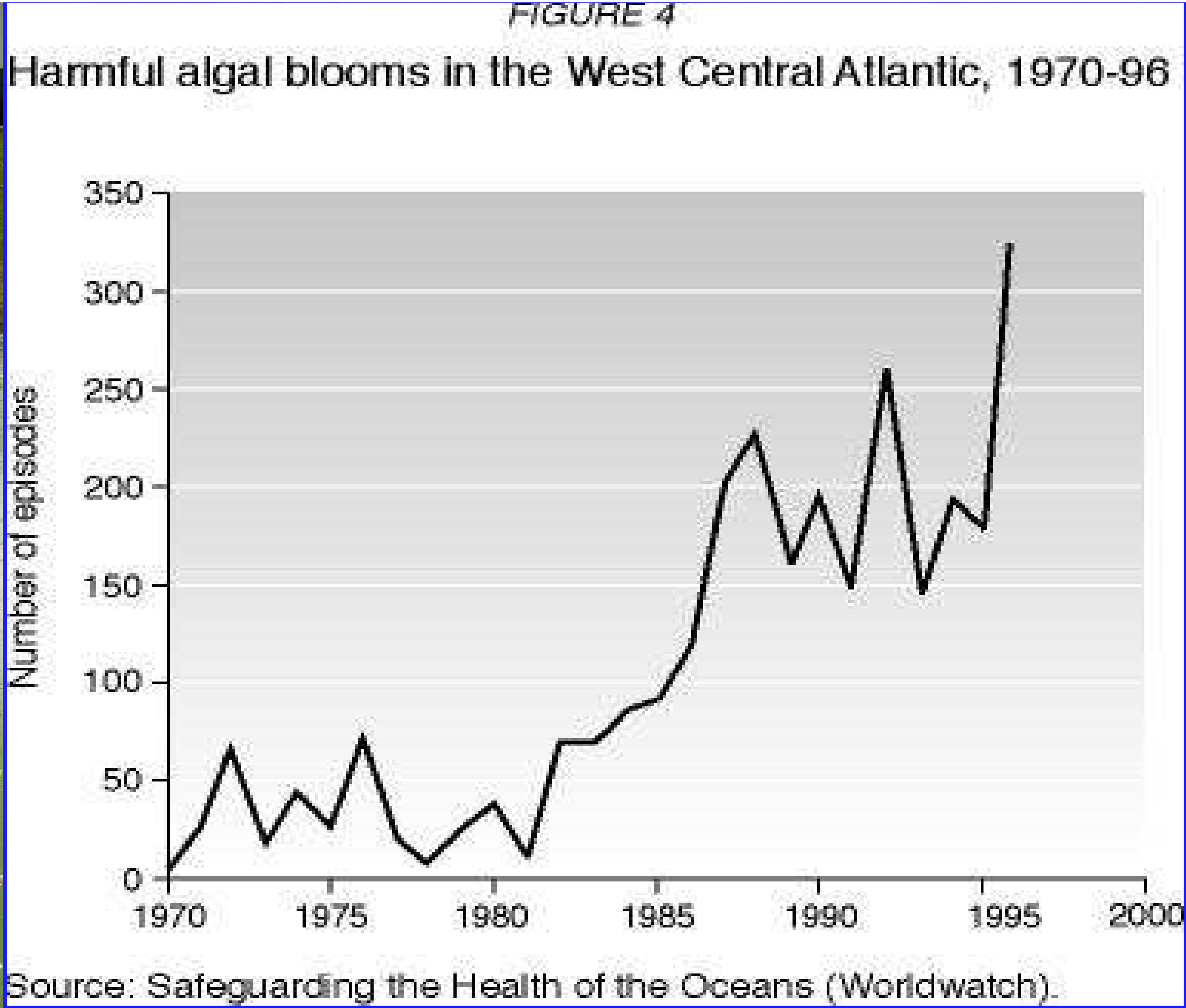
Flock & Lock

Innovatieve en veelbelovende manier om blauwalgenoverlast te beteugelen

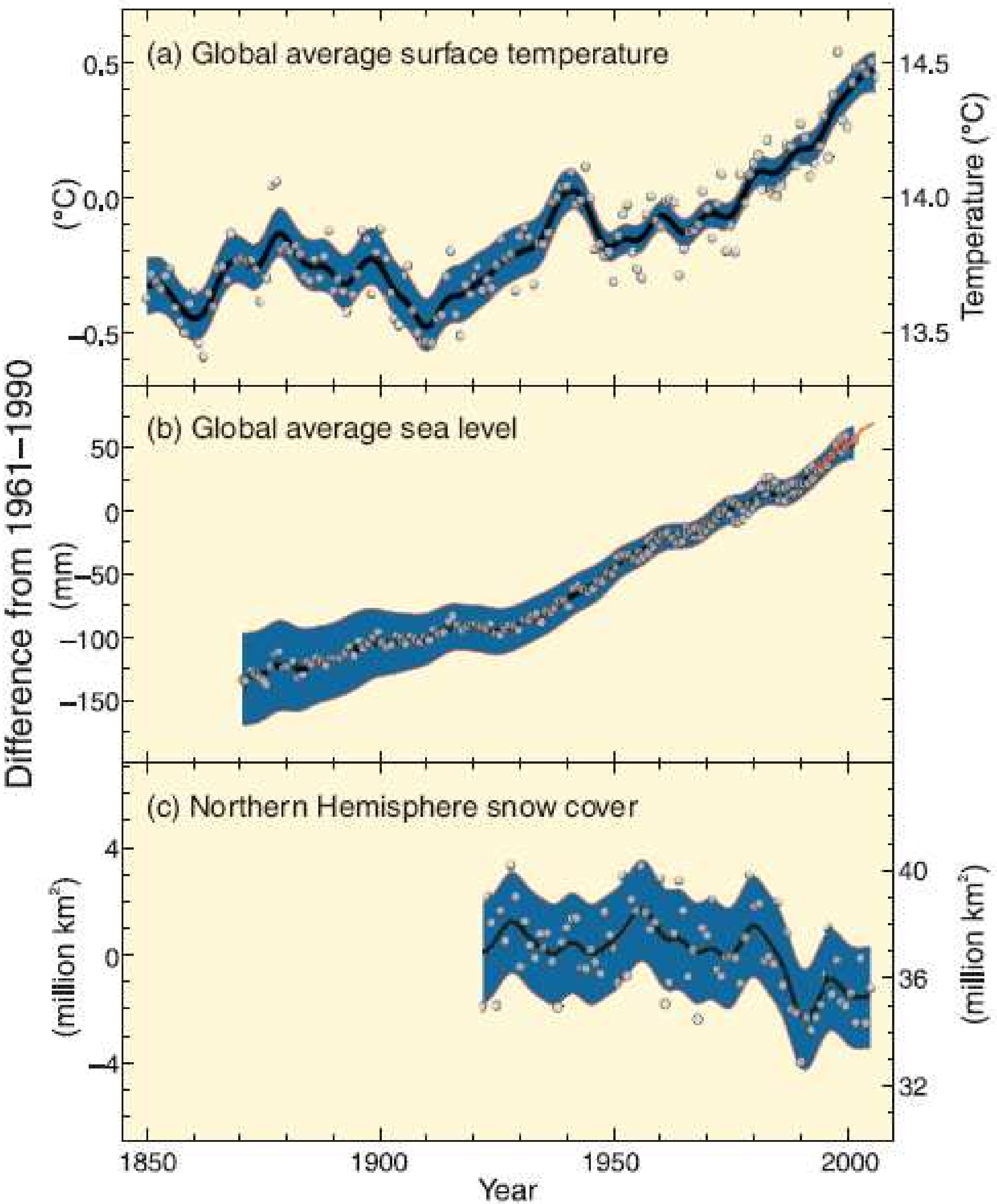
Miquel Lurling & Frank van Oosterhout


AZUL
MARINHO
modified clay



Harmful algal blooms in the West Central Atlantic, 1970-96. (2001). In *UNEP/GRID-Arendal Maps and Graphics Library*.
http://maps.grida.no/go/graphic/harmful_algal_blooms_in_the_west_central_atlantic_1970_96.

Changes in temperature, sea level and Northern Hemisphere snow cover



IPCC, 2007

WMO

Climate Change 2007: Impacts, Adaptation and Vulnerability

Contribution of Working Group II
to the Fourth Assessment Report of the
Intergovernmental Panel on Climate Change

Published for the Intergovernmental Panel on Climate Change

3.4.4 Water quality

Higher water temperature and variations in runoff are likely to produce adverse changes in water quality affecting human health, ecosystems, and water use (Patz, 2001; Lehman, 2002; O'Reilly et al., 2003; Hurd et al., 2004). Lowering of the water levels in rivers and lakes will lead to the re-suspension of bottom sediments and liberating compounds, with negative effects on water supplies (Atkinson et al., 1999). More intense rainfall will lead to an increase in suspended solids (turbidity) in lakes and reservoirs due to soil fluvial erosion (Leemans and Kleidon, 2002), and pollutants will be introduced (Mimikou et al., 2000; Neff et al., 2000; Bouraoui et al., 2004).

Higher surface water temperatures will promote algal blooms (Hall et al., 2002; Kumagai et al., 2003) and increase the bacteria and fungi content (Environment Canada, 2001). This may lead to a bad odour and taste in chlorinated drinking water and the occurrence of toxins (Moulton and Cuthbert, 2000; Robarts et al., 2005). Moreover, even with enhanced phosphorus removal in wastewater treatment plants, algal growth may increase with warming over the long term (Wade et al., 2002). Due to the high cost and the intermittent nature of algal blooms, water utilities will be unable to solve this problem with the available technology (Environment Canada, 2001). Increasing nutrients and sediments due to higher runoff, coupled with lower water levels, will negatively affect water quality (Hamilton et al., 2001), possibly rendering a source unusable unless special treatment is introduced (Environment Canada, 2004). Furthermore, higher water temperatures will enhance the transfer of volatile and semi-volatile compounds (e.g., ammonia, mercury, dioxins, pesticides) from surface water bodies to the atmosphere (Schindler, 2001).

In regions where intense rainfall is expected to increase, pollutants (pesticides, organic matter, heavy metals, etc.) will be increasingly washed from soils to water bodies (Fisher, 2000; Boorman, 2003b; Environment Canada, 2004). Higher runoff is expected to mobilise fertilisers and pesticides to water bodies in regions where their application time and low vegetation growth

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Klimaatverandering stimuleert blauwalgenbloei

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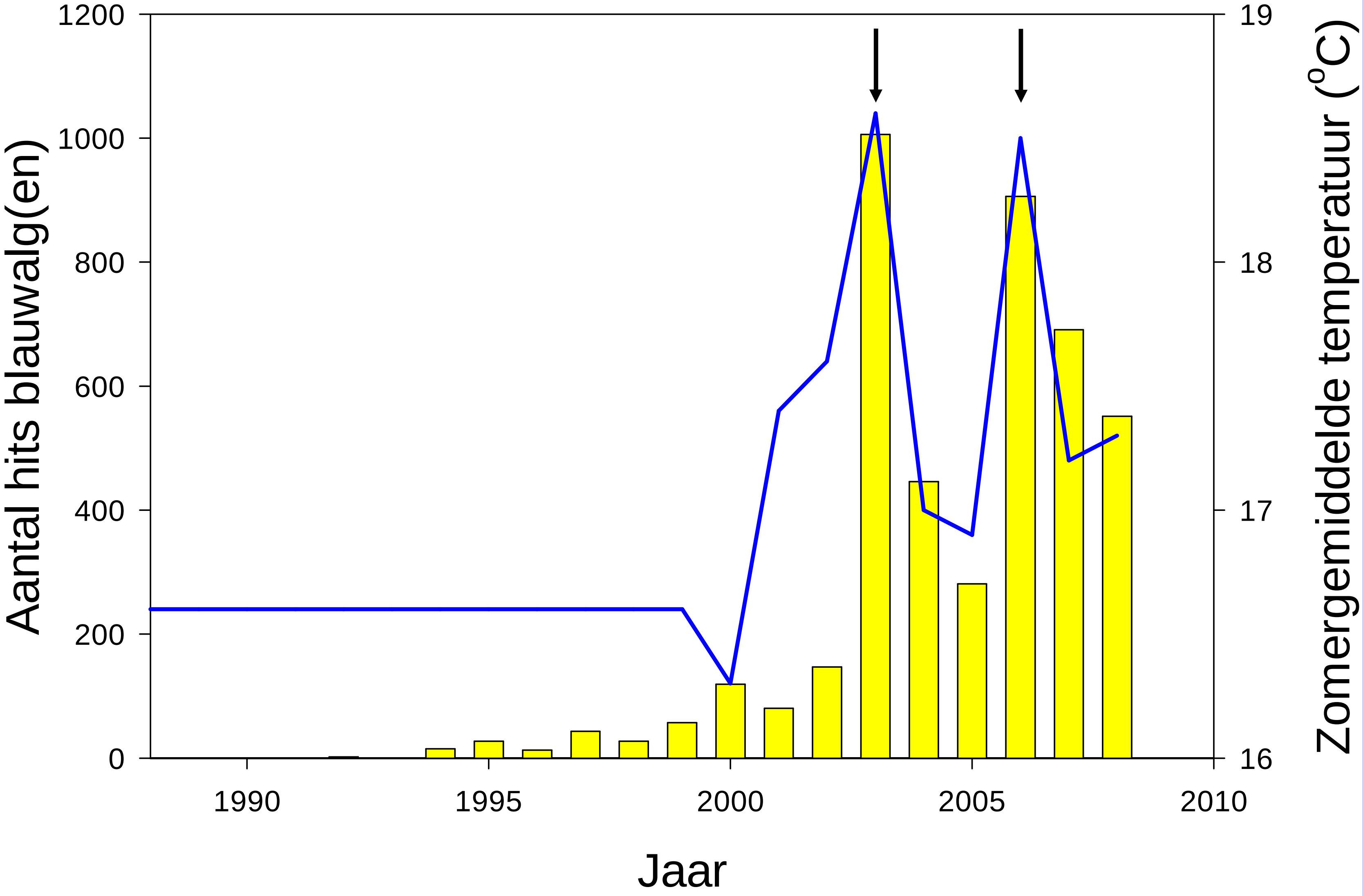
Foto: Yora Tolman

Foto: Brabantse Delta

LexisNexis *Academic NL* **&** **KNMI**



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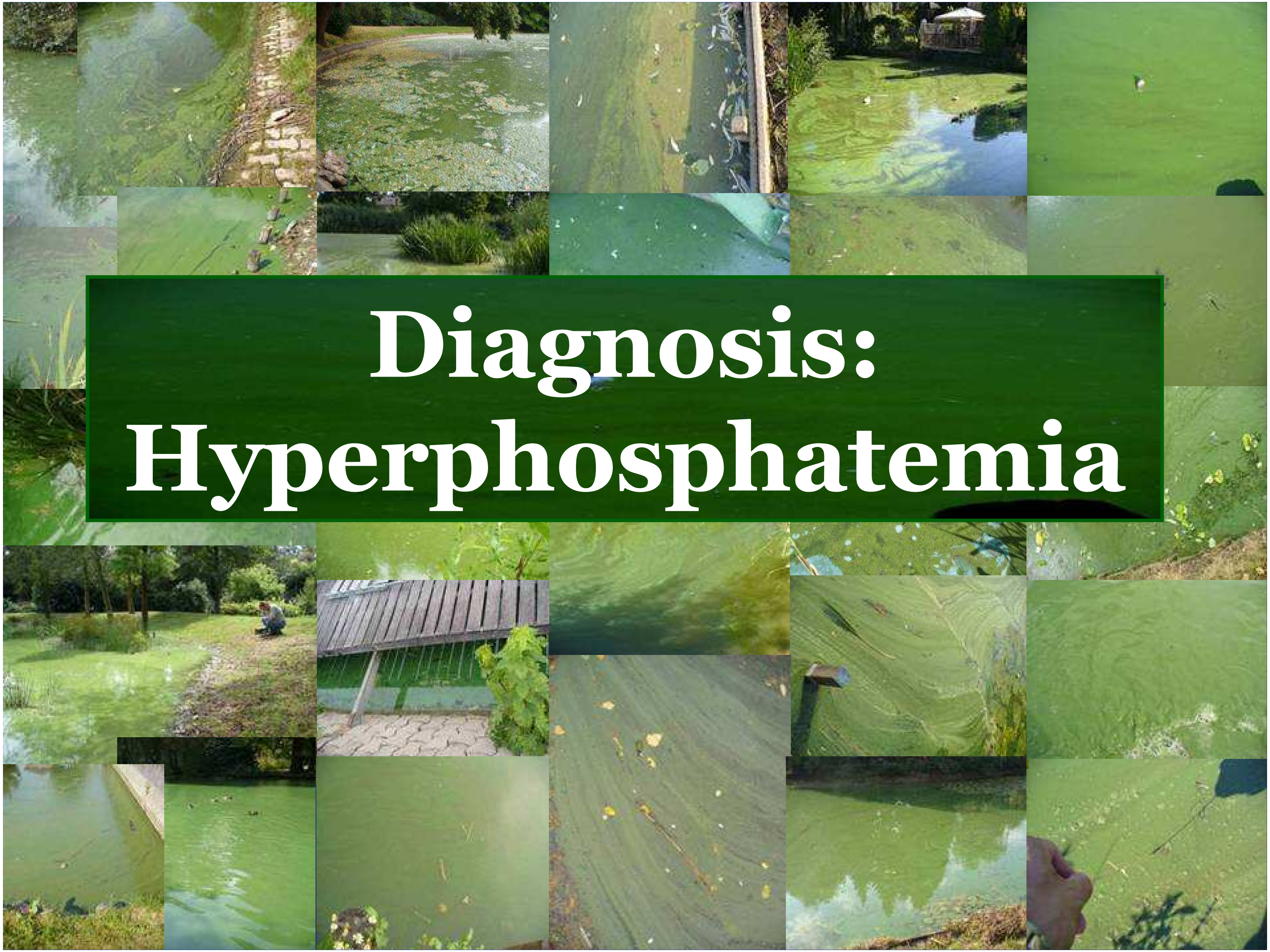
Merge and live happily everafter

Diagnosis: Hyperphosphatemia



Lanthanum: A Safe Phosphate Binder

Veerle P. Persy, Geert J. Behets, An R. Bervoets, Marc E. De Broe, and Patrick C. D'Haese
University of Antwerp, Antwerp, Belgium

FOSRENOL®
(lanthanum carbonate)

Accumulation of inorganic phosphate due to renal functional impairment contributes to the increased cardiovascular mortality observed in dialysis patients. Phosphate plays a causative role in the development of vascular calcification in renal failure; treatment with calcium-based phosphate binders and vitamin D can further increase the $Ca \times PO_4$ product and add to the risk of ectopic mineralization. The new generation of calcium-free phosphate binders, sevelamer and lanthanum, can control hyperphosphatemia without adding to the patients calcium load. In this article, the metabolism of lanthanum carbonate and its effects in bone, liver and brain are discussed. Although lanthanum is a metal cation its effects are not comparable to those of aluminum. Indeed, in clinical studies no toxic effects of lanthanum have been reported after up to four years of follow-up. The bioavailability of lanthanum is extremely low. The effects observed in bone are due to phosphate depletion, with no signs of direct bone toxicity yet observed in rats or humans. The liver is the main route of excretion for lanthanum carbonate, which can be localized in the lysosomes of hepatocytes. No lanthanum could be detected in brain tissue.

Address correspondence to: Veerle P. Persy, MD, PhD, University of Antwerp, Universiteitsplein 1, B-2610 Wilrijk, Antwerp, Belgium, or e-mail: veerle.persy@ua.ac.be.
Seminars in Dialysis—Vol 19, No 3 (May–June) 2006 pp. 195–199

Nephrol Dial Transplant (2006) 21: 2217–2224
doi:10.1093/ndt/gfl146
Advance Access publication 4 April 2006

NDT
Nephrology Dialysis Transplantation

Original Article

Evolution of bone and plasma concentration of lanthanum in dialysis patients before, during 1 year of treatment with lanthanum carbonate and after 2 years of follow-up

Goce B. Spasovski[1], Aleksandar Sikole[1], Saso Gelev[1], Jelka Masin-Spasovska[1], Tony Freemont[2], Isabel Webster[3], Maggie Gill[3], Chris Jones[3], Marc E. De Broe[4] and Patrick C. D'Haese[4]

are the results from one centre that participated in a multicentre trial to assess the effect of treatment with LC and calcium carbonate (CC) on the evolution of renal osteodystrophy in dialysis patients. Bone biopsies were performed at baseline, after 1 year of treatment and after a further 2-year follow-up period to assess the lanthanum concentration in bone and plasma.

Methods. Twenty new dialysis patients were randomized to receive LC (median dose 1250 mg) for 1 year ($n = 10$), followed by 2 years of CC treatment or CC ($n = 10$) during the whole study period (3 years).

Results. After 36 weeks of treatment, steady state was reached with plasma lanthanum levels varying around 0.6 ng/ml. Six weeks after cessation of 1 year of treatment, the plasma lanthanum levels declined to a value of 0.17 ± 0.12 ng/ml ($P < 0.05$) and after 2 years to 0.09 ± 0.03 ng/ml. Plasma and bone lanthanum levels did not correlate with the average lanthanum dose at any time point. The mean bone concentration in patients receiving LC increased from 0.05 ± 0.03 to 2.3 ± 1.6 μg/g ($P < 0.05$) after 1 year and slightly decreased at the end of the study to 1.9 ± 1.6 μg/g ($P < 0.05$).

Conclusions. Bone deposition after 1 year of treatment with LC is low (highest concentration: 5.5 μg/g). There is a slow release of lanthanum from its bone deposits 2 years after the discontinuation of the treatment and no association with aluminium-like bone toxicity.

Introduction

In patients with chronic renal failure (CRF), abnormalities in bone histology known as renal osteodystrophy (ROD) are already observed before dialysis treatment is started [1,2]. The decline in renal function in end-stage renal disease (ESRD), leads to high serum phosphorus levels, which stimulate parathyroid hormone (PTH) secretion [3]. Additionally, insufficient calcitriol production in patients with ESRD and/or insufficient calcium intake [4] may increase PTH secretion and thus can contribute to the development of high-turnover ROD indirectly. Hence, to achieve an adequate control of hyperphosphataemia, patients are administered phosphate binders, of which aluminium hydroxide and calcium carbonate (CC) have historically been the most widely used. Although very effective, aluminium containing compounds accumulate in the body and can lead to the development of low-turnover bone diseases (osteomalacia or adynamic bone), encephalopathy and/or microcytic anaemia [5,6]. Calcium-based binders, particularly when used in combination with vitamin D analogues, may result in over-suppression of PTH and development of adynamic bone disease. In particular, a high intake

lanthanum carbonate. It can be concluded that lanthanum is not genotoxic and that lanthanum carbonate is unlikely to present a latent hazard in therapeutic use.

Long-Term Efficacy and Tolerability of Lanthanum Carbonate: Results from a 3-Year Study

Nephron Clin Pract 2006;102:c61–c71

Alastair J. Hutchison[a] Bart Maes[b] Johan Vanwalleghem[c] Gernot Asmus
Elfatih Mohamed[a] Roland Schmieder[e] Wolfgang Backs[f] Rene Jamar[g]
Andre Vosskühler[h]

Nephrol Dial Transplant (2007) 22: 316–318
doi:10.1093/ndt/gfl720
Advance Access publication 6 December 2006

Lanthanum carbonate—new data on parathyroid hormone control without liver damage

Mario Cozzolino and Diego Brancaccio

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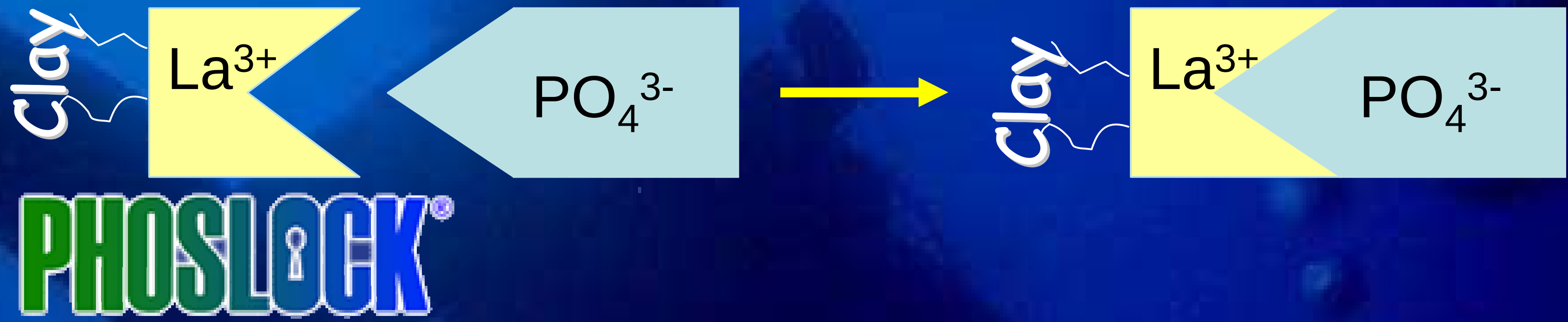
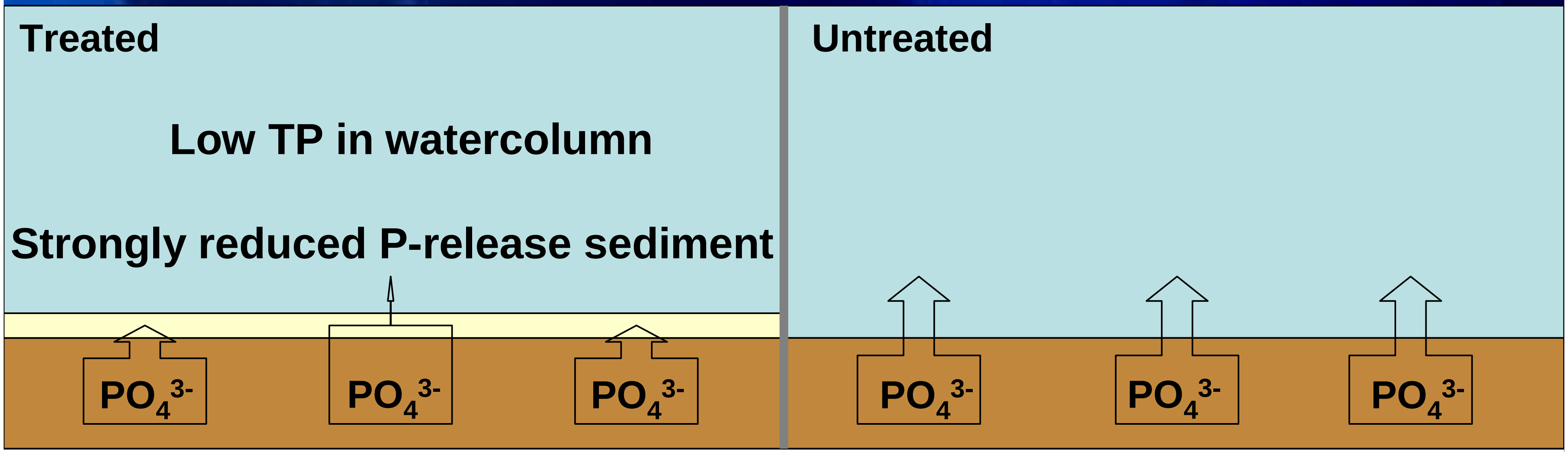
Extreem laag oplosbaarheidsproduct lanthaan – orthofosfaat (rhabdophane):

$$La^{3+} + PO_4^{3-} \rightarrow LaPO_4 \cdot nH_2O\,(s)$$

Ksp = $10^{-24.7}$ to $10^{-25.7}$ mol^2 l^{-2} at 25°C

Johanneson & Lyons 1994; Liu & Byrne 1997





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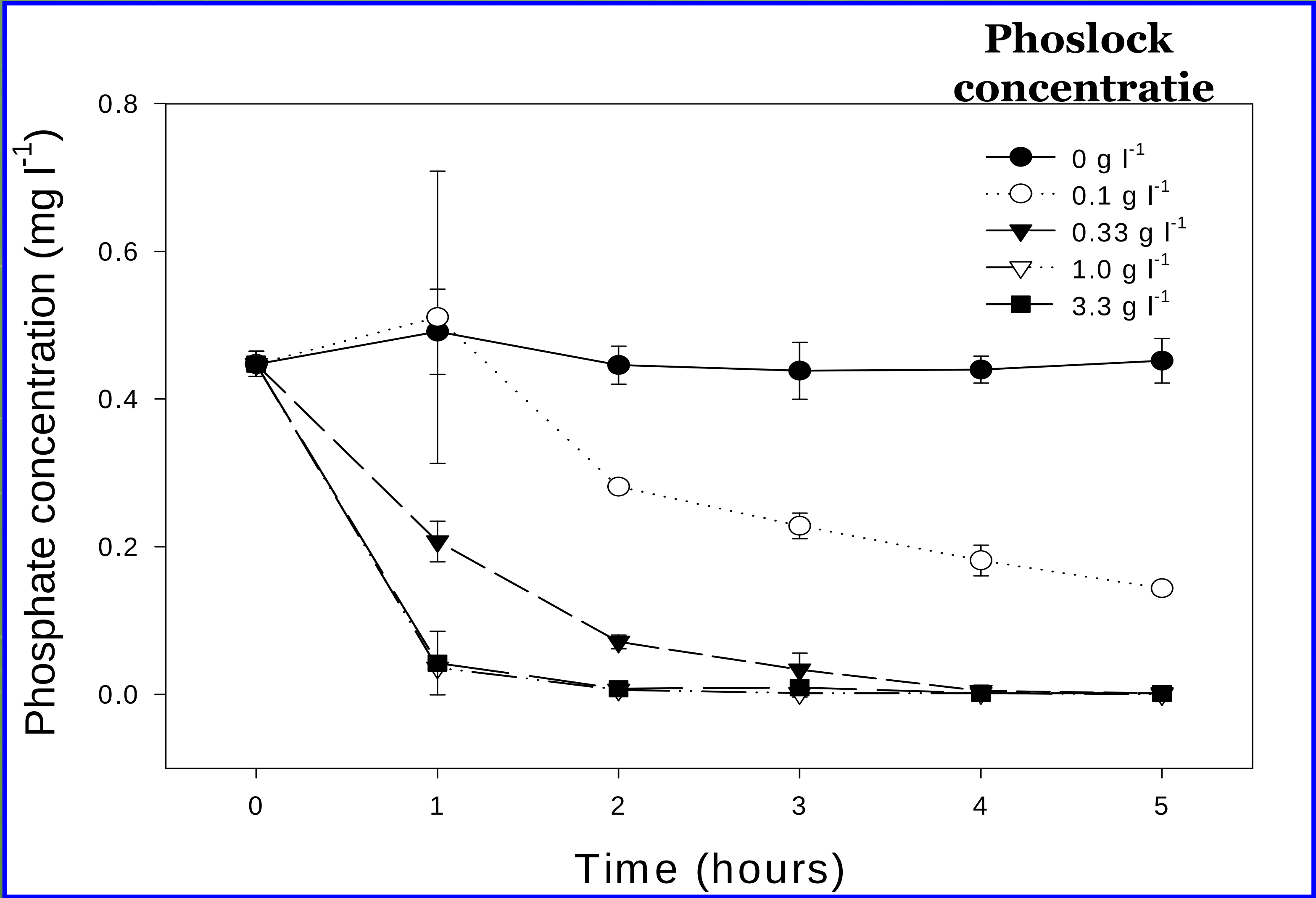

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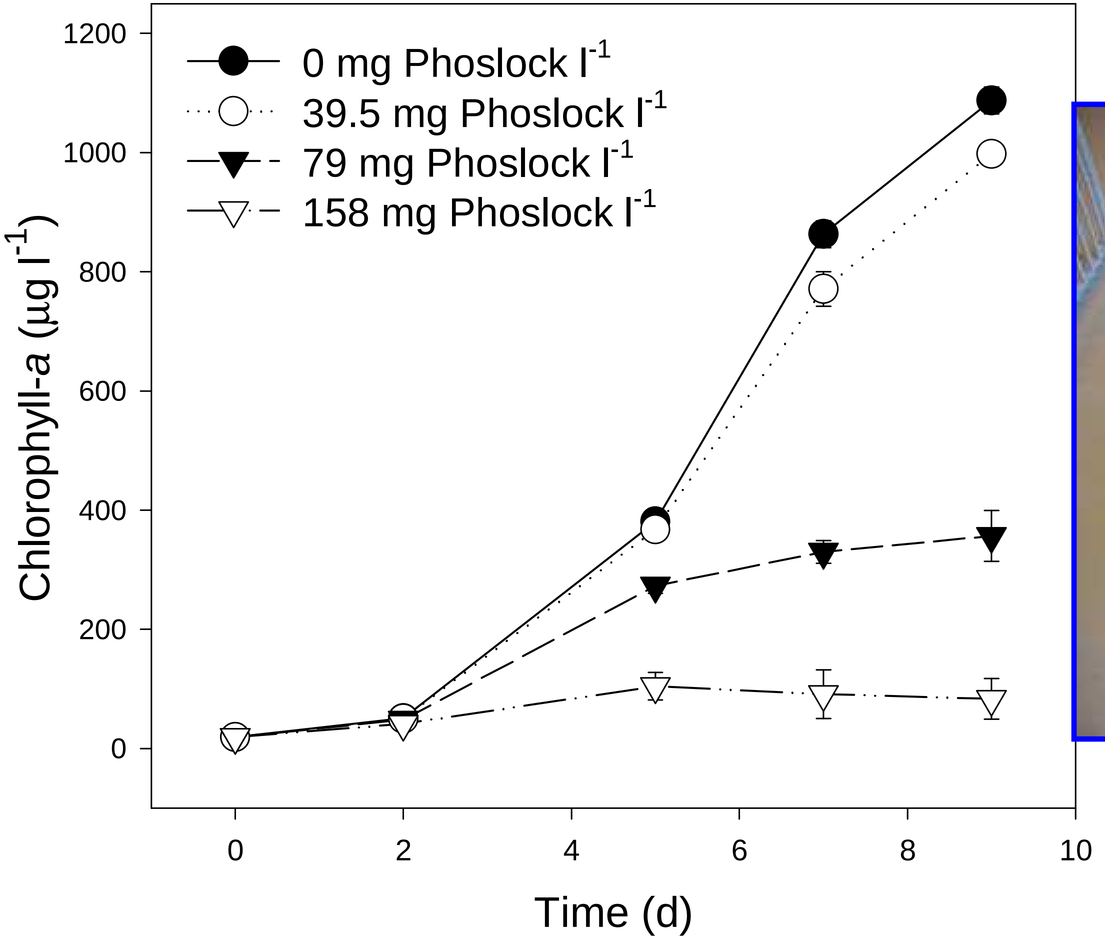
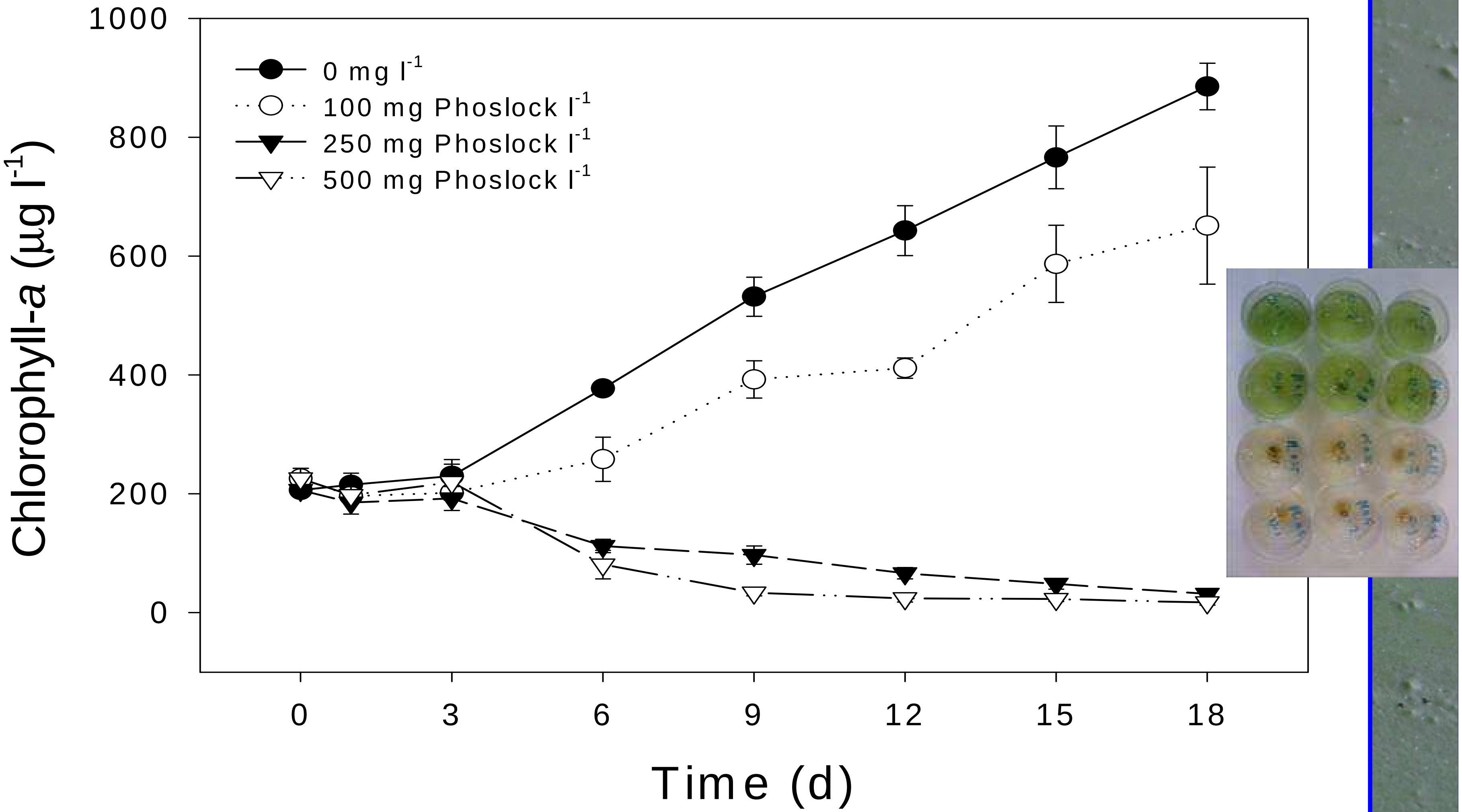
Is het ook niet langer biobeschikbaar?

Medium 385 µg P l^{-1}, *Microcystis aeruginosa*



Effect op *Anabaena* bloei



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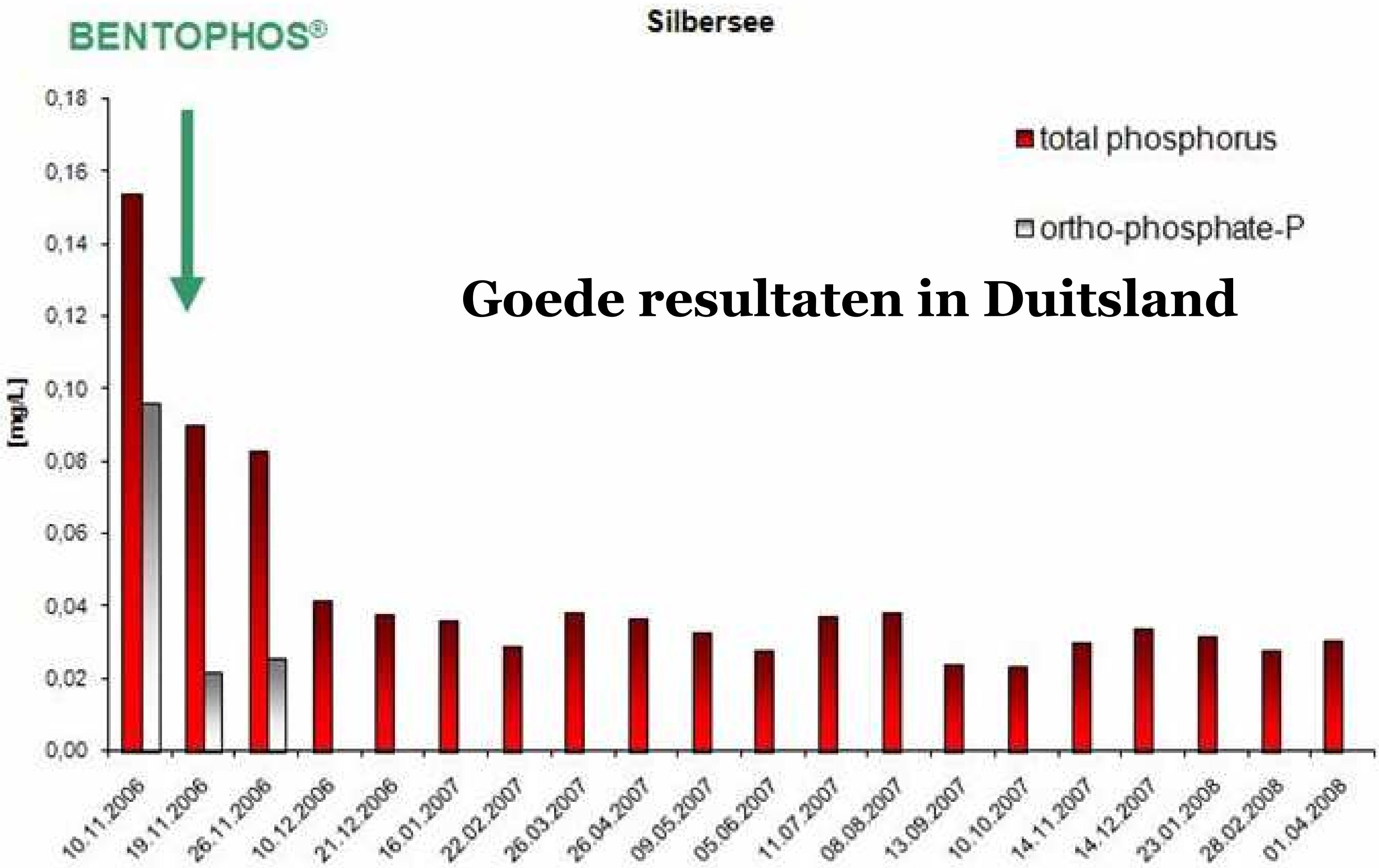
Goede resultaten in Duitsland



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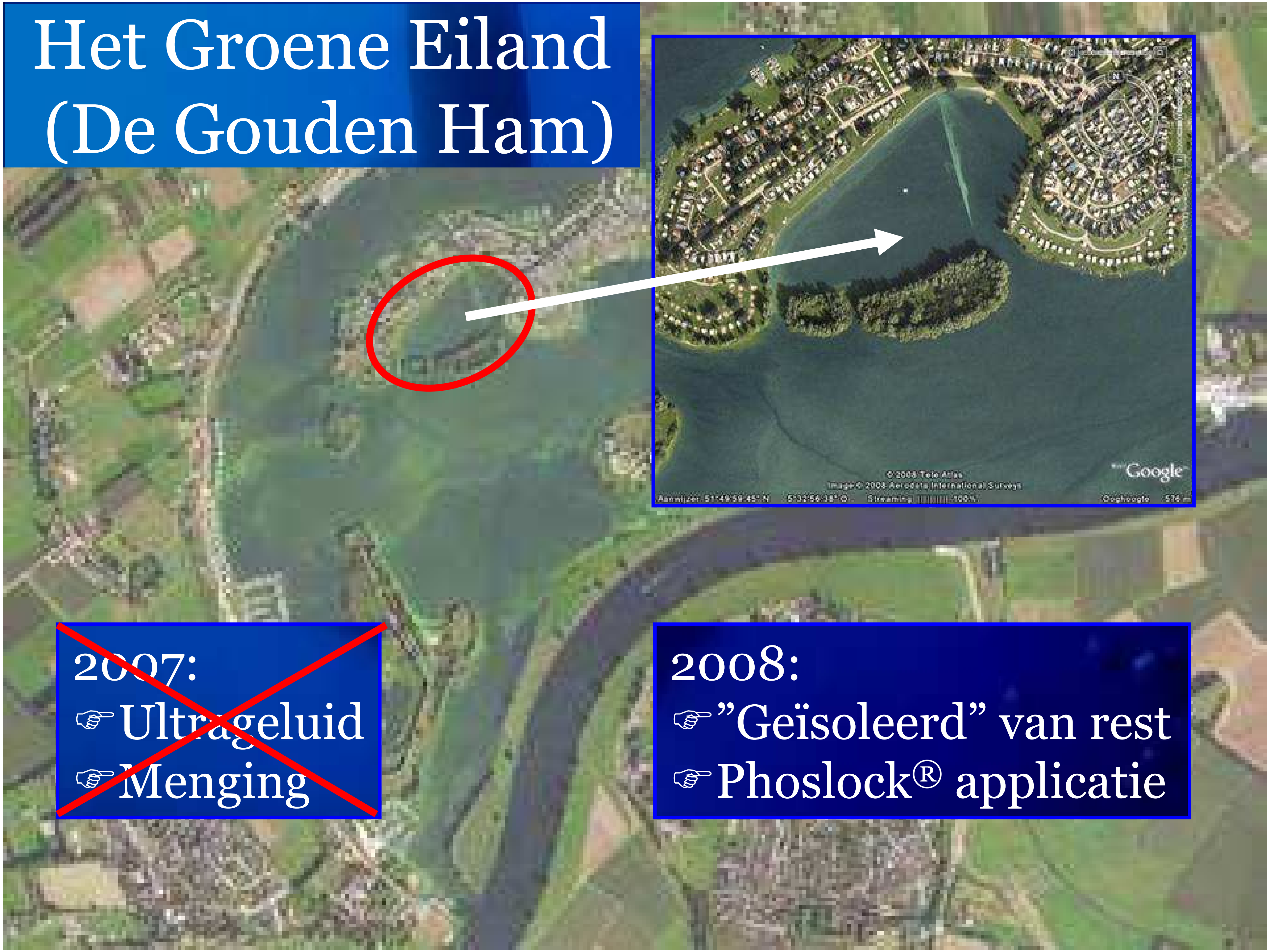
Het Groene Eiland (De Gouden Ham)



~~2007:~~

- ~~Ultrageluid~~
- ~~Menging~~

2008:

- "Geïsoleerd" van rest
- Phoslock® applicatie

Foto's Instituut Dr Nowak


PHOSLOCK

Fosfaat is de sleutel tot succesvol herstel

letters to nature

Phosphate concentrations in lakes

Jeff J. Hudson*†, William D. Taylor‡ & David W. Schindler*

* *Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E9, Canada*
‡ *Department of Biology, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada*

Phosphate is an important nutrient that restricts microbial production in many freshwater[1–3] and marine environments[4–6].

Limnol. Oceanogr., 51(1, part 2), 2006, 356–363

Recent advances in the understanding and management of eutrophication

D. W. Schindler[1]
Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E9, Canada

Abstract

Major advances in the scientific understanding and management of eutrophication have been made since the late 1960s. The control of point sources of phosphorus reduced algal blooms in many lakes. Diffuse nutrient sources from land use changes and urbanization in the catchments of lakes have proved possible to control but require many years of restoration efforts. The importance of water residence time to eutrophication has been recognized. Changes in aquatic communities contribute to eutrophication via the trophic cascade, nutrient stoichiometry, and transport of nutrients from benthic to pelagic regions. Overexploitation of piscivorous fishes appears to be a particularly common amplifier of eutrophication. Internal nutrient loading can be controlled by reducing external loading, although the full response of lakes may take decades. In the years ahead, climate warming will aggravate eutrophication in lakes receiving point sources of nutrients, as a result of increasing water residence times. Decreased silica supplies from dwindling inflows may increasingly favor the replacement of diatoms by nitrogen-fixing Cyanobacteria. Increases in transport of nitrogen by rivers to estuaries and coastal oceans have followed increased use of nitrogen in agriculture and increasing emissions to the atmosphere. Our understanding of eutrophication and its management has evolved from simple control of nutrient sources to recognition that it is often a cumulative effects problem that will require protection and restoration of many features of a lake's community and its catchment.

PNAS PNAS PNAS

Eutrophication of lakes cannot be controlled by reducing nitrogen input: Results of a 37-year whole-ecosystem experiment

David W. Schindler*[†], R. E. Hecky[‡], D. L. Findlay[§], M. P. Stainton[§], B. R. Parker*, M. J. Paterson[§], K. G. Beaty[§], M. Lyng[§], and S. E. M. Kasian[§]

*Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada T6G 2E9; [‡]Department of Biology, University of Minnesota, Duluth, MN 55812; and [§]Freshwater Institute, Canadian Department of Fisheries and Oceans, Winnipeg, MB, Canada R3T 2N6

Contributed by David W. Schindler, May 28, 2008 (sent for review March 25, 2008)

Lake 227, a small lake in the Precambrian Shield at the Experimental Lakes Area (ELA), has been fertilized for 37 years with constant annual inputs of phosphorus and decreasing inputs of nitrogen to test the theory that controlling nitrogen inputs can control eutrophication. For the final 16 years (1990–2005), the lake was fertilized with phosphorus alone. Reducing nitrogen inputs increasingly favored nitrogen-fixing cyanobacteria as a response by the phytoplankton community to extreme seasonal nitrogen limitation. Nitrogen fixation was sufficient to allow biomass to continue to be produced in proportion to phosphorus, and the lake remained highly eutrophic, despite showing indications of extreme nitrogen limitation seasonally. To reduce eutrophication, the focus of management must be on decreasing inputs of phosphorus.

lead to the erroneous conclusion that N inputs must be controlled to reduce eutrophication. These bioassays and the related assumptions have led to very expensive mitigation programs in several countries.

Aquatic scientists have often relied on the Redfield ratio to gauge whether nutrient supplies are sufficient. Redfield (14) observed that the ratio of carbon:nitrogen:phosphorus in marine phytoplankton was quite constant, with mean ratios by weight of ≈40:7:1. The Redfield ratio has subsequently been accepted as a general indicator for balanced growth with potential for near optimum growth rates (8). In the Experimental Lakes Area (ELA), lakes rendered eutrophic by experimental additions of N and P at N:P ratios less than Redfield ratio (7:1 weight ratio)

Empirical study of cyanobacterial toxicity along a trophic gradient of lakes

A. Giani, D.F. Bird, Y.T. Prairie, and J.F. Lawrence

Abstract: A series of 22 lakes in southern Quebec spanning a wide trophic range were sampled to develop models of changes in cyanobacterial abundance and toxicity. All lakes contained toxic cyanobacteria, and epilimnetic toxin content, expressed as microcystin equivalents, was best predicted by total nitrogen concentration and total phosphorus concentration (TP). Although phytoplankton biomass increased linearly with increases in TP among lakes, toxigenic biomass increased as greater than the squared power of TP. The only potentially toxigenic genera whose biomass was correlated with microcystin concentration were *Microcystis* and *Anabaena*. Surprisingly, the best model for toxic-species biomass was based on epilimnetic nitrogen. The level of the hepatotoxin microcystin per unit biomass in these organisms did not vary markedly among lakes, supporting the idea that environmental factors control the occurrence, but have only a limited effect on the toxicity, of potentially toxic species.

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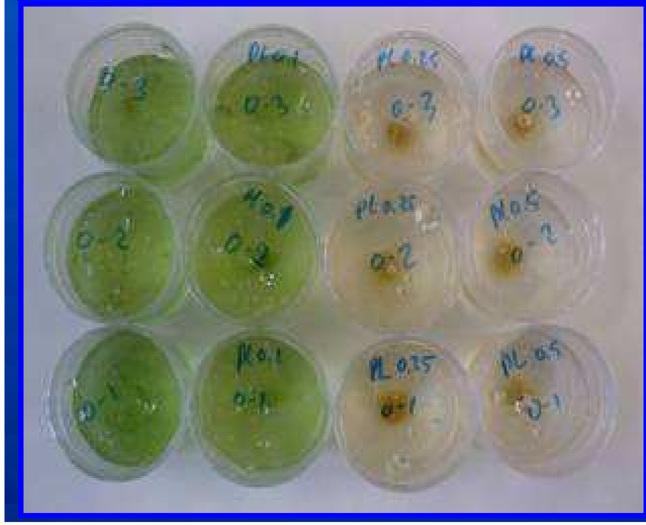
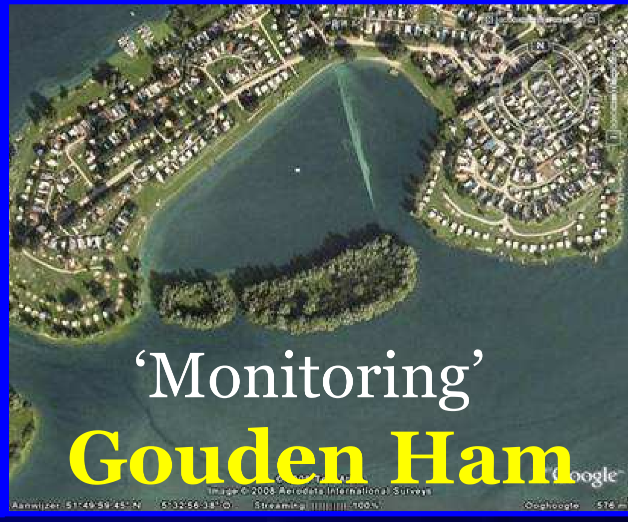
Flock?

- Vaak particulair-P aanwezig
- Onmiddellijk helder water
- Hele jaar toepasbaar

→ PAC

Laboratorium Experimenten → Gecontroleerd Veldexperiment → 'Whole-Lake' Experiment





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De Rauwbraken: toename cyanobloei sinds 2000
4 maanden zwemverbod in 2007 !

blauwalg in Rauwbraken

BD 8 juni 2007

Verdwijnen karpers mogelijk oorzaak van overlast door blauwalg.

door **Bas Markensteijn**

BERKEL-ENSCHOT – Veertig internationale studenten van de Universiteit Wageningen doen 18 en 19 juni onderzoek naar de blauwalgpopulatie in strandbad Rauwbraken in Berkel-Enschot. Zij hopen met hun onderzoek meer licht te werpen op de hoge concentratie blauwalg, waardoor het recreatiebad dit jaar nog niet open is ge-

verleden veel last gehad van de bacterie en doet sinds 2005 metingen. Blauwalgen groeien vooral in fosfaatrijk water, zeker in landbouwgebieden waar vroeger te veel kunstmest is gebruikt.
Volgens onderzoeker Frank van Oosterhout van de stichting Nederlandse Onderwaterparken (SNOP) zijn er in het verleden grove fouten gemaakt. „In de jaren tachtig zijn hier graskarpers uitgezet om alle waterplanten op te eten. Dat is rampzalig gebleken", aldus Van Oosterhout. „Waterplanten werken namelijk zuiverend, omdat ze

men." Volgens Frank van Oosterhout gaat het nu eindelijk weer goed met de populatie waterplanten. De laatste graskarper in de Rauwbraken is in 2004 gezien. „Maar blauwalgen zitten vaak op 7,5 meter en zo lang zijn de wortels van de planten nog niet."
Het is op dit moment niet te voorspellen wanneer de Rauwbraken weer open zal gaan voor publiek. Er zijn in ieder geval nog geen abonnementen uitgegeven voor dit seizoen. Als het strandbad nog opengaat deze zomer, worden de tarieven van de abonnementen

De Rauwbraken is een zorgenkindje

Blauwalg in zwemwater Berkel-Enschot vraagt structurele oplossing.

door **Ben Ackermans**

BERKEL-ENSCHOT – Er is nog een beetje hoop voor de zwemlustigen in Berkel-Enschot. Als een gisteren genomen monster van het water van de Rauwbraken vrij blijkt te zijn van blauwalg, kan het

de Rauwbraken wordt begroot op 22.000. In een bijzondere zomer kan dat tot 35.000 doorschieten. Maar dan moet wel die vermaledijde alg wegblijven.
„We bekijken daarom of een structurele oplossing te vinden is", zegt sportwethouder Jan Hamming.

kindje. In de zomer van 2005 ging de ketting vanwege de alg bijna twee maanden om de poorten. Vorig jaar bleef dat het strandbad bespaard, nu is het opnieuw raak.
„Het moet niet jaar over jaar gebeuren. Dat zou voor Berkel-Enschot een ramp zijn."
Inwoners van het dorp vormen verreweg de grootste klandizie van het zwemwater dat al een lange geschiedenis kent.
Het jaarlijks bezoekersaantal van

moet dan wel worden gefilterd."
Ook uitbaggeren van het ven zou kunnen bijdragen aan een watermilieu waarin de blauwalg het minder naar zijn zin heeft.

Blauwalg vertraagt opening Rauwbraken

BERKEL-ENSCHOT – Doordat in het water van natuurbad De Rauwbraken in Berkel-Enschot blauwalgen

dicht.

Zie verder pagina 2 en 3.

Vanaf woensdag 15 juni is Strandbad Rauwbraken in Berkel-Enschot tijdelijk gesloten vanwege de constatering van blauwalg in het zwemwater. Ondanks de lage concentratie is in overleg met de Provincie en het Waterschap besloten het strandbad te sluiten en geen risico´s te nemen ten aanzien van de gezondheid van de bezoekers. De sluiting is naar verwachting van korte duur, aangezien de blauwalg

Blauwalg in Strandbad Rauwbraken

in het stadium van afsterven is. Zodra het strandbad weer geopend mag worden, wordt deze informatie vermeld op www.sportintilburg.nl. Mocht u de afge-

“Herstel De Rauwbraken”

☞ Oevers/vegetatie

☞ Vis verwijdering 2001 – 2003 (graskarpers ≤ 92 cm) Rauwbraken stocked in jaren 80 met 500 graskarpers

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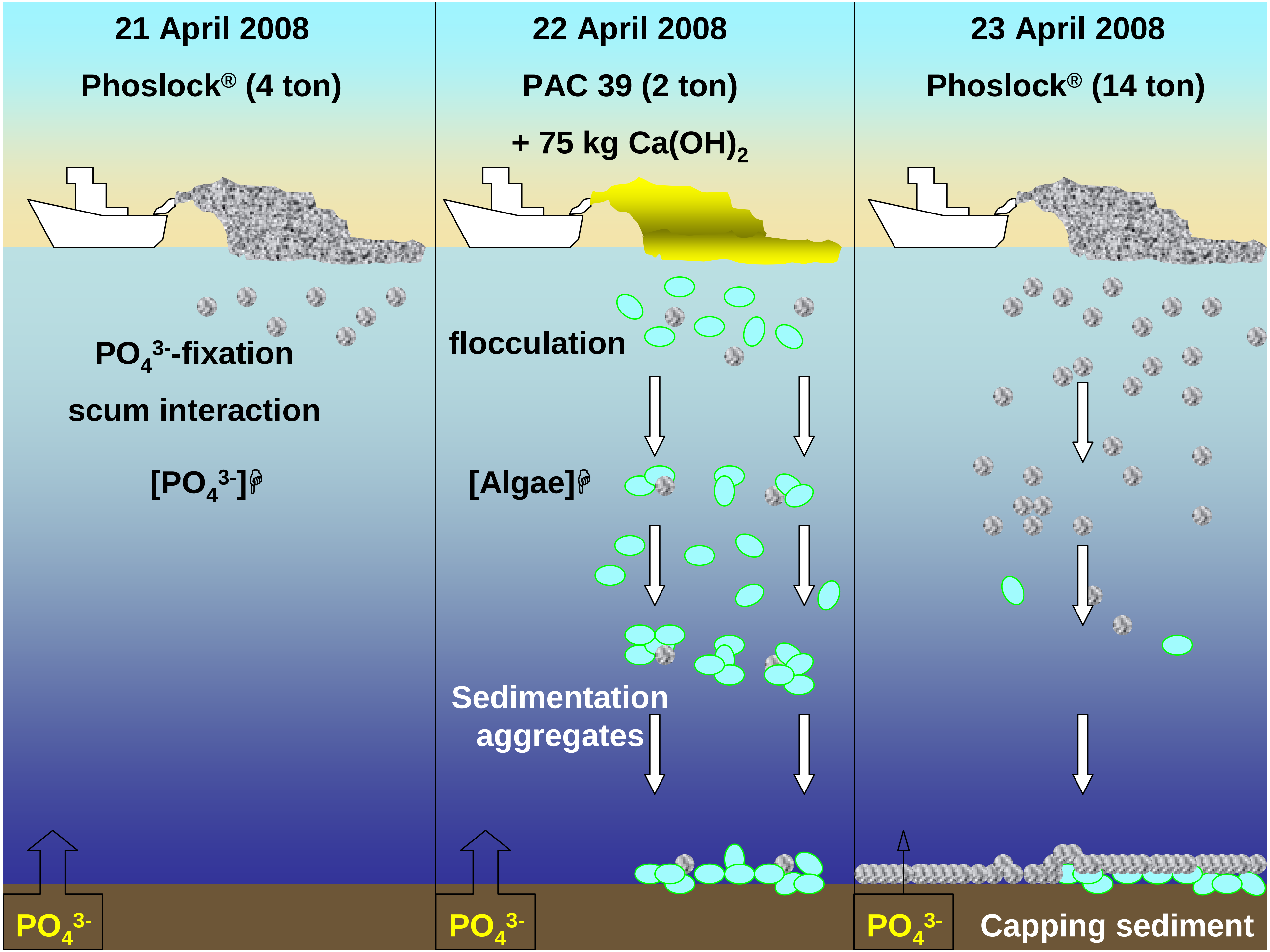
April 2008: Drijflaag *Aphanizomenon*



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Sedimentation aggregates
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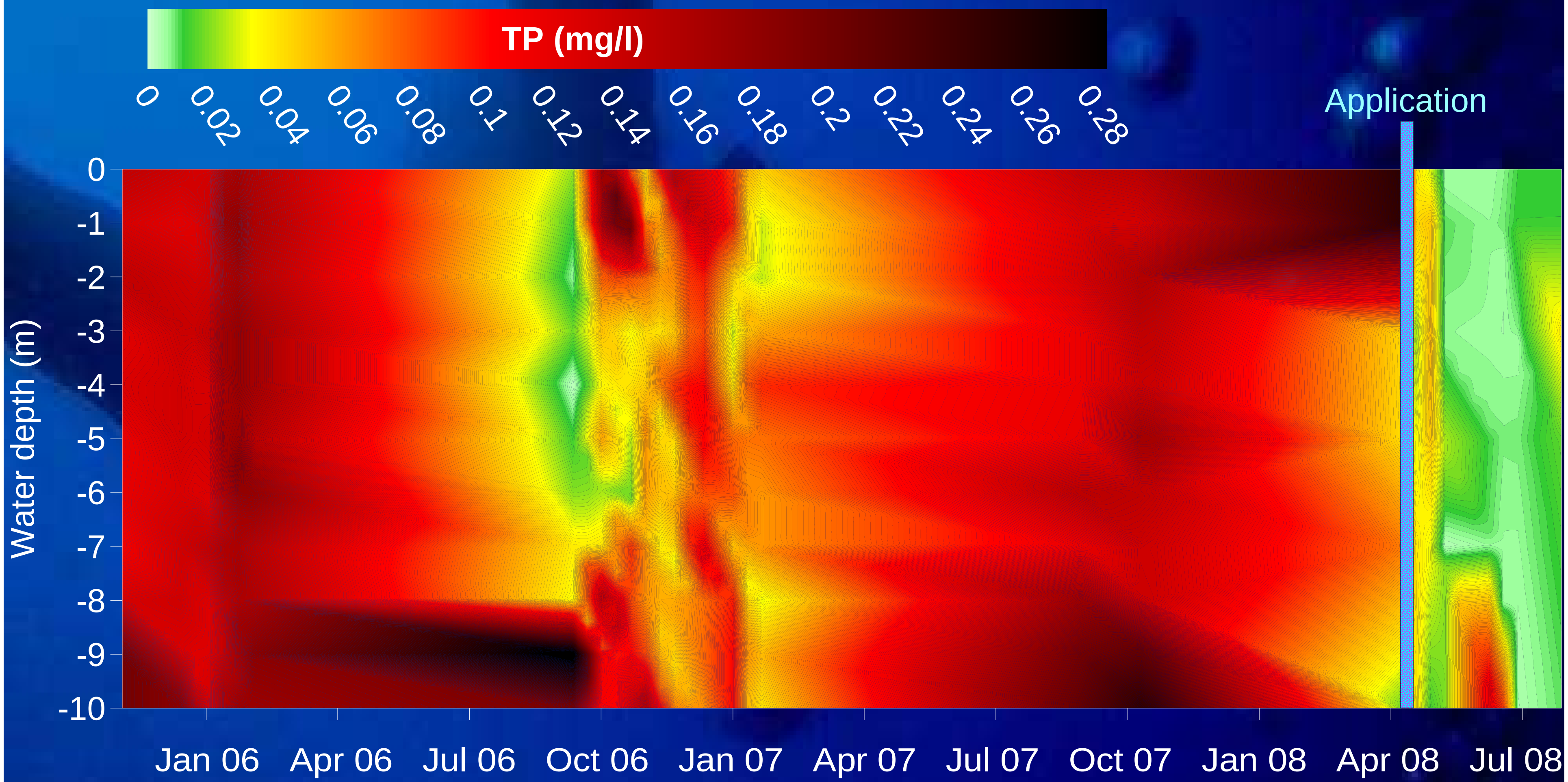
Totaal P (fosfor)



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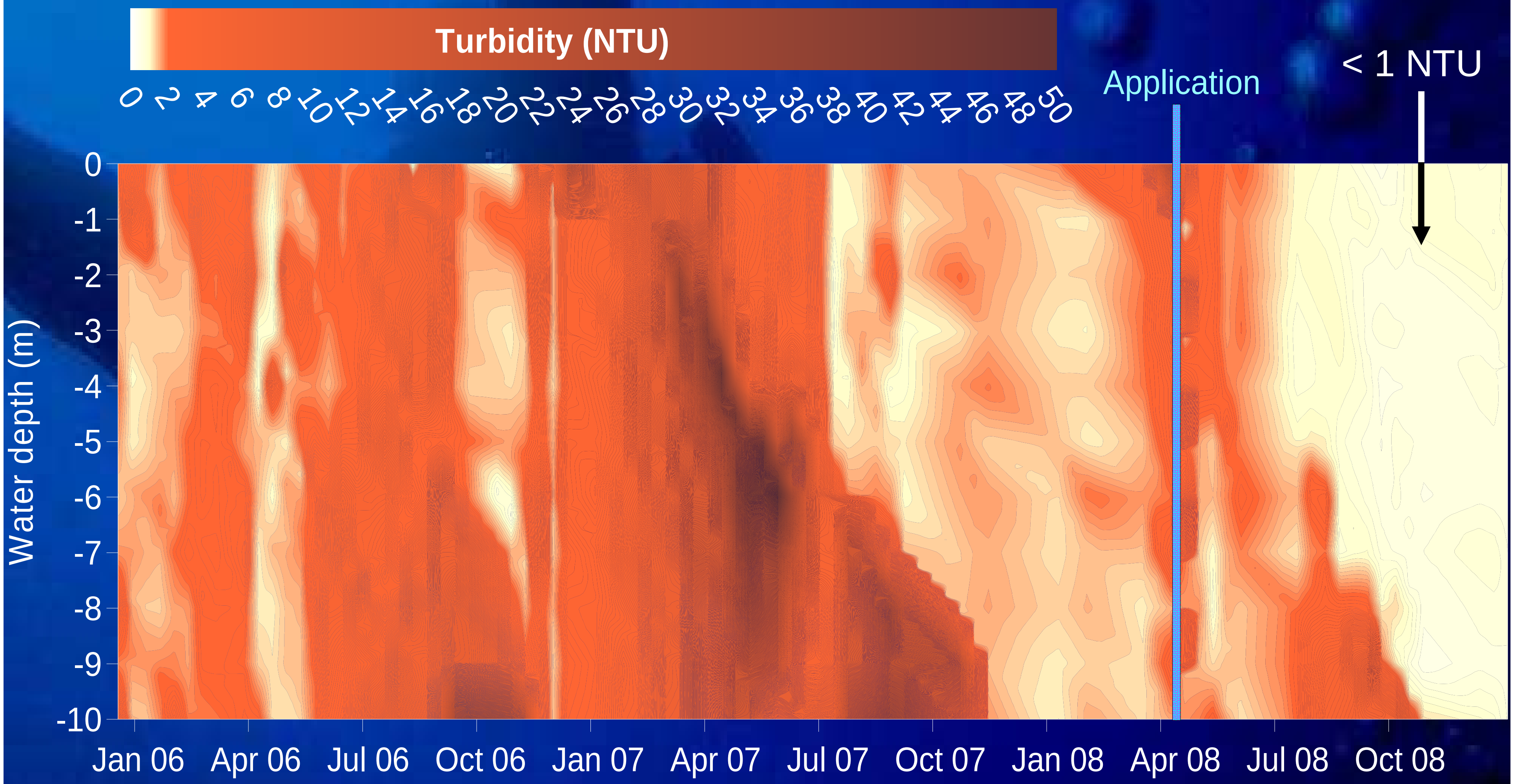
Turbiditeit



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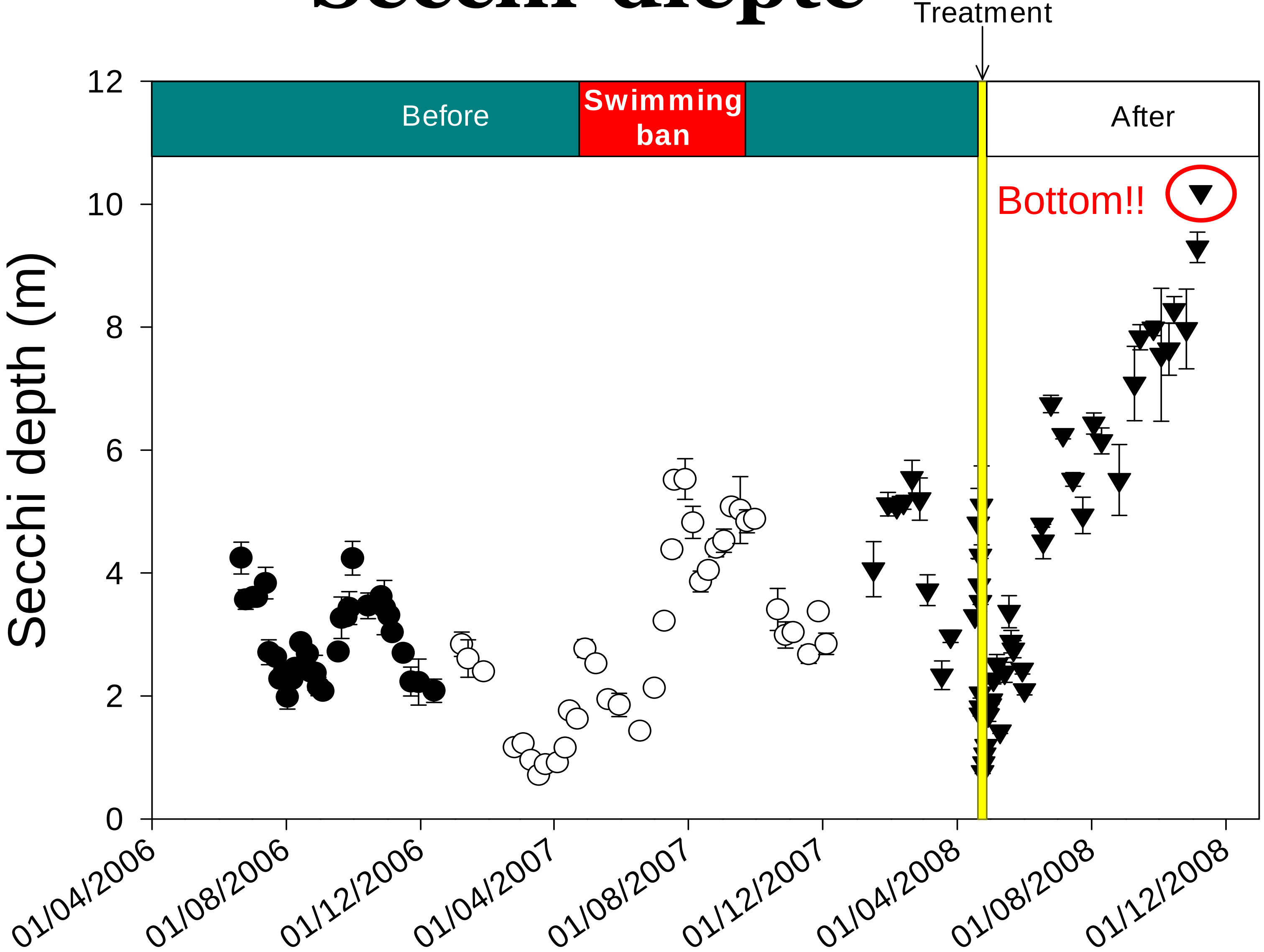
Secchi-diepte



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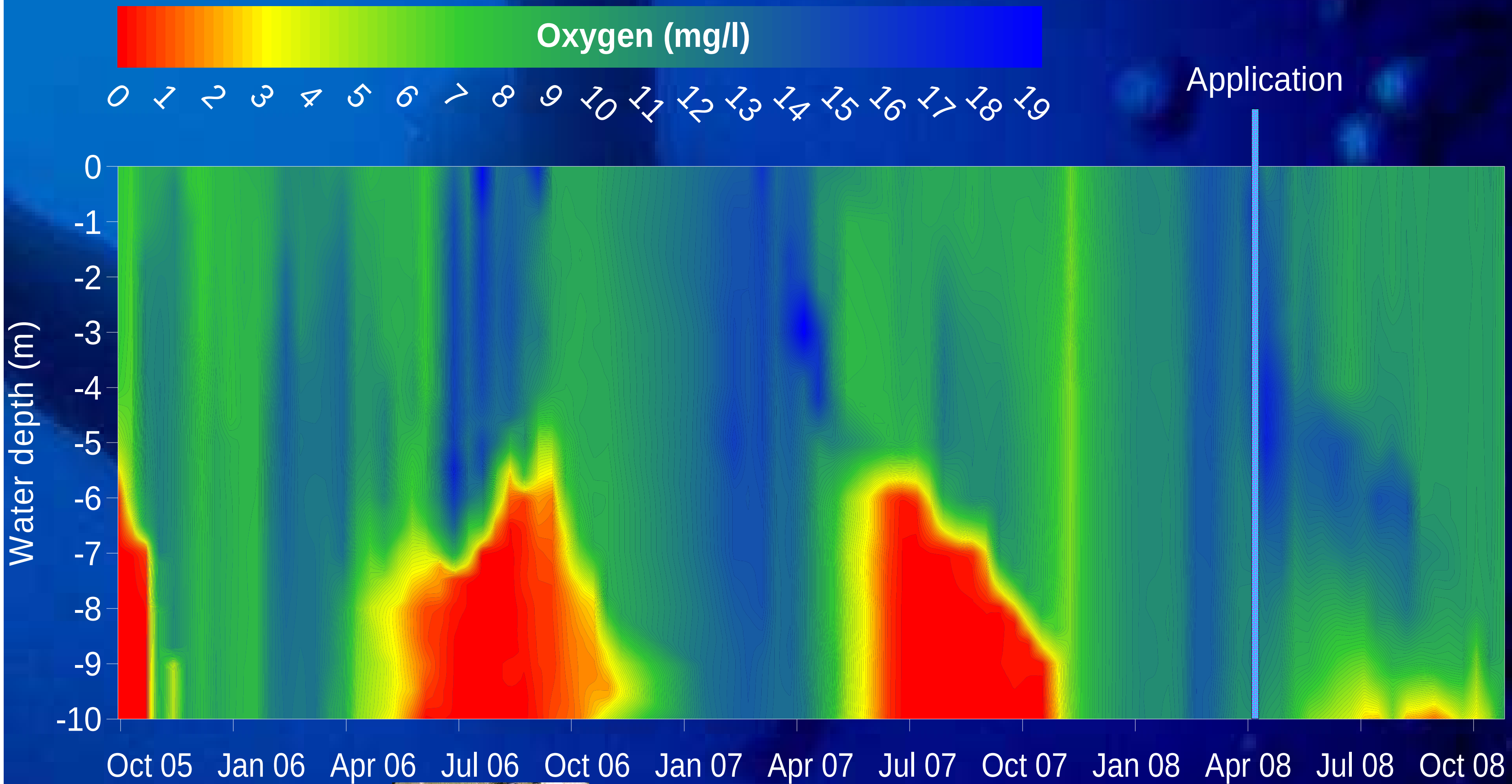
Zuurstof



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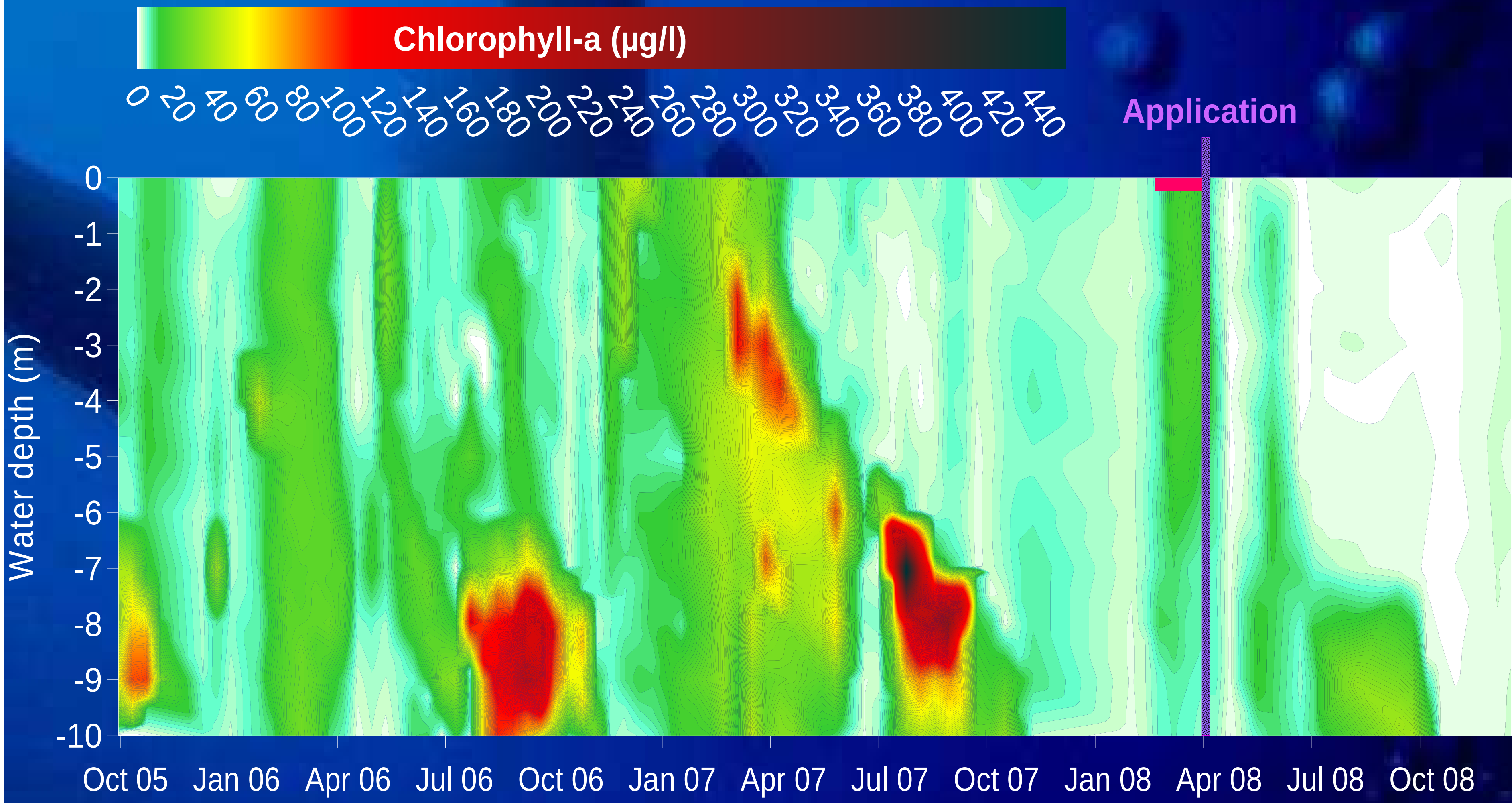
Chlorofyl-*a*



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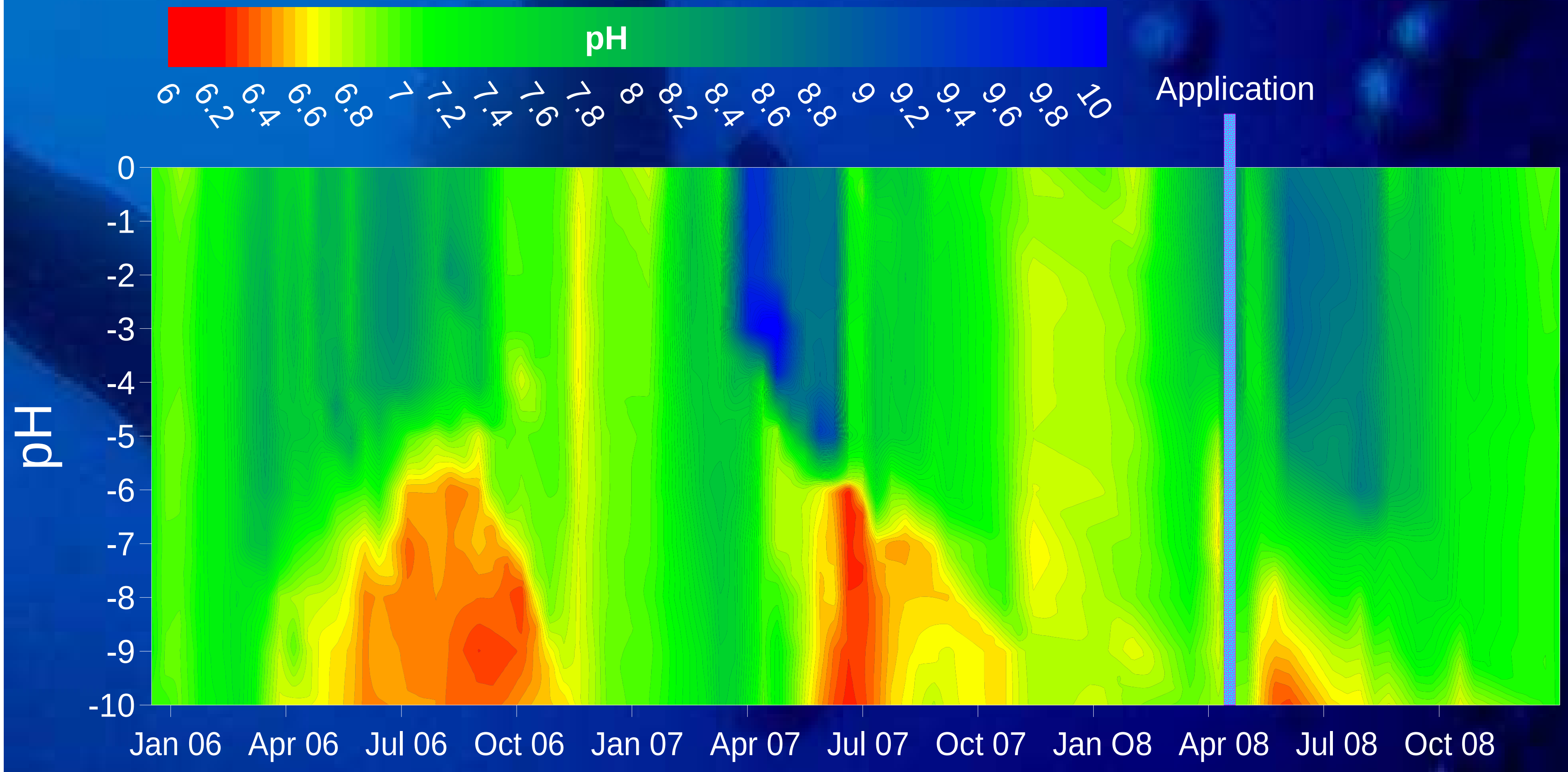
pH



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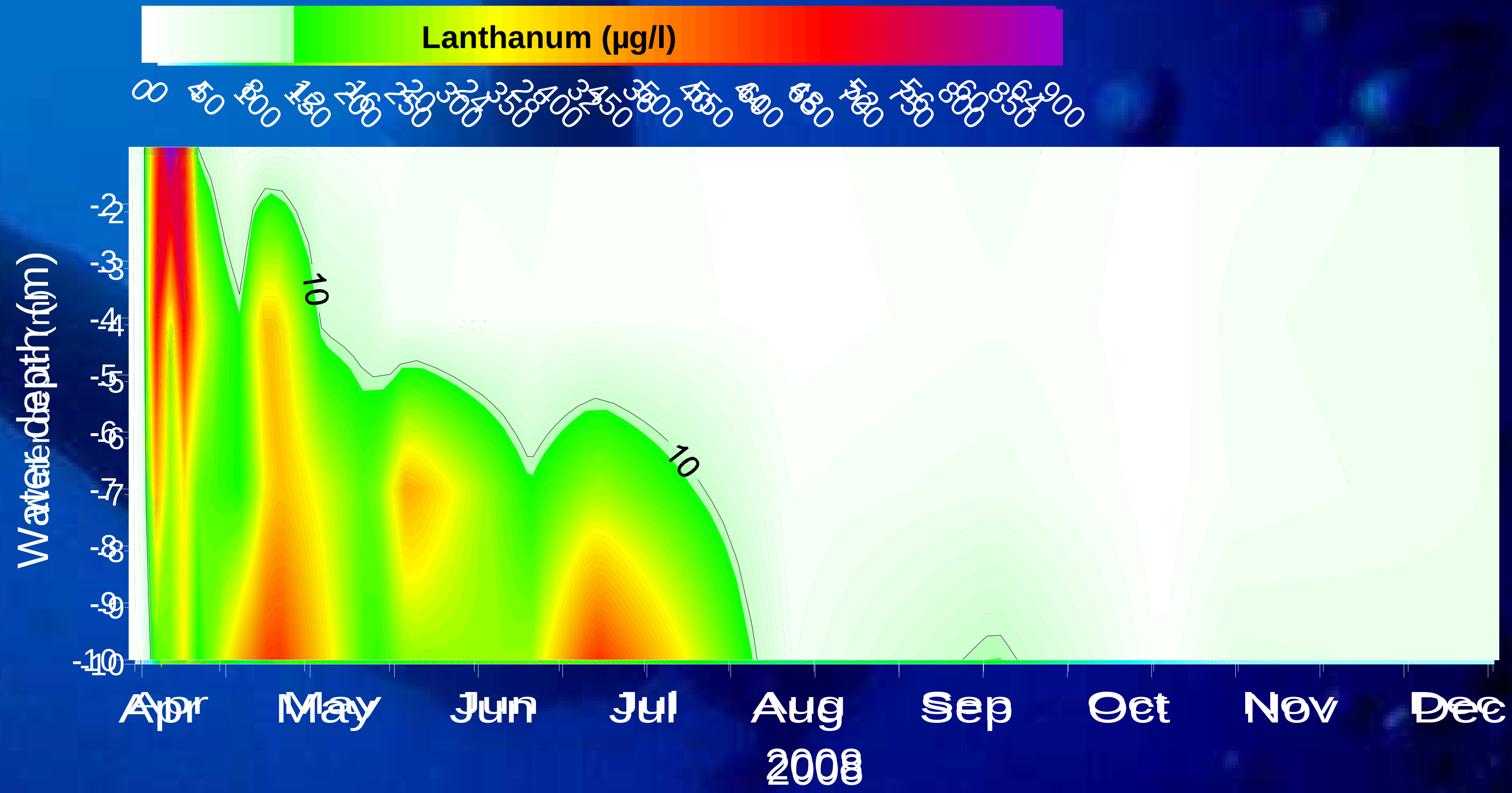
Filtreerbaar Lanthaan



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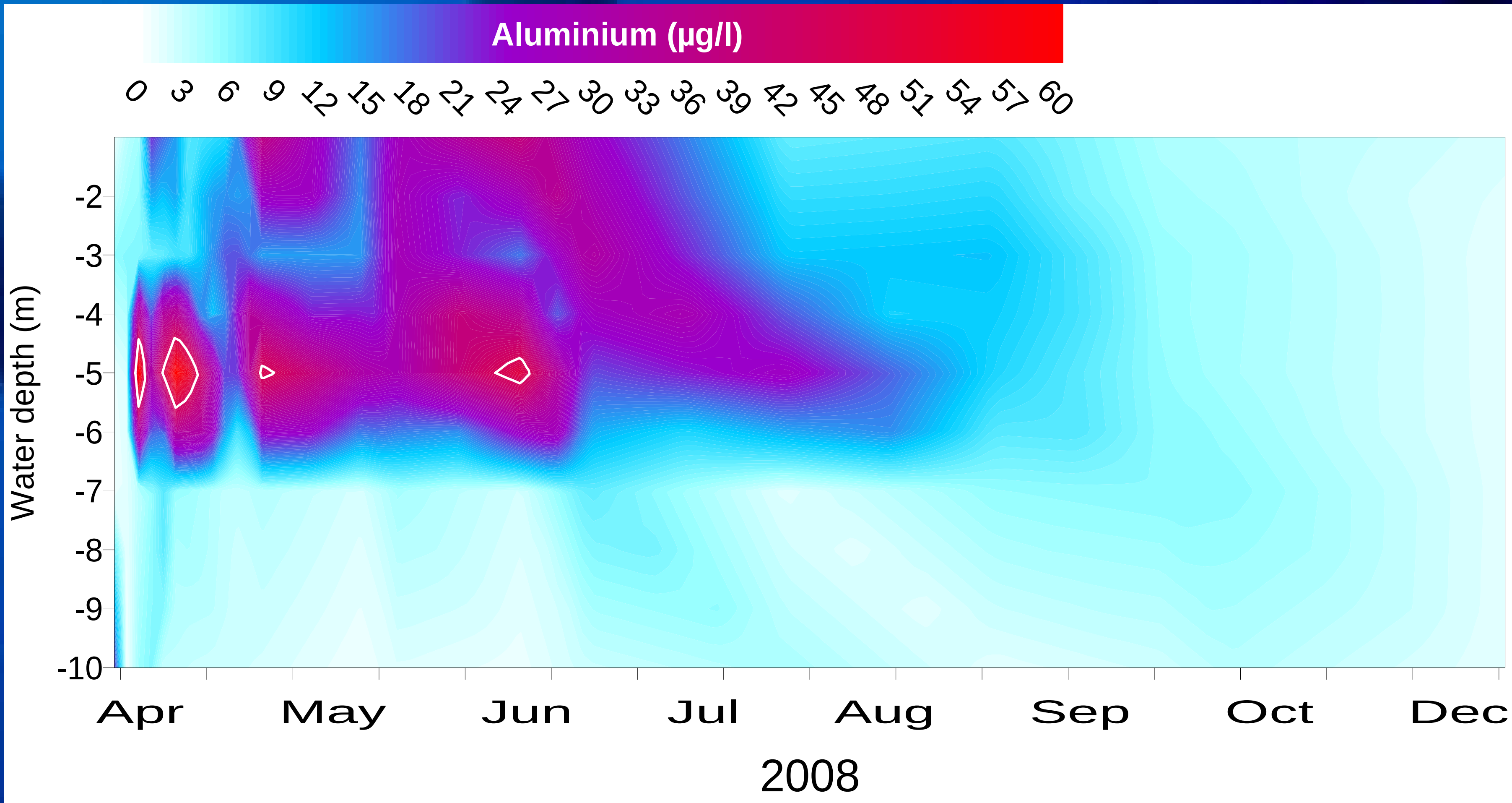
Filtreerbaar Aluminium



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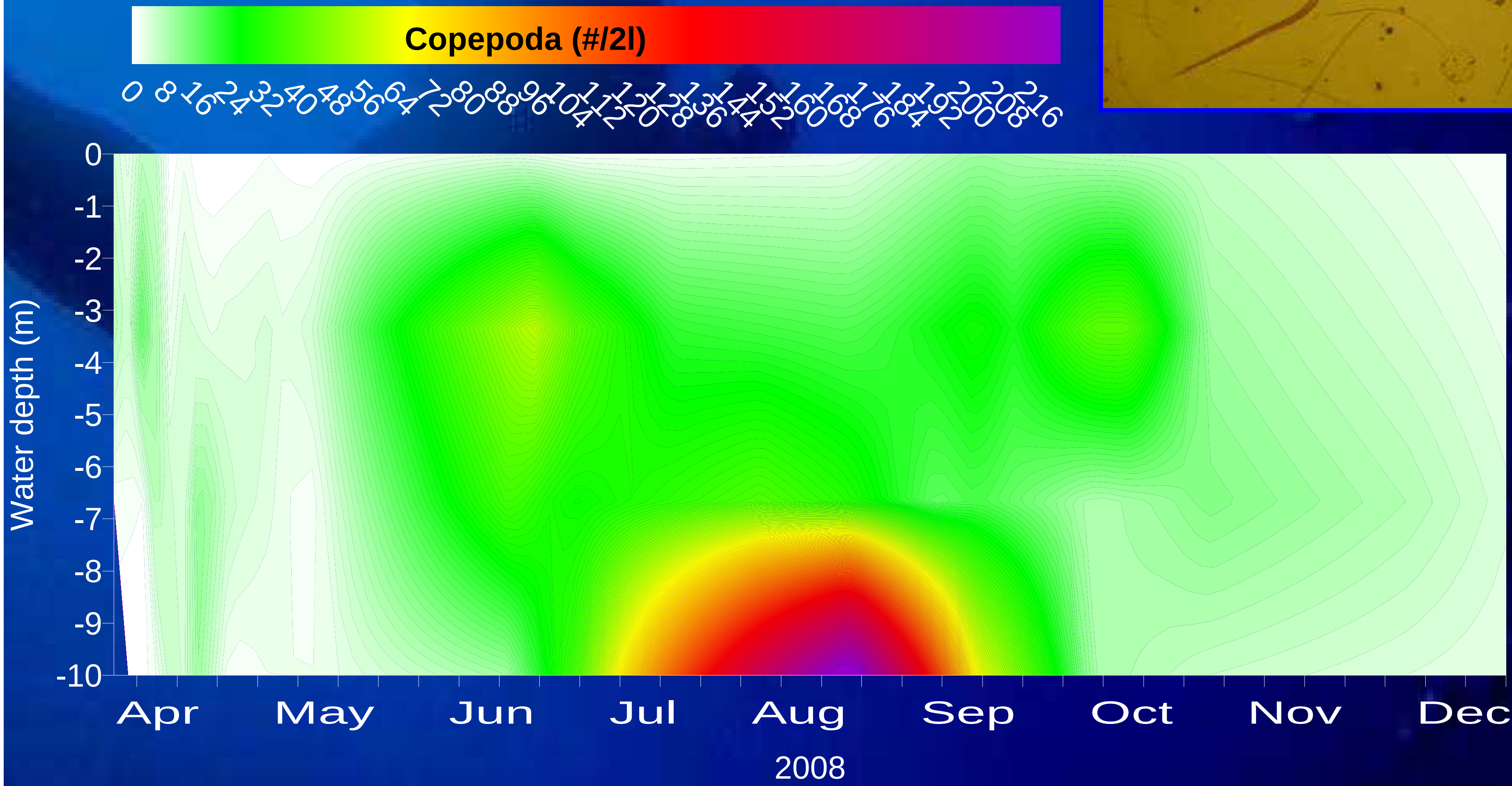
Copepoda



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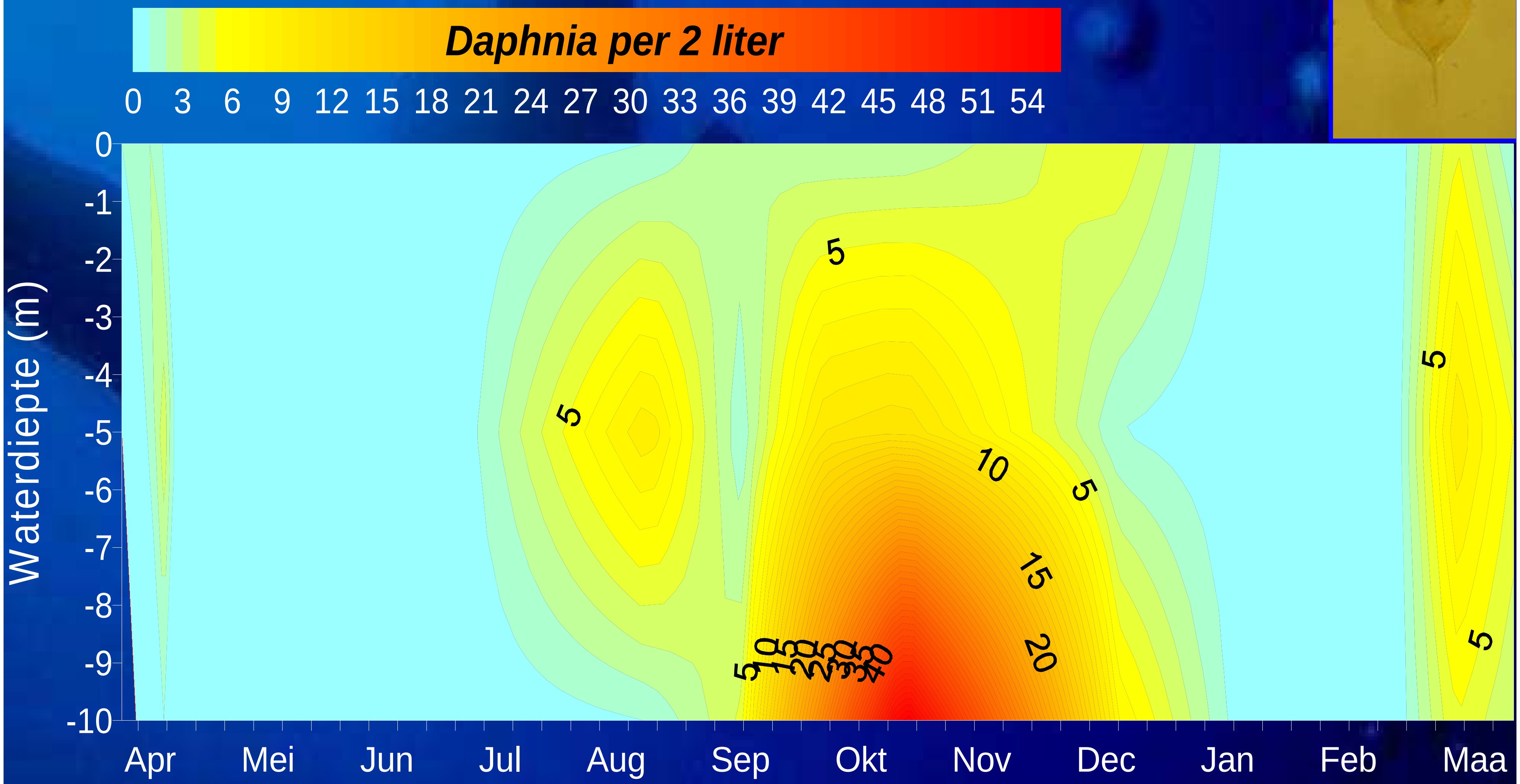
Daphnia



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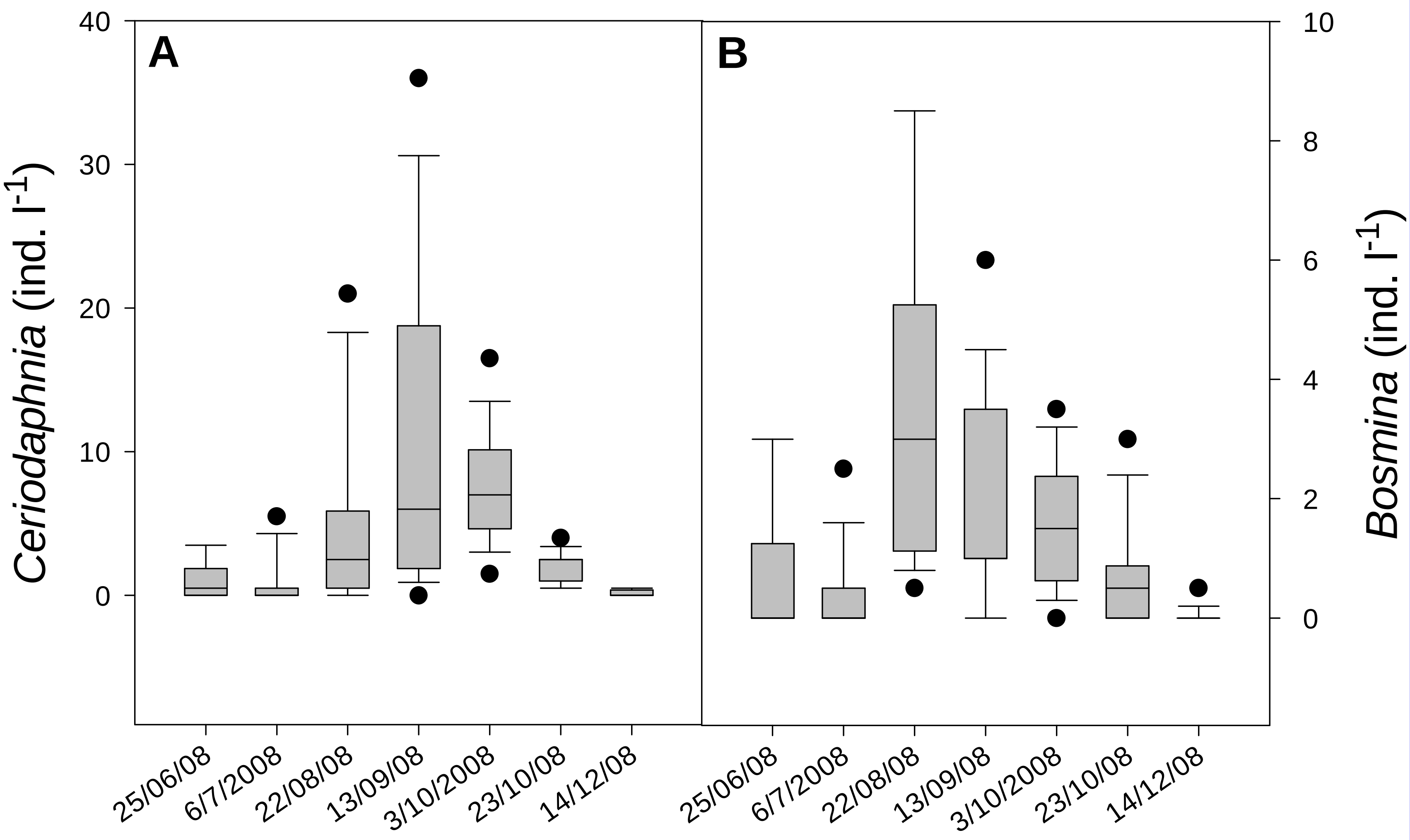
A
B
Ceriodaphnia (ind. l-1)
Bosmina (ind. l-1)
40
30
20
10
0
10
8
6
4
2
0
25/06/08
6/7/2008
22/08/08
13/09/08
3/10/2008
23/10/08
14/12/08
25/06/08
6/7/2008
22/08/08
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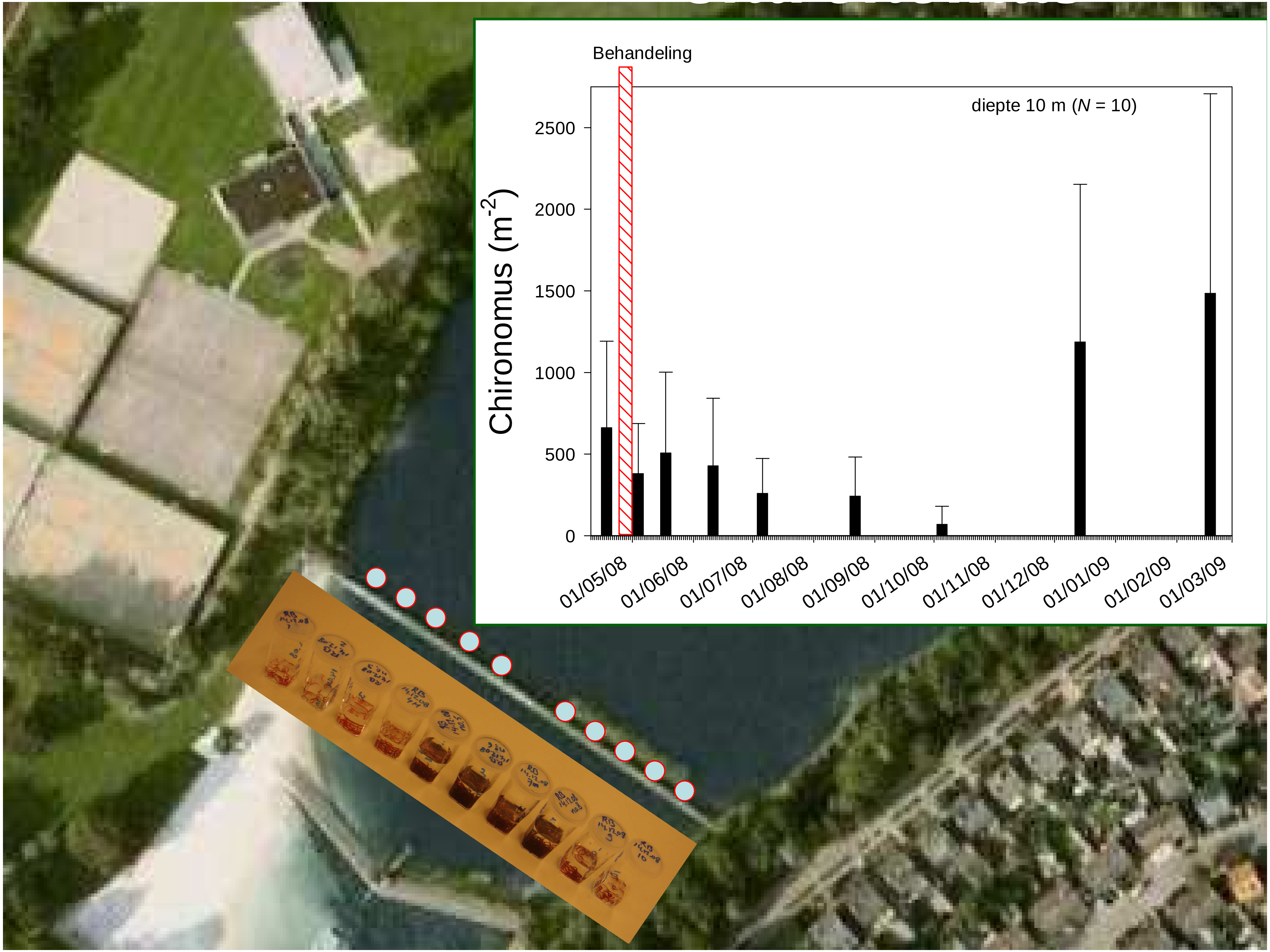
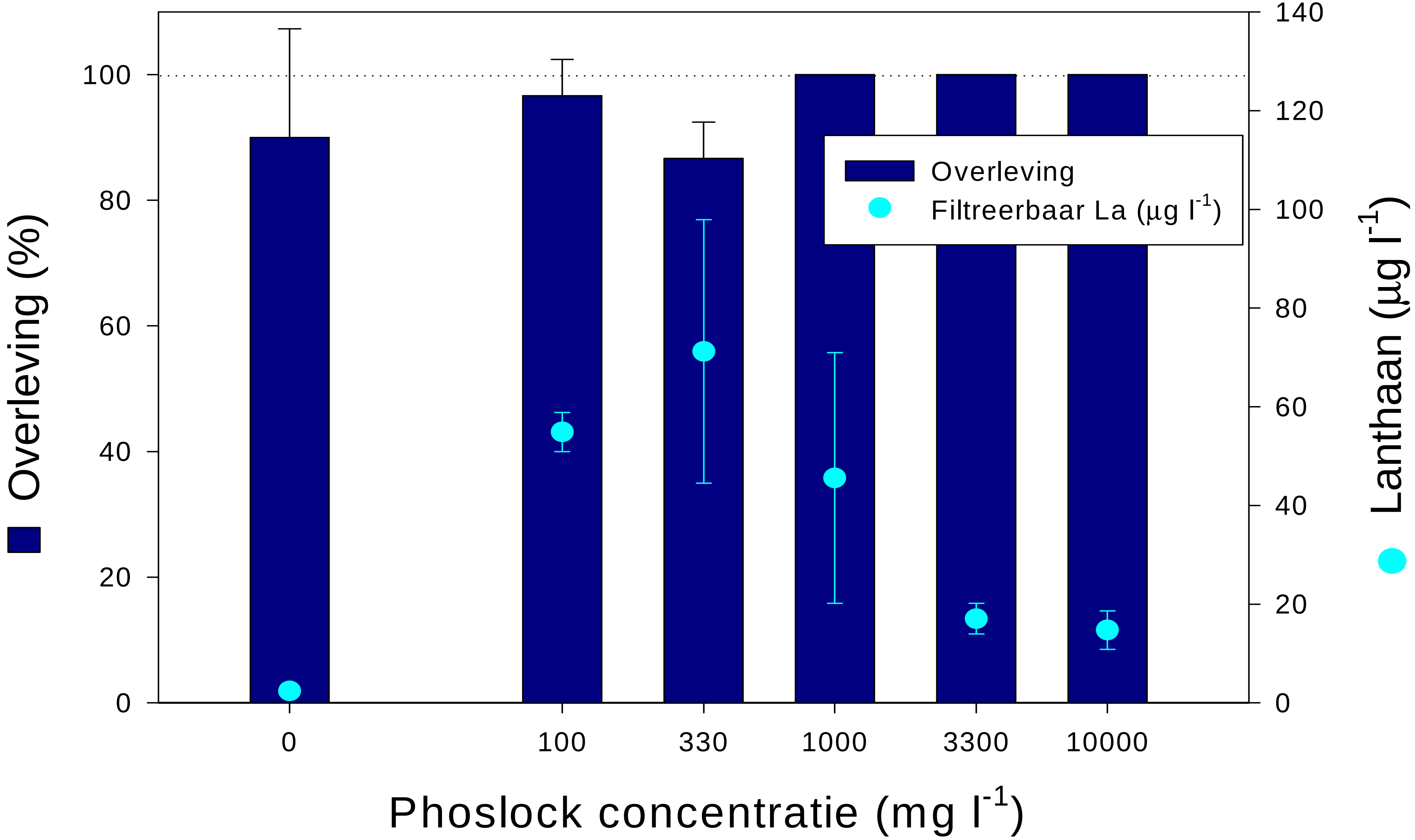
3/10/2008
23/10/08
14/12/08



Behandeling
diepte 10 m (N = 10)
Chironomus (m-2)
0
500
1000
1500
2000
2500
01/05/08
01/06/08
01/07/08
01/08/08
01/09/08
01/10/08
01/11/08
01/12/08
01/01/09
01/02/09
01/03/09

Chironomus 7 d-assay



Phoslock® laag in diepe deel onzichtbaar

Lanthaan metingen zullen verduidelijken

Modificatie: hypolimnetische injectie

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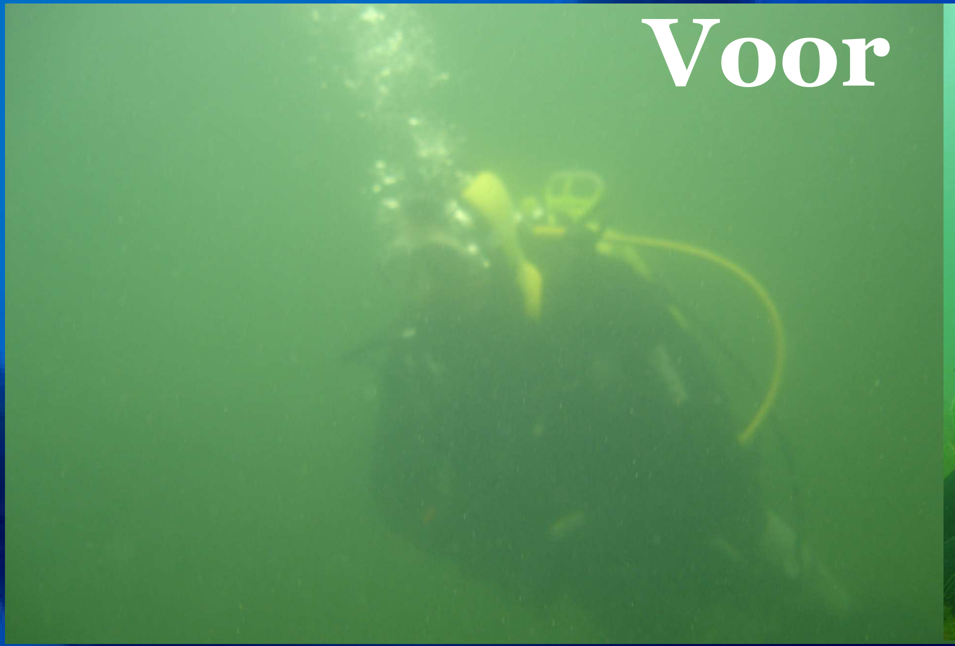
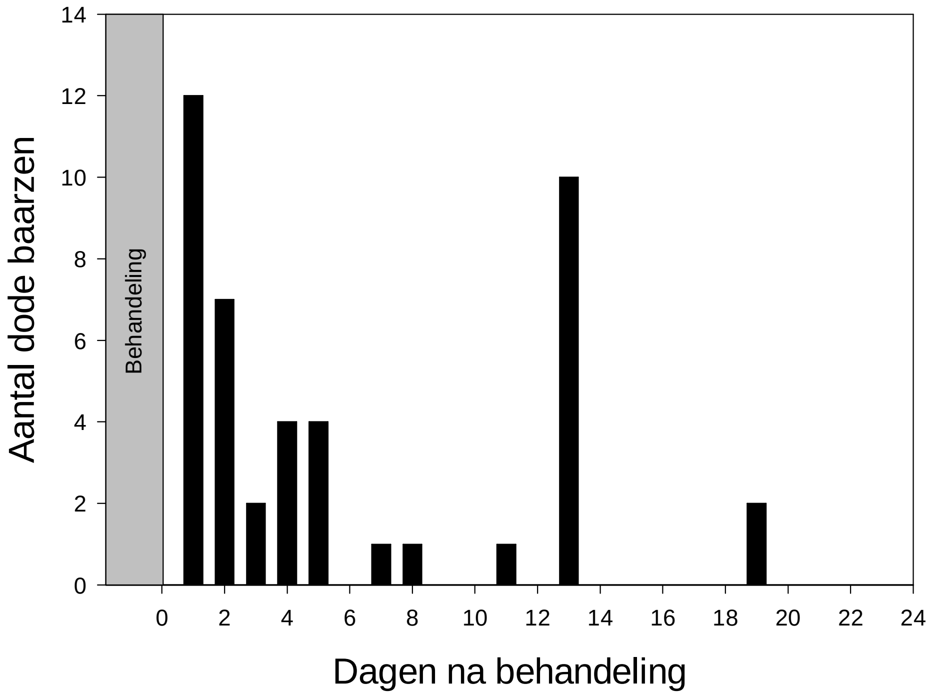
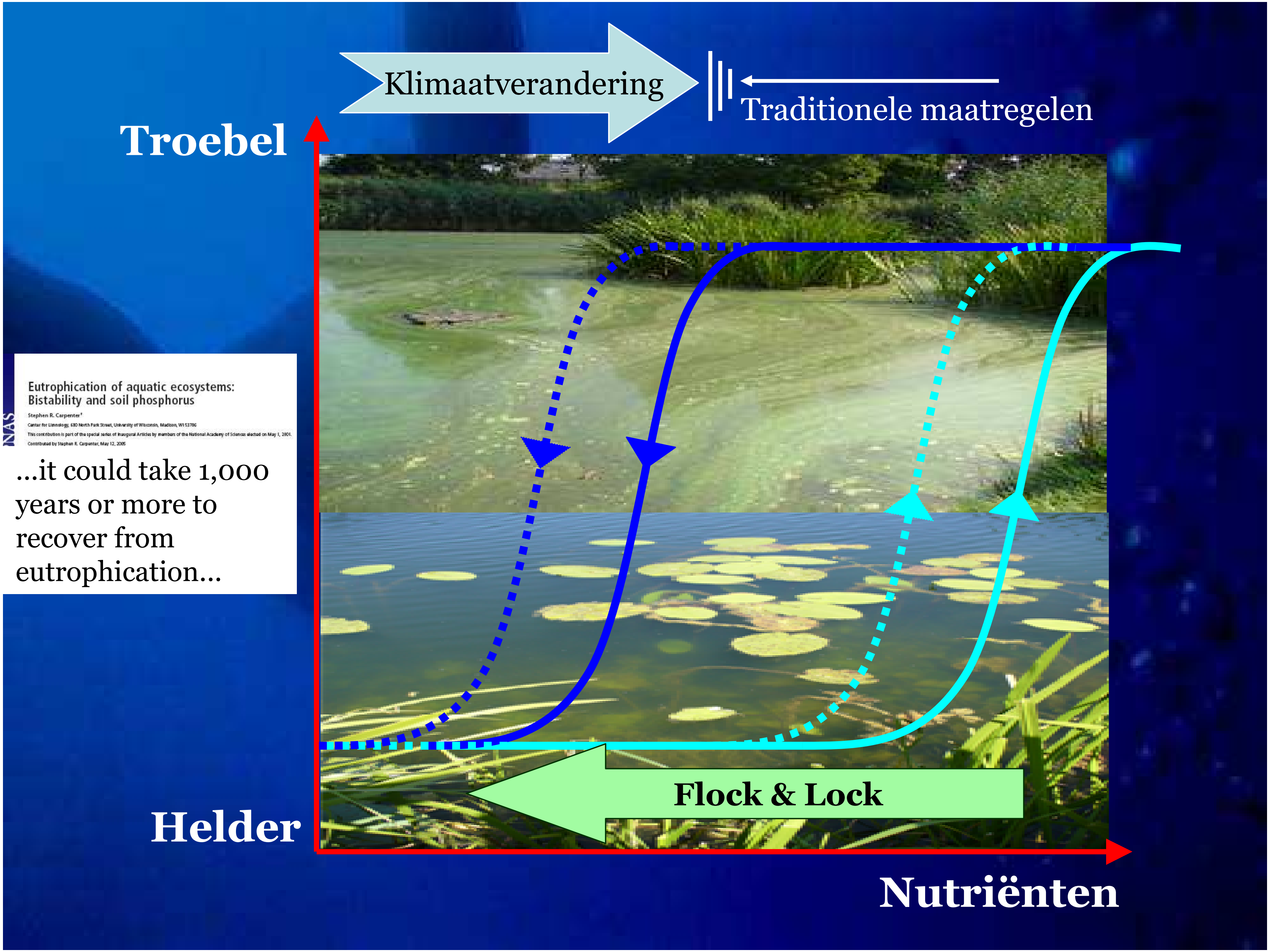


TP	107 ± 60 µg l^{-1}	20 ± 20 µg l^{-1}
PO_4	18 ± 26 µg l^{-1}	5 ± 4 µg l^{-1}
CHL-*a*	19 ± 35 µg l^{-1}	4 ± 7 µg l^{-1}
NTU	5.3 ± 7.5	2.4 ± 2.4 (1.6 ± 1.0)
Sd	3.1 ± 1.2 m	4.4 ± 2.6 (5.2 ± 2.6)
Hypol.	Geen O_2	Ja O_2
Zwemverboden		Geen zwemverbod



Aantal dode baarzen
14
12
10
8
6
4
2
0
Behandeling
0
2
4
6
8
10
12
14
16
18
20
22
24
Dagen na behandeling


Klimaatverandering
Traditionele maatregelen
Troebel
Eutrophication of aquatic ecosystems:
Bistability and soil phosphorus
Stephen R. Carpenter
Center for Limnology, 680 North Park Street, University of Wisconsin, Madison, WI 53706
This contribution is part of the special series of Inaugural Articles by members of the National Academy of Sciences elected on May 1, 2001.
Contributed by Stephen R. Carpenter, May 12, 2005
…it could take 1,000 years or more to recover from eutrophication…
Flock & Lock
Helder
Nutriënten

research for man and environment

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NATIONAL INSTITUTE OF PUBLIC HEALTH AND THE ENVIRONMENT

Tabel I. MTT, achtergrondconcentratie (Cb) en MTR voor oppervlaktewater (opgelost), sediment, en bodem

Element	oppervlaktewater (µg/L)						sediment (g/kg d.s.)						bodem (mg/kg d.s.)		
	zoet			zout			zoet			zout					
	MTT	*Cb*	MTR	MTT	*Cb*	MTR	MTT	*Cb*	MTR	MTT	*Cb*	MTR	MTT	*Cb*	MTR
Y	6.2	0.22[a]	6.4	0.72	0.22[a]	0.94	1.4	0.017	1.4	0.16	0.019	0.18			
La	10.0	0.08[a]	10.1	1.0	0.012	1.01	4.7	0.039	4.7	0.47	0.044	0.51			
Ce	22.0	0.13[a]	22.1	0.15	0.13[a]	0.28	18.7	0.069	18.8	0.13	0.093	0.22	44	9.0	53
Pr	9	0.08[a]	9.1	0.92	0.08	1.00	5.8	0.008	5.8	0.60	0.011	0.61			
Nd	1.4	0.39[a]	1.8	0.85	0.0092	0.86	7.2	0.036	7.5	0.44	0.040	0.48			
Sm	7.6	0.56[a]	8.2	0.42	0.0005	0.42	2.5	0.006	2.5	0.14	0.008	0.15			
Gd	6.8	0.33[a]	7.1	0.52	0.33[a]	0.85	1.8	0.005	1.8	0.14	0.006	0.14			
Dy	9.1	0.22[a]	9.3	3.6	0.22[a]	3.8	2.2	0.004	2.2	0.88	0.004	0.89			

[a]Detection limit

RIZA, Lelystad
[3]Department of Radiochemistry, Interfaculty Reactor Institute, Delft

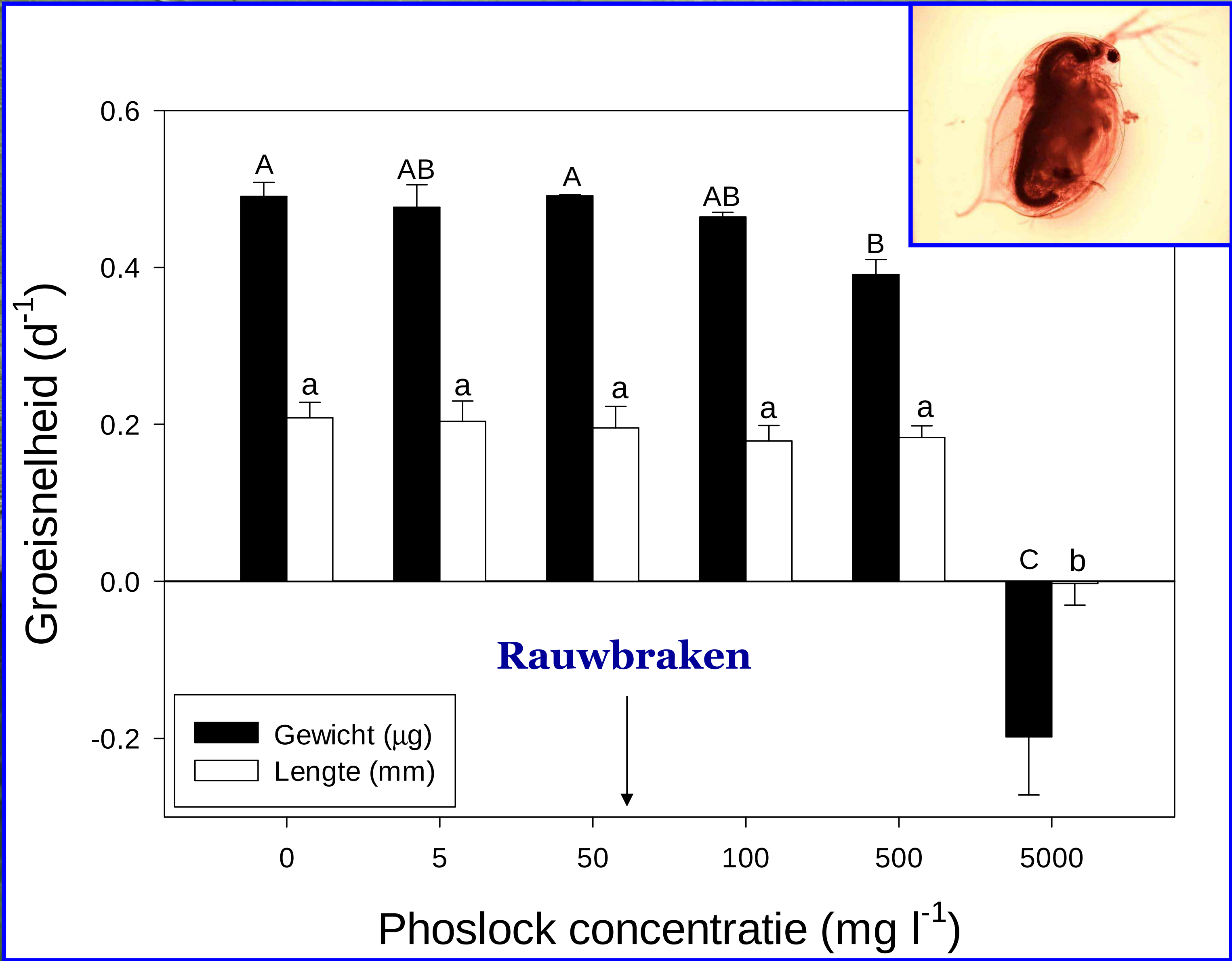
Table 1. Metals (in $\mu g\ l^{-1}$, ± 1 SD, $N = 3$) measured in 0.45 µm filtrates from 5 $g\ l^{-1}$ suspension of two different batches of Phoslock®.

	Al	Cd	Cu	Hg	La	Pb	Zn
Control	0.7 (1.3)	0	0.17 (0.09)	< 1	0	0	9.9 (2.1)
Batch 1	218.1 (145.5)	0	0.31 (0.09)	< 1	22.9 (17.5)	0.02 (0.02)	30.3 (18.0)
Batch 2	16.2 (2.6)	0	0.21 (0.10)	< 1	3.4 (0.8)	0 (0.01)	26.2 (15.0)

Uit 5 g Phoslock l^{-1}

In Rauwbraken 60 mg l^{-1}

→ 0.04 – 0.3 µg La l^{-1}



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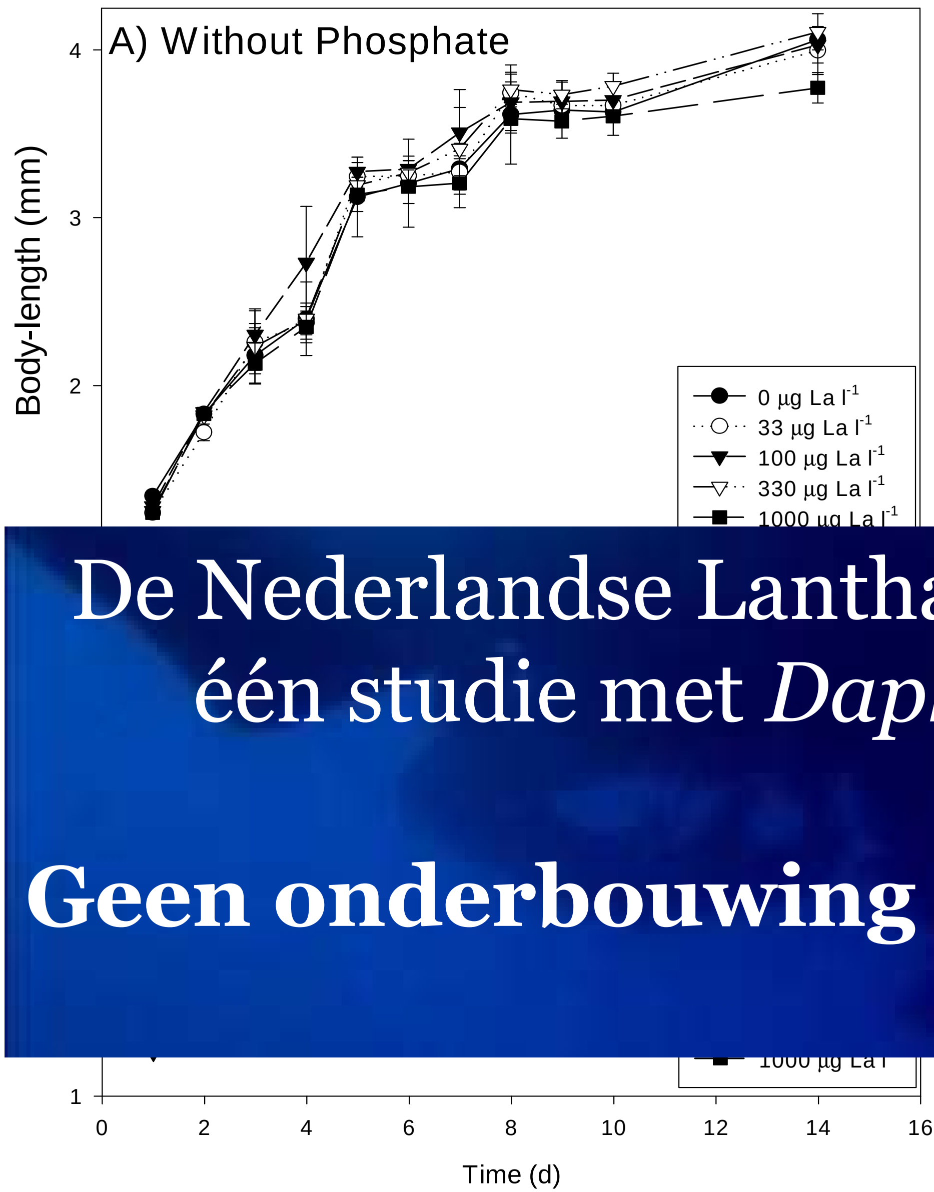

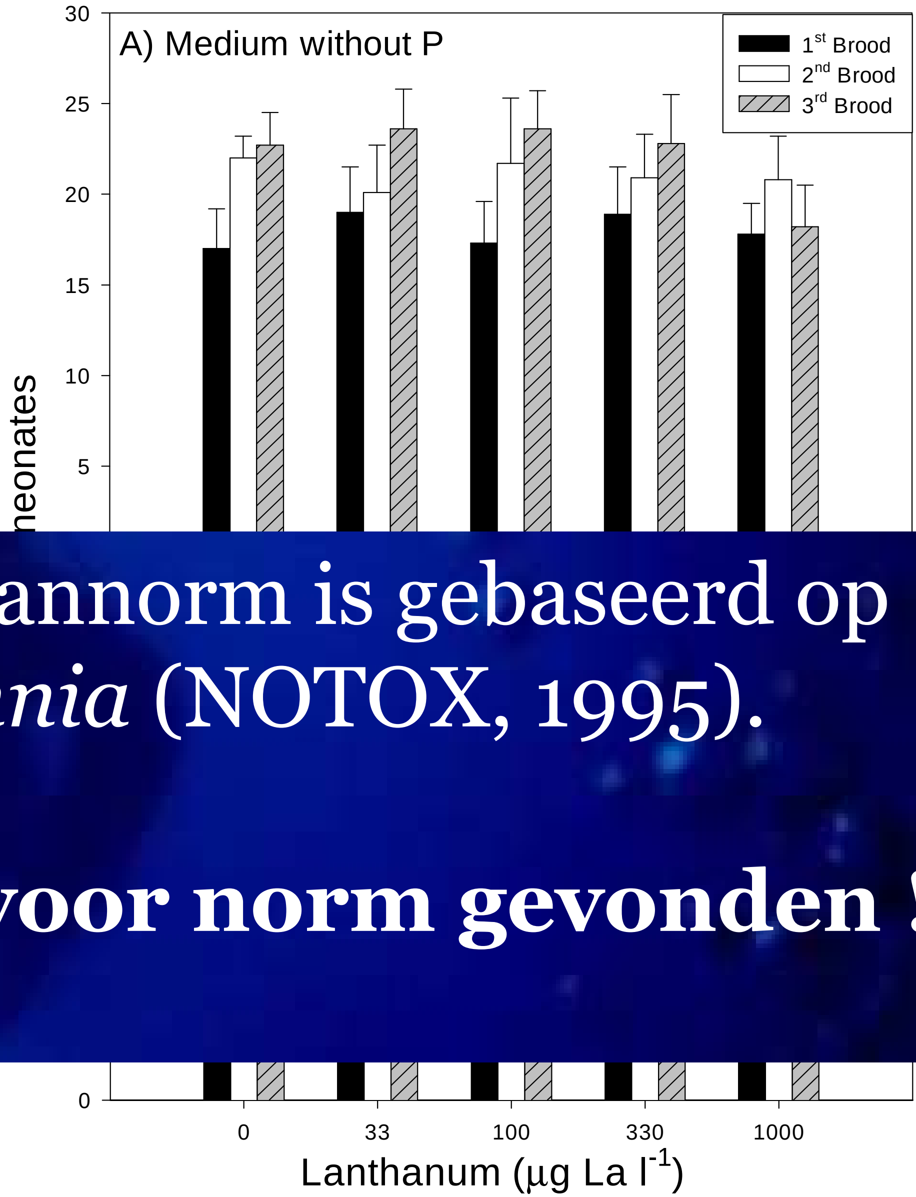

De Nederlandse Lanthaannorm is gebaseerd op één studie met *Daphnia* (NOTOX, 1995).

Geen onderbouwing voor norm gevonden !

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Rauwbraken

- Sterke reductie P
- Zeer sterke reductie phytoplankton
- Zuurstof in hypolimnion
- Elodea en Nitella tot 9 m diepte
- Toenemend doorzicht (> 10 m)
- Phoslock niet in diepe delen
- NL lanthaannorm ???

Hartelijk dank

Meer info?

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of

info@rauwbraken.nl

www.blauwalg.wur.nl