Bigelow | Laboratory for Ocean Sciences

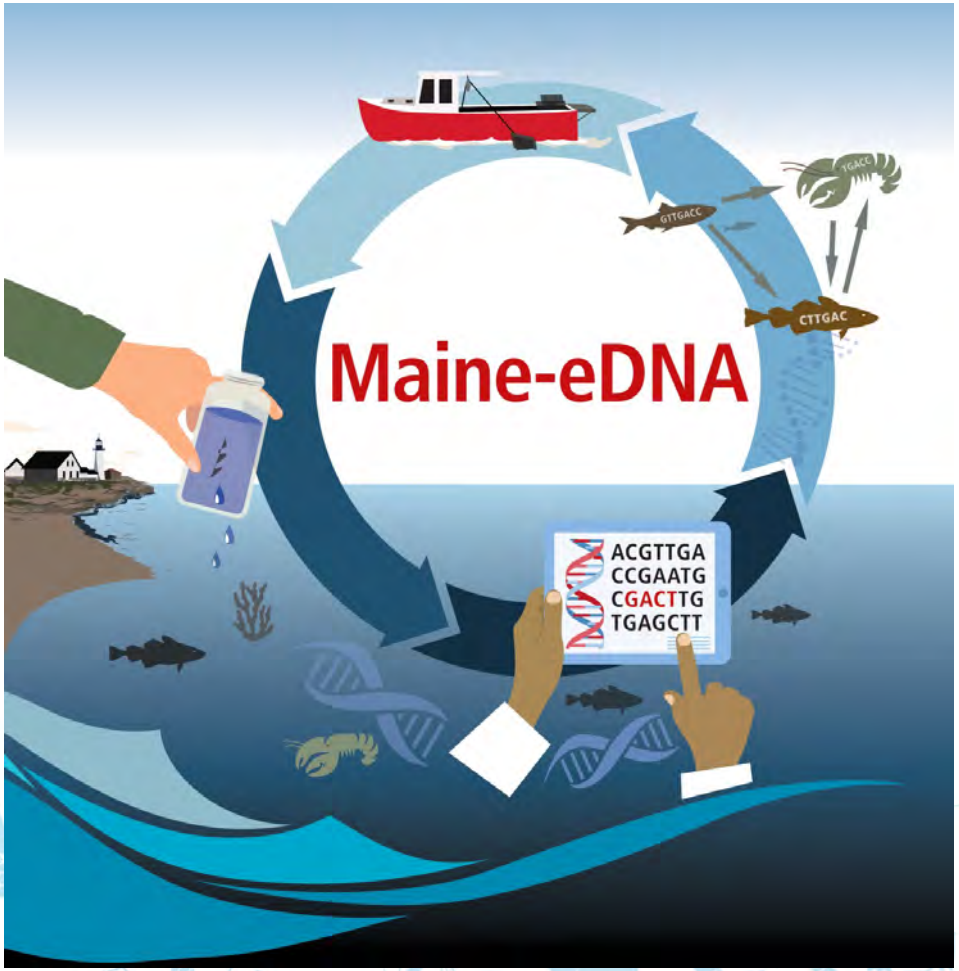
The distribution of toxic *Dolichospermum* strains across Maine

Robin Sleith and Pete Countway

Maine-eDNA

- Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine

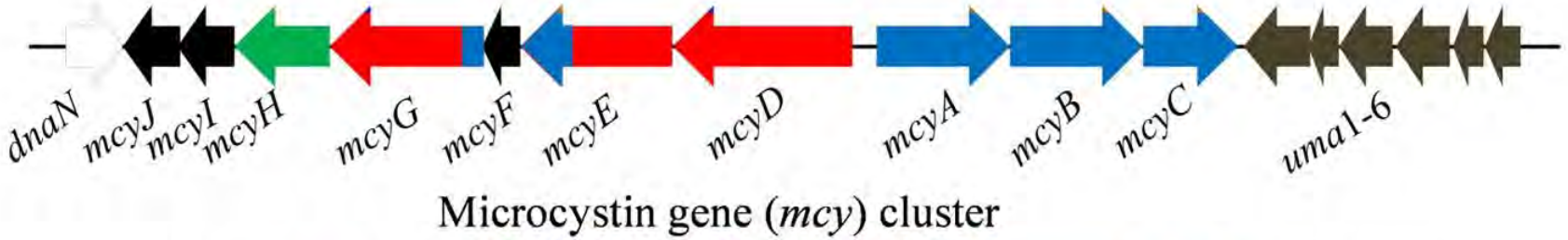
- A $20 million NSF EPSCoR Research Infrastructure Improvement Track-1 Award



Overview

- Toxin biosynthesis
- Toxic and non-toxic strains
- ddPCR of microcystin biosynthesis genes
- The road ahead

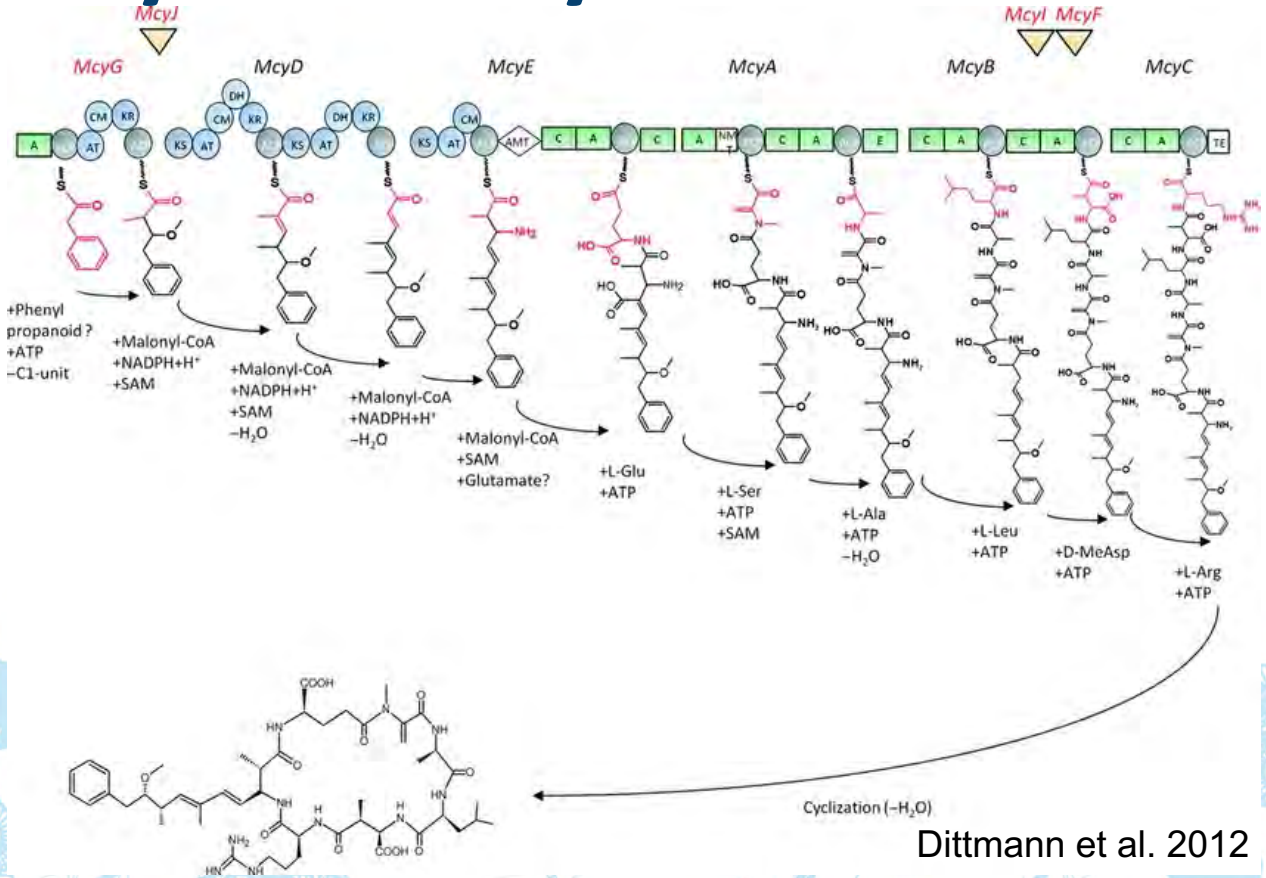
Microcystin biosynthesis



Microcystin gene (*mcy*) cluster

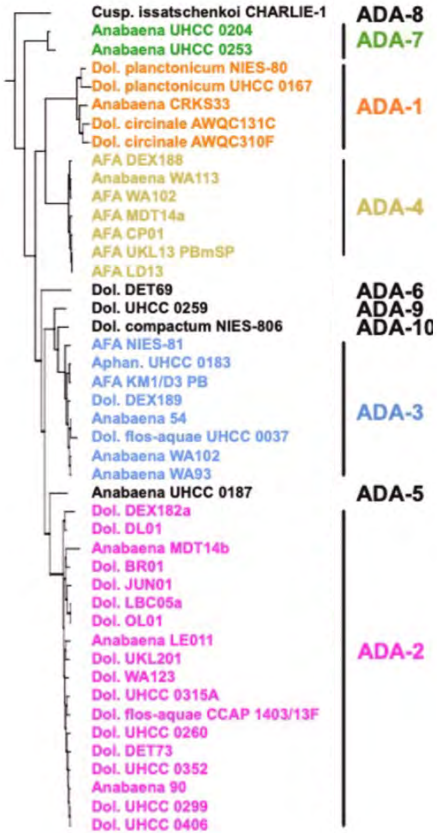
Rastogi et al. 2015

Microcystin Biosynthesis



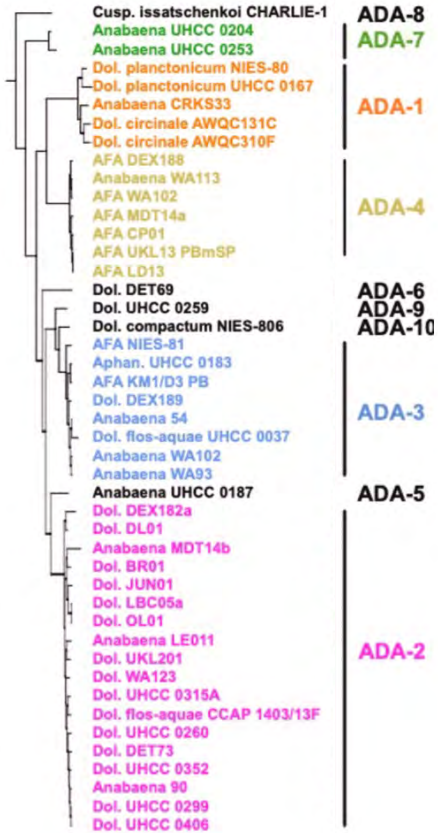
Dittmann et al. 2012

Toxic strains of *Dolichospermum*



Dreher et al. 2021

Toxic strains of *Dolichospermum*



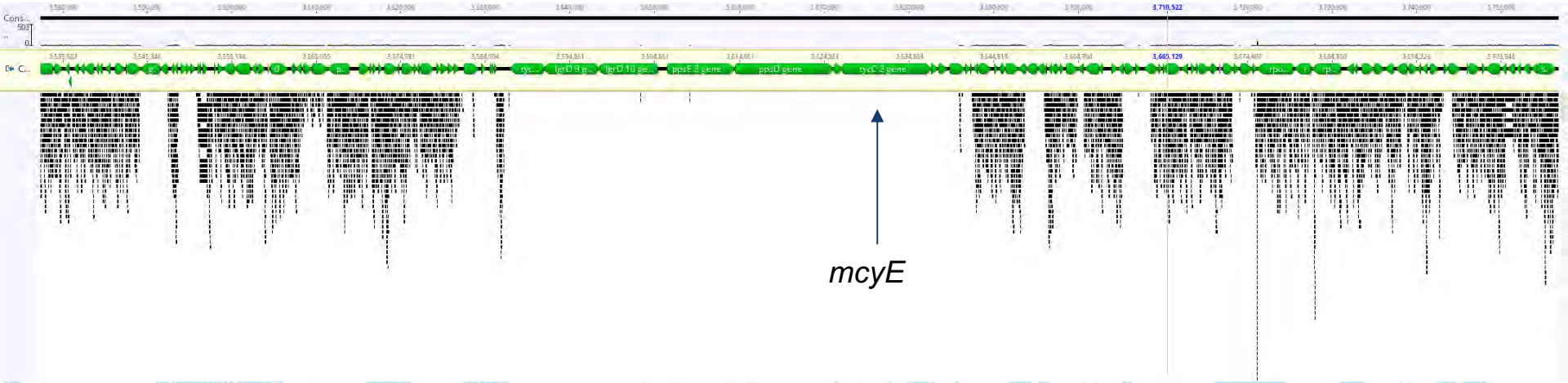
Damariscotta Lake
China Lake
North Pond

Damariscotta Lake
Little Dyer Pond
China Lake
North Pond
Lake Winnipesaukee

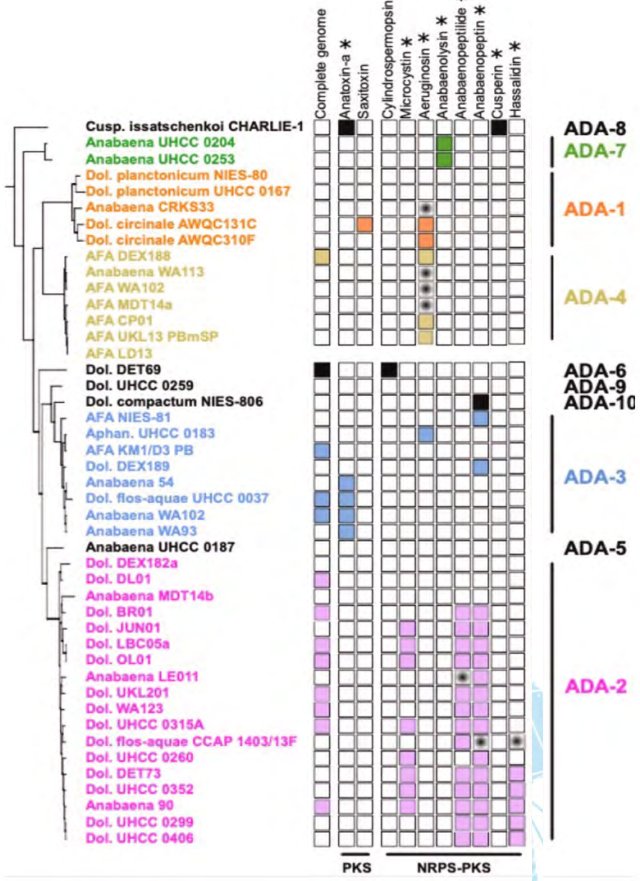
Dreher et al. 2021

Toxic strains of *Dolichospermum*

- Damariscotta Lake *Dolichospermum* lack microcystin biosynthesis pathway

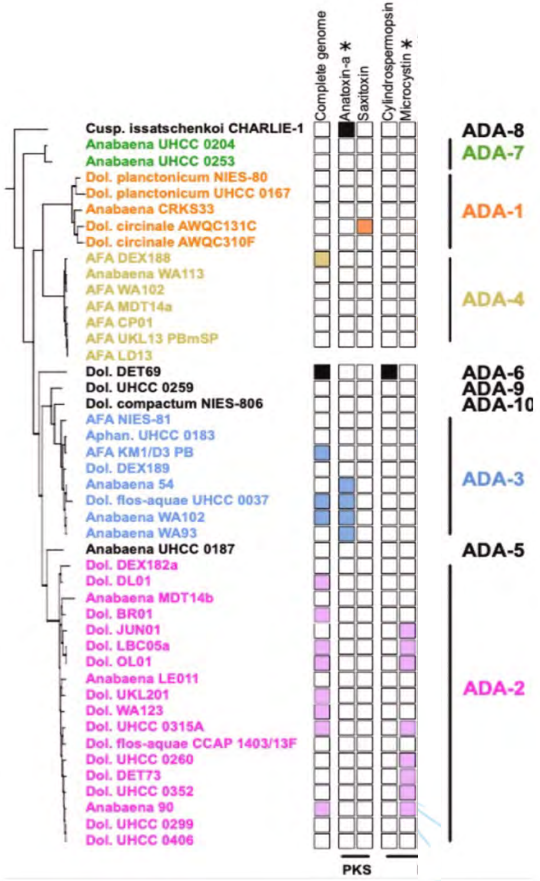


Toxic strains of *Dolichospermum*



Dreher et al. 2021

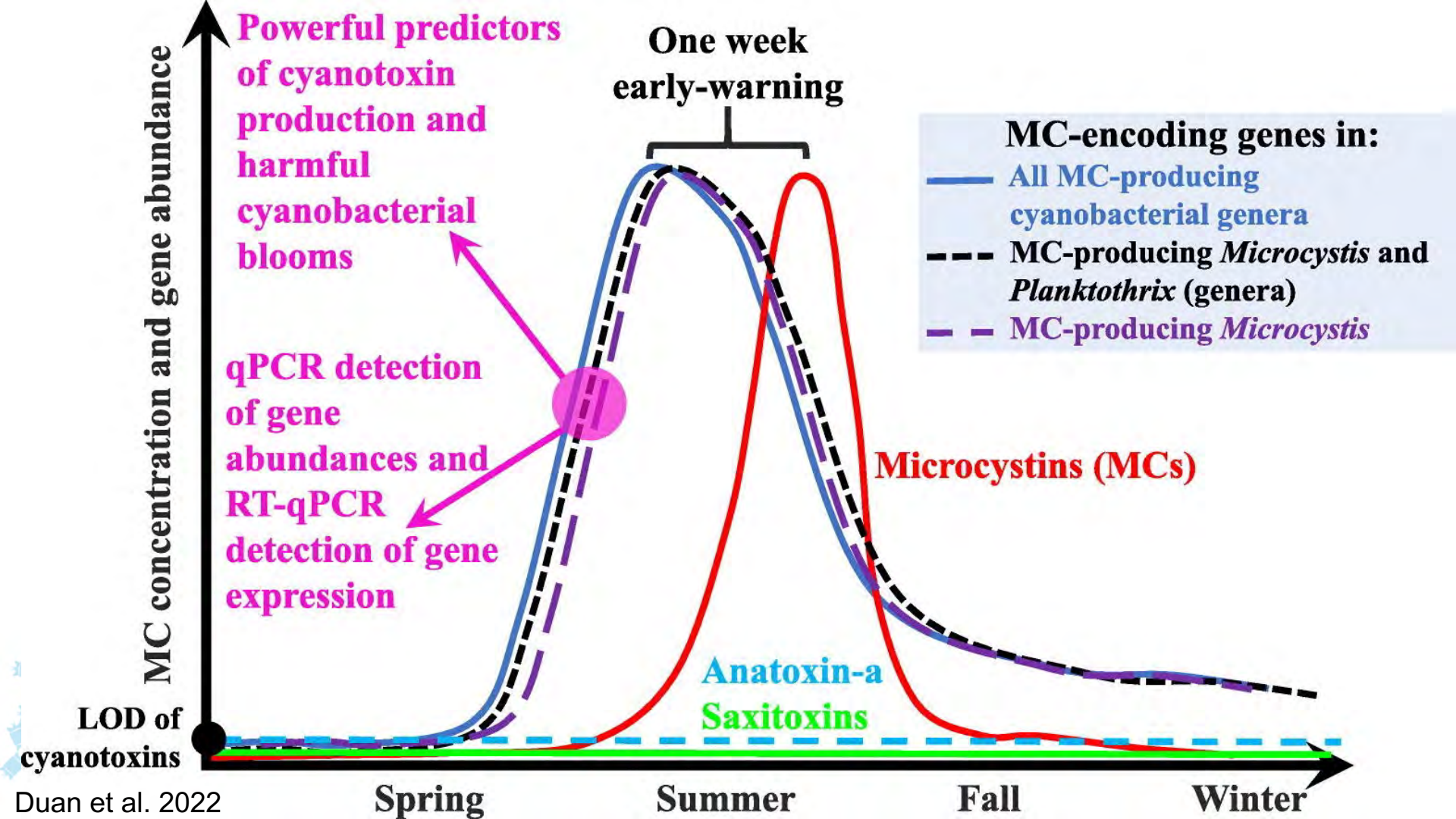
Toxic strains of *Dolichospermum*



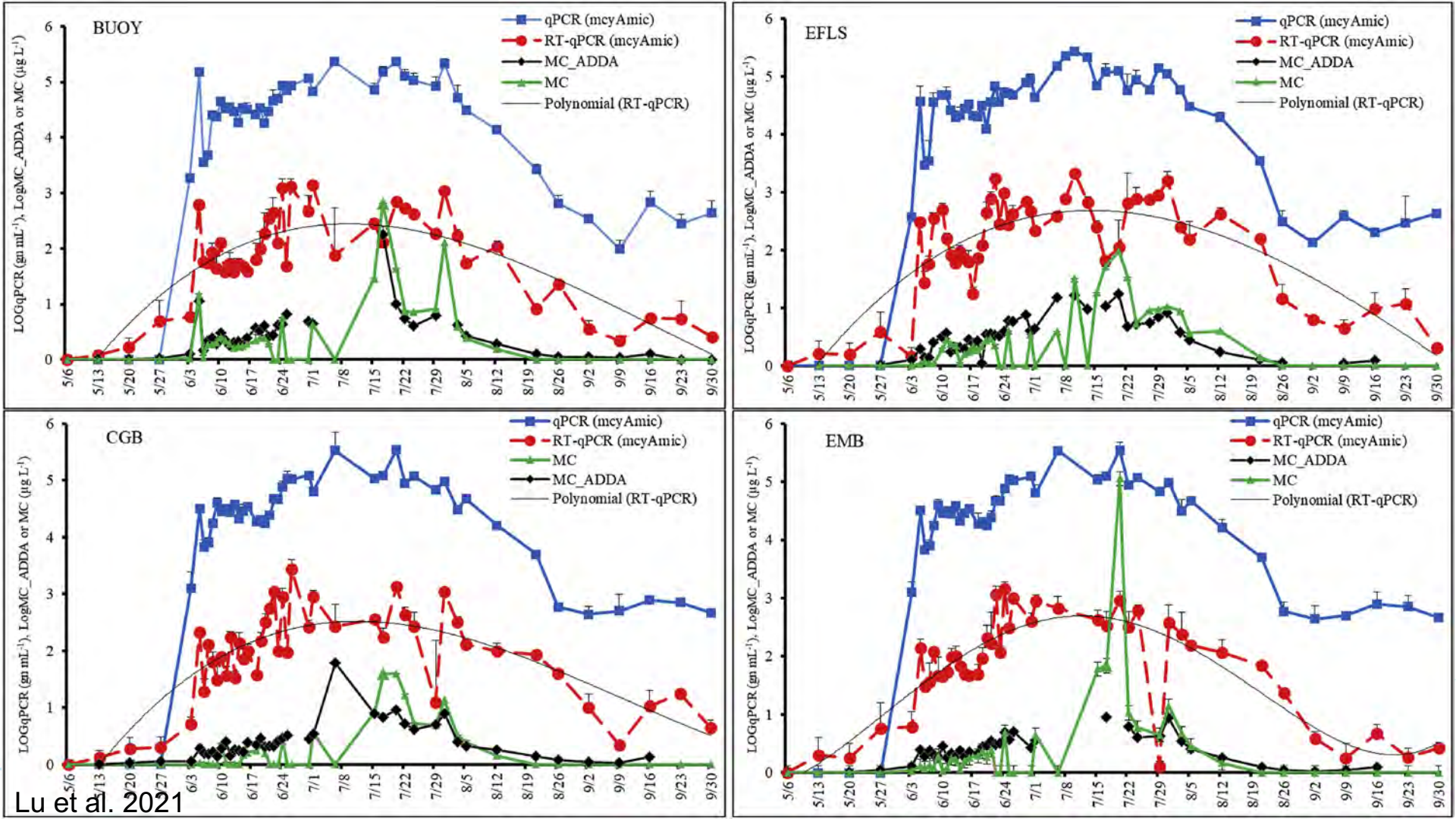
Dreher et al. 2021

Toxin genes as sentinels of change

- Primers and probes target key biosynthesis gene (e.g. *mcyE*)
- qPCR, ddPCR, RT-qPCR techniques track gene or transcript abundance over time



Duan et al. 2022


BUOY
EFLS
CGB
EMB
qPCR (mcyAmic)
RT-qPCR (mcyAmic)
MC_ADDA
MC
Polynomial (RT-qPCR)
LOGqPCR (gn mL-1), LogMC_ADDA or MC (µg L-1)
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
9/2
9/9
9/16
9/23
9/30

Lu et al. 2021

Toxin genes as sentinels of change

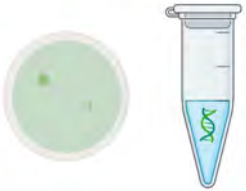
- To link gene abundance to toxicity can be a challenge
  - Frequent sampling
  - Likely different lag times and patterns based on local conditions
- Toxin gene presence/abundance nevertheless an important piece of the HABS puzzle
- Species level resolution important as mitigation strategies are often species specific!

Maine *mcyE* gene abundances

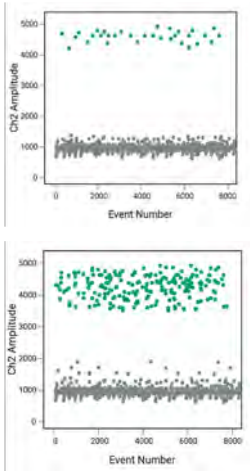
- 50 samples (triplicate filters) from lakes across Maine provided by Linda Bacon
- Qiagen PowerWater extractions
- Duplex ddPCR targeting *mcyE* in *Microcystis* and *Anabaena/Dolichospermum* (ADA2) from Ngwa et al. (2013)

Step 1: Collect a water sample

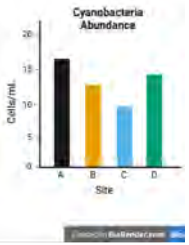
Step 2: Filter the water sample



Step 3: Extract DNA from filter

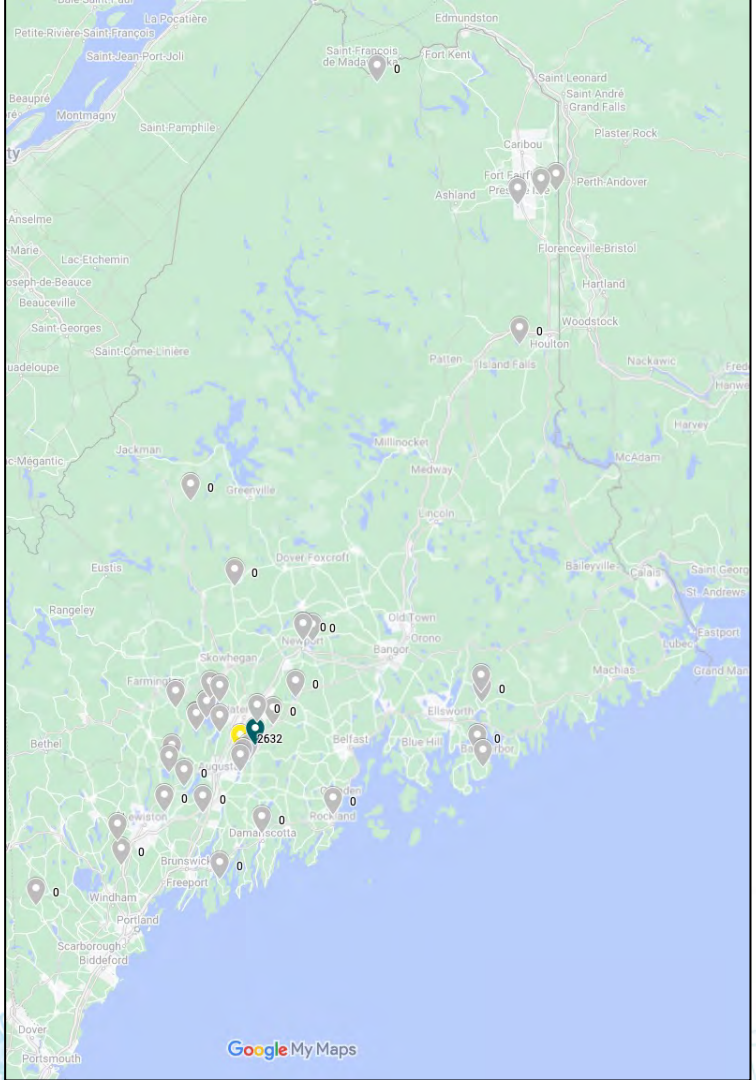


Step 4: Run ddPCR

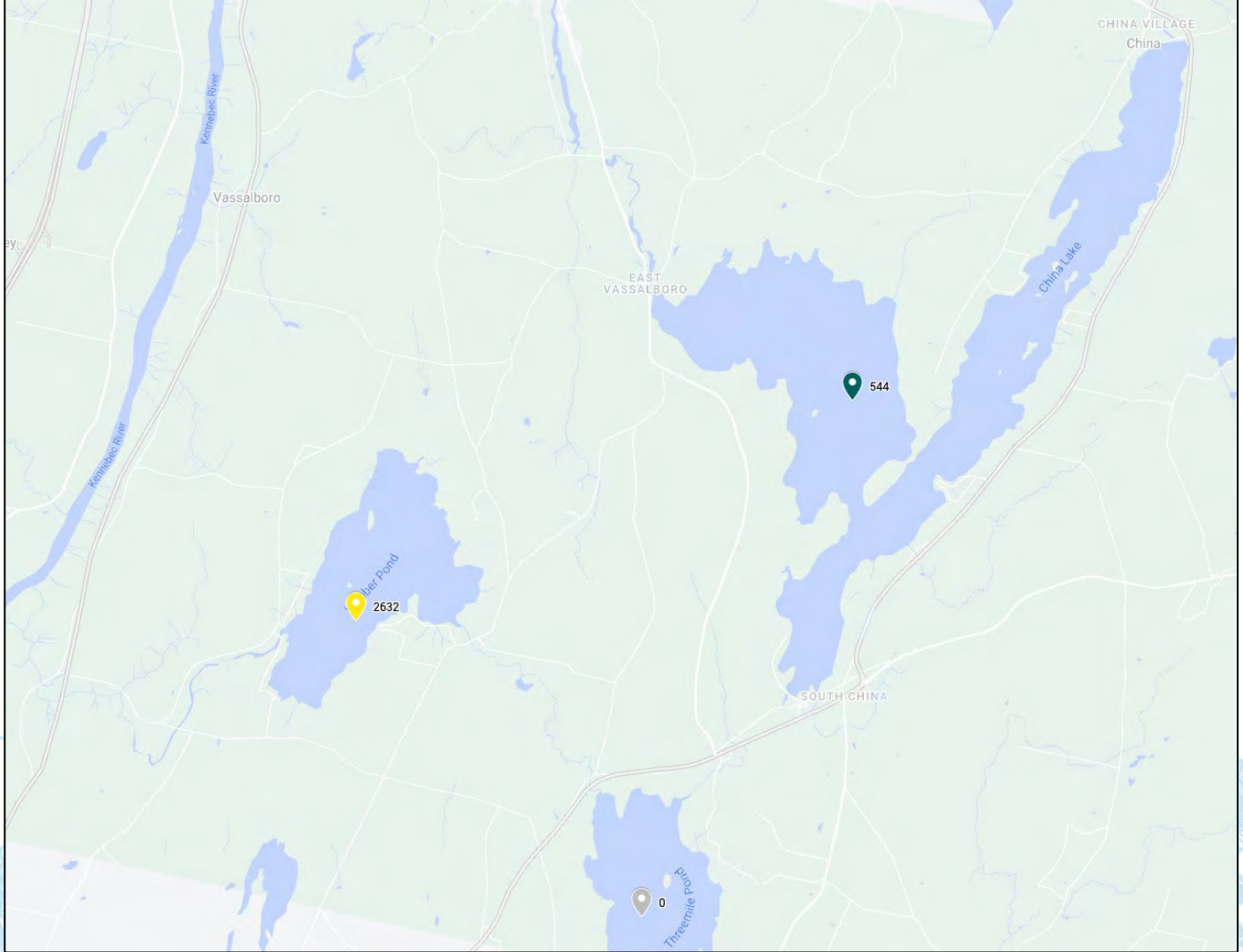


Step 5: Convert output to abundance

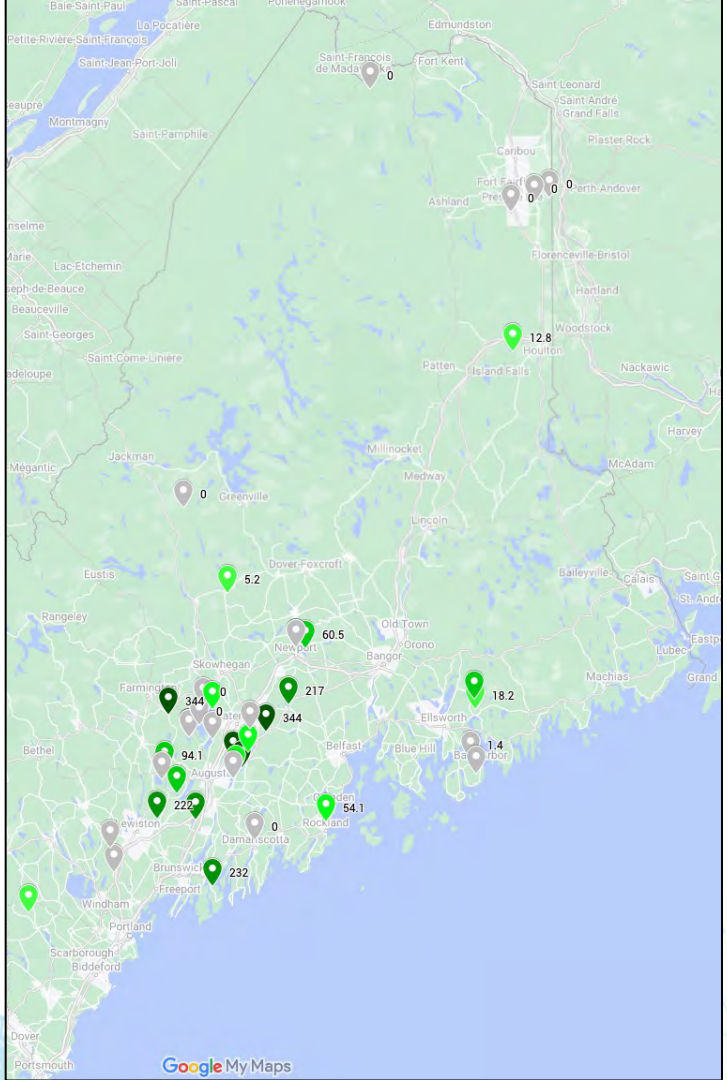
ADA-2 *mcyE*

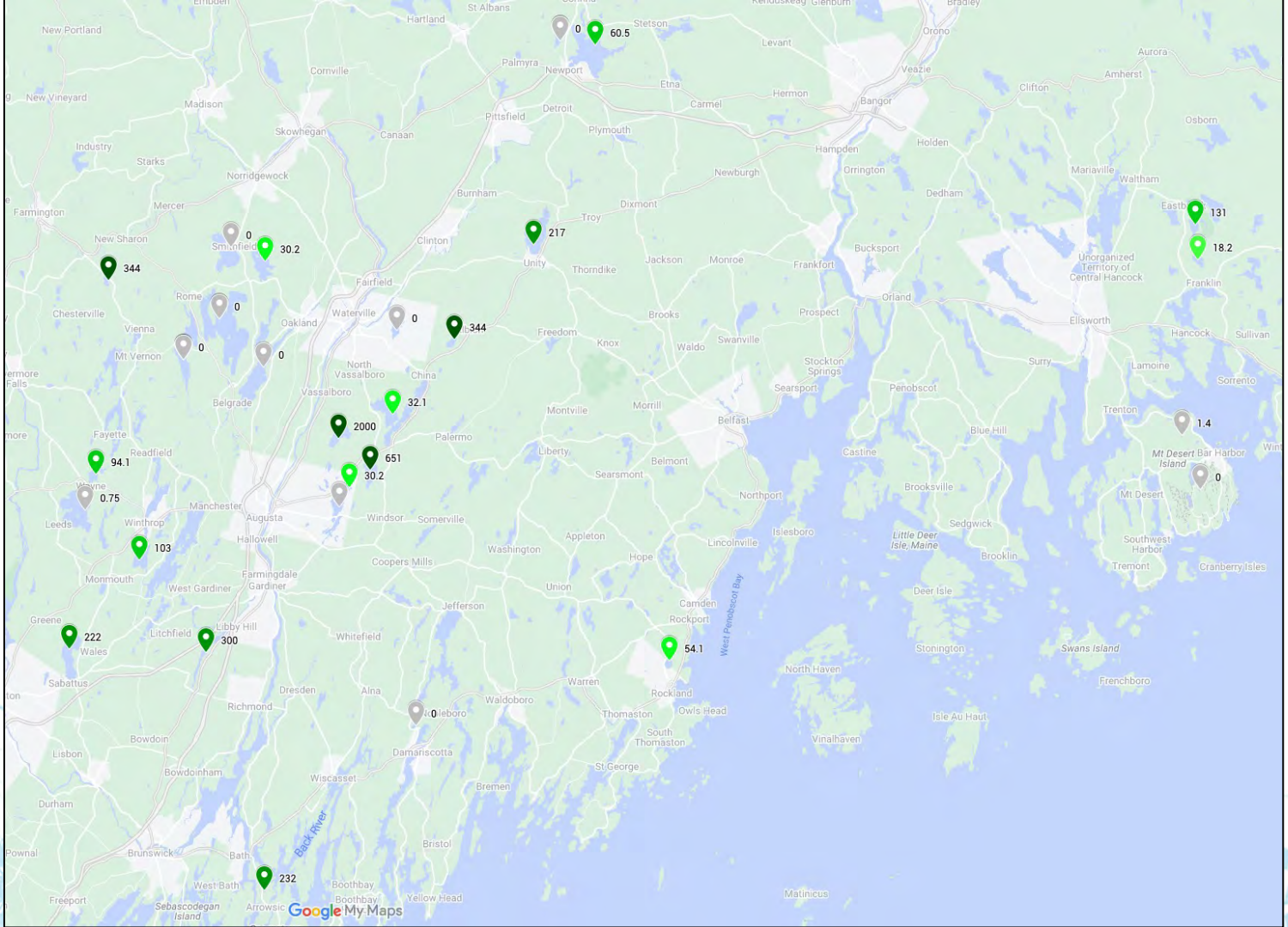

Edmundston
Saint-Jean-Port-Joli
Petite-Rivière-Saint-François
Montmagny
Saint-Pamphile
Fort Kent
Saint Leonard
Grand Falls
Plaster Rock
Caribou
Perth-Andover
Ashland
Florenceville-Bristol
Hartland
Woodstock
Houlton
Patten
Island Falls
Nackawic
Millinocket
Medway
McAdam
Harvey
Jackman
Greenville
Lincoln
Dover-Foxcroft
Eustis
Rangeley
Old Town
Orono
Bangor
Skowhegan
Ellsworth
Blue Hill
Belfast
Machias
Eastport
Bethel
Rockland
Brunswick
Freeport
Windham
Portland
Scarborough
Biddeford
Dover
Portsmouth
2632
Google My Maps

ADA-2 *mcyE*


CHINA VILLAGE
China
Kennebec River
Vassalboro
EAST
VASSALBORO
China Lake
544
Kennebec River
2632
SOUTH CHINA
0
Threemile Pond

Microcystis mcyE




0
60.5
0
30.2
344
0
0
0
0
344
217
131
18.2
32.1
2000
651
30.2
94.1
0.75
103
222
300
54.1
1.4
0
0
232
Google My Maps

Conclusions and next steps

- Toxic ADA-2 distribution extremely limited, why?
- Toxic *Microcystis* widespread, is toxicity widespread, Linda?
- What controls the distributions of toxic genotypes?

Acknowledgements

Pete Countway

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