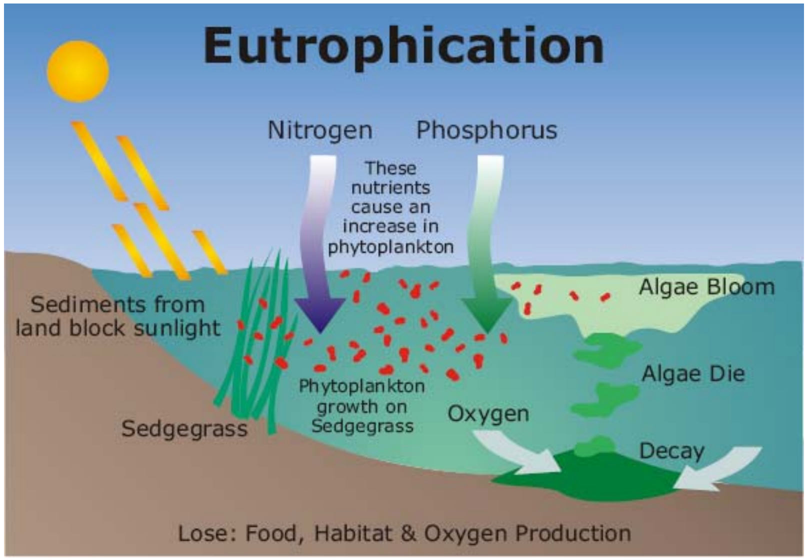
Introduction

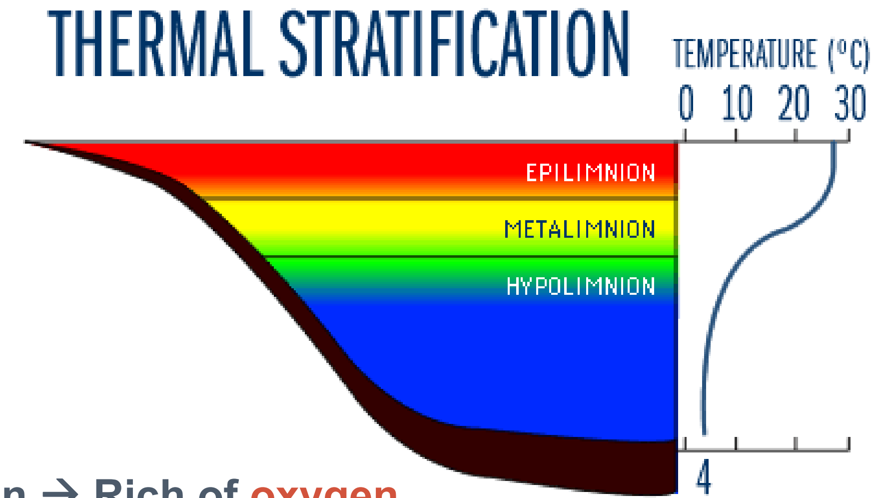
- **Water quality management**
- **Eutrophication**
- **Algae blooms**



Diaz and Rosenberg (2008)

Why modeling?



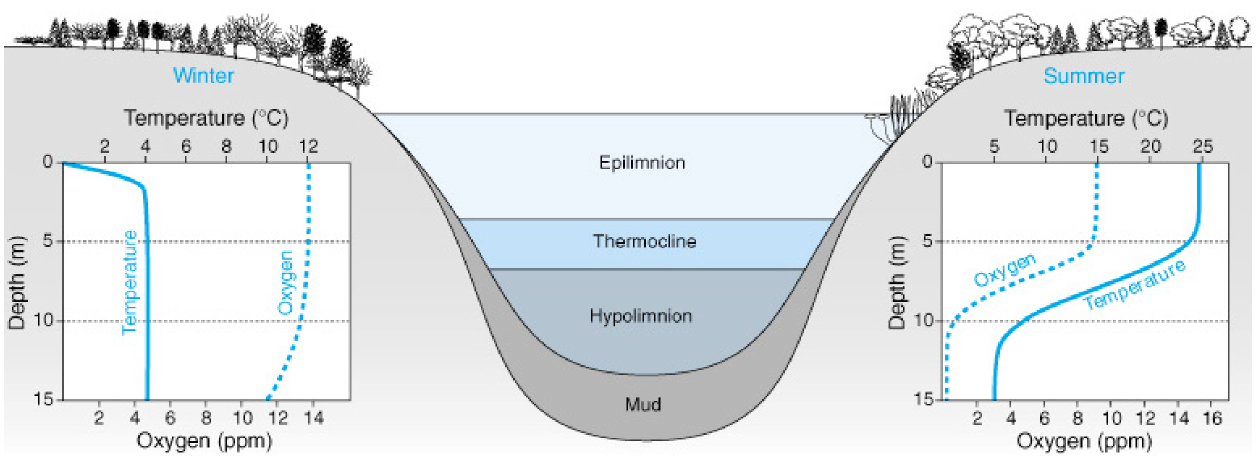


Epilimnion → Rich of **oxygen**

Metalimnion (Thermocline)

Hypolimnion → Lack of **oxygen**

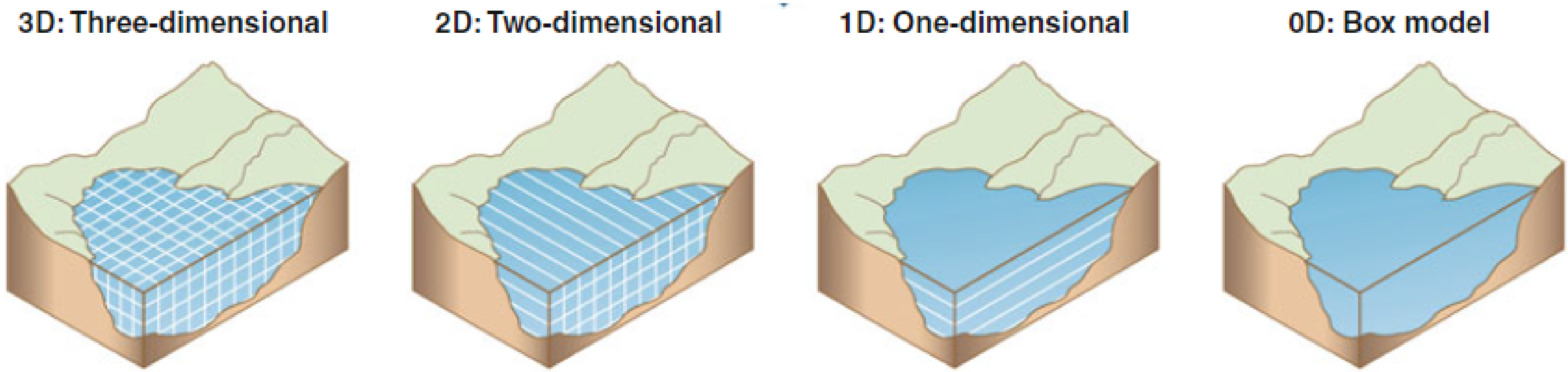
- **Hypoxia** (Oxygen<5 mg/l)
- **Anoxia** (Oxygen≈0 mg/l)

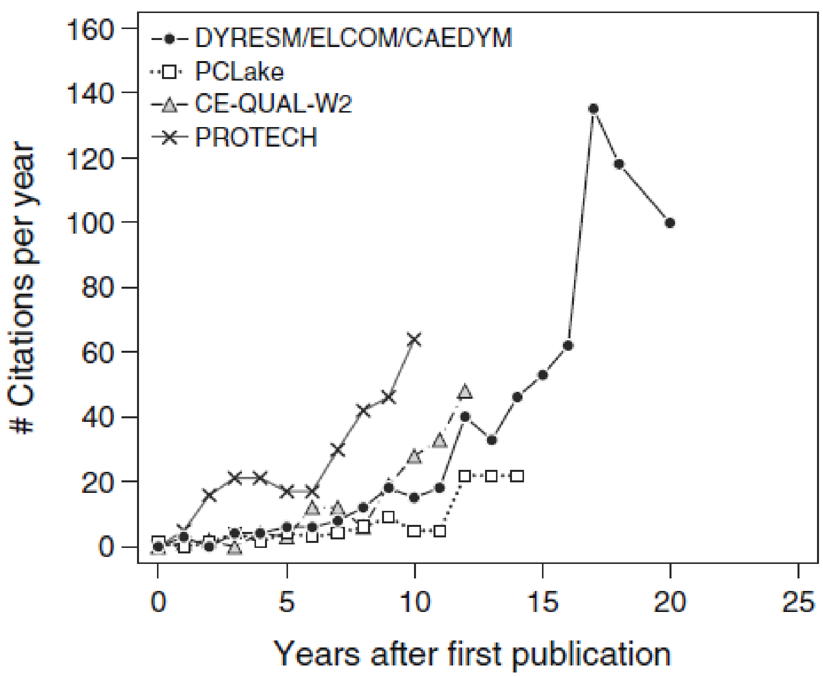


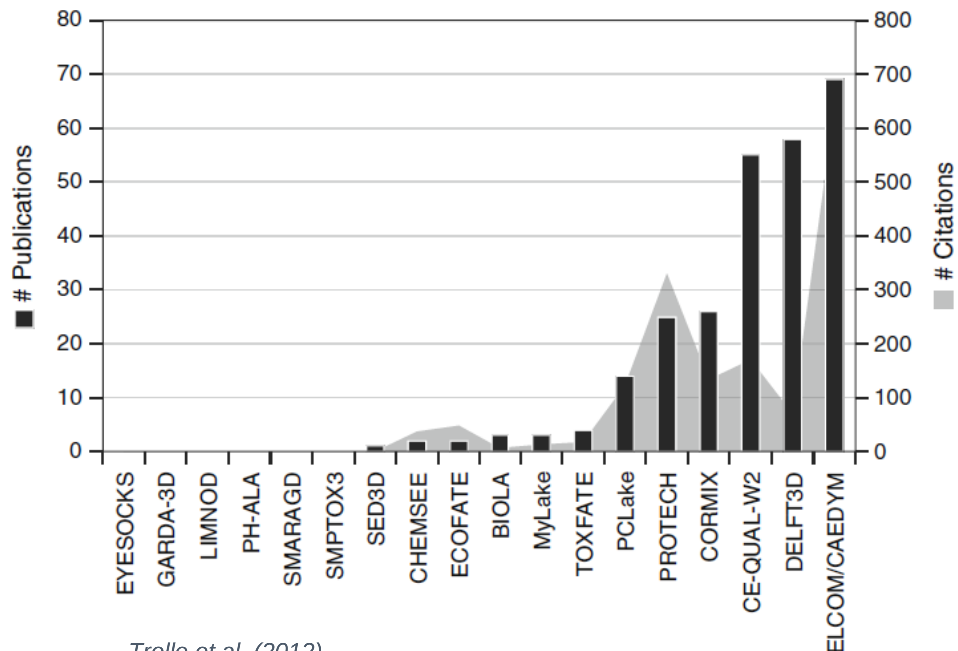
➢ CAEDYM

CAEDYM variable	Parameter	Estimated value based on the measurements in Appendix B
PO4	Soluble reactive phosphorus	PO_4
DOPL	Dissolved organic phosphate	TDP-PO_4
POPL	Particulate organic phosphate	(0.6-0.8) × (TPP) - IP
PIP	Particulate inorganic phosphate	TPP-POPL
IP	Internal P loading of phytoplankton	C:chl*a* 50:1; C:P (41000-77000):1
NH4	Ammonium	NH_4
NO3	Nitrate	NO_3+NO_2
DONL	Dissolved organic nitrogen	(TKN-NH_4-PIN)2/3
PONL	Particulate organic nitrogen	(TKN-NH_4-PIN)1/3
Algae groups	The introduced groups to the model	Based on percentage × chl*a* measurements

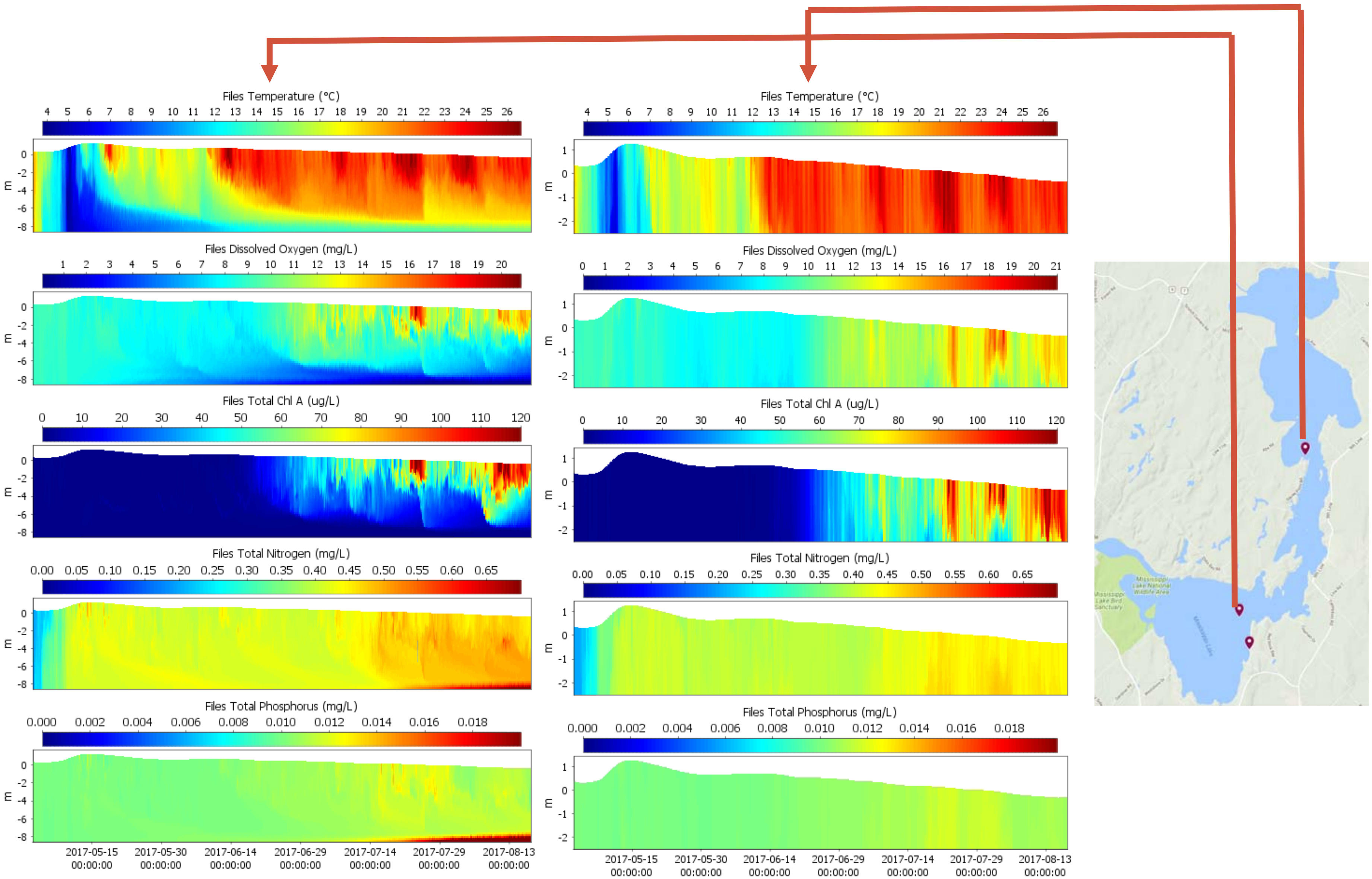
- Rapid growth of **models**
- The need for more quantitative understanding of **water quality**







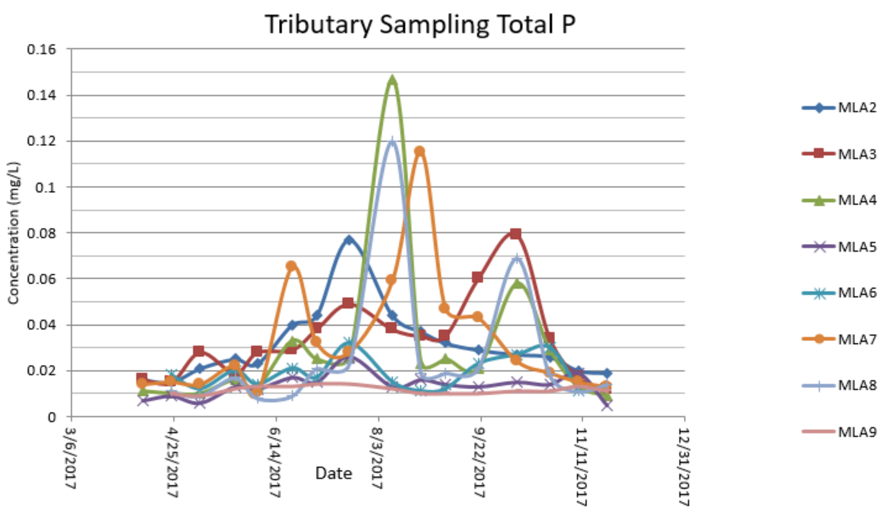
Trolle et al. (2012)

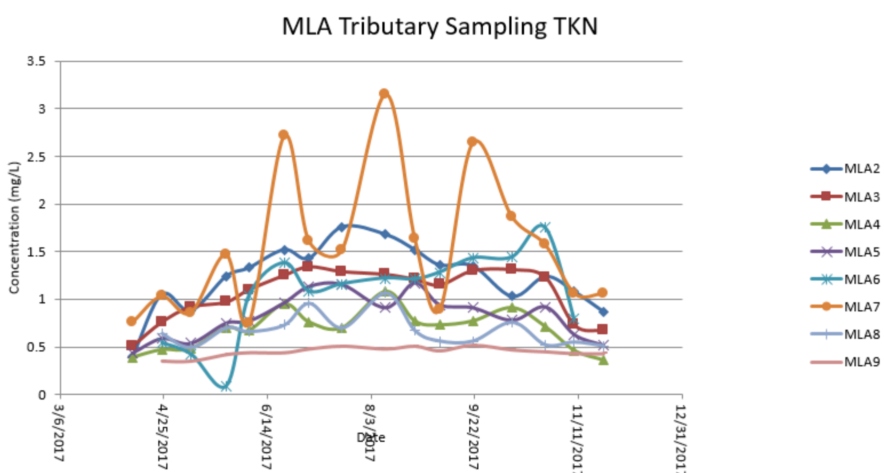


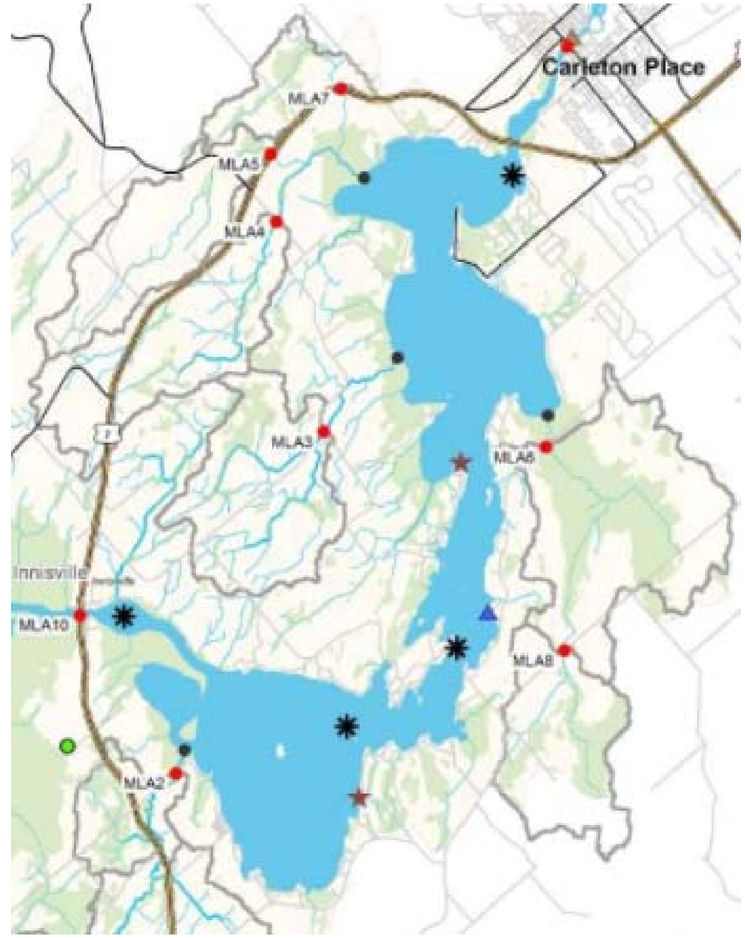
Files Temperature (°C)
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Files Dissolved Oxygen (mg/L)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Files Total Chl A (ug/L)
0 10 20 30 40 50 60 70 80 90 100 110 120
Files Total Nitrogen (mg/L)
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65
Files Total Phosphorus (mg/L)
0.000 0.002 0.004 0.006 0.008 0.010 0.012 0.014 0.016 0.018
m
2017-05-15 00:00:00
2017-05-30 00:00:00
2017-06-14 00:00:00
2017-06-29 00:00:00
2017-07-14 00:00:00
2017-07-29 00:00:00
2017-08-13 00:00:00
Files Temperature (°C)
Files Dissolved Oxygen (mg/L)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Files Total Chl A (ug/L)
Files Total Nitrogen (mg/L)
Files Total Phosphorus (mg/L)

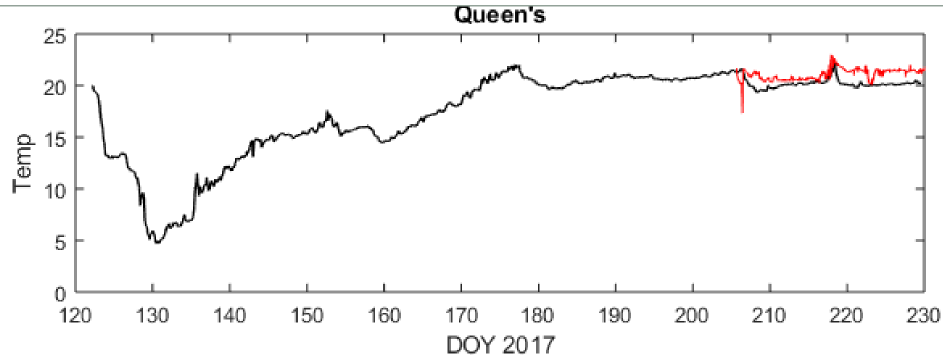
Water Quality Sampling Program

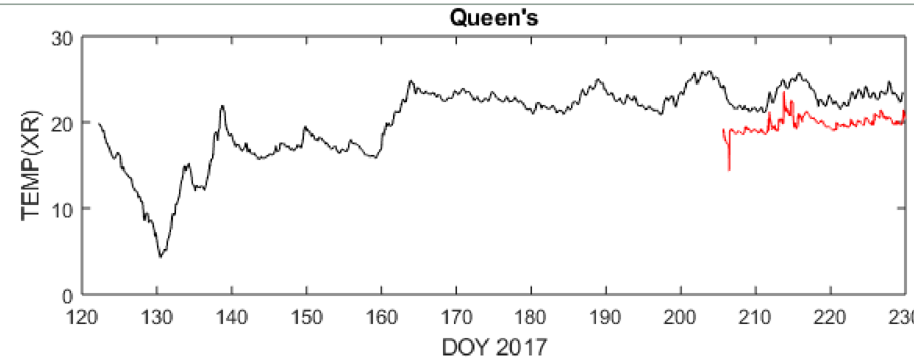
- 2017 – 8 stations

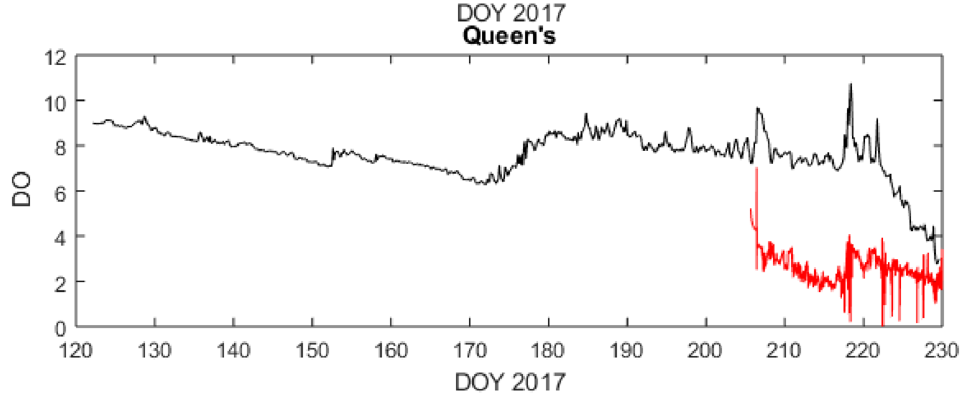


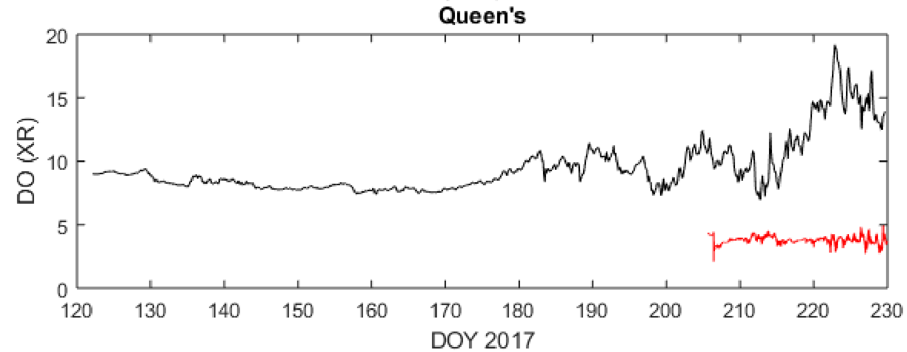





Queen's
Temp
DOY 2017
0 5 10 15 20 25
120 130 140 150 160 170 180 190 200 210 220 230


Queen's
TEMP(XR)
DOY 2017
0 10 20 30
120 130 140 150 160 170 180 190 200 210 220 230


Queen's
DO
DOY 2017
0 2 4 6 8 10 12
120 130 140 150 160 170 180 190 200 210 220 230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DO (XR)
DOY 2017
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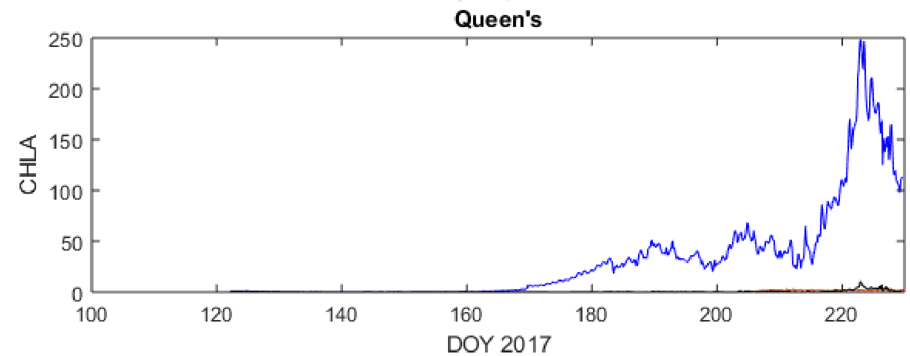
120 130 140 150 160 170 180 190 200 210 220 230


Queen's
CHLA
DOY 2017
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100 120 140 160 180 200 220