Harmful Algal Blooms, Climate Change, and Challenges of Managing Lakes in Alberta

Rolf Vinebrooke

Department of Biological Sciences, University of Alberta

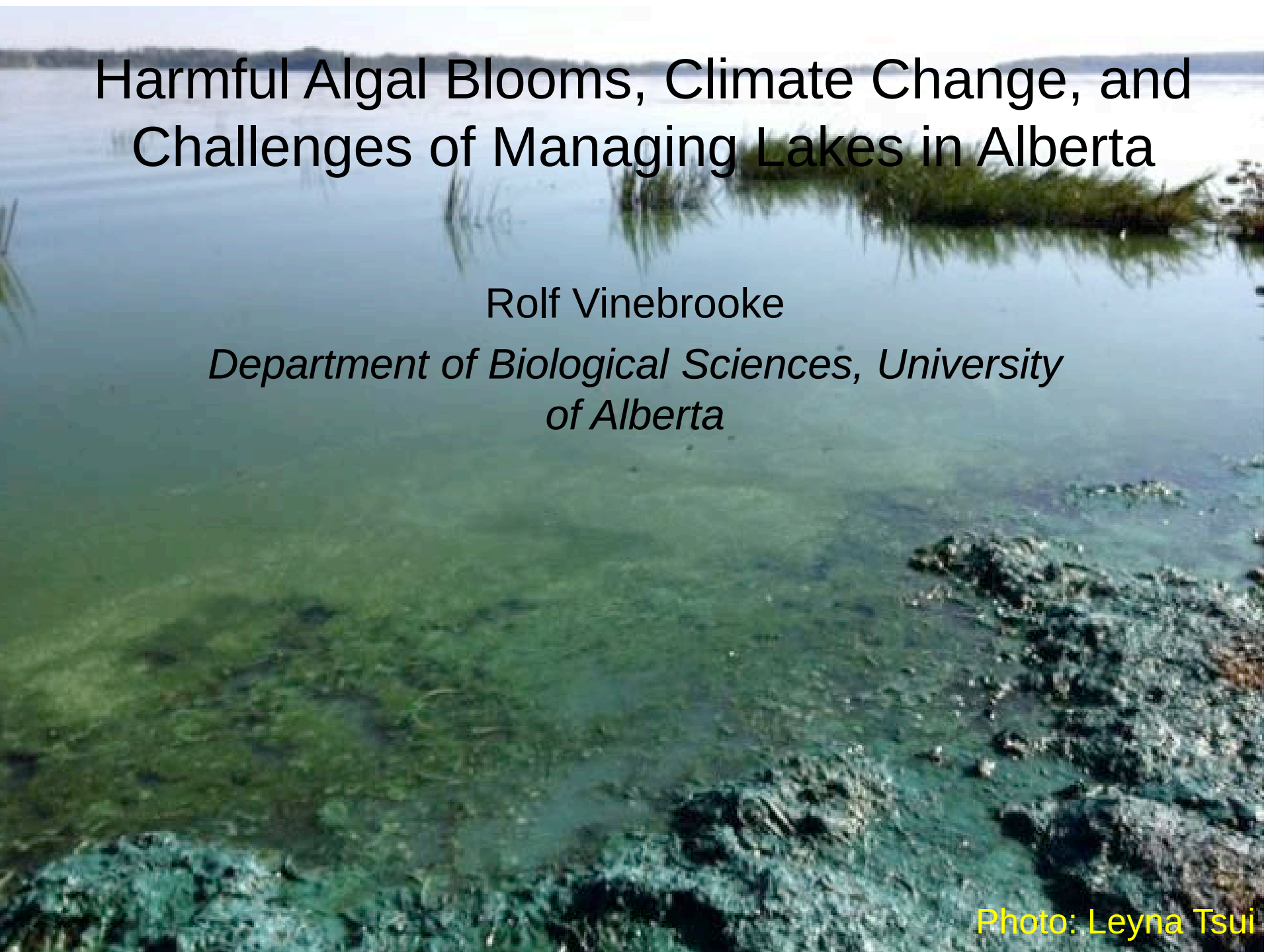


Photo: Leyna Tsui

Main goals

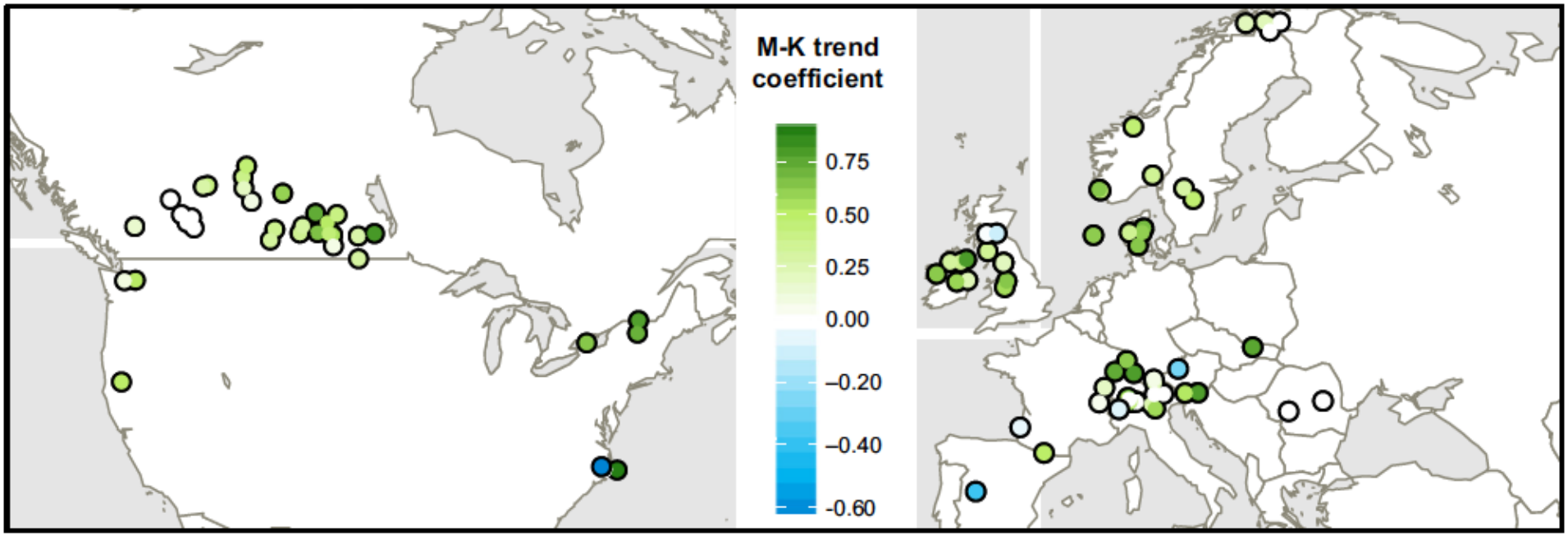
- Provide an overview of recent scientific findings of how climate change and nutrients affect cyanobacterial blooms in freshwater lakes.
- Review a quantitative synthesis of bioremediation efforts involving temperature eutrophic lakes from around the world.
- Table a framework for remediation strategies for eutrophied lakes in Alberta.

ECOLOGY LETTERS

Ecology Letters, (2015) doi: 10.1111/ele.12420

LETTER

Acceleration of cyanobacterial dominance in north temperate-subarctic lakes during the Anthropocene



Taranu et al. 2015

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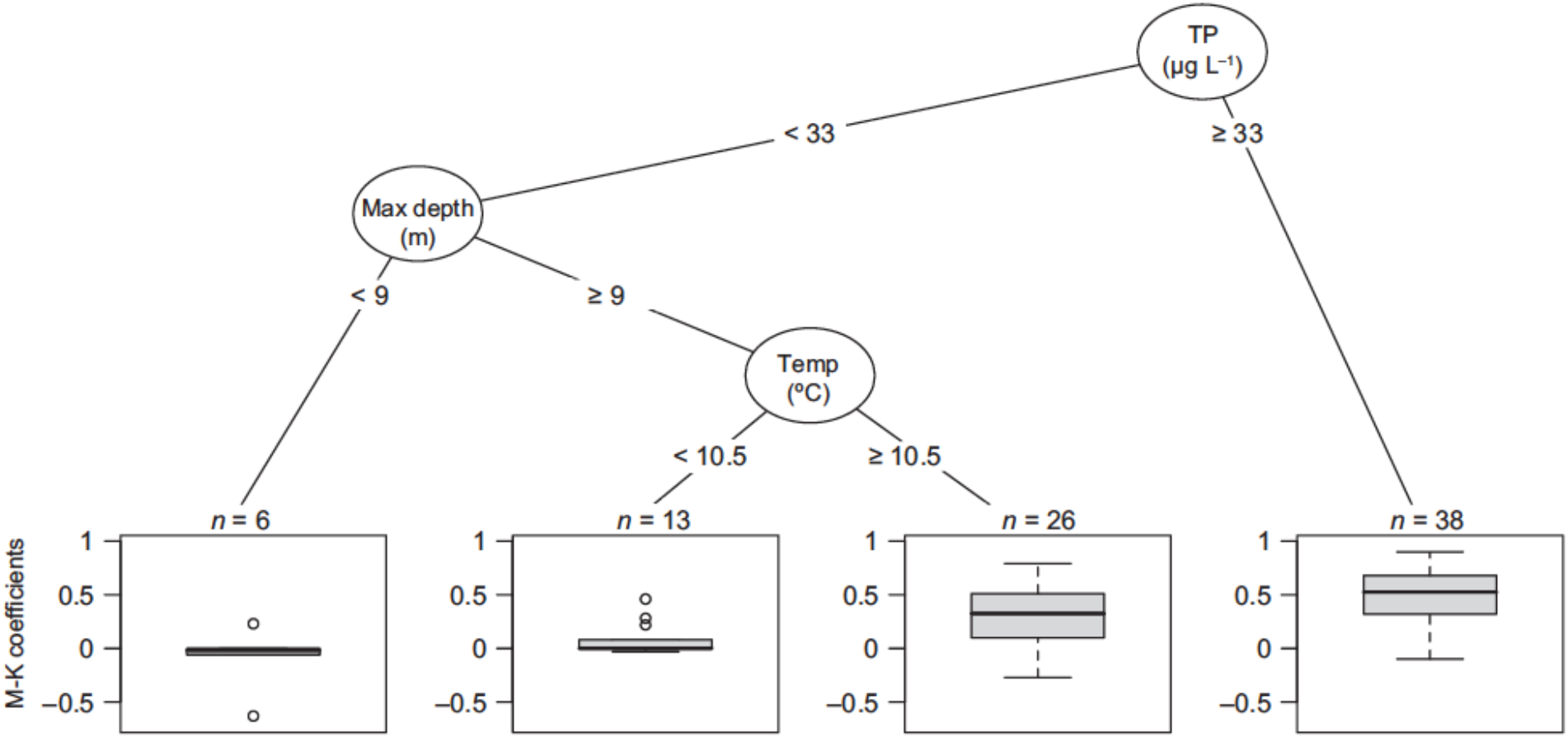


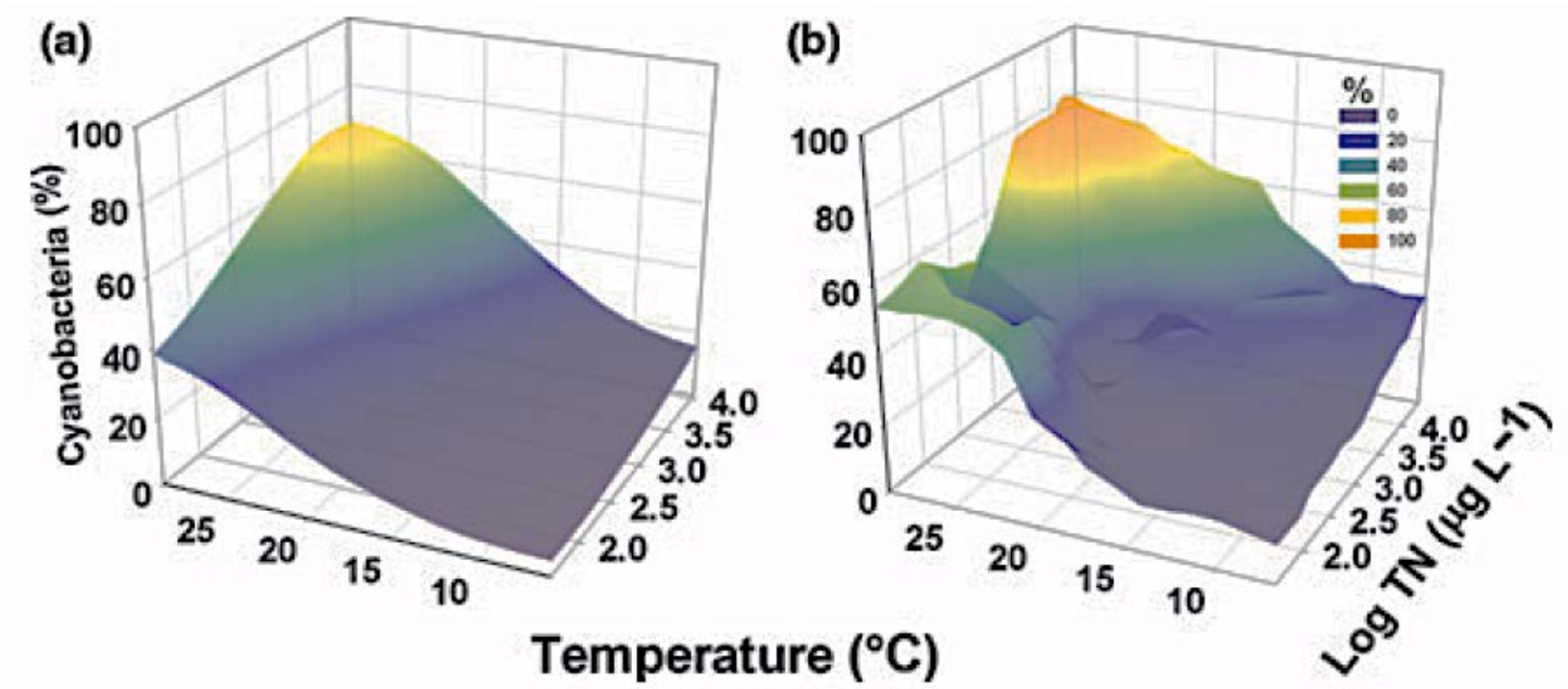
Taranu et al. 2015

Global Change Biology

Global Change Biology (2012) 18, 118–126, doi: 10.1111/j.1365-2486.2011.02488.x

Warmer climates boost cyanobacterial dominance in shallow lakes

SARIAN KOSTEN*‡‡‡, VERA L. M. HUSZAR†, ELOY BÉCARES‡, LUCIANA S. COSTA†, ELLEN VAN DONK§, LARS-ANDERS HANSSON¶, ERIK JEPPESEN‖***†††, CARLA KRUK**, GISSELL LACEROT**, NÉSTOR MAZZEO††, LUC DE MEESTER‡‡, BRIAN MOSS§§, MIQUEL LÜRLING*, TIINA NÕGES¶¶§§§, SUSANA ROMO‖‖ and MARTEN SCHEFFER*



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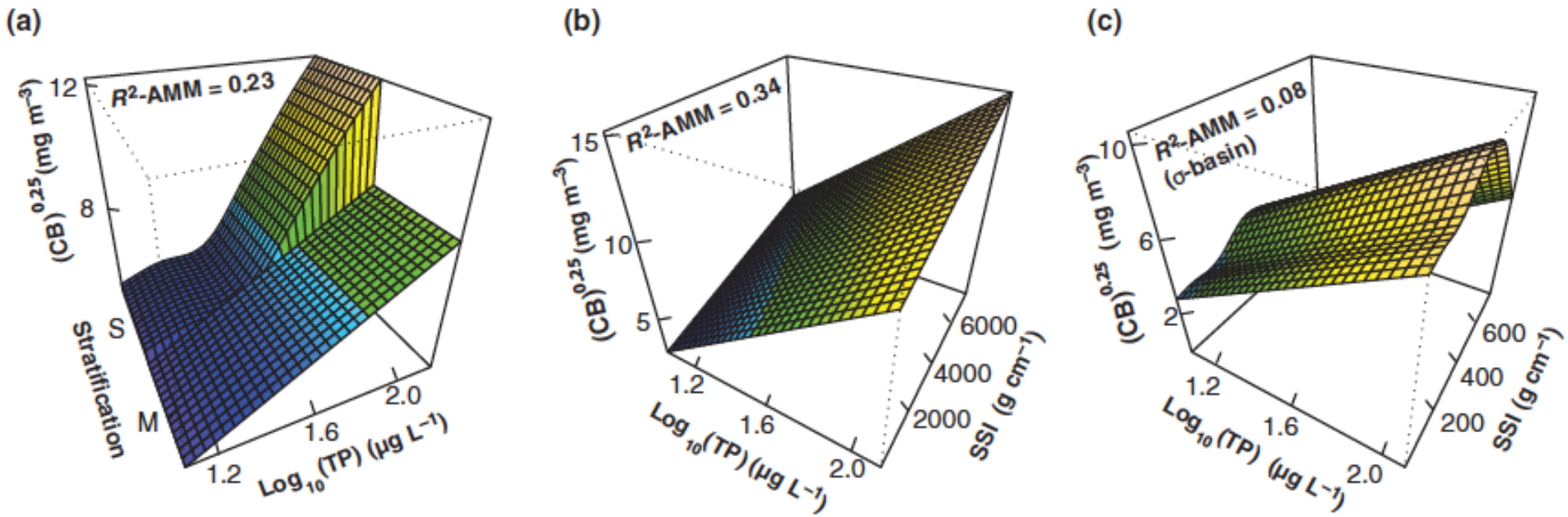
Predicting cyanobacterial dynamics in the face of global change: the importance of scale and environmental context

ZOFIA E. TARANU*†, RON W. ZURAWELL‡, FRANCES PICK§ and IRENE GREGORY-EAVES*†

*Department of Biology, McGill University, 1205 Docteur Penfield, Montreal, QC Canada, H3A 1B1, †Groupe de Recherche Interuniversitaire en Limnologie, ‡Water Policy Branch, Alberta Environment and Sustainable Resource Development, Edmonton, AB Canada, T5K 2J6, §Department of Biology, University of Ottawa, Ottawa, ON Canada, K1N 6N5



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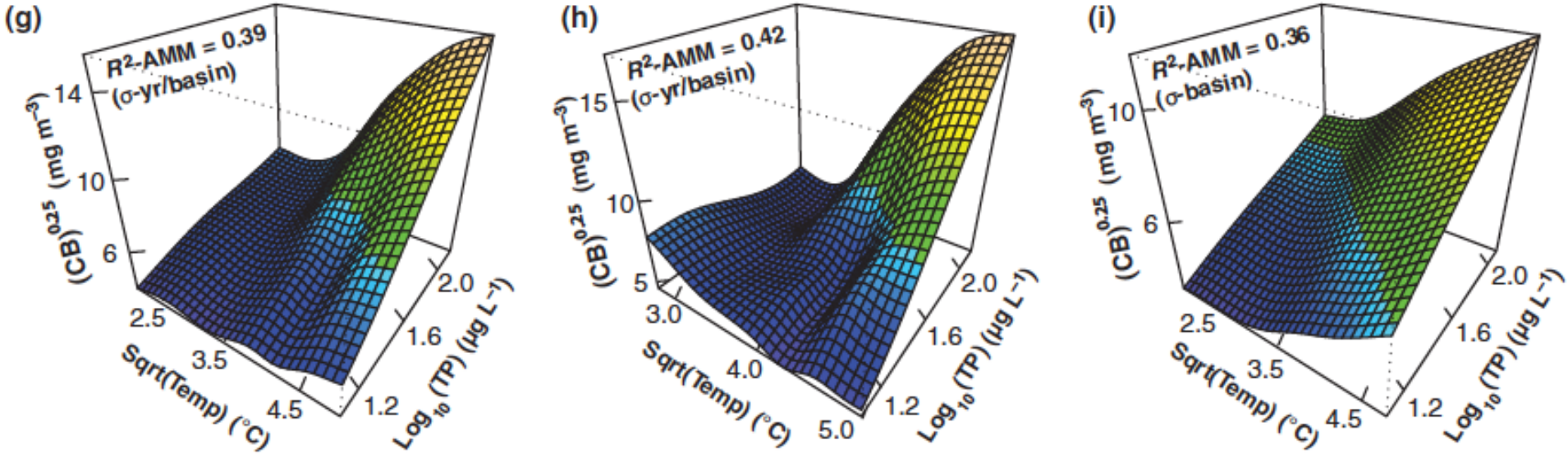

LIMNOLOGY and OCEANOGRAPHY

ASLO

Limnol. Oceanogr. 60, 2015, 856–871

doi: 10.1002/lno.10076

The "nutrient pump:" Iron-poor sediments fuel low nitrogen-to-phosphorus ratios and cyanobacterial blooms in polymictic lakes

Diane M. Orihel,*[1] David W. Schindler,[1] Nathaniel C. Ballard,[2] Mark D. Graham,[1] David W. O'Connell,[3] Lindsey R. Wilson,[1] Rolf D. Vinebrooke[1]

[1]Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada
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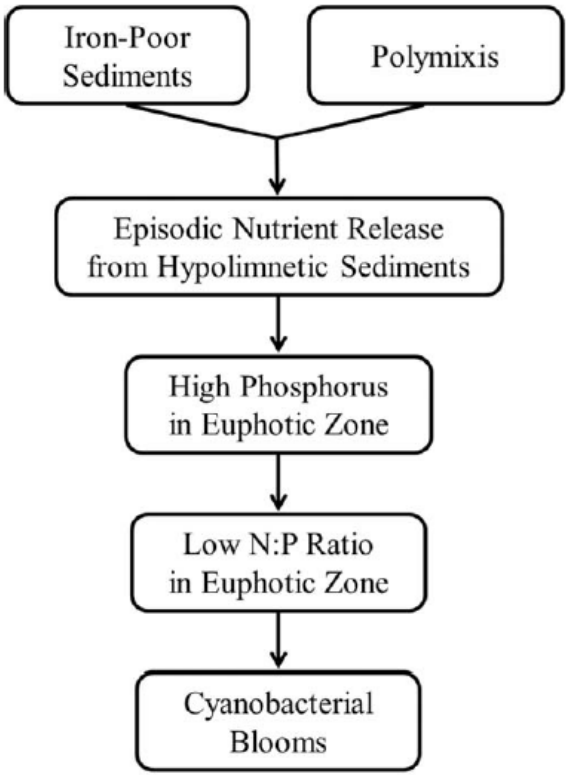

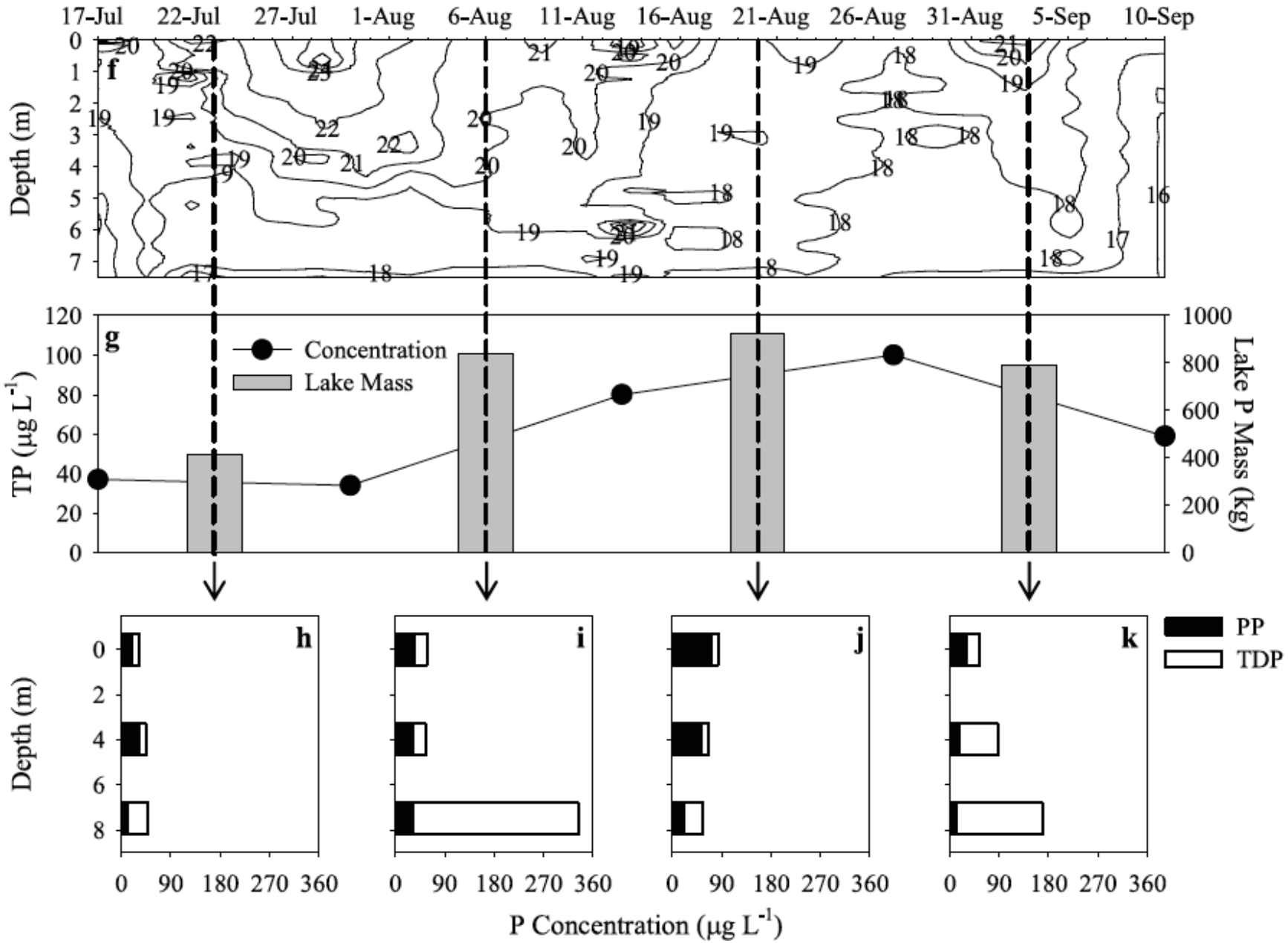

Orihel et al. 2015

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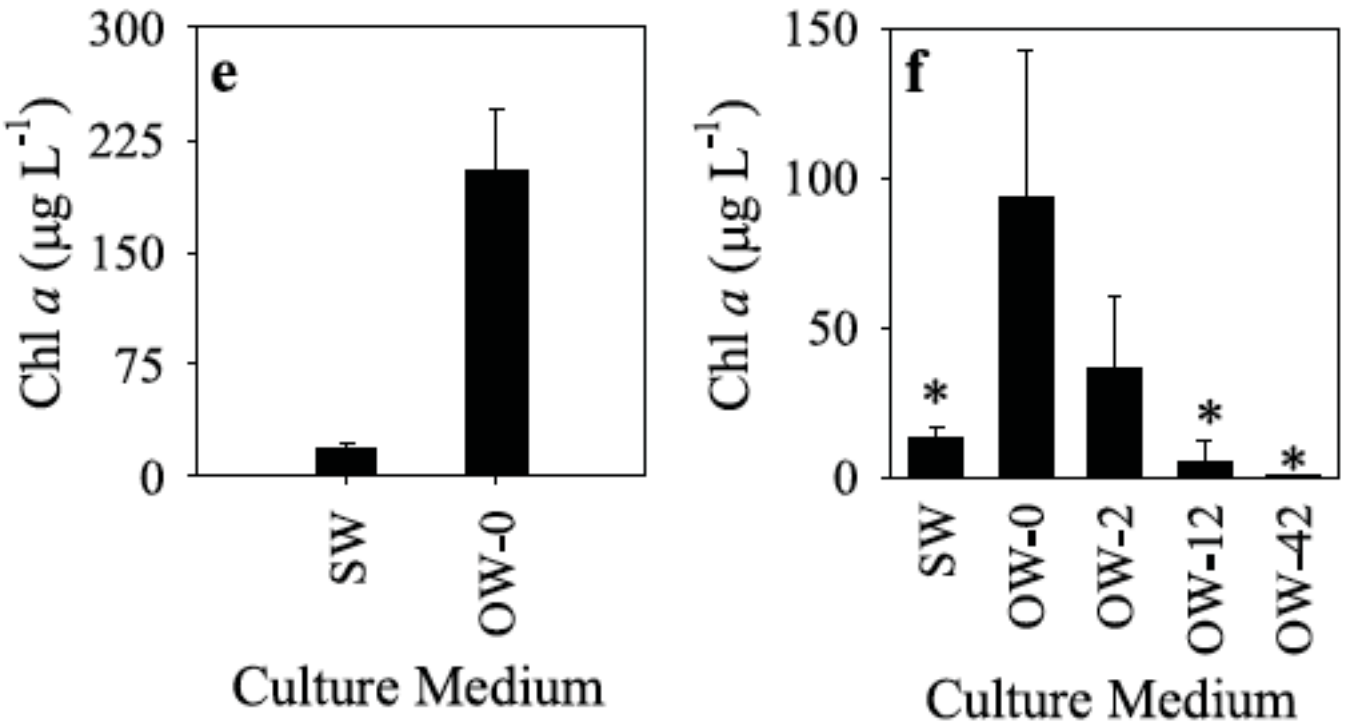

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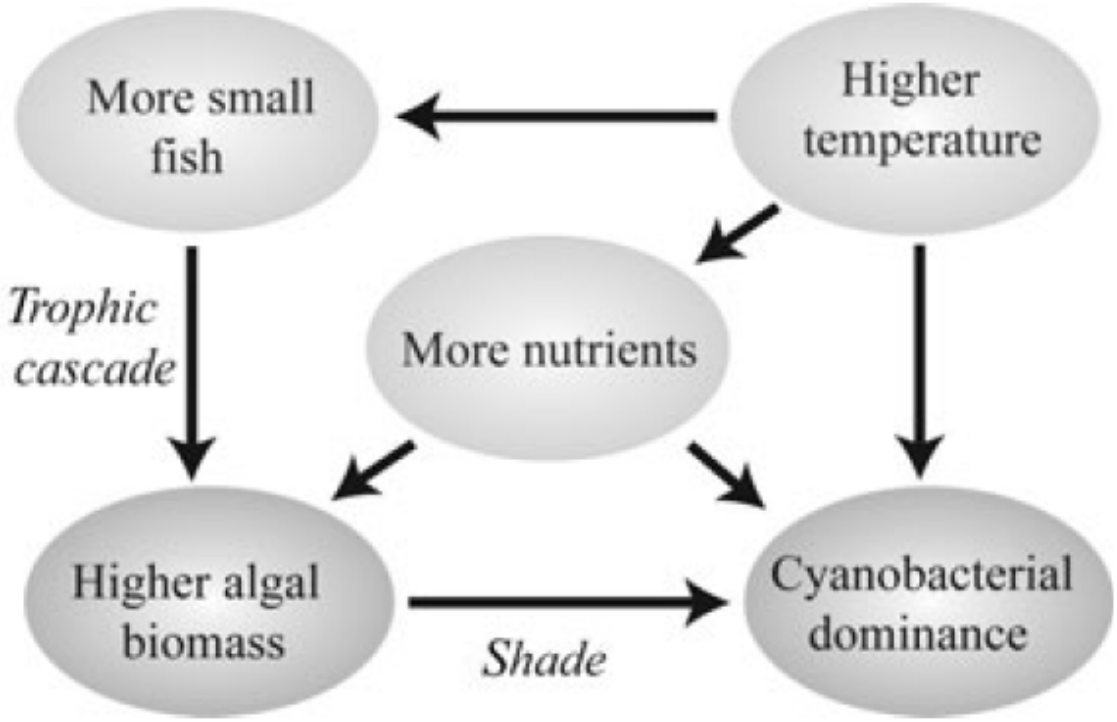


Bioremediation and the trophic cascade concept

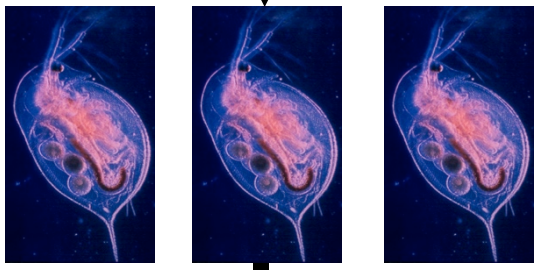
No/Low Piscivores

With Piscivores

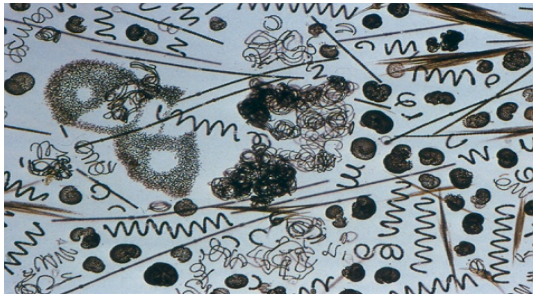
Piscivore

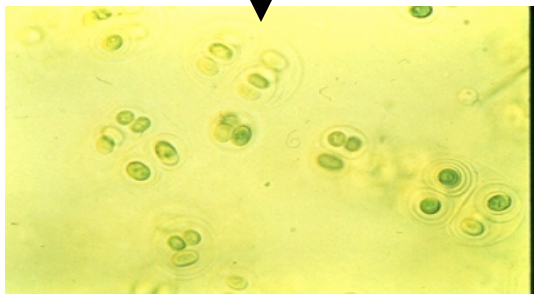
Planktivore

Zooplankton



Phytoplankton
(Blue-green Algae)





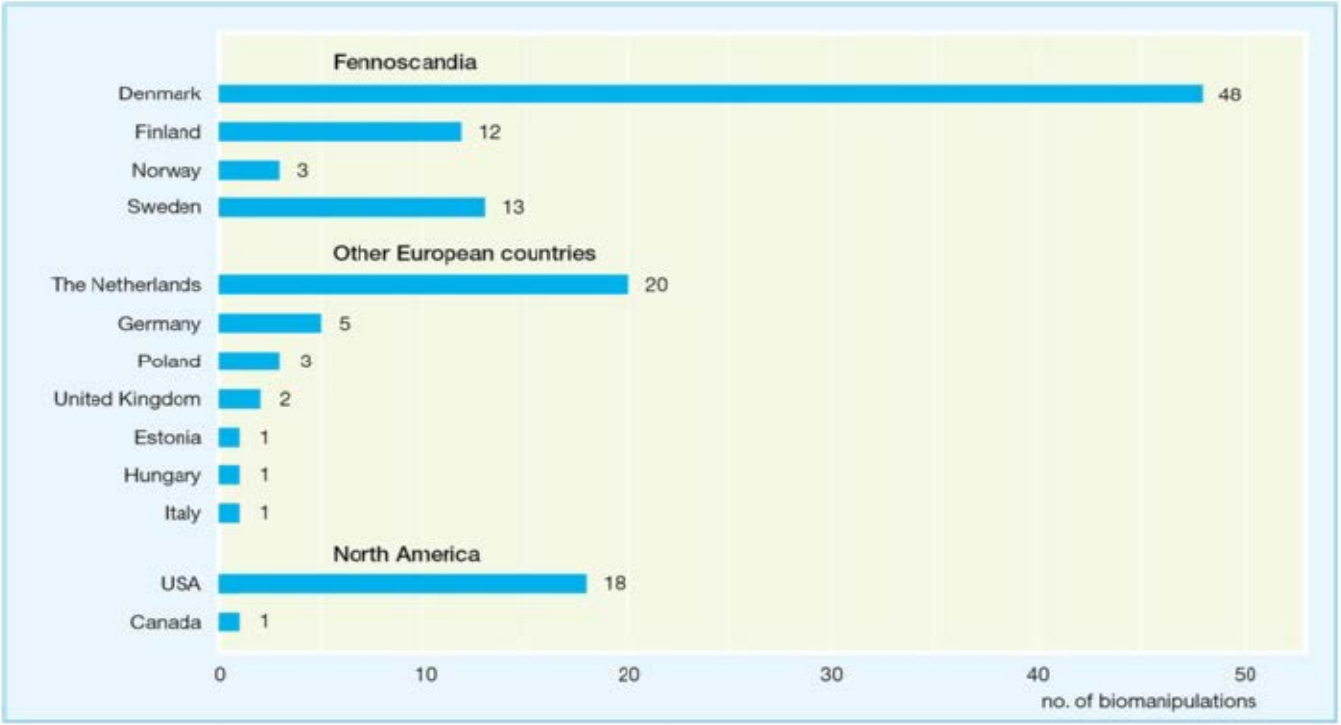
Bernes *et al. Environmental Evidence* (2015) 4:7
DOI 10.1186/s13750-015-0032-9

ENVIRONMENTAL EVIDENCE

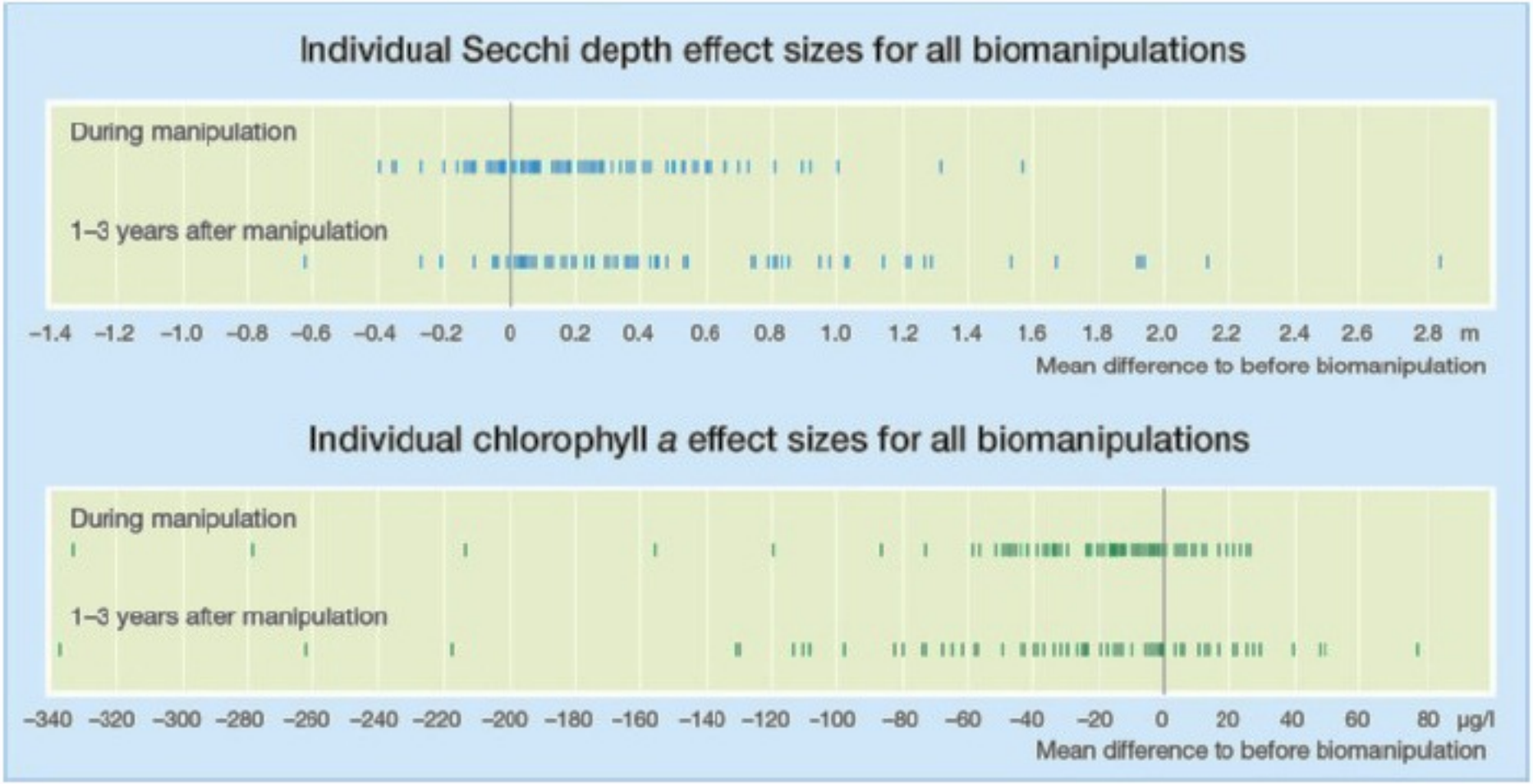
SYSTEMATIC REVIEW Open Access

What is the influence of a reduction of planktivorous and benthivorous fish on water quality in temperate eutrophic lakes? A systematic review

Claes Bernes[1*], Stephen R Carpenter[2], Anna Gårdmark[3], Per Larsson[4], Lennart Persson[5], Christian Skov[6], James DM Speed[7] and Ellen Van Donk[8]

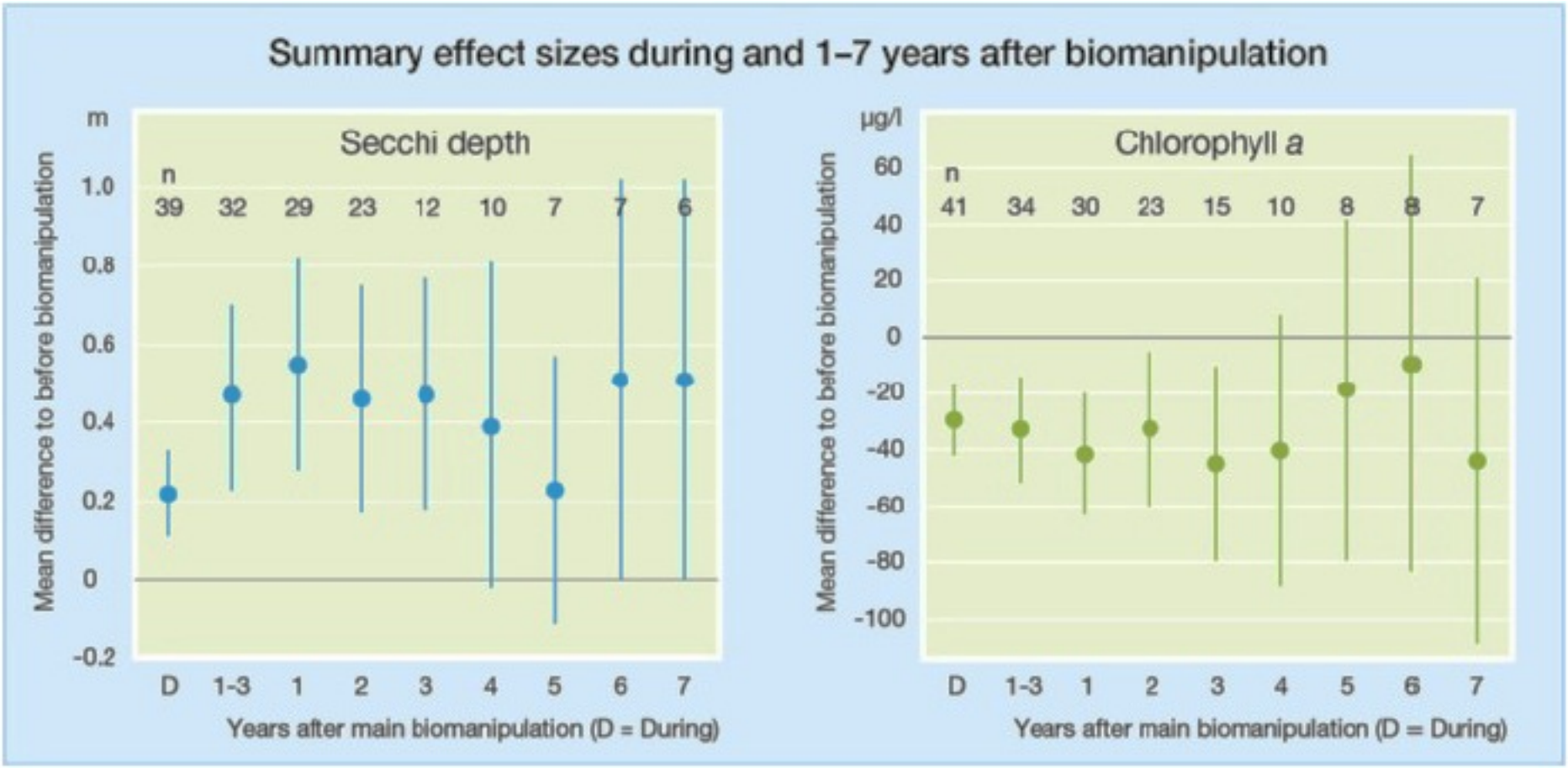


Positive but variable bioremediation effects



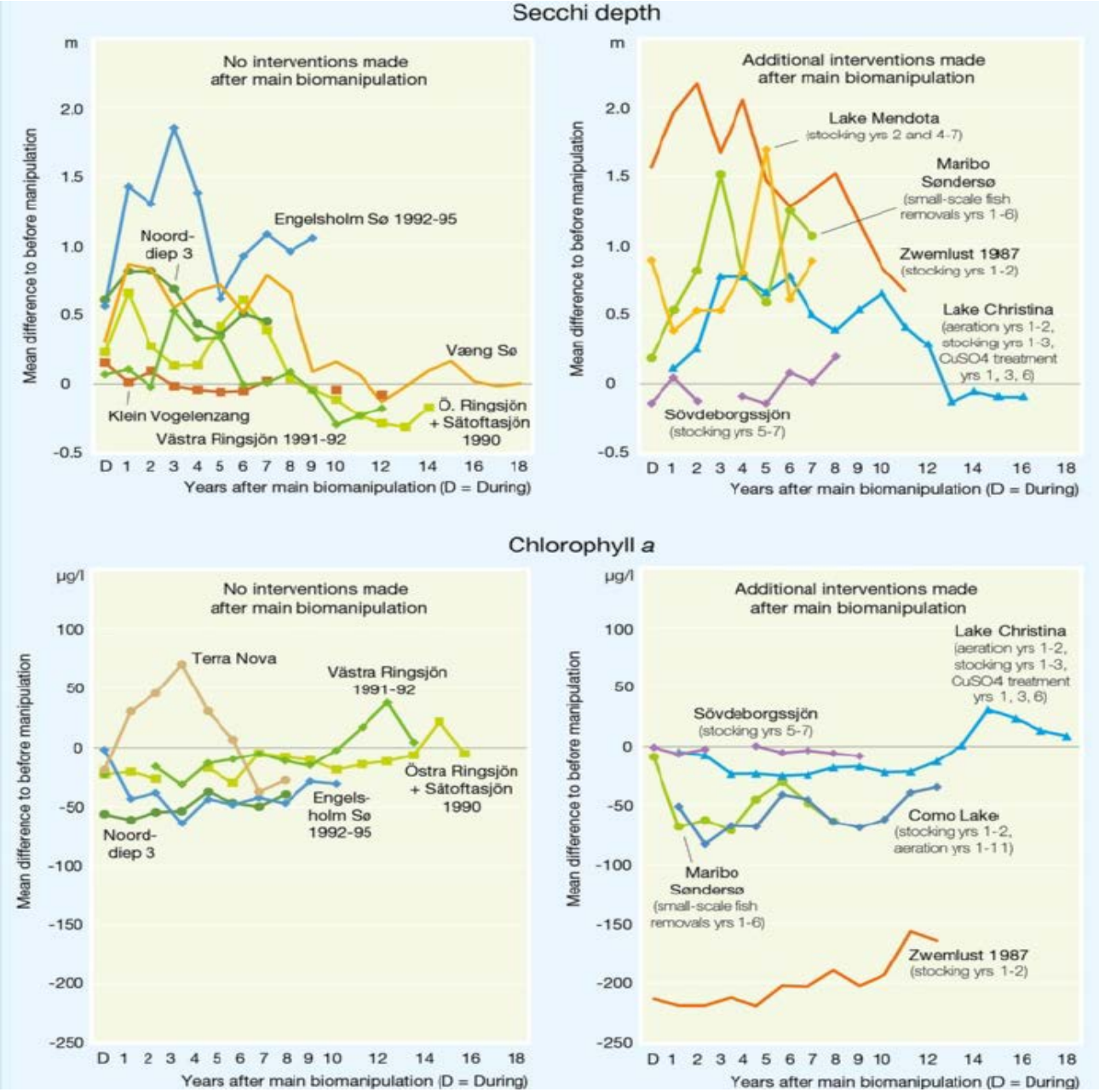
Bernes et al. 2015

Persistence of bioremediation effects



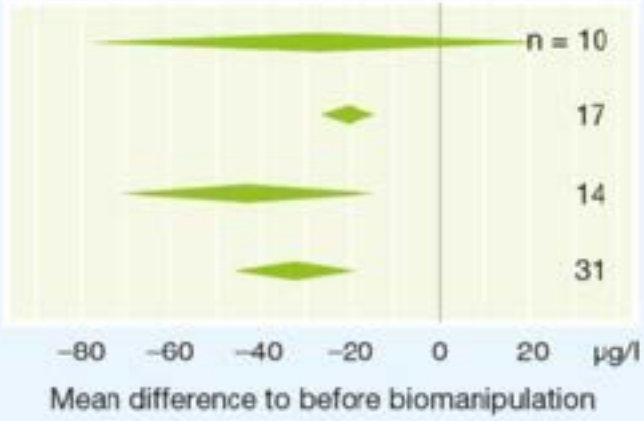
Bernes et al. 2015

Persistence of additional bioremediation effects

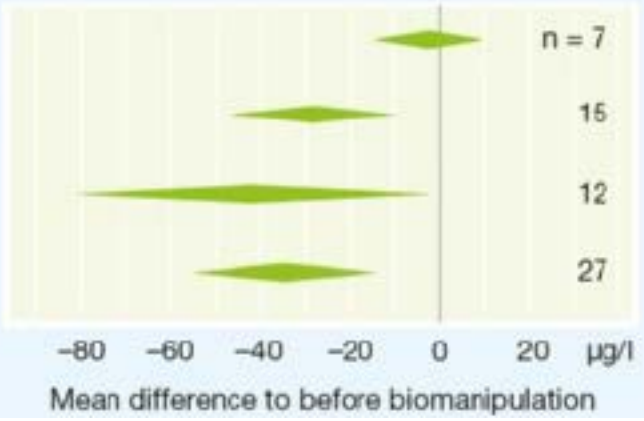


Bernes et al. 2015

Removal of minnows more effective than stocking of piscivorous sportfish



	Mean lake area (ha)	Mean pre-manip. TP (µg/l)	Mean fish removal (kg/ha/yr)
Piscivore stocking only	10	197	0
Planktivore/benthivore removal only	52	129	82
Planktivore/benthivore removal with piscivore stocking	21	191	159
Planktivore/benthivore removal with or without piscivore stocking	35	153	113



	Mean lake area (ha)	Mean pre-manip. TP (µg/l)	Mean fish removal (kg/ha/yr)
Piscivore stocking only	17	190	0
Planktivore/benthivore removal only	26	118	117
Planktivore/benthivore removal with piscivore stocking	17	222	162
Planktivore/benthivore removal with or without piscivore stocking	22	156	139

Bernes et al. 2015

Bioremediation efforts most effective in small hypereutrophic lakes having short water residence times

	Secchi depth		Chlorophyll *a*	
	During manipulation	1-3 years after manipulation	During manipulation	1-3 years after manipulation
Lake properties				
Lake area	*		*	*
Mean depth				
Retention time			*	*
Pre-manipulation TP concentration	**		***	***
Mean atmospheric temperature	*			
Measures of intervention strength				
Duration of main manipulation				
Fish removal (kg/ha)				
Fish removal (kg/ha/yr)	**		**	
Fish stock depletion		***		

Bernes et al. 2015

A framework for remediation of eutrophic lakes in Alberta

- 1) Establish historical baseline conditions to highlight a realistic remediation target
  - Long-term monitoring or paleolimnology
- 2) Adopt a multi-approach strategy.
  - Elimination of terrestrial phosphorus inputs.
  - In-lake reduction of bioavailable phosphorus (e.g., aeration, chemical remediation, harvest removal of algal biomass)
  - Bioremediation involving promotion of grazing pressure on cyanobacteria.
- 3) Adaptation to climate change
  - Increased temperatures and more variable wind-driven mixing events in lakes.


Questions?
Photo: Leyna Tsui