

Harmful and toxic algae blooms in the Bay of Quinte AOC



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Environment
Canada

Environnement
Canada

Status of BUIs, December 2015

Table 1. Current Status of Beneficial Use Impairments of the Bay of Quinte (Bay of Quinte Restoration Council, 2015)

| BUI | Description | December 2015 Status |
|-----|---|-----------------------------------|
| 1 | Restrictions on Fish and Wildlife Consumption | Impaired |
| 3 | Degradation of Fish and Wildlife Populations | Impaired pending redesignation |
| 6 | Degradation of Benthos | Impaired pending redesignation |
| 7 | Restrictions on Dredging Activities | Not Impaired |
| 8 | Eutrophication or Undesirable Algae | Impaired |
| 9 | Restrictions on Drinking Water and Taste and Odour Problems | Impaired pending redesignation |
| 10 | Beach Closures | Impaired pending redesignation |
| 11 | Degradation of Aesthetics | Impaired pending further analysis |
| 13 | Degradation of Phytoplankton and Zooplankton Populations | Impaired |
| 14 | Loss of Fish and Wildlife Habitat | Impaired pending redesignation |

(Lambert et al. 2016. Quinte Conservation Algae Monitoring and Assessment Project 2015/2016 report)

Sampling sites

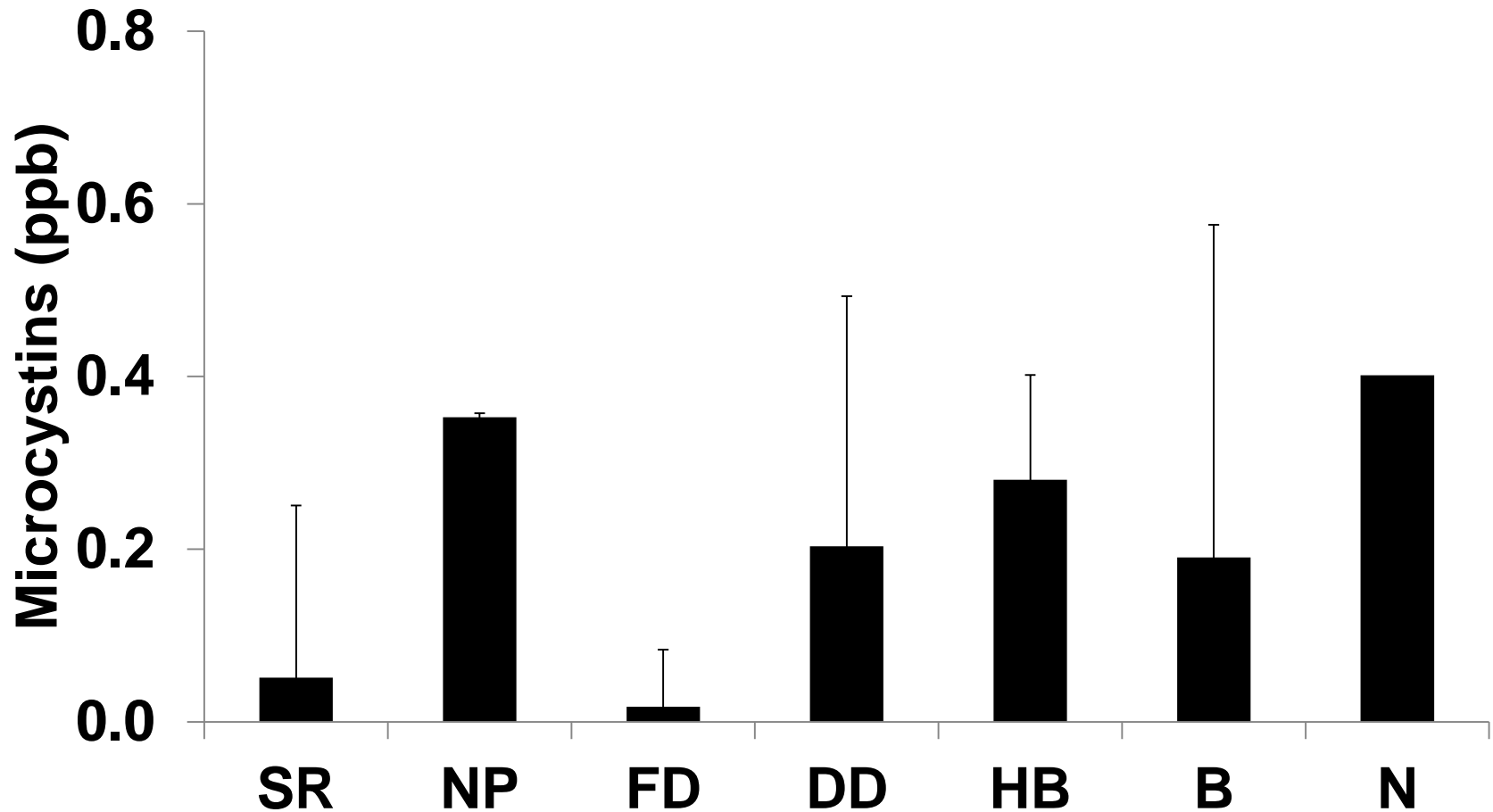
Yellow – shoreline (parks, docks)
Red - offshore



Cyanotoxins results 2015 - ECCCC

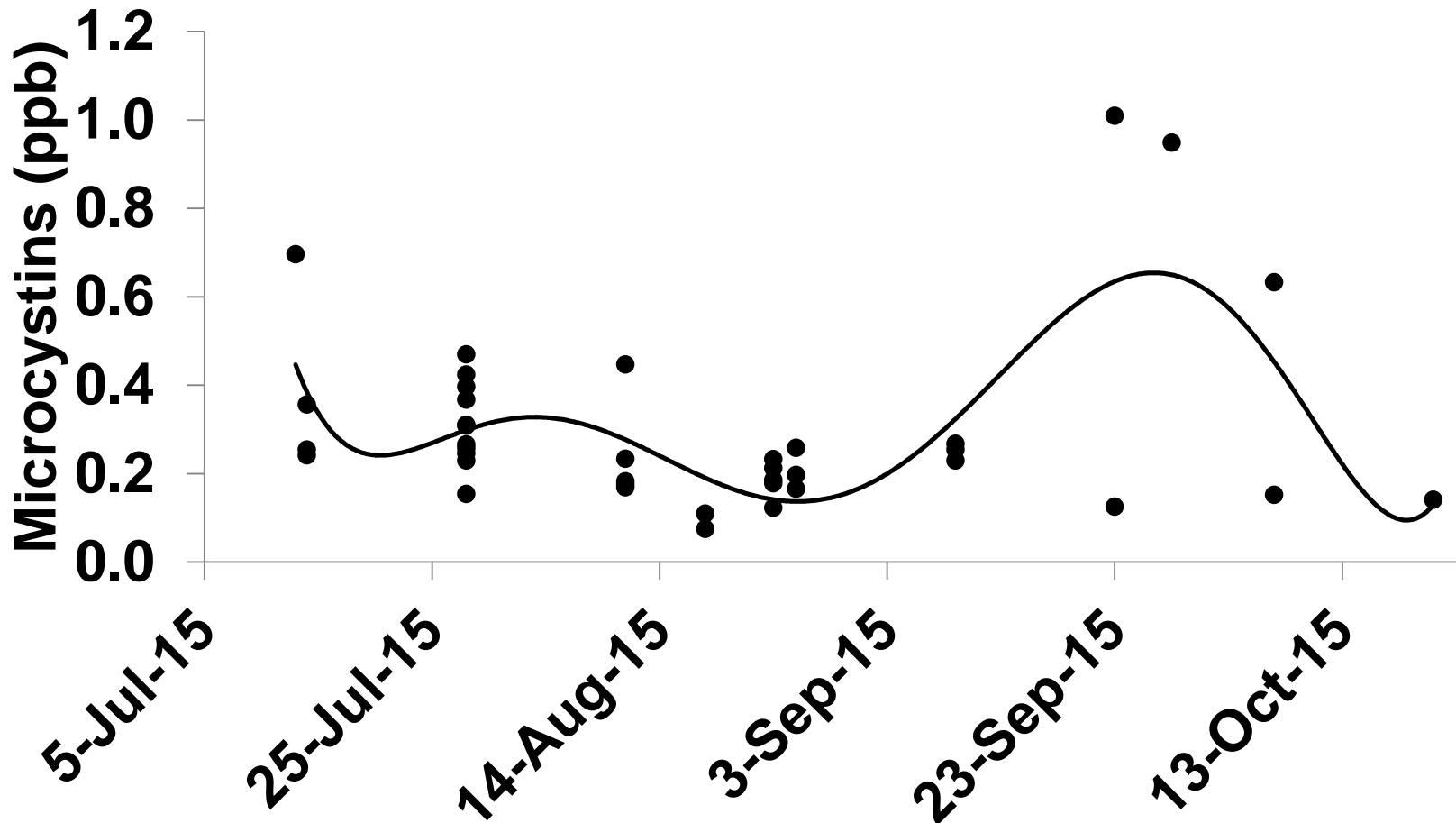
- Samples collected by ECCCC, DFO, Hastings Prince Edward Public Health
- **Not targeting bloom occurrences – scheduled**
- Shoreline and offshore sampling
- Analysis by ECCCC by LC-MS/MS

MC concentrations **below** HC DW and RW GL of 1.5 and 20 ppb

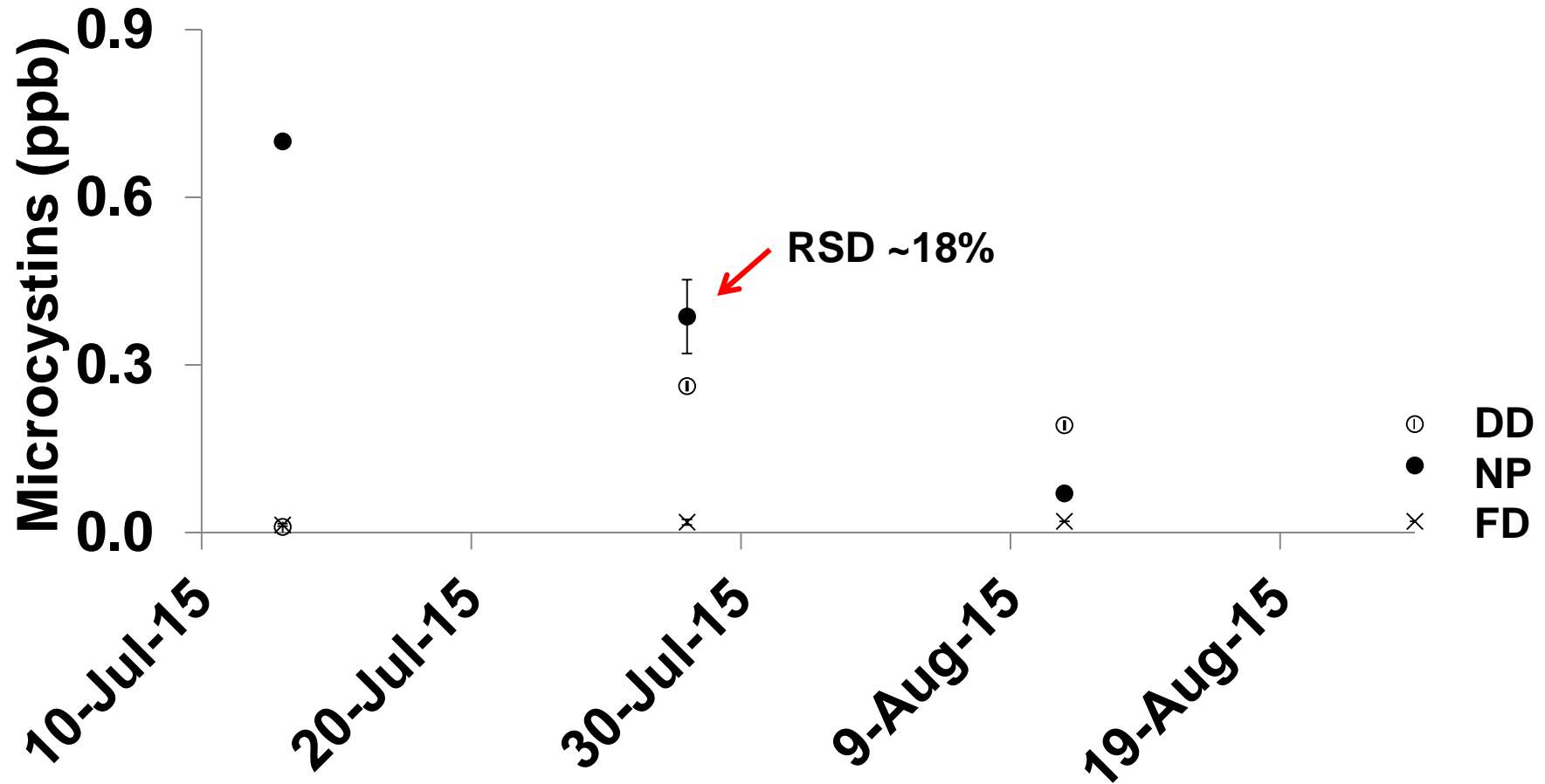


Seasonal changes in microcystins

– peak end of September



Low variability in concentration within shoreline transects



Variant composition

- Frequency of occurrence in toxic samples

- 87% LR

- 81% RR

- 65% LA

- 45% YR

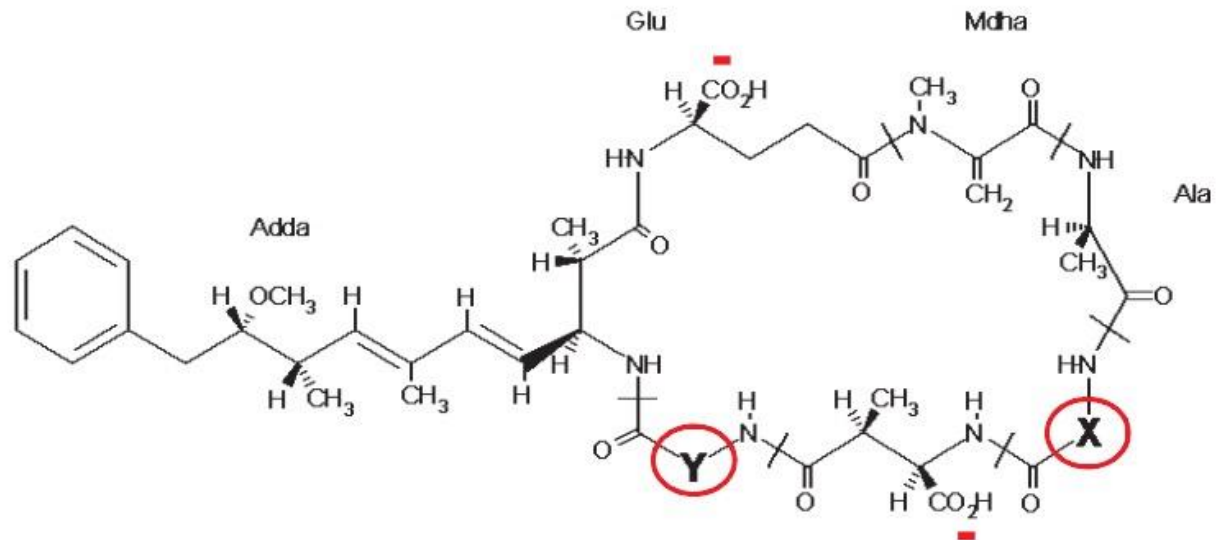
- 20% WR

- 9% LF

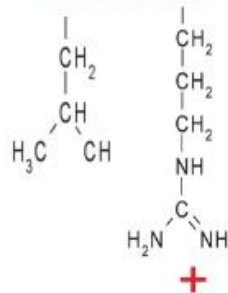
- 3% 7dmLR

- 1% LY

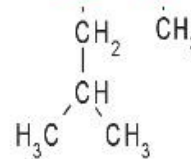
- 0% LW



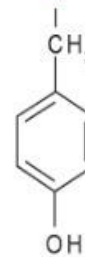
MC-LR



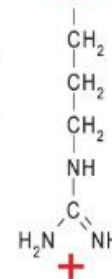
LA



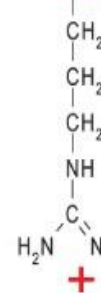
Y



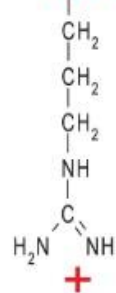
R



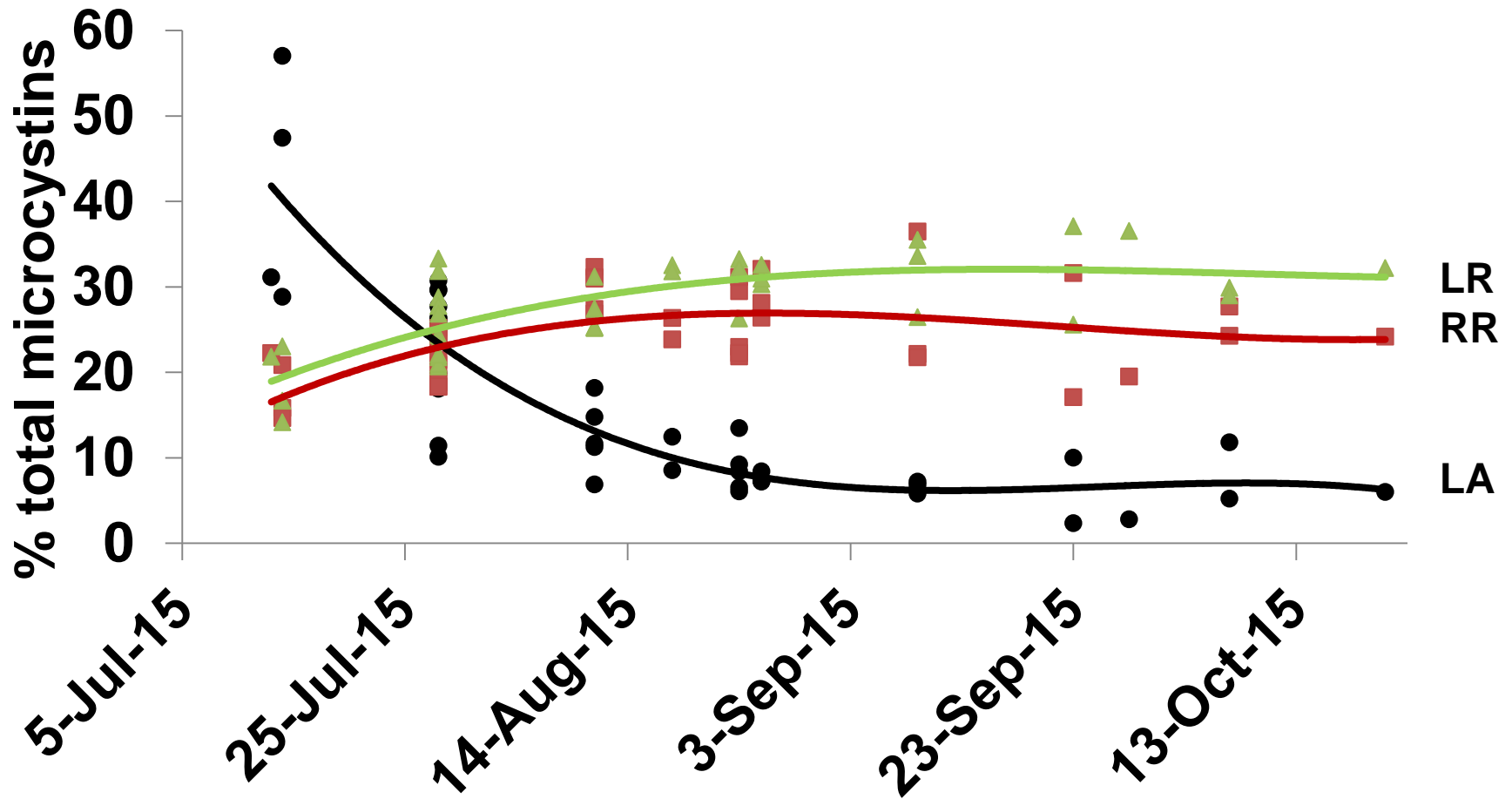
R



R



Seasonal dynamics of variants - all data



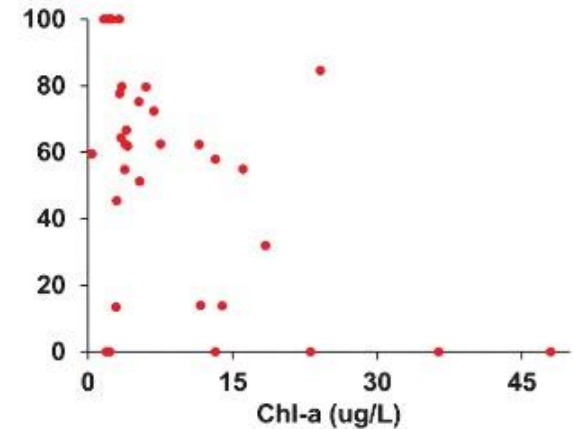
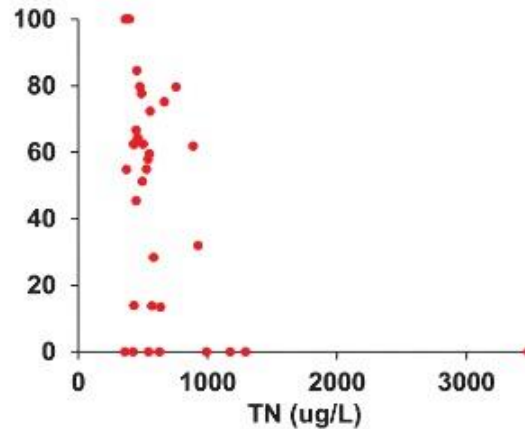
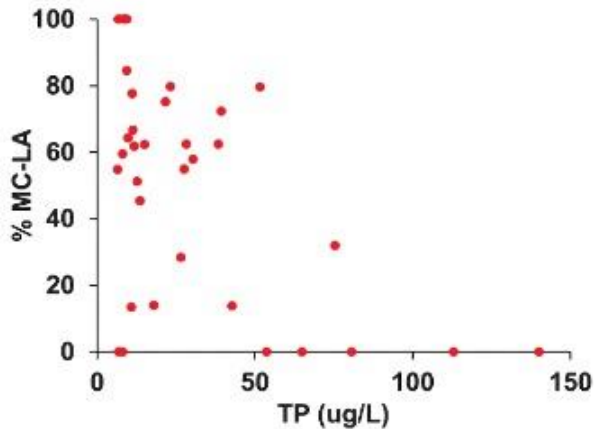
Over 90 variants known

| | MC-LA | MC-LR | MC-YR | MC-RR |
|--|----------|------------|----------|-----------|
| Molecular weight | 909 | 994 | 1044 | 1037 |
| Amino acid substituents | Leu, Ala | Leu, Arg | Tyr, Arg | Arg, Arg |
| % N (mass) | 10.78 | 14.08 | 13.40 | 17.54 |
| Net charge (pH 7) | - 2 | - 1 | - 1 | 0 |
| Hydrophobicity | ----- | decreasing | ----- | -- → |
| Toxicity (mouse bioassay LD ₅₀ µg/kg) | 20 - 50 | 50 - 90 | 70 - 100 | 200 - 800 |

MC-LA one of the most toxic variants

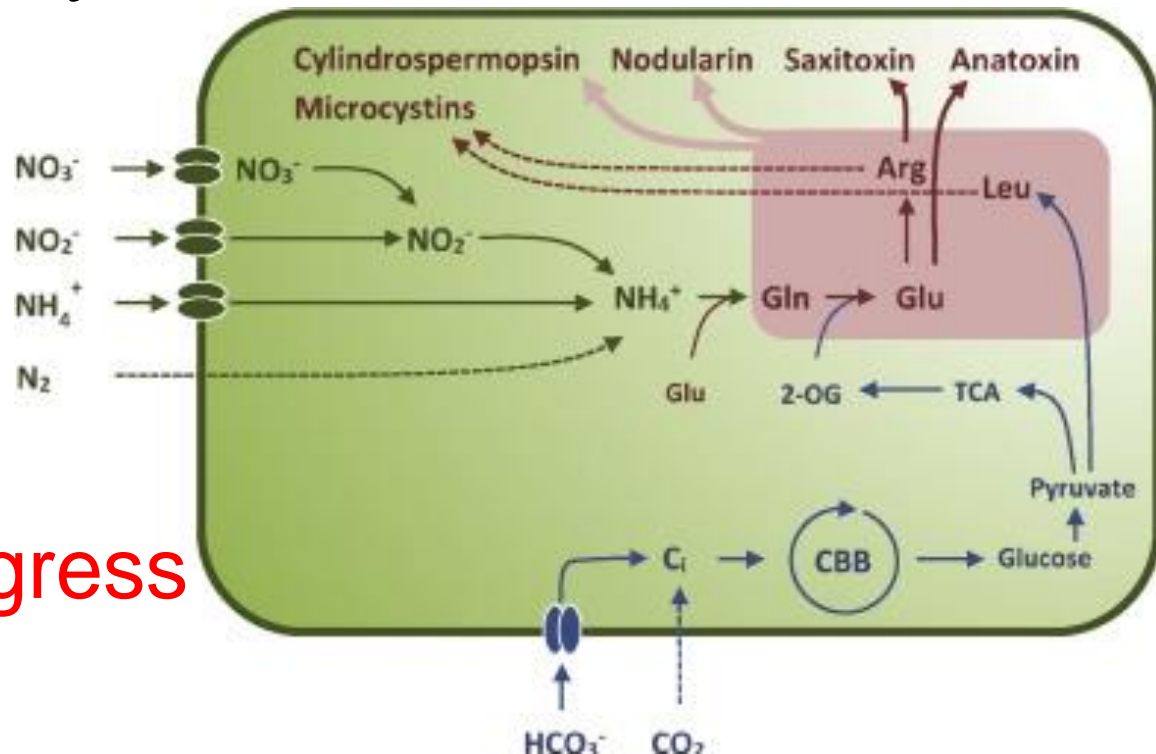
What drives variant composition?

- In Lake Erie, the **more toxic variant MC-LA** appears to dominate under **lower nutrient** conditions



What drives variant composition?

- Nutrient stoichiometry (C:N:P)?
- Nutrient forms (NH_4 , NO_3 , DON – urea)?
- Amino acid availability?
- Cell or community level? (Gobler et al. 2016)



- Analysis in progress

Cyanotoxin results 2015 - MOECC

- Samples collected by MOECC
- Response to reports of bloom occurrences
- Shorelines subjected to public use
- Analysis by MOECC by ELISA and LC-MS/MS

MC concentrations **above** HC DW and RW GL of 1.5 and 20 ppb

July 6th, 2015

August 26th, 2015

| | | | |
|--------------------------|------|--------------------------|------|
| desmethyilmicrocystin-RR | 4.9 | desmethyilmicrocystin-RR | 0.50 |
| Microcystin-RR | 39. | Microcystin-RR | 5.7 |
| Microcystin-LA | 130 | Microcystin-LA | 5.5 |
| desmethyilmicrocystin-LR | 28. | desmethyilmicrocystin-LR | 0.67 |
| Microcystin-LR | 190 | Microcystin-LR | 9.6 |
| Microcystin-LF | 0.20 | Microcystin-LF | 0.50 |
| Microcystin-LY | 1.4 | Microcystin-LY | 0.50 |
| Microcystin-HilR | 4.8 | Microcystin-HilR | 0.50 |
| Microcystin-LW | 0.20 | Microcystin-LW | 0.50 |
| Microcystin-YR | 15. | Microcystin-YR | 0.81 |
| Microcystin-HtyR | 2.0 | Microcystin-HtyR | 0.50 |
| Microcystin-WR | 7.9 | Microcystin-WR | 0.50 |

**Much higher concentrations during dates and at nearby similar to those monitored by ECCC –
targeted vs. non-targeted**

MC concentrations **above** HC DW and RW GL of 1.5 and 20 ppb

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| | | | |
|-------------------------|--------|-------------------------|------|
| desmethylmicrocystin-RR | 4.9 | desmethylmicrocystin-RR | 0.50 |
| Microcystin-RR | 39. | Microcystin-RR | 5.7 |
| Microcystin-LA | 130 | Microcystin-LA | 5.5 |
| desmethylmicrocystin-LR | 28. | desmethylmicrocystin-LR | 0.67 |
| Microcystin-LR | 190 | Microcystin-LR | 9.6 |
| Microcystin-LF | 0.20 | Microcystin-LF | 0.50 |
| Microcystin-LY | 1.4 | Microcystin-LY | 0.50 |
| Microcystin-HiLR | 4.8 | Microcystin-HiLR | 0.50 |
| Microcystin-LW | 0.20 | Microcystin-LW | 0.50 |
| Microcystin-YR | 15. | Microcystin-YR | 0.81 |
| Microcystin-HtyR | 2.0 | Microcystin-HtyR | 0.50 |
| Microcystin-WR | 7.9 | Microcystin-WR | 0.50 |
| Microcystins (total) | 1812.8 | Microcystins (total) | 14.6 |

| | | |
|-----------------|-----------|---------|
| LCMSMS ~420 ppb | ~420 ppb | ~27 ppb |
| ELISA | ~1800 ppb | ~15 ppb |

ELISA overestimates concentration by >4X → semi-quantitative only especially when scum/bloom or high DOM sample

Conclusions and recommendations

- Targeted and non-targeted approaches are both important in assessing prevalence and toxicity of harmful/toxic cyanobacterial proliferations
- No exceedance of HC DW and RW GLs of 1.5 ppb and 20 ppb unless notified by public to sample – important role for remote monitoring and educated citizens
- ELISAs are quick and easy but should only be used as a screening method rather than for quantitation

Conclusions and recommendations

- Peak toxicity at end of September
- Observed **change** in most prevalent microcystin **variant** over the **season**
 - More toxic variant present earlier
 - Suspected drivers are nutrient forms
- Within site transect variation minimal