Department of Environment and Resource Management

Cyanobacteria: their impact on Queensland's water security and aquatic ecosystems

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Queensland Government

Cyanobacteria in Queensland

- HABs are common seasonal phenomena occurring throughout Queensland in both fresh and coastal marine waters.
- Typically cyanobacterial blooms have been associated with:
  - reservoirs and weir pools
  - riverine reaches and waterholes (no or low flow periods)
  - farm dams
  - recreational and ornamental lakes and ponds
  - marine and estuarine systems

Toxicogenic cyanobacteria known from Queensland waters

Cylindrospermopsin	Lyngbya toxins
Aphanizomenon ovalisporum *Cylindrospermopsis raciborskii* *Lyngbya wollei*	*Lyngbya majuscula*
PSPs	Microcystins
Anabaena circinalis	*Microcystis aeruginosa*
Nodularin	*Microcystis panniformis*?
Nodularia spumigena	

Qld Harmful Algal Bloom Response Plan

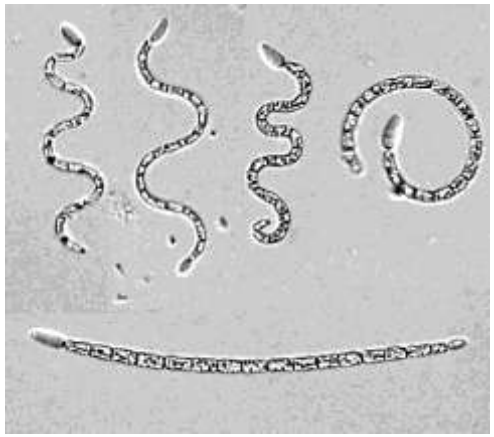
- The HAB Plan outlines the Queensland Government's contingency plan for responding to HAB incidents.
- Coordinates the roles of the various state agencies (4 departments), local government, and water storage operators.
- Water storage operators have traditionally taken the lead role in monitoring and management of CyanoHABS

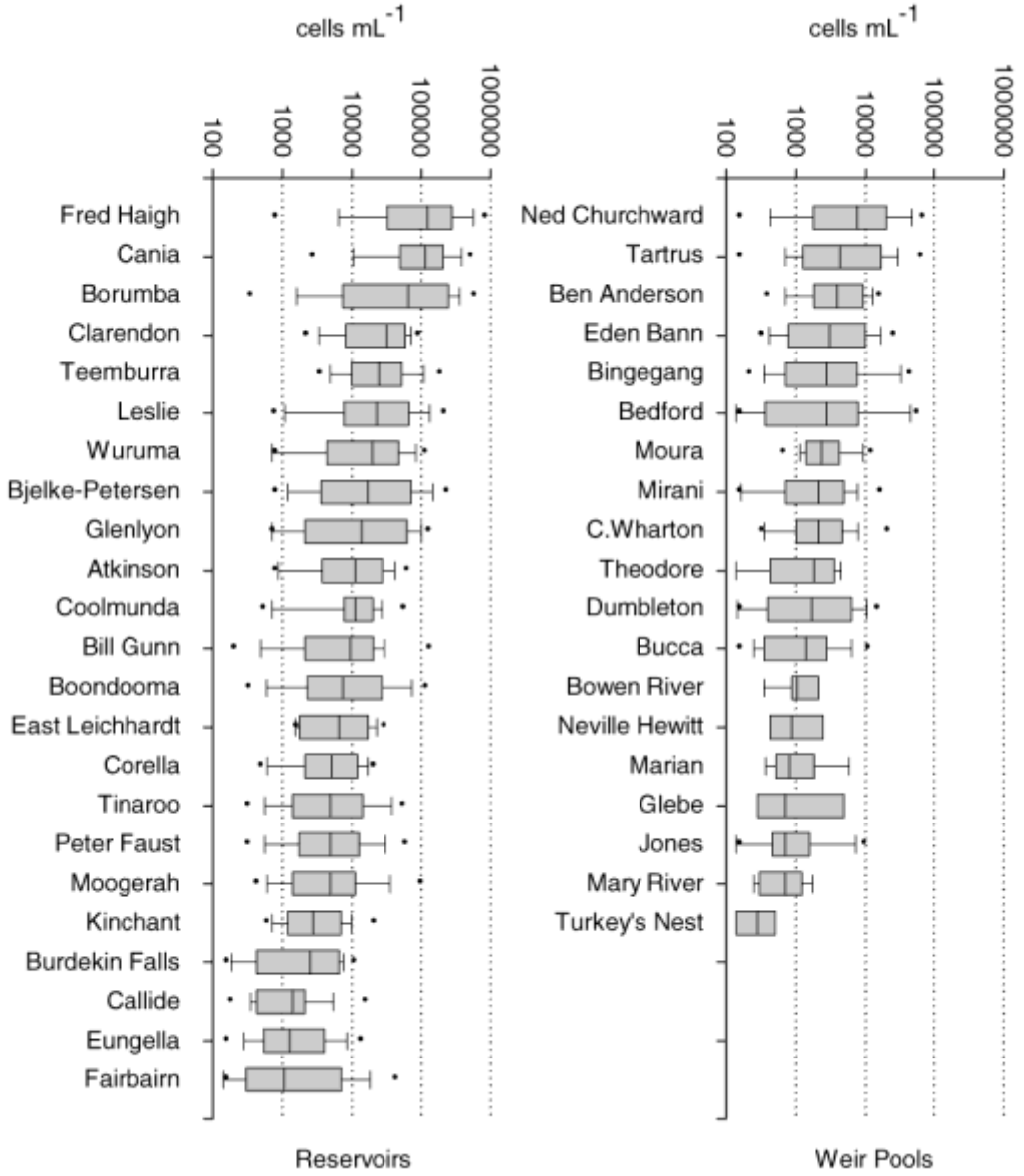
Cylindrospermopsis raciborskii

- Most common and widespread toxicogenic freshwater planktonic cyanobacteria in Queensland
- Distribution
- Spatial and temporal variability
- Long-term temporal variability

C. raciborskii - Distribution

- *Cylindrospermopsis raciborskii* is widespread throughout Queensland including sub-tropical and tropical regions – recorded in 54 of the 69 reservoirs monitored
- Cell concentrations are generally an order of magnitude higher in reservoirs than in weir pools

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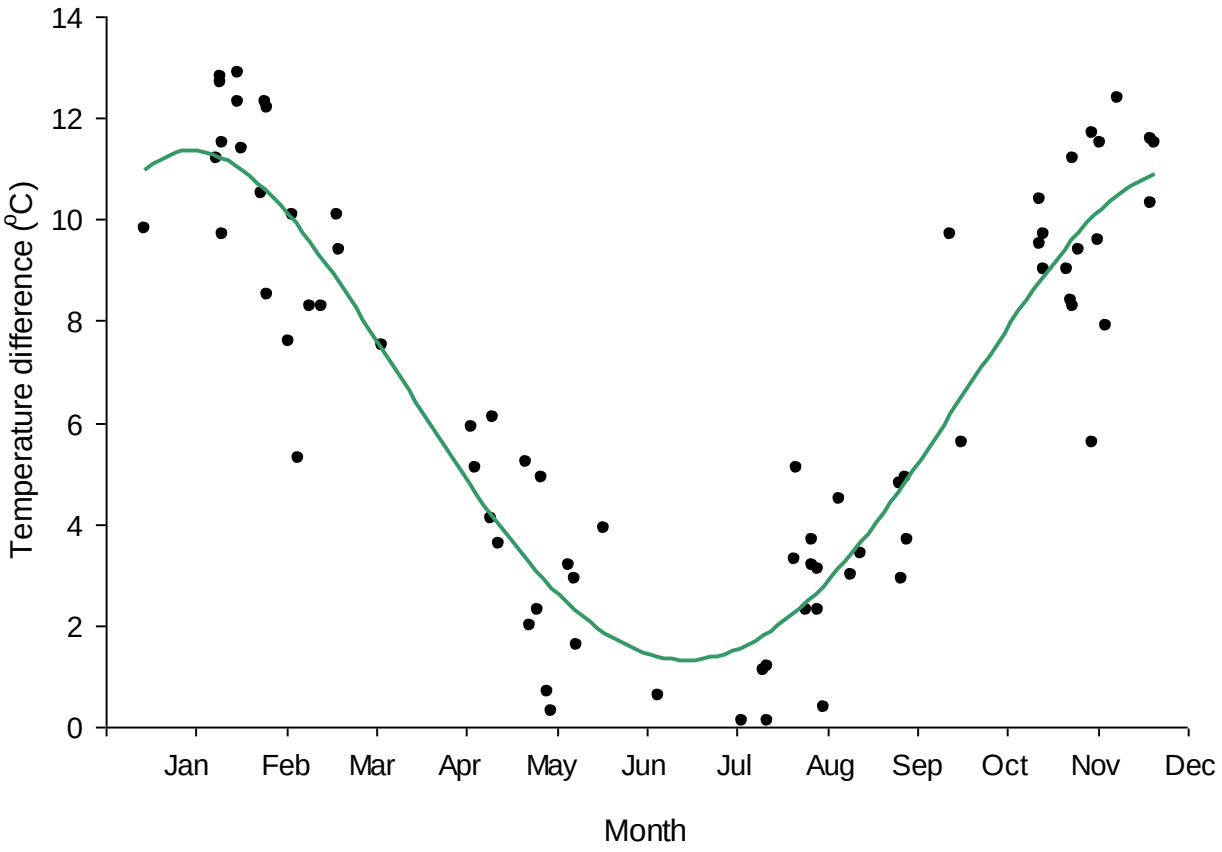
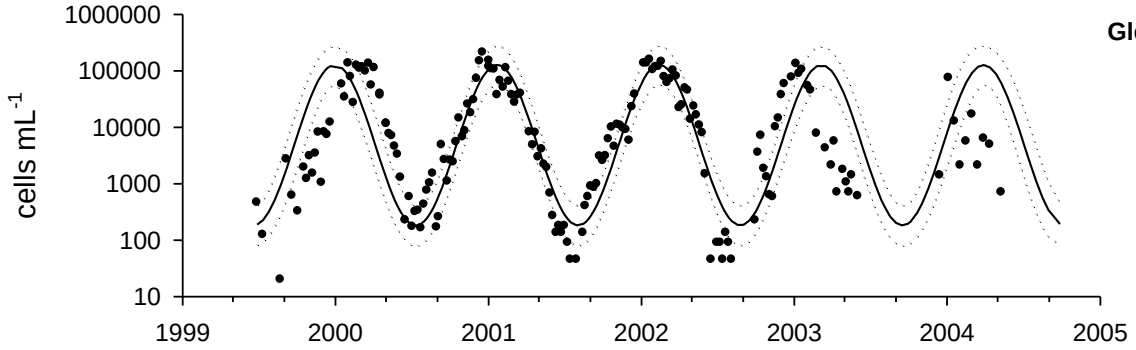
10000
100000
1000000
Fred Haigh
Cania
Borumba
Clarendon
Teemburra
Leslie
Wuruma
Bjelke-Petersen
Glenlyon
Atkinson
Coolmunda
Bill Gunn
Boondooma
East Leichhardt
Corella
Tinaroo
Peter Faust
Moogerah
Kinchant
Burdekin Falls
Callide
Eungella
Fairbairn
Reservoirs
cells mL-1
100
1000
10000
100000
1000000
Ned Churchward
Tartrus
Ben Anderson
Eden Bann
Bingegang
Bedford
Moura
Mirani
C.Wharton
Theodore
Dumbleton
Bucca
Bowen River
Neville Hewitt
Marian
Glebe
Jones
Mary River
Turkey's Nest
Weir Pools

C. raciborskii - Temporal variation

- *Cylindrospermopsis raciborskii* shows a marked seasonal pattern of abundance in all the reservoirs, however in general this is less pronounced in weir pools
- Seasonal pattern tracks the annual reservoir stratification

Summary of 8 reservoirs seasonal thermal stratification pattern

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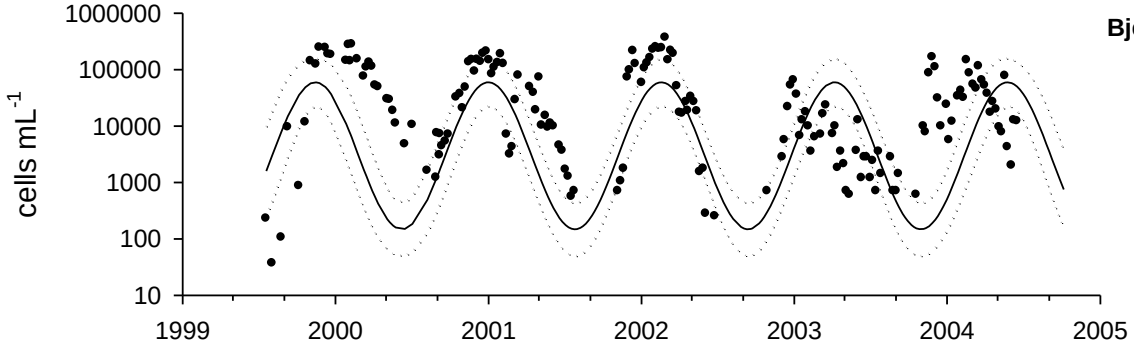
2005


Bjelke-Petersen
cells mL-1
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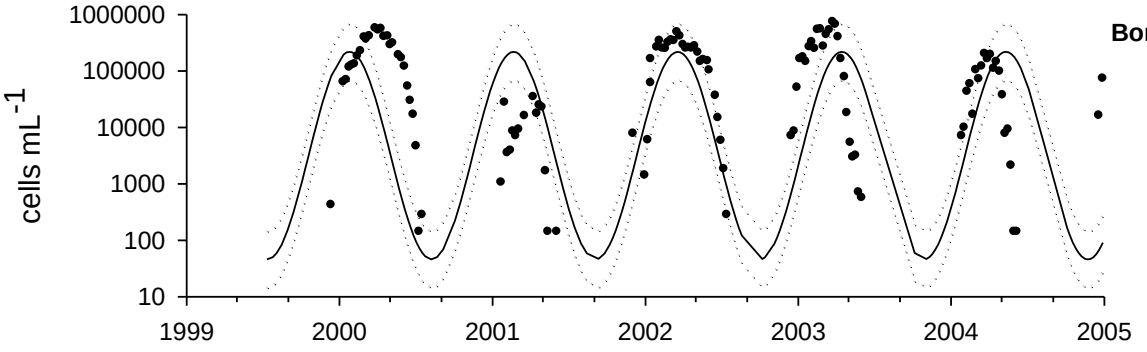
Borumba
cells mL-1
1000000
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100
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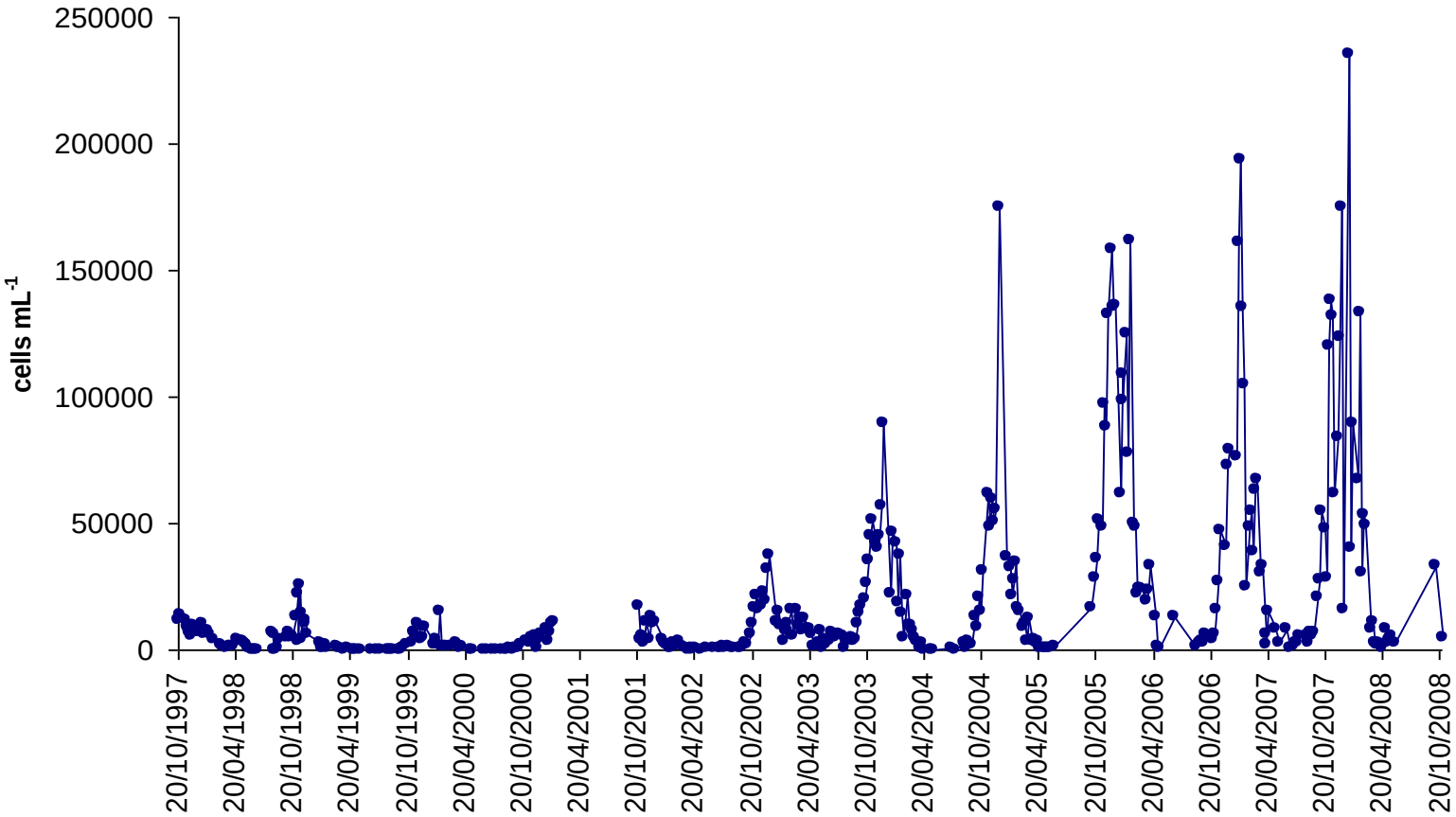
1999
2000
2001
2002
2003
2004
2005

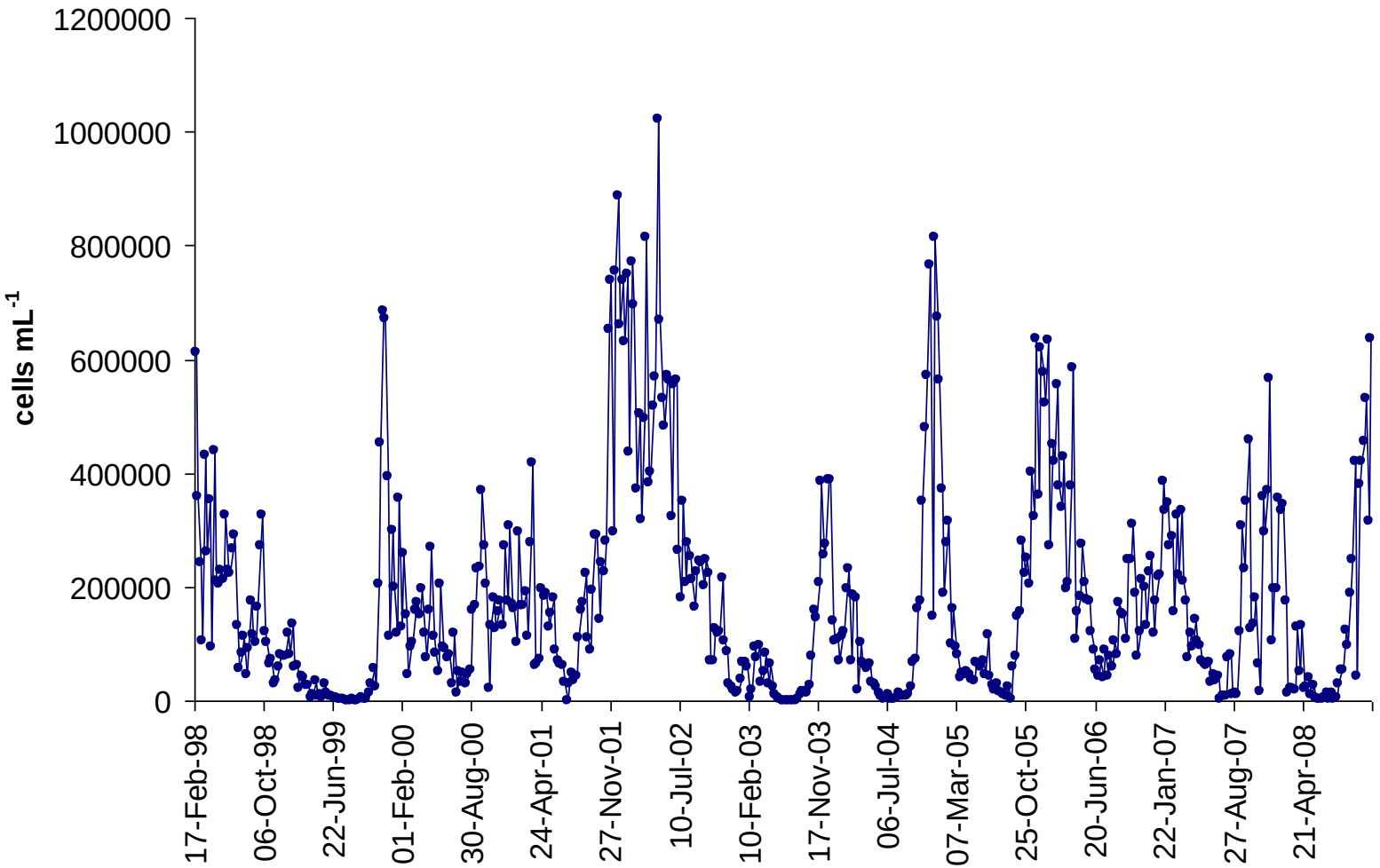
C. raciborskii - Long term temporal variability

- Has there been a change in the magnitude, frequency, timing and duration of *Cylindrospermopsis raciborskii* blooms in Queensland over the past 10 years?
- Reservoirs from north, central, south-east, and southern Queensland

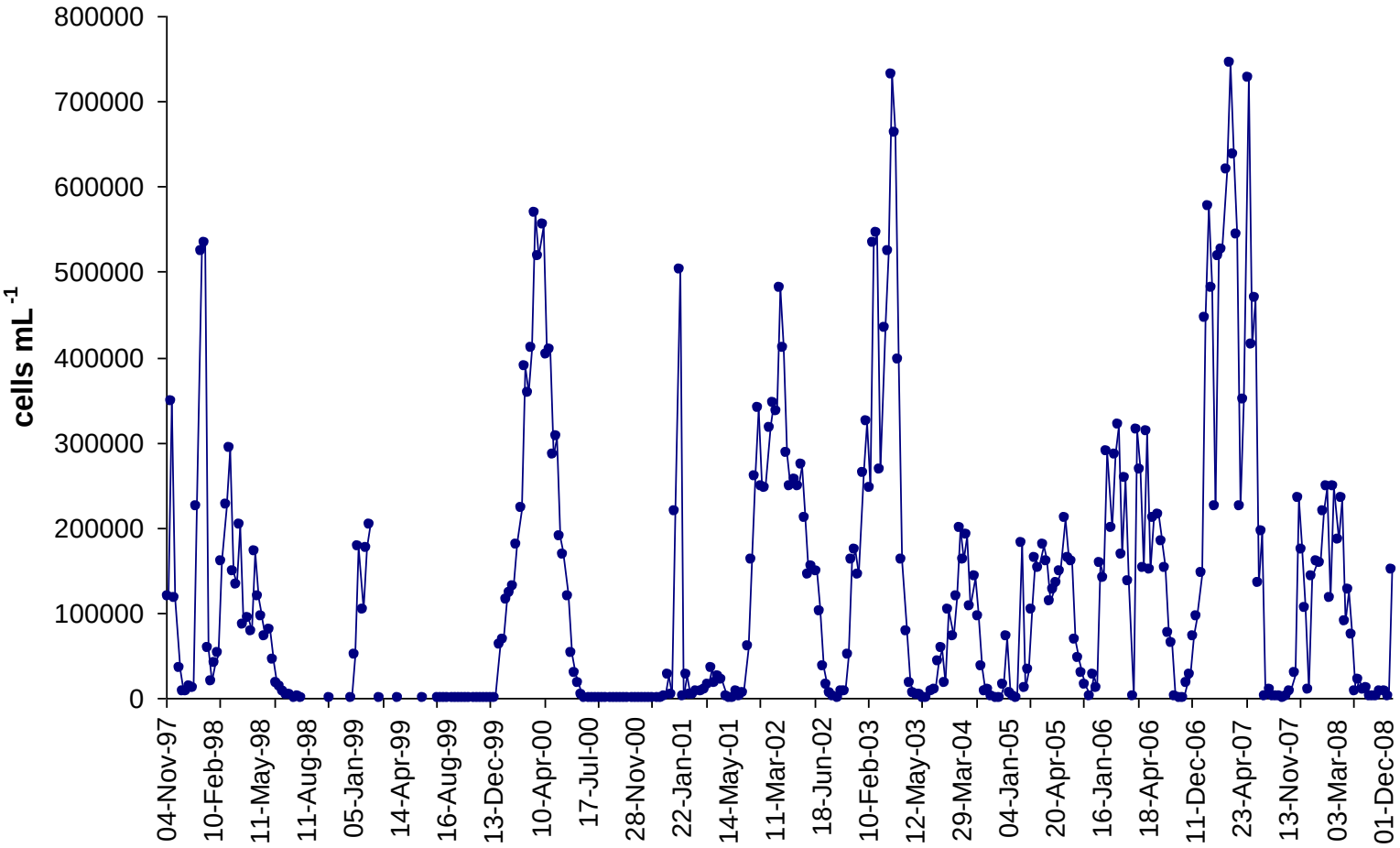
Tinaroo Falls Dam – Northern Qld



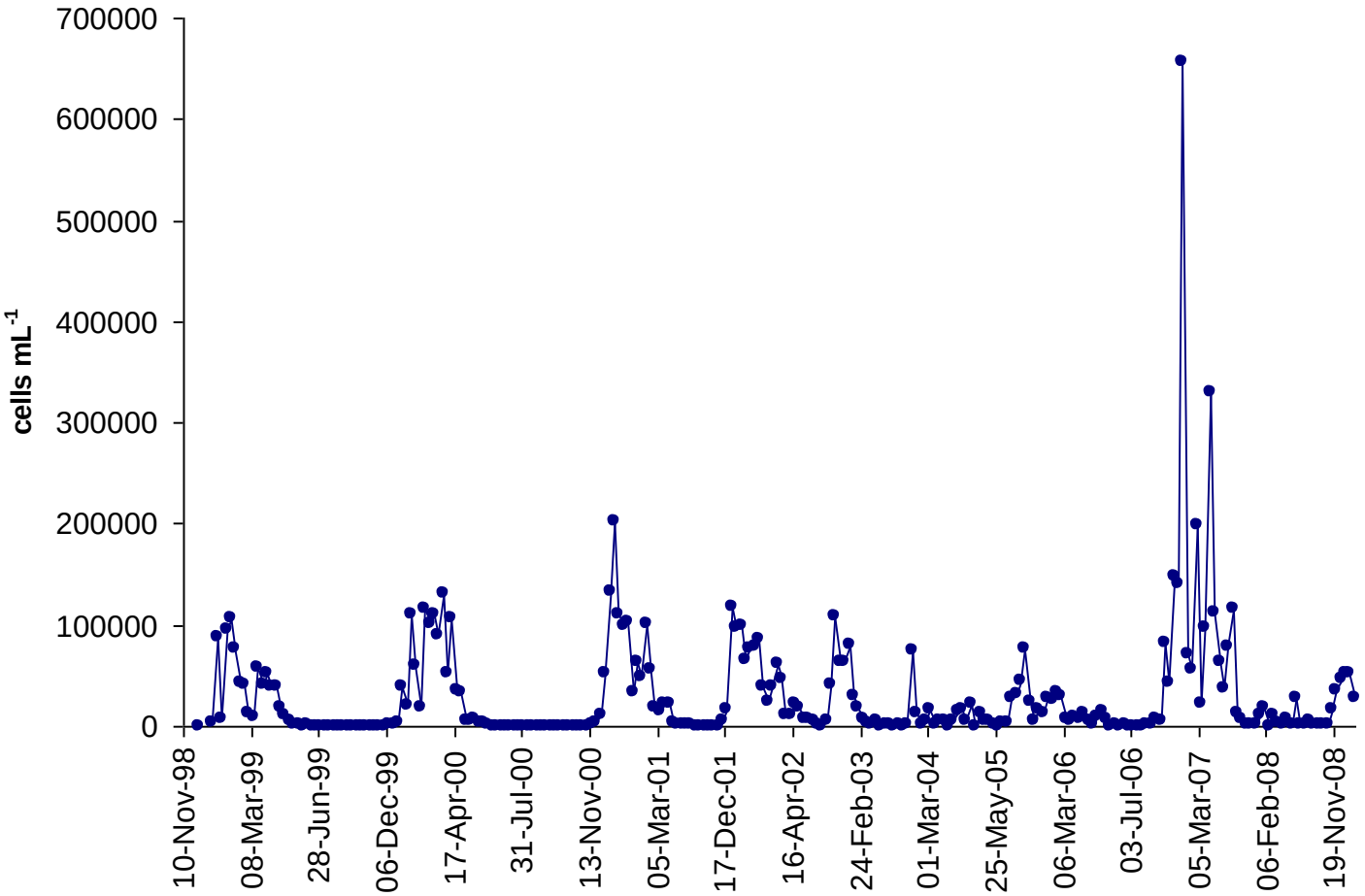
Fred Haigh Dam – Central Qld



Borumba Dam – South-east Qld



Glenlyon Dam – Southern Qld



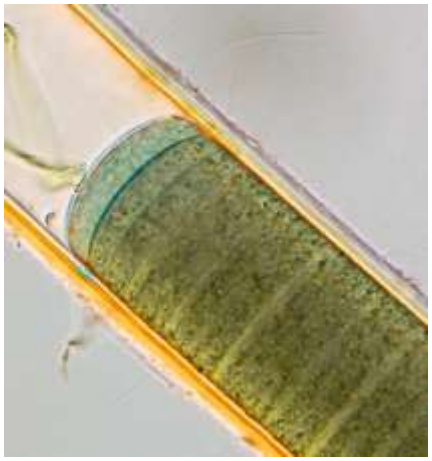
New and emerging issues

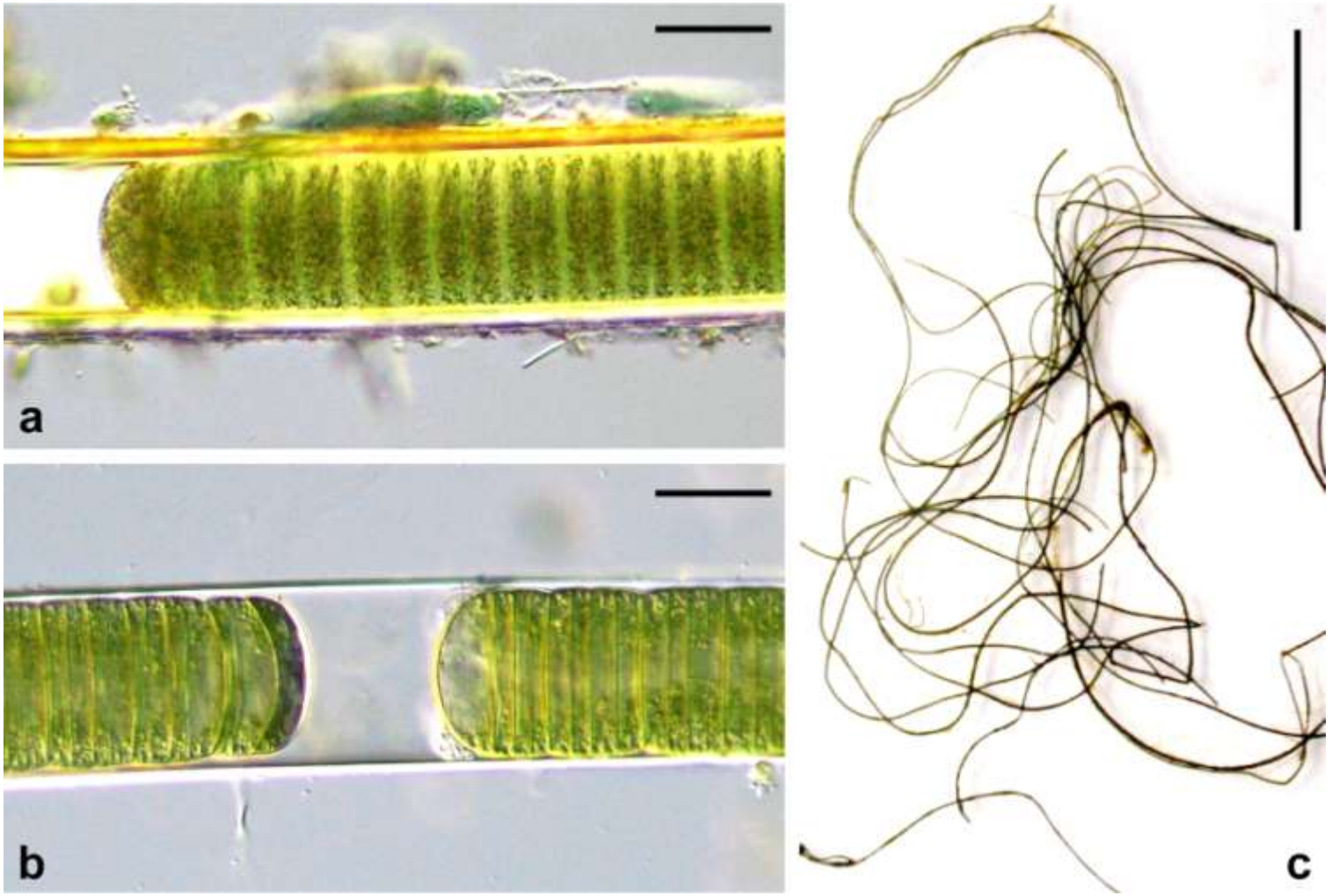
Toxicogenic benthic cyanobacteria

- *Lyngbya majuscula*
  - Seasonal blooms in Moreton Bay, S.E. Queensland
  - Impact on fisheries, tourism, aquatic ecosystems (seagrass communities, turtles, dugongs)
  - Also reported from Hervey Bay and more recently in Shoalwater Bay, Hinchinbrook Island and Great Keppel Island.

Lyngbya wollei

- Freshwater filamentous benthic cyanobacteria
- Known from riverine and reservoirs systems
- Identified as producing PSPs in the USA
- Identified as producing CYN and deoxy-CYN from Queensland





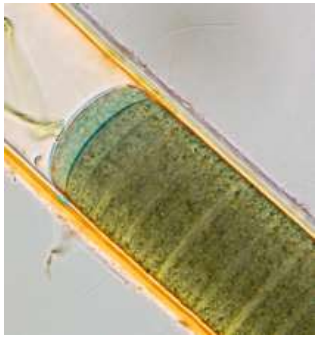
Scale bars a, b = 30 µm, c = 5 cm

Comparison of CYN and deoxy-CYN concentrations (µg g^{-1} dry weight) in selected cyanobacteria

Species	CYN	deoxy-CYN	Reference
Aphanizomenon ovalisporum	500		Shaw et al 1999
Aphanizomenon flos-aquae	2300 – 6600		Preubel et al 2006
Cylindrospermopsis raciborskii	5500		Hawkins et al 1997
	600 – 3500		
	1020	102	Li et al 2001a
	6600		Saker & Eaglesham 1999
	1400 – 2000		Saker et al 1999
	2000		Shaw et al 1999
Raphidiopsis curvata	56	1300	Li et al 2001b
Lyngbya wollei	0 – 33	0.5 – 546.8	Queensland material

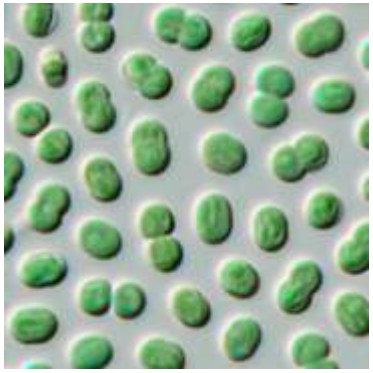
Lyngbya wollei - Significance

- *Lyngbya wollei* represents a hitherto unrecognised source of CYN and deoxy-CYN in the freshwater environment
- Benthic algae and cyanobacteria are not routinely monitored in rivers, lakes and reservoirs
- The mortality of domestic and wild animals has been reported following the consumption of benthic cyanobacterial mats; notably marine and freshwater members of the Oscillatoriales



Current and future challenges

- **Increased urban/agricultural footprint and subsequent water demand**
  - increased reservoir draw down and water residence time
  - catchment generated nutrient and contaminant loads
- **Climate change**
  - rainfall variability
  - reservoir stratification dynamics
  - HAB frequency, intensity and duration
- **Inter-basin transfers and recycled water reuse**
  - movement of bloom inoculum (akinetes)
  - alteration of physico-chemical/hydrological environment



Current and future challenges

- **Currently unrecognised toxicogenic species and range expansion of known species**
  - under estimation of potential risk
  - adequacy of current monitoring strategies
  - adequacy of current water treatment processes

- **Consistent application of current guidelines**
  - Cell concentration vs cell biovolume for recreational risk assessment
  - Consistent risk communication

Current and future challenges

- **Solutions to support regional and remote individuals and communities**
  - Translation of reservoir scale monitoring and management techniques to the farm dam, agricultural system scale

- **Continued support for the ongoing development of a regional (Australasian) cyanobacteria taxonomy**
  - Development of tools to facilitate the accurate, reliable and timely identification of cyanobacteria from a range of habitats (morphological, molecular and ecological)