Société royale belge d'Entomologie
Koninklijke Belgische Vereniging voor Entomologie

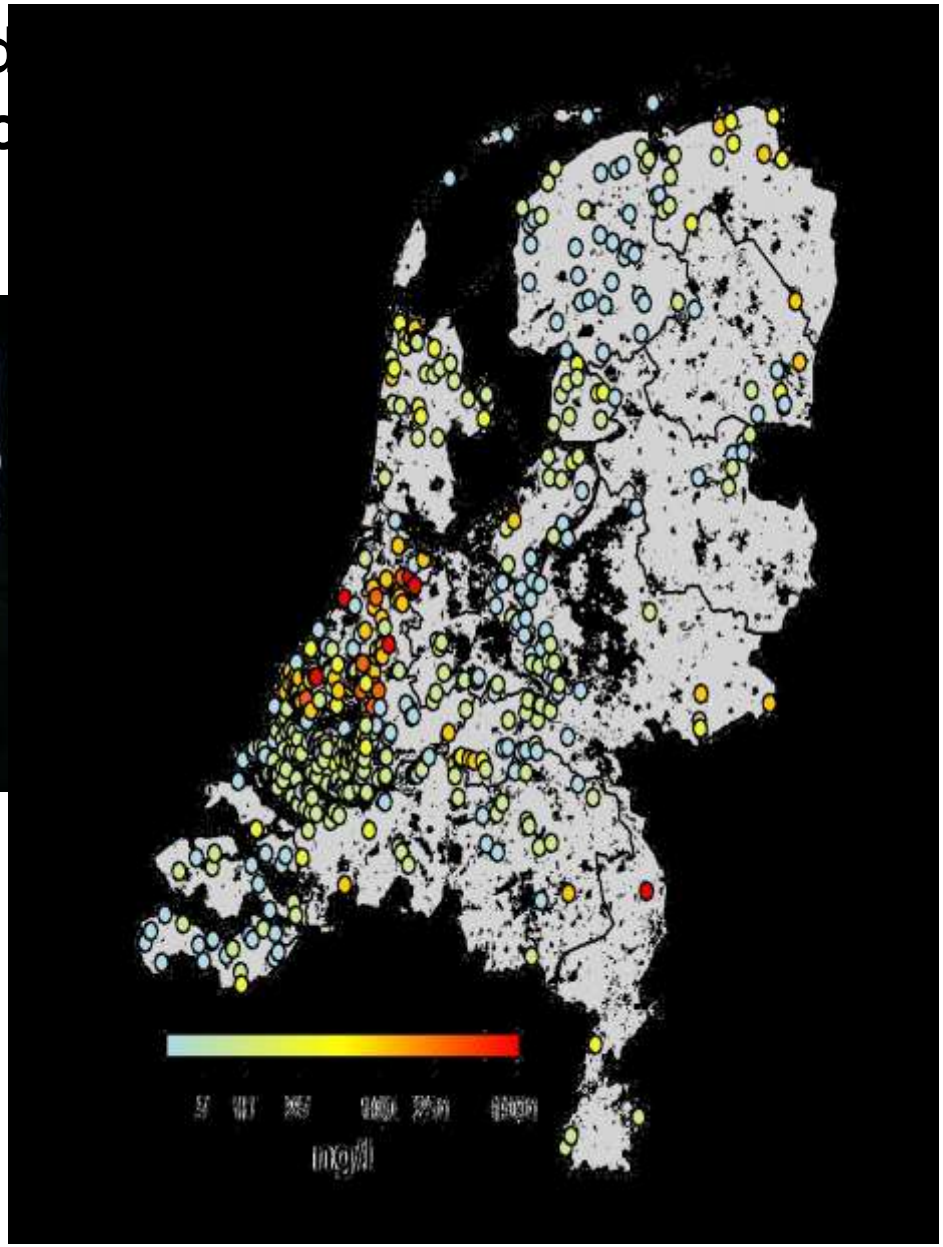
"Insects and Nature Management" December 7, 2018

Three major causes of insect decline and how to deal with it.

Henk Siepel

Radboud University

Imidaclopri
concentratio
water



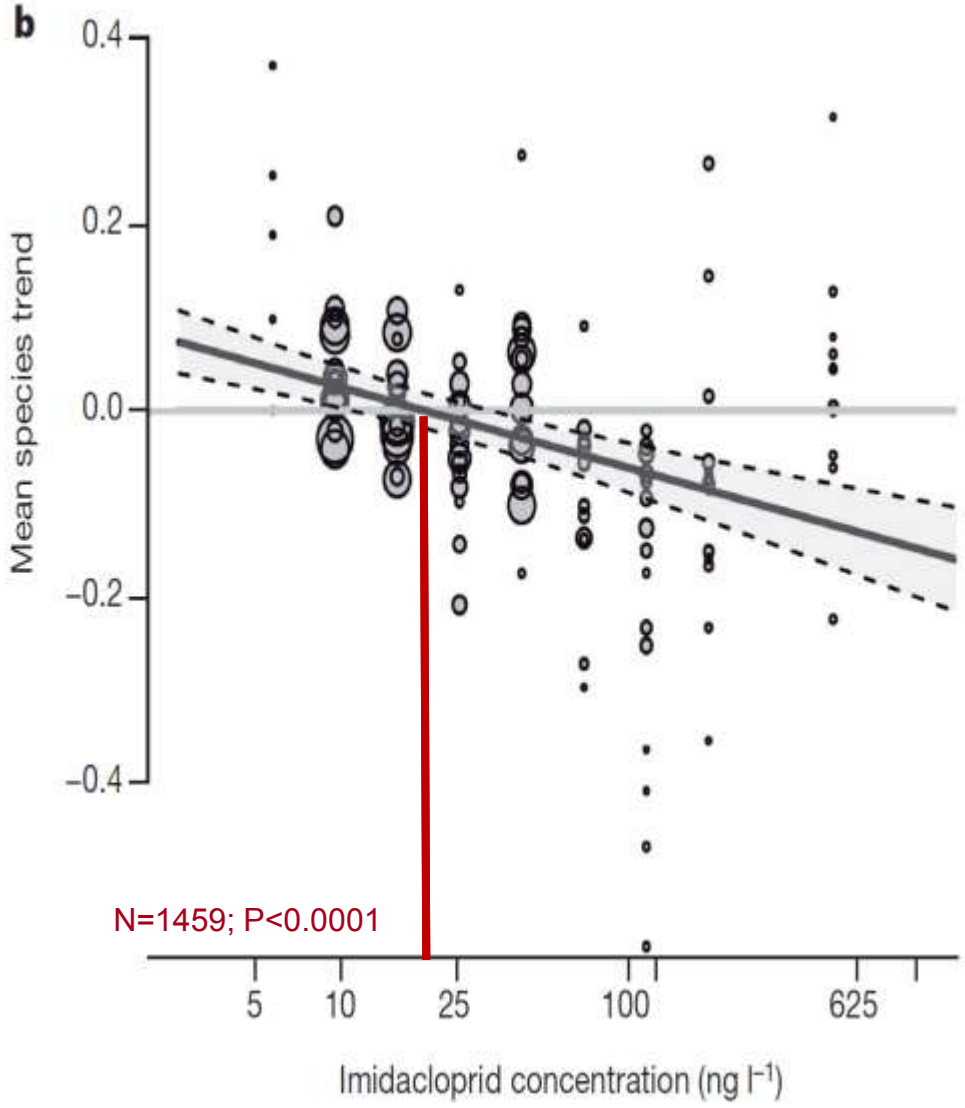
Jouke Altenburg (SOVON)

Populations of 15 insectivorous farmland bird species

Sovon

change perspective

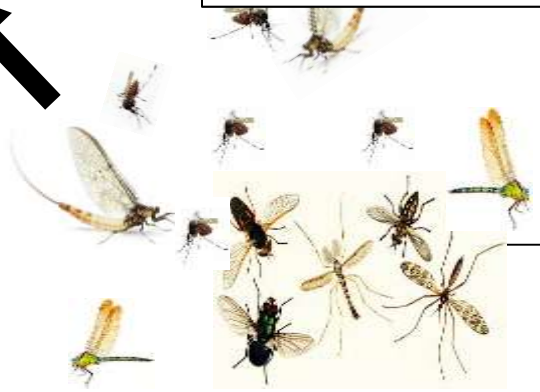
Radboud University



>20 ng/l imidacloprid

3.5% bird population decline per year

Our hypothesis: **Food shortage**



LETTER

doi:10.1038/nature13531

Declines in insectivorous birds are associated with high neonicotinoid concentrations

Caspar A. Hallmann[1,2], Ruud P. B. Foppen[2,3], Chris A. M. van Turnhout[2], Hans de Kroon[1] & Eelke Jongejans[1]

Radboud University

Neonicotinoid impacts on insects

SETAC PRESS

Environmental Toxicology and Chemistry, Vol. 32, No. 5, pp. 1096–1100, 2013
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Printed in the USA
DOI: 10.1002/etc.2201

Short Communication

THE NEONICOTINOID IMIDACLOPRID SHOWS HIGH CHRONIC TOXICITY TO MAYFLY NYMPHS

Ivo Roessink,† Lemessa B. Merga,‡ Hans J. Zweers,† and Paul J. Van den Brink*†‡
†Alterra, Wageningen University and Research Centre, Wageningen, The Netherlands
‡Department of Aquatic Ecology and Water Quality Management, Wageningen University, Wageningen, The Netherlands

OPEN ACCESS Freely available online

PLOS ONE

Macro-Invertebrate Decline in Surface Water Polluted with Imidacloprid

Tessa C. Van Dijk, Marja A. Van Staalduinen, Jeroen P. Van der Sluijs*

Environmental Sciences, Utrecht University, Utrecht, The Netherlands

Entomological collections in 63 German nature reserves 1989-2016

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Total weight of trapped flying insects

How can we explain differences between the samples?

What factors can explain the trend over time?

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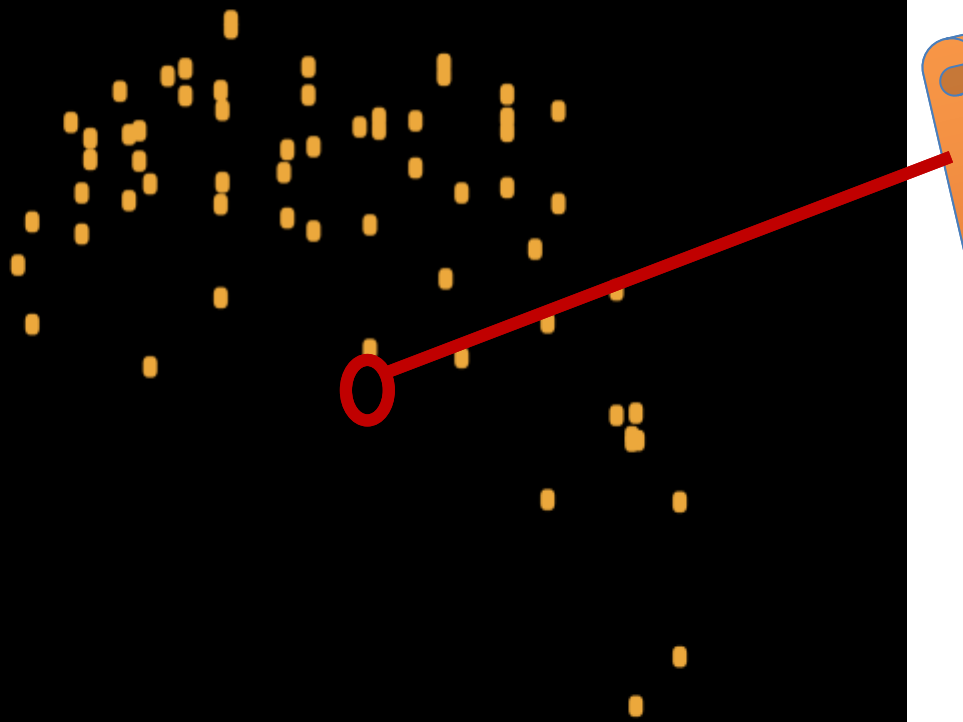
Seasonal differences in insect biomass



- Day nbr
- Year
- Habitat type
- Temperature
- Rainfall
- Landscape configuration
- #plant species
- …

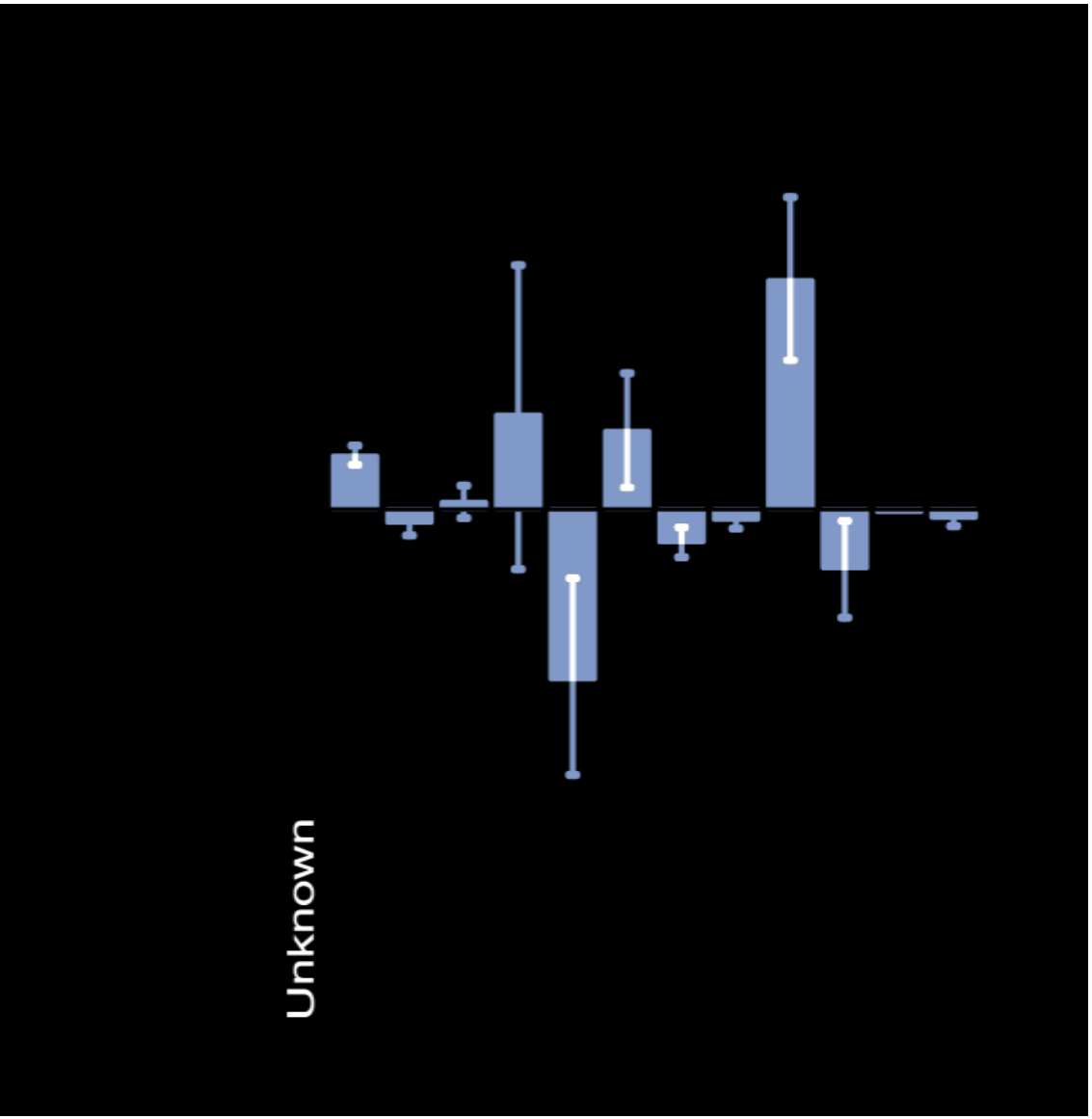
2010

2011

012

3

19


Unknown

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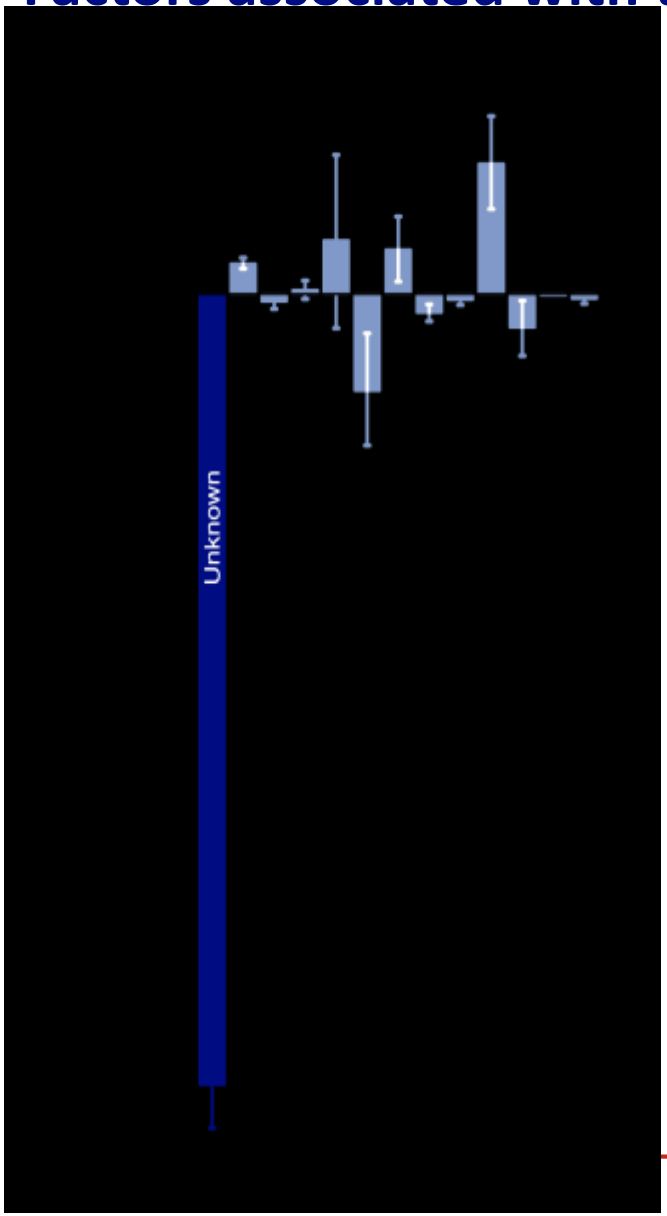
Factors associated with the trend

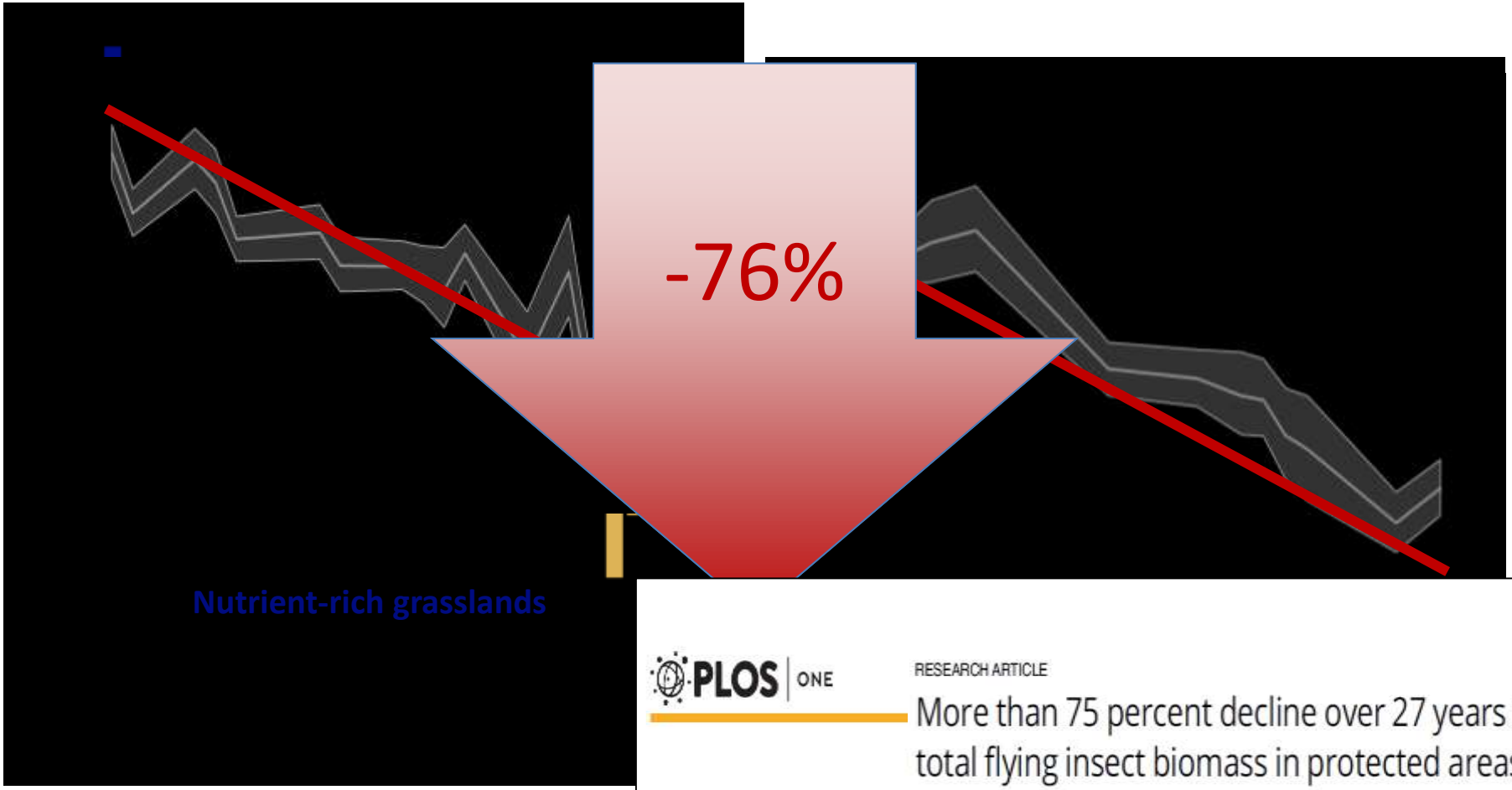


Different types of reserves

Nutrient-rich grasslands

Nutrient-poor heathlands

Dramatic decline in insect biomass over 27 years



change perspective

PLOS ONE

RESEARCH ARTICLE

More than 75 percent decline over 27 years in total flying insect biomass in protected areas

Caspar A. Hallmann[1]*, Martin Sorg[2], Eelke Jongejans[1], Henk Siepel[1], Nick Hofland[1], Heinz Schwan[2], Werner Stenmans[2], Andreas Müller[2], Hubert Sumser[2], Thomas Hörren[2], Dave Goulson[3], Hans de Kroon[1]

1 Radboud University, Institute for Water and Wetland Research, Animal Ecology and Physiology & Experimental Plant Ecology, PO Box 9100, 6500 GL Nijmegen, The Netherlands, 2 Entomological Society Krefeld e.V., Entomological Collections Krefeld, Marktstrasse 159, 47798 Krefeld, Germany, 3 University of Sussex, School of Life Sciences, Falmer, Brighton BN1 9QG, United Kingdom

Donderdag **19 oktober 2017**

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★★★★★ NRC
RIJKS MUSEUM T/M 7.01.2018

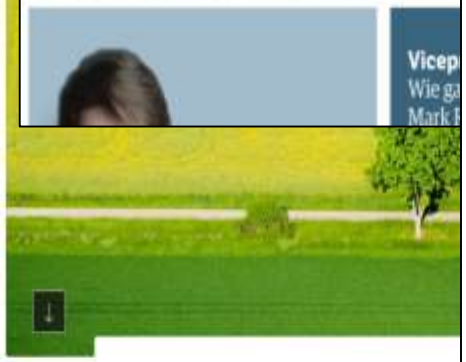
ALGEMEEN HANDELSBLAD (1828) EN NIEUWE ROTTERDAMSE COURANT (1844) nrc.nl JAARGANG 48 NO. 16 PRIJS €2,60

China
Xi houdt ook in de moderne wereld vast aan marxisme
Buitenland 15

ECOLOGIE

Dramatische afname van insecten

Het gaat slecht met veel insecten, blijkt uit groot meerjarig onderzoek in Duitsland.



Das Insektensterben lässt sich nicht mehr ab
Entomologen-Verein hat jetzt in einer Langz
sind seit der Wende um drei Viertel geschrun
Landwirtschaft, welchen das Klima?

deVerdieping Trouw

WWW.TROUW.NL | 75STE JAARGANG NR 22381 | E-MAIL VIA WWW.TROUW.NL/SERVICE | POSTBUS 859 1000 AW AMSTERDAM

Insect verdwijnt in rap tempo uit Europa

NATUUR De achteruitgang van het aantal insecten in Europa is alarmerend. Wetenschappers: Dit is erger dan gedacht.

Newsweek

Business Tech & Science Culture Sports Health Opinion

FLYING INSECT NUMBERS FALL BY 75 PERCENT:

theguardian

Scientists tell of alarm at huge fall in flying insects

Damian Carrington
Environment editor

The number of flying insects has plunged by three-quarters in 27 years, according to a new study that has shocked scientists.

Insects are an integral part of life as both pollinators and prey, and it was known that some species such as butterflies were declining. But the scale of the apparent losses to all insects has prompted warnings that the world is "on course for ecological armageddon", with profound impacts on human society.

The data was gathered in nature reserves across Germany but has implications for all landscapes dominated by agriculture, the researchers said.

The cause of the decline is unclear, although experts said the destruction of wild areas and widespread use of pesticides were the most likely factors, and

The decline in flying insects in German nature reserves in 27 years. Experts say the drop has implications for all life on Earth

76%

climate change may play a role. The sci-

Windshield phenomenon

What are the causes of insect decline?

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Spread of pesticides into the reserves?

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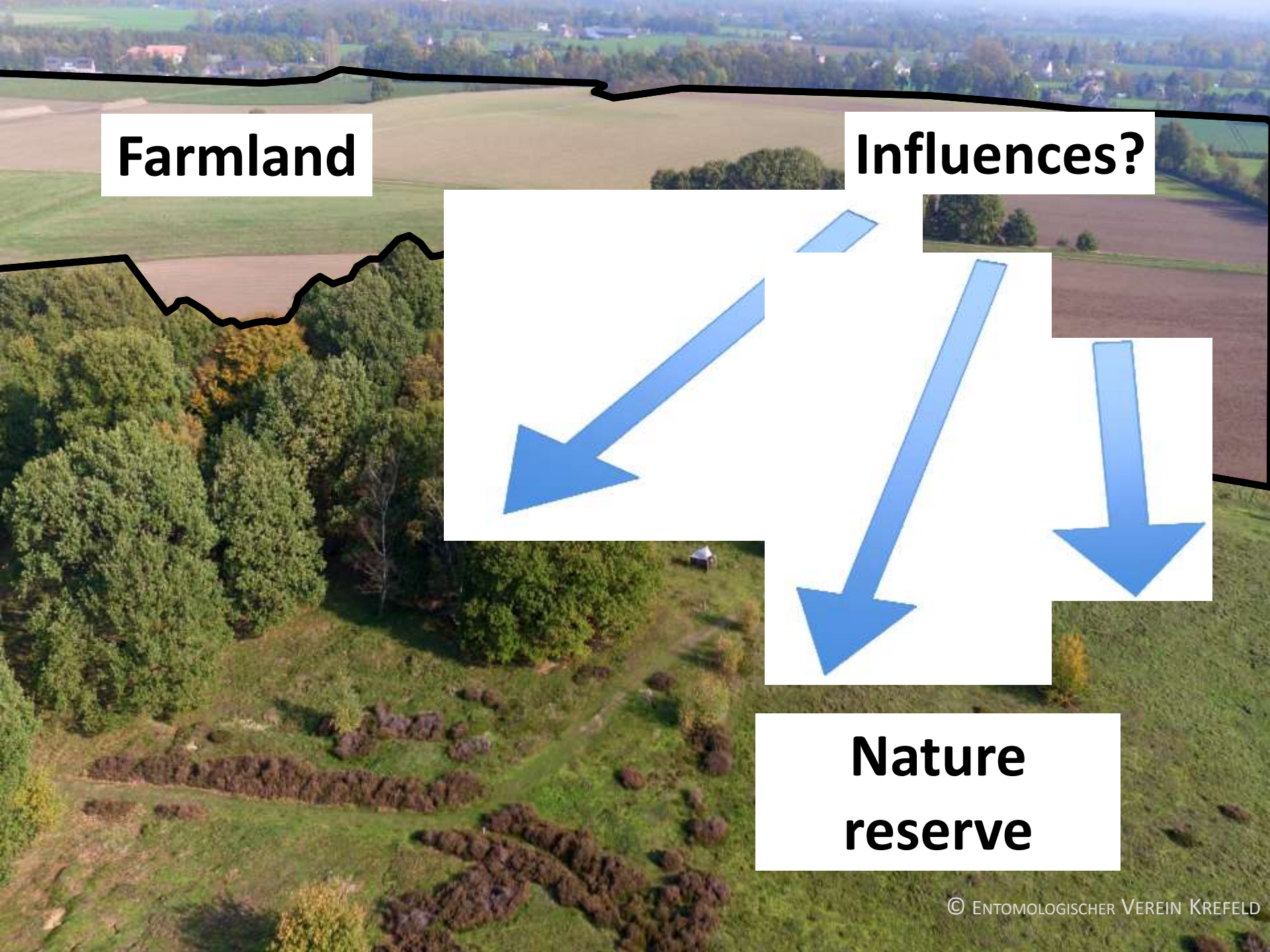

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LETTER

doi:10.1038/nature14420

Seed coating with a neonicotinoid insecticide negatively affects wild bees

Maj Rundlöf[1], Georg K. S. Andersson[1,2], Riccardo Bommarco[3], Ingemar Fries[3], Veronica Hederström[1], Lina Herbertsson[2], Ove Jonsson[4,5], Björn K. Klatt[2], Thorsten R. Pedersen[6], Johanna Yourstone[1] & Henrik G. Smith[1,2]

PNAS

Museum specimens reveal loss of pollen host plants as key factor driving wild bee decline in The Netherlands

Jeroen Scheper[a,1], Menno Reemer[b], Ruud van Kats[a], Wim A. Ozinga[c,d], Giel T. J. van der Linden[e], Joop H. J. Schaminée[c,d], Henk Siepel[f,g], and David Kleijn[a,e]

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Conservation and Plant Ecology Group, Wageninge
Water and Wetland Research, Radboud University

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

ELSEVIER

Exploring the relationships between landscape complexity, wild bee species richness and reproduction, and pollination services along a complexity gradient in the Netherlands

Tibor Bukovinszky[a], Joke Verheijen[a], Susan Zwerver[a], Esther Klop[a], Jacobus C. Biesmeijer[b,c], Felix L. Wäckers[d,e], Herbert H.T. Prins[a], David Kleijn[a,f,*]

change perspective

Dispersal of insects into the hostile surroundings?

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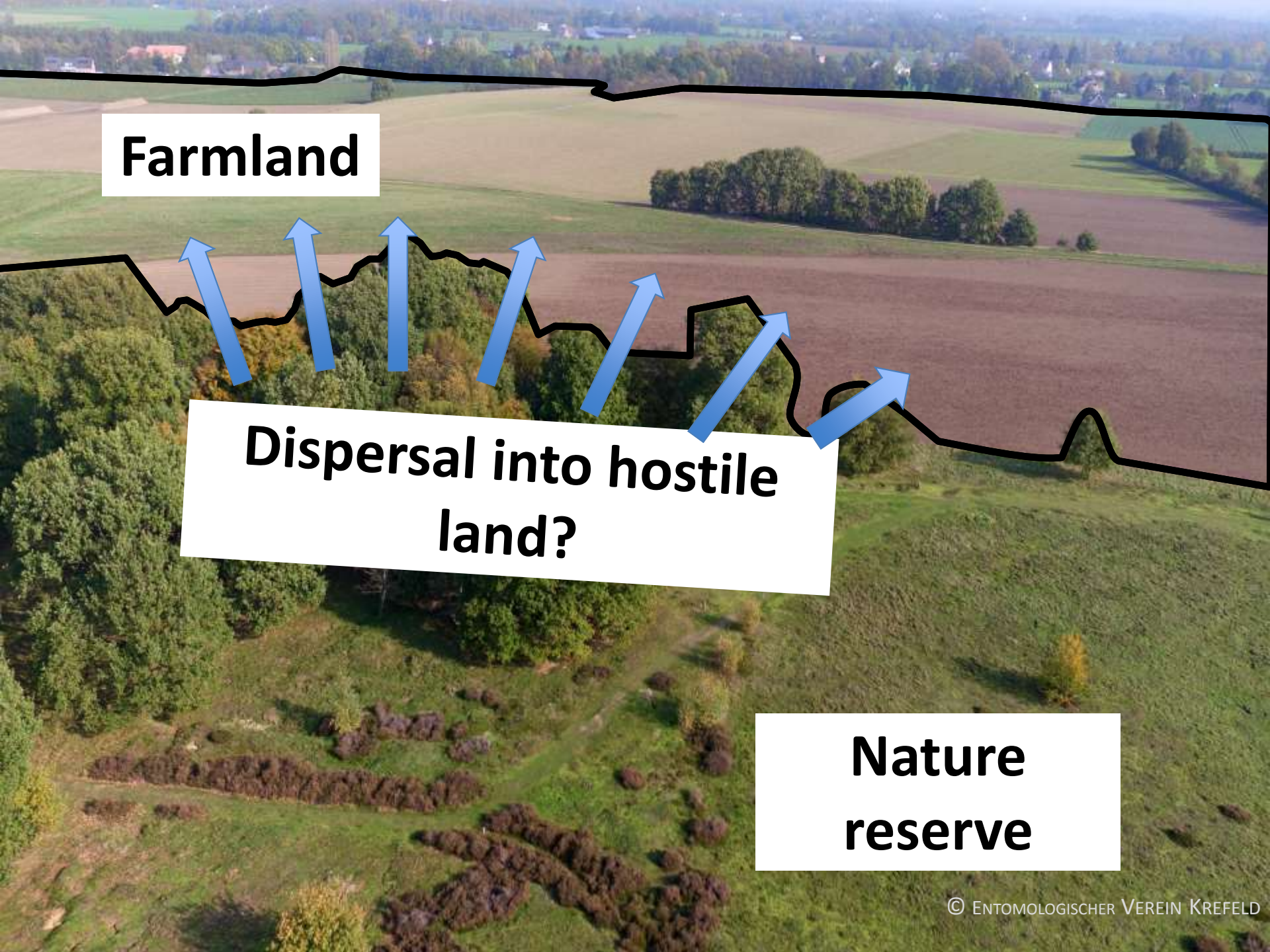

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When Good Animals Love Bad Habitats: Ecological Traps and the Conservation of Animal Populations

JAMES BATTIN*

Center for Environmental Sciences and Education, Box 5694, Northern Arizona University, Flagstaff, AZ 86011-5694, U.S.A.

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Why is agricultural land so hostile?

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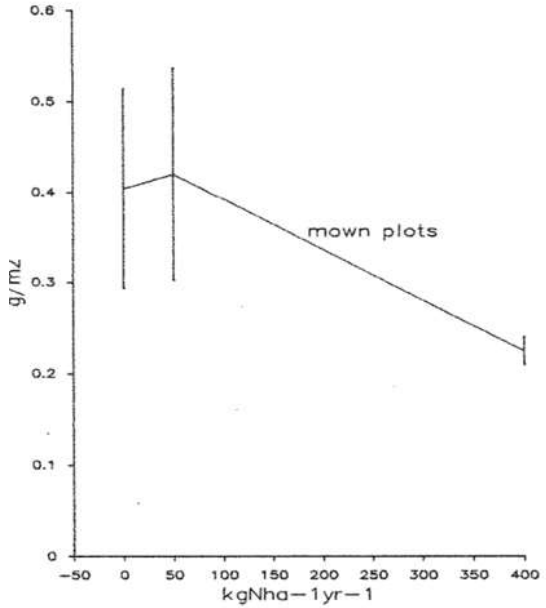
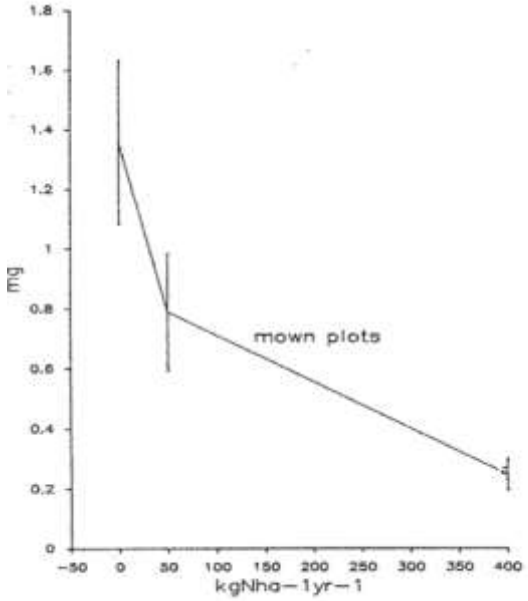
Shifts in insect biomass under intensive management

Biomass in gram per m^2



Biomass per individual



From: Siepel, 1990

Also life in soil is under pressure!

Selected:

- sandy soils
- groundwater always below surface
- fertilization > 250 kg N $ha^{-1}.jr^{-1}$
- use as grassland or arable land

Remains:

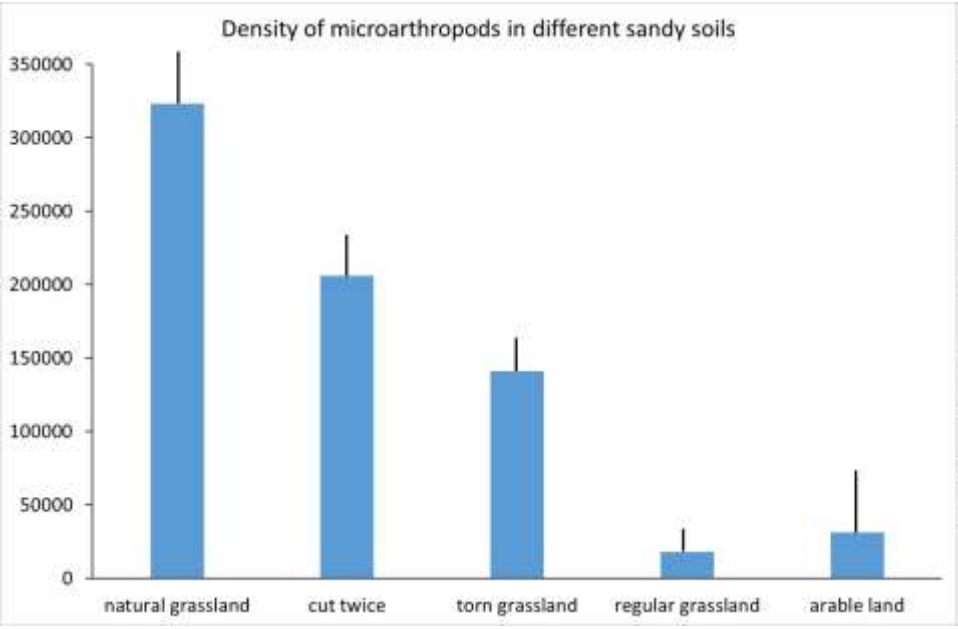
- 458.149 ha

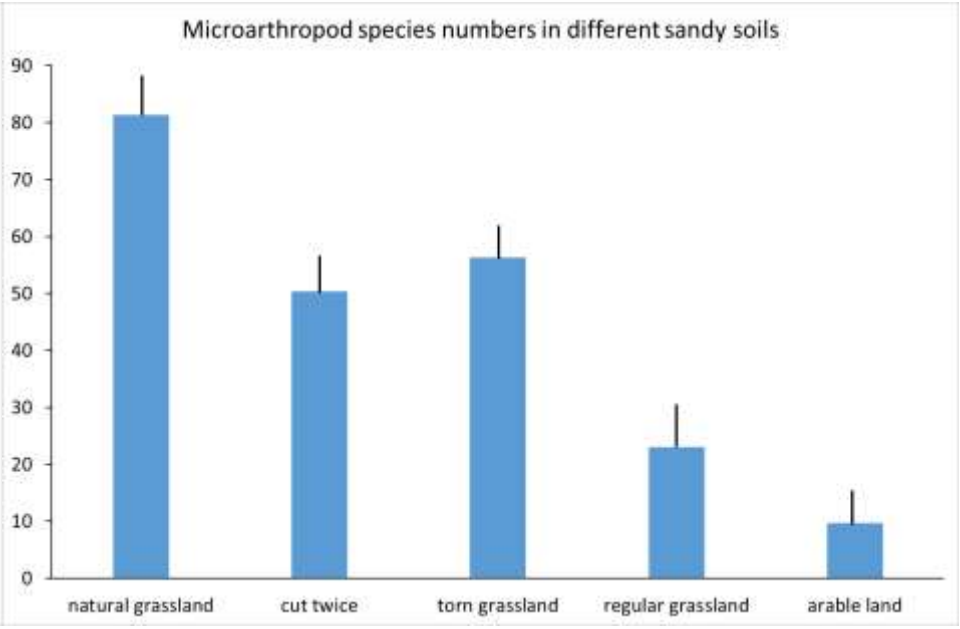
Tested:

- 50 locations sampled
- at random and double blind

From: Siepel 2018

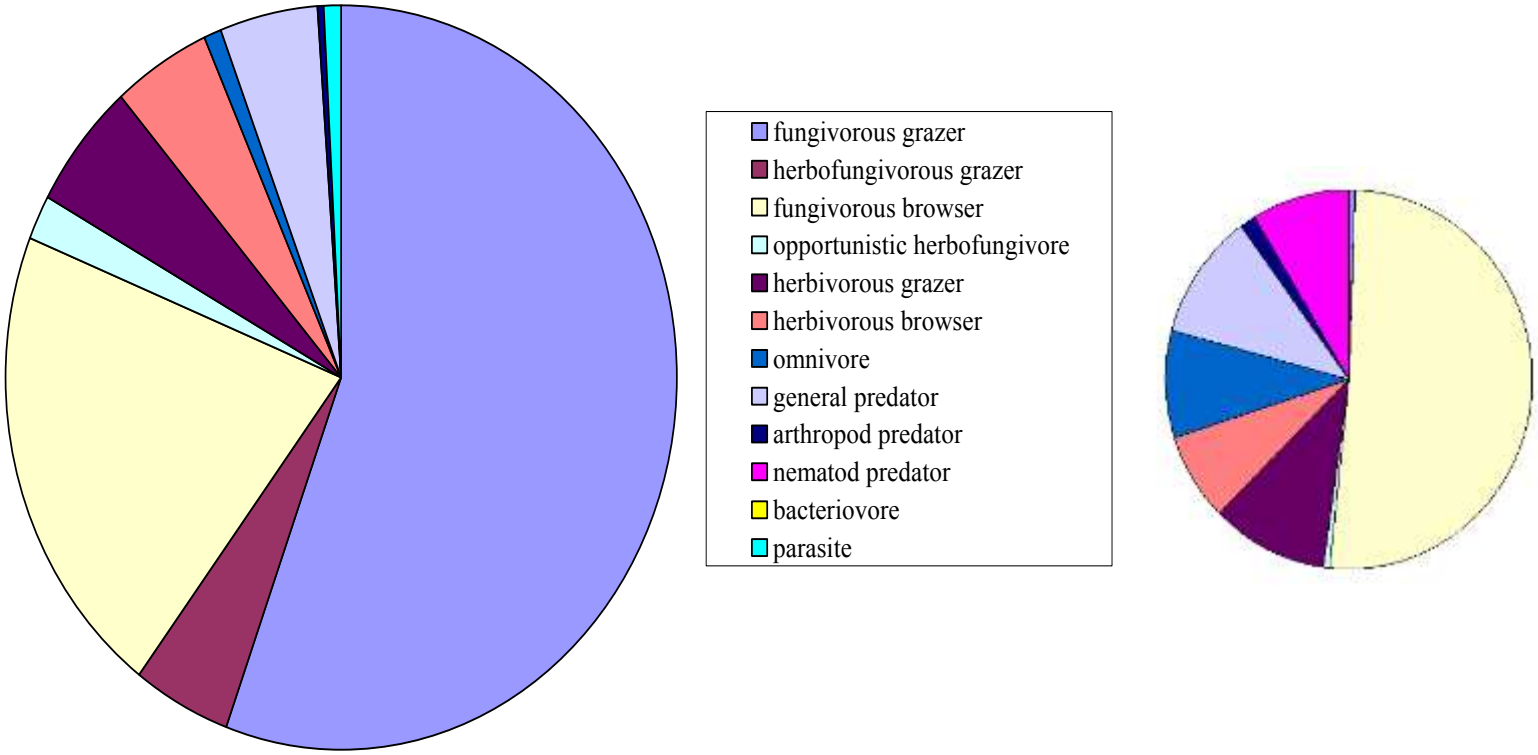
Both densities as well as number of species decline under frequent tillage





From: Siepel 2018

More importantly: the functionality changes to the detriment



From: Siepel 2018

Effects of N deposition on fauna in nature reserves?

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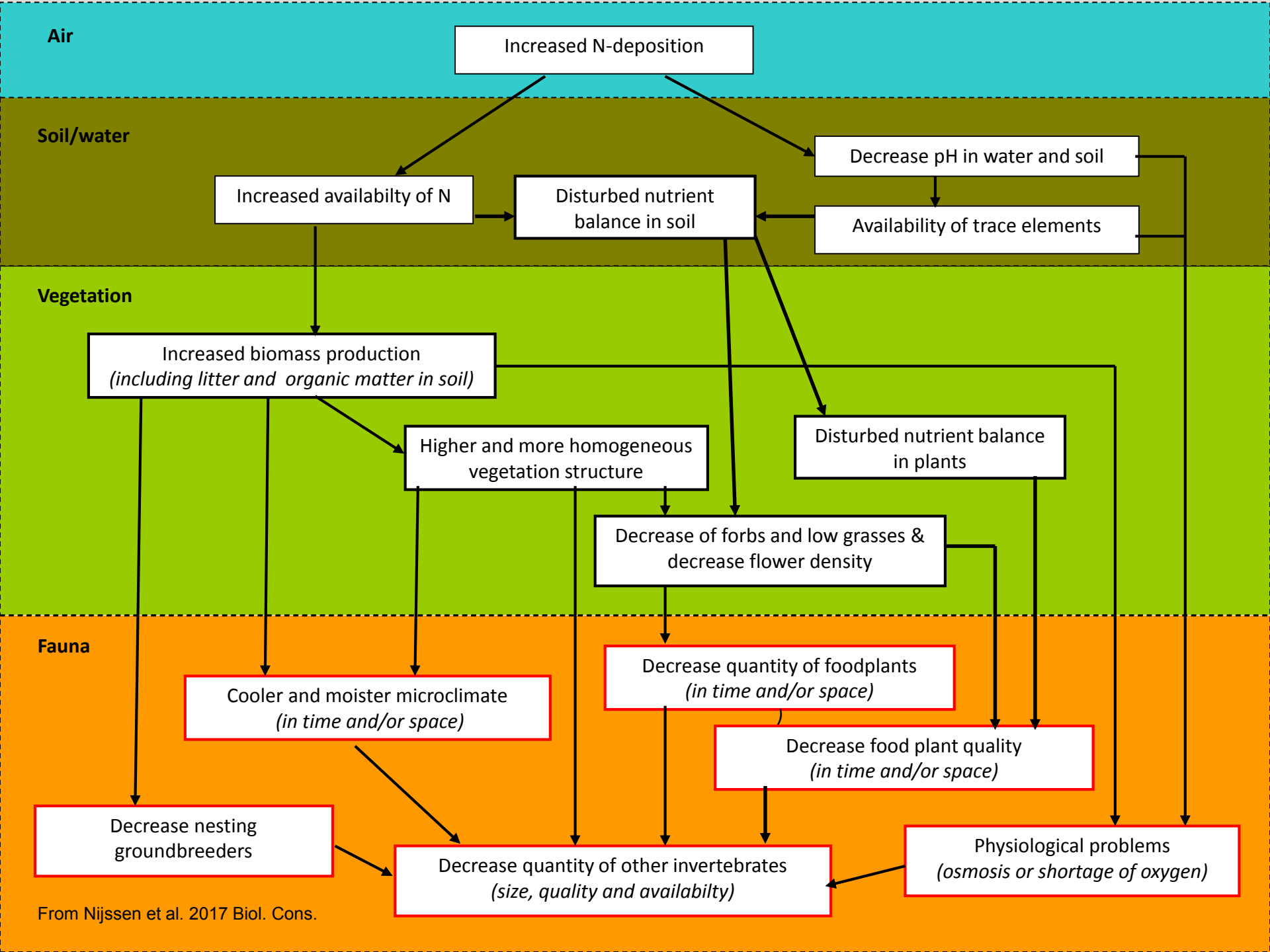
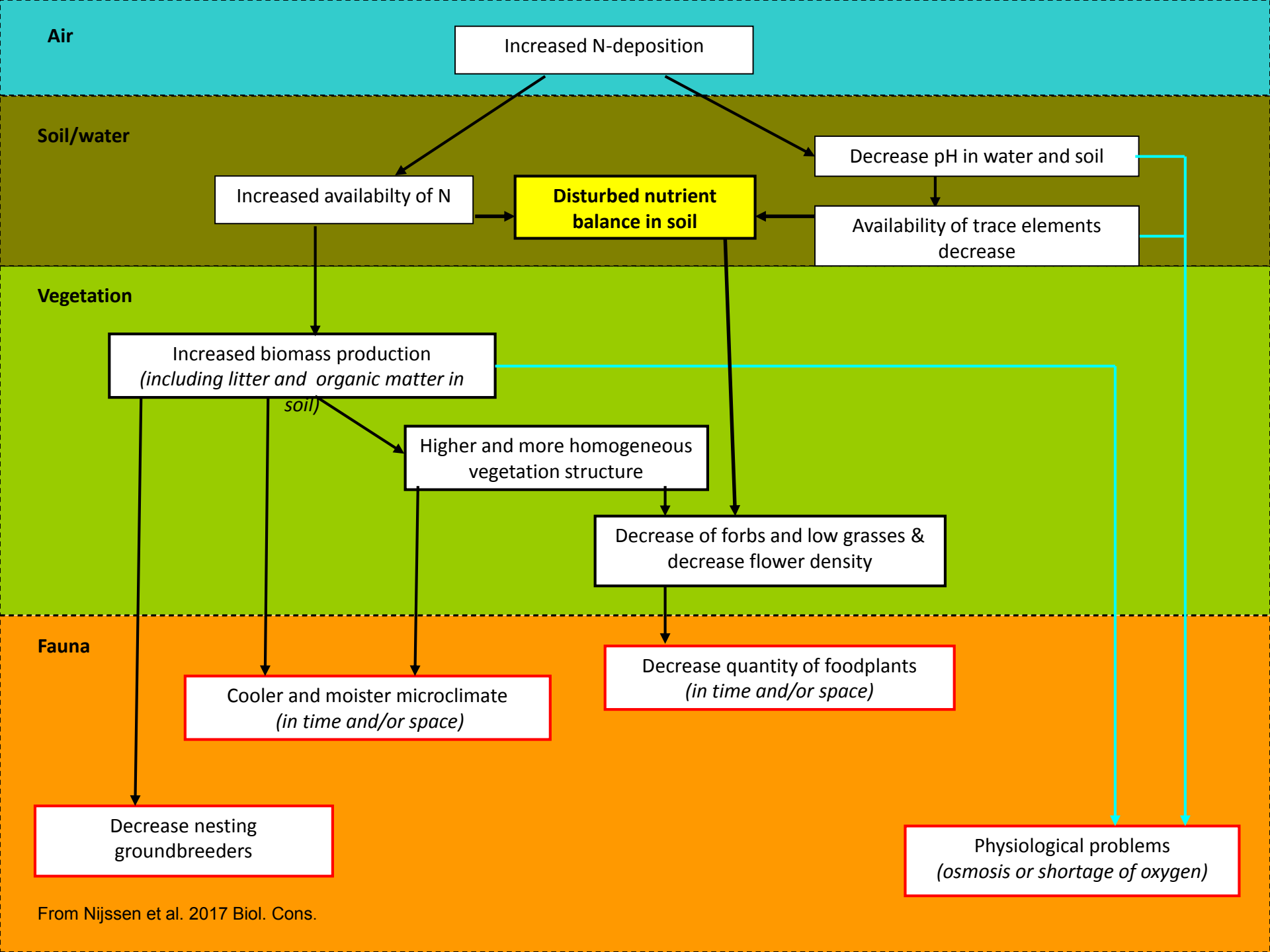
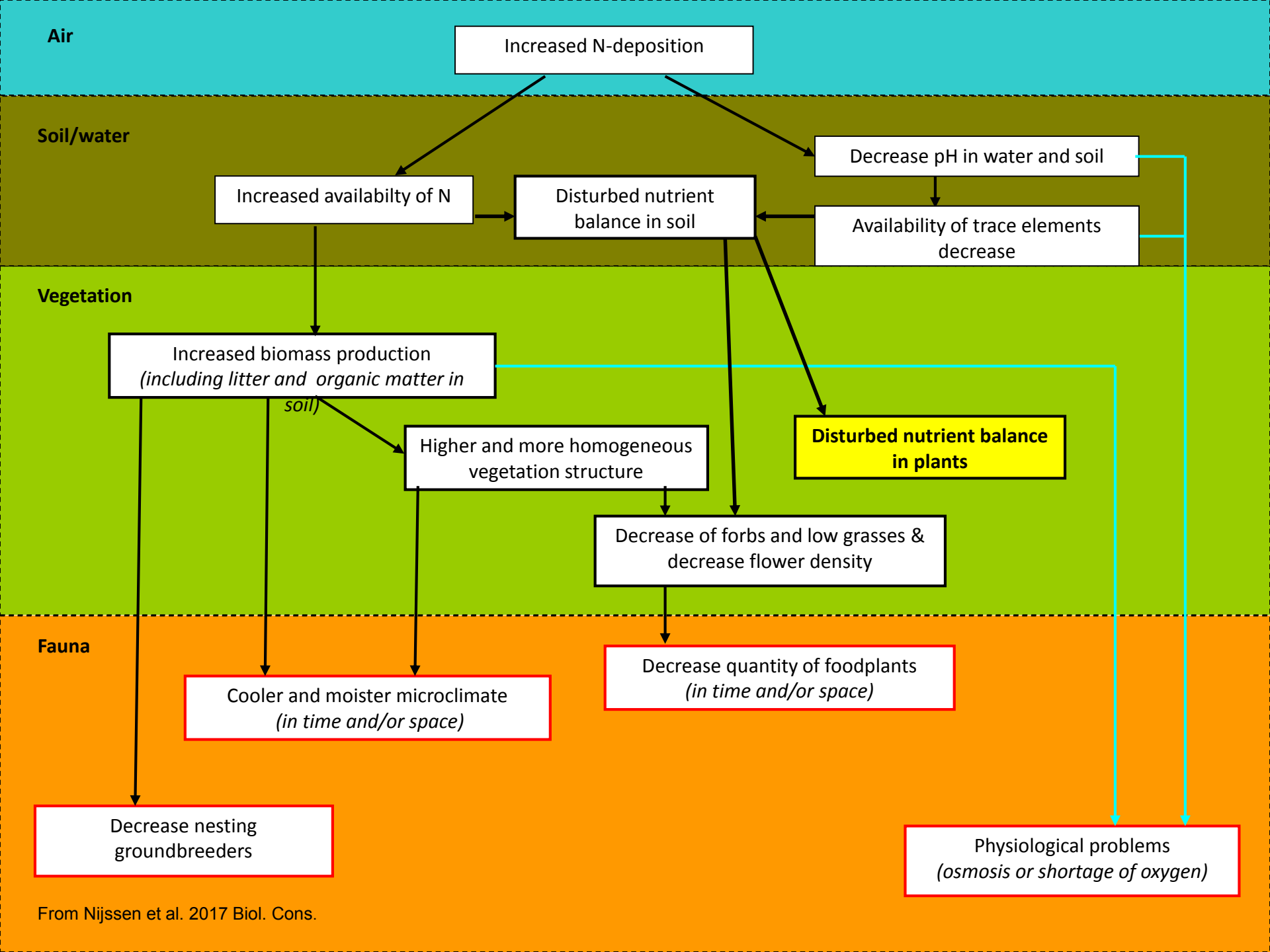

Air
Increased N-deposition
Soil/water
Decrease pH in water and soil
Increased availabilty of N
Disturbed nutrient balance in soil
Availability of trace elements
Vegetation
Increased biomass production (including litter and organic matter in soil)
Higher and more homogeneous vegetation structure
Disturbed nutrient balance in plants
Decrease of forbs and low grasses & decrease flower density
Fauna
Decrease quantity of foodplants (in time and/or space)
Cooler and moister microclimate (in time and/or space)
Decrease food plant quality (in time and/or space)
Decrease nesting groundbreeders
Decrease quantity of other invertebrates (size, quality and availabilty)
Physiological problems (osmosis or shortage of oxygen)
From Nijssen et al. 2017 Biol. Cons.



From Nijssen et al. 2017 Biol. Cons.



From Nijssen et al. 2017 Biol. Cons.

Air

Soil/water

Vegetation

Fa

Increased N-deposition

Increased availabilty of N

Disturbed nutrient balance in soil

Decrease pH in water and soil

Availability of trace elements decrease

Increased biomass production *(including litter and organic matter in soil)*

Higher and more homogeneous vegetation structure

Disturbed nutrient balance in plants

Decrease of forbs and low grasses & decrease flower density

Decrease quantity of foodplants *(in time and/or space)*

Decrease food plant quality *(in time and/or space)*

Physiological problems *(osmosis or shortage of oxygen)*

From Nijssen et al. 2017 Biol. Cons.

Stoichiometrical effects

The ratio between N and P gets out of balance:

- Increased acid deposition (SO_x, NO_x and NH_3) in the Netherlands since 1950 (70 years) from especially traffic and agriculture resulted in a extra deposition of acid equivalents equal to the total natural deposition during the entire Holocene (11,500 years)
- Remedy was on heathlands: more sod cutting
- Effect: removal of all nutrients via the organic matter, thus exhaustion of mainly P and K

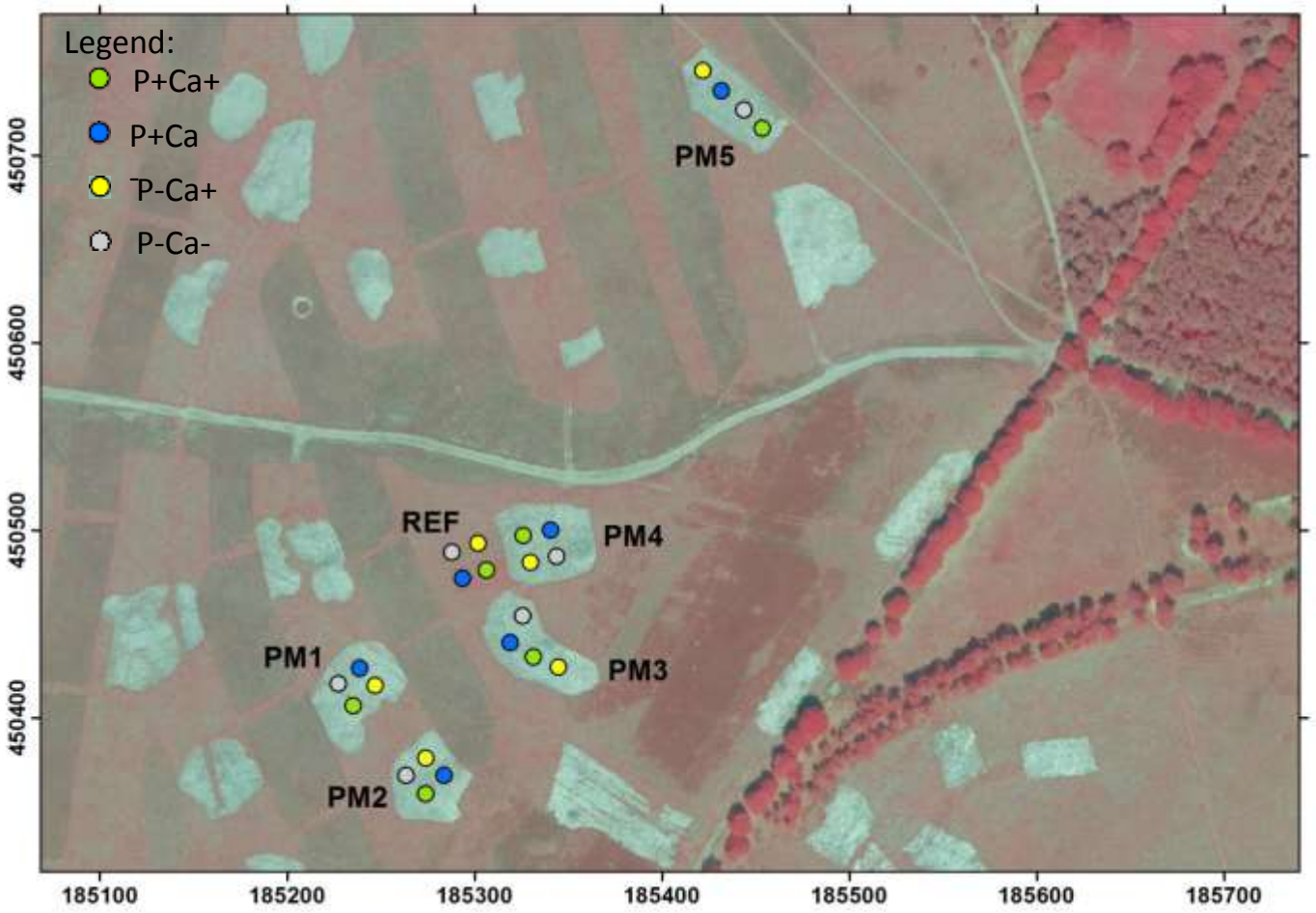
Fauna response models from heathlands

	Parameter	Estimate	Adj. SE	z value	Pr(>|z|)
Herbivorous Diptera density	**Plant N:P ratio**	**-0.029**	**0.013**	**2.136**	**<0.05**
	Cover of ericaceous shrubs	**0.011**	**0.003**	**3.709**	**<0.001**
	Plant C:N ratio	**-0.050**	**0.012**	**4.046**	**<0.001**
Detritivorous Diptera density	**Plant N:P ratio**	**-0.049**	**0.020**	**2.47**	**<0.05**
	Cover of ericaceous shrubs	**0.014**	**0.004**	**3.321**	**<0.001**
	Plant C:N ratio	-0.023	0.015	1.5	N.S.
Herbivorous Carabidae SR	**Plant N:P ratio**	**-0.042**	**0.015**	**2.826**	**<0.01**
	Cover of ericaceous shrubs	**-0.008**	**0.003**	**2.504**	**<0.05**
	Plant C:N ratio	0.008	0.013	0.57	NS
Carnivorous Carabidae SR	**Plant N:P ratio**	**-0.018**	**0.007**	**2.516**	**<0.05**
	Cover of ericaceous shrubs	**-0.005**	**0.002**	**3.147**	**<0.01**
	Plant C:N ratio	**0.021**	**0.006**	**3.305**	**<0.001**
	Herb species richness	**0.073**	**0.026**	**2.787**	**<0.01**

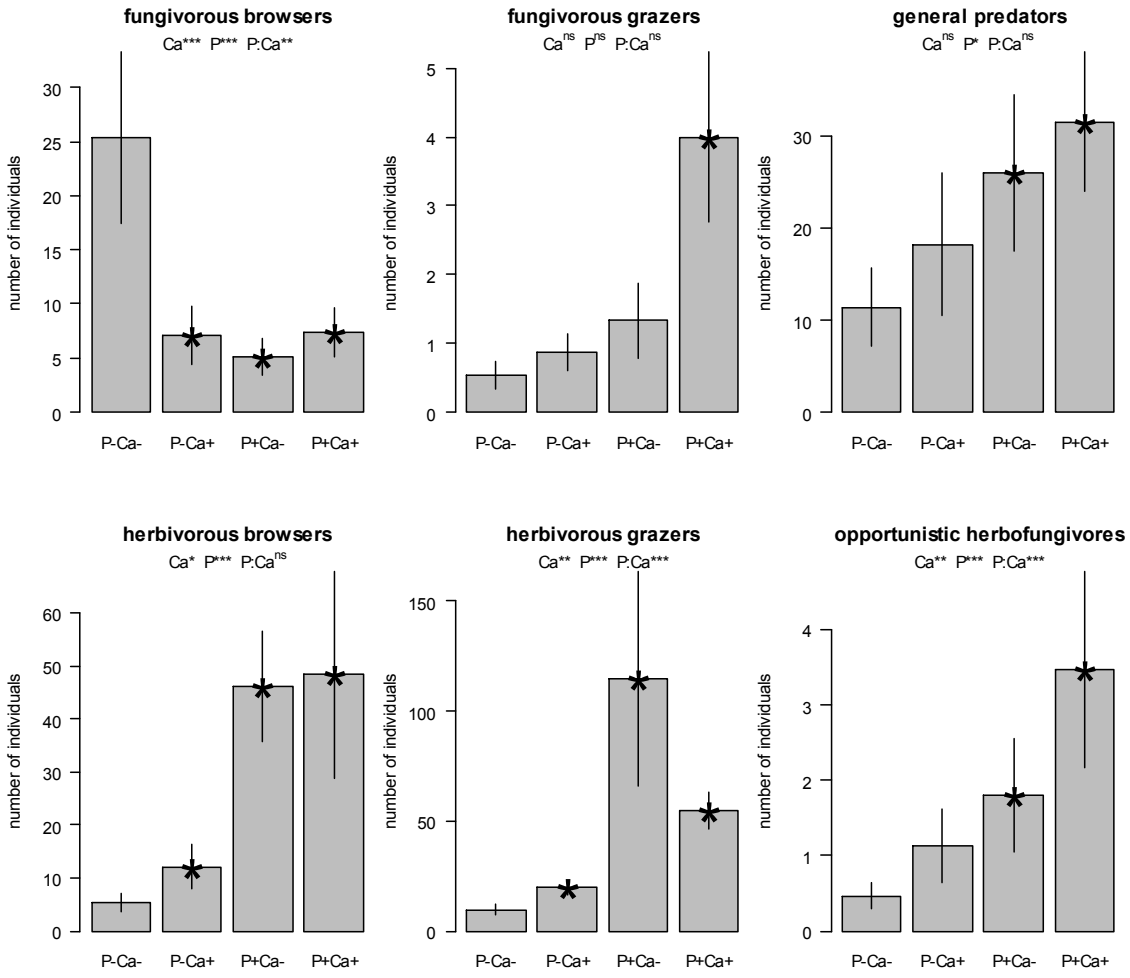
From: Vogels et al. 2017 Boil. Cons.

Is P limiting for animals?

Field experiment Hoge Veluwe
Full factorial experiment with P addition and/or Dolokal (Ca) addition



From: Siepel et al. 2018 Soil Biol Biochem



From: Siepel et al. 2018 Soil Biol Biochem

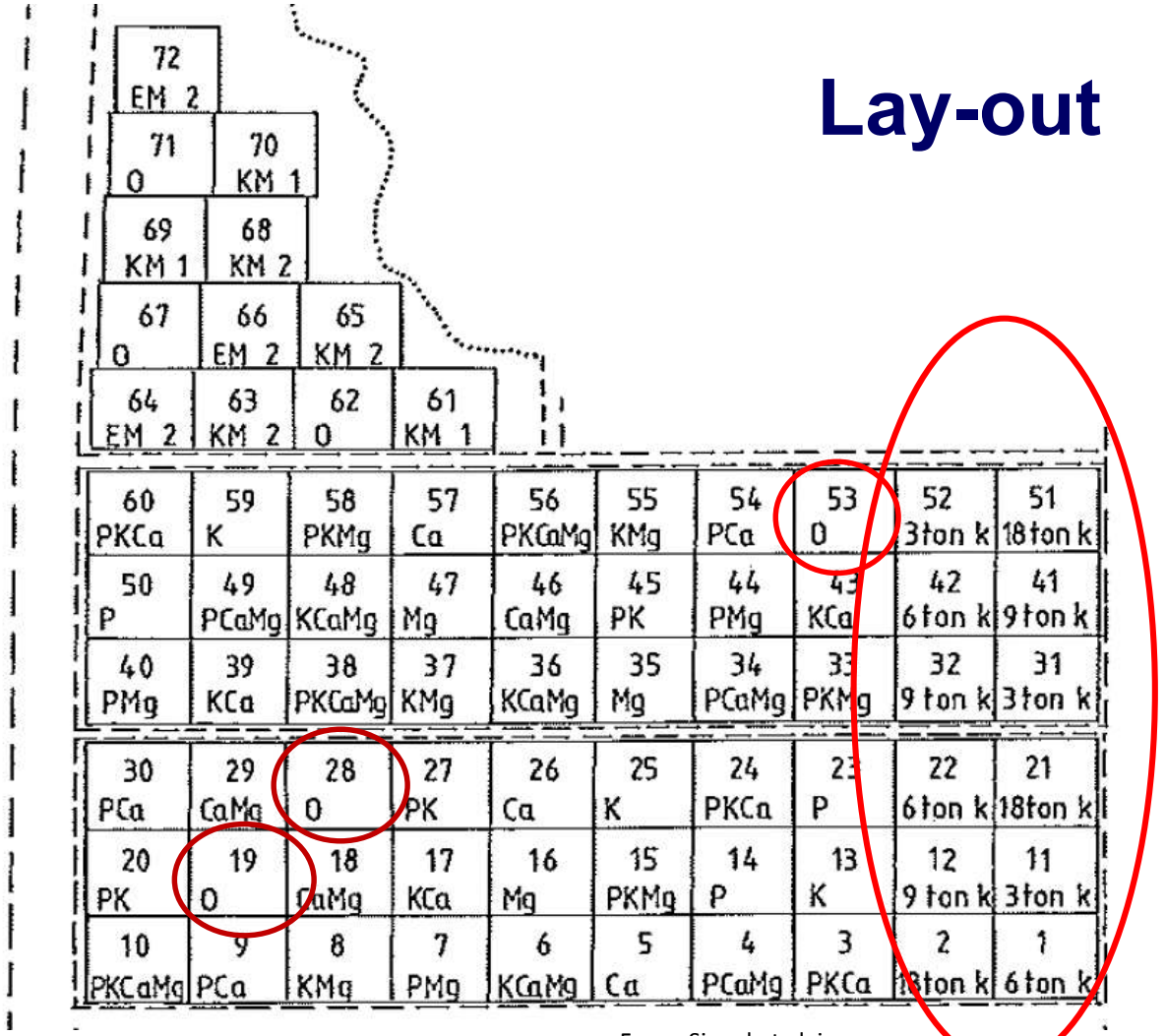
Experimental set-up: forest floor liming

- Control with four levels of added carbonated lime in 1985: 3, 6, 9 and 18 ton/ha
- Three replicates per treatment
- Plot sizes: 22 x 25 m^2

- In every plot 4 samples (100 cc, 0-5 cm.) have been taken at 17-X-2017 for collection of microarthropods
- Soil chemical analysis: pH and soluble Ca^{2+}, Al^{3+}, PO_4^{3-}
- Vegetation cover and composition

From: Siepel et al. in prep.

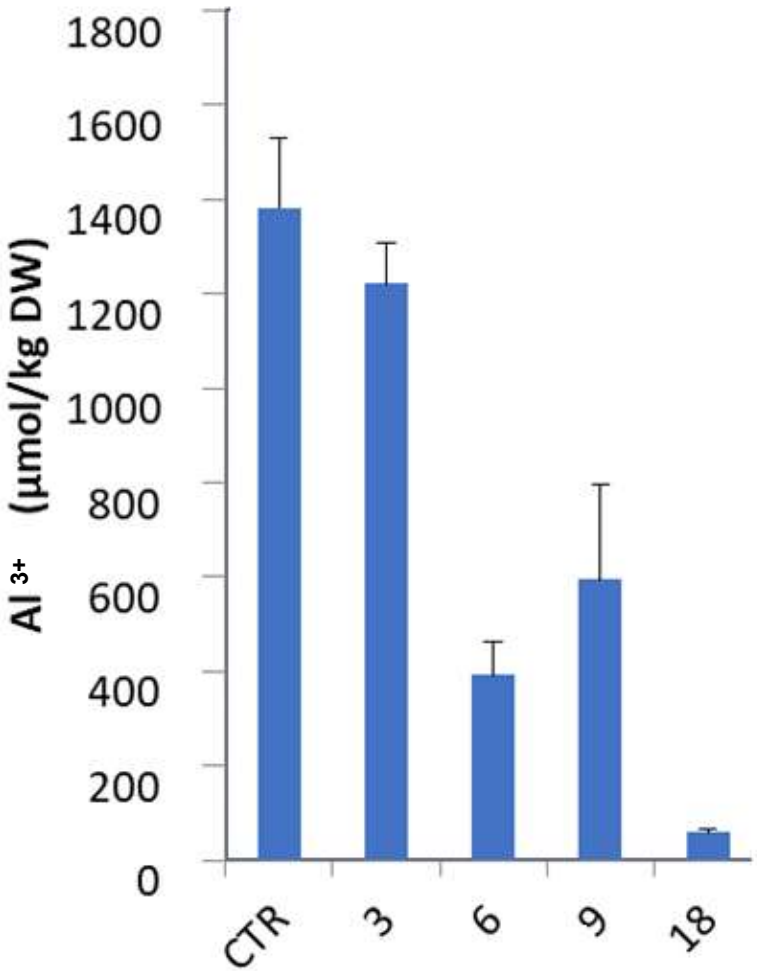
Lay-out

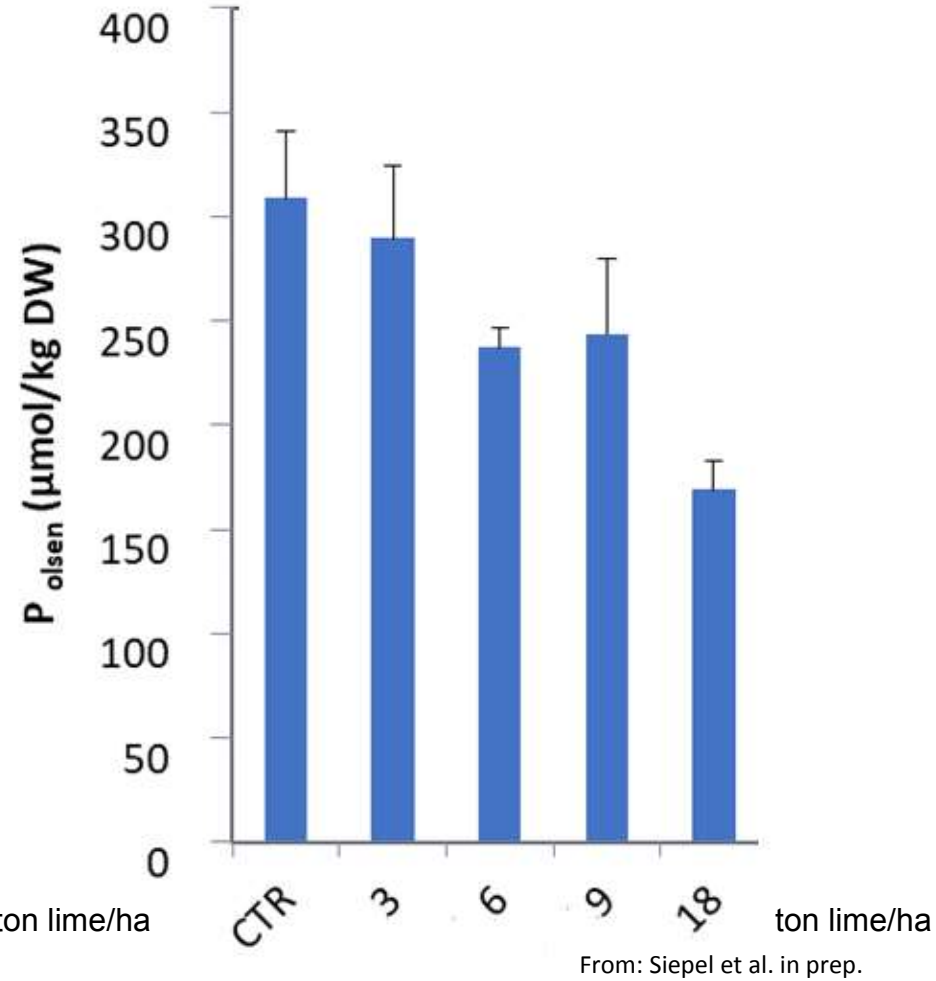


From: Siepel et al. in prep.

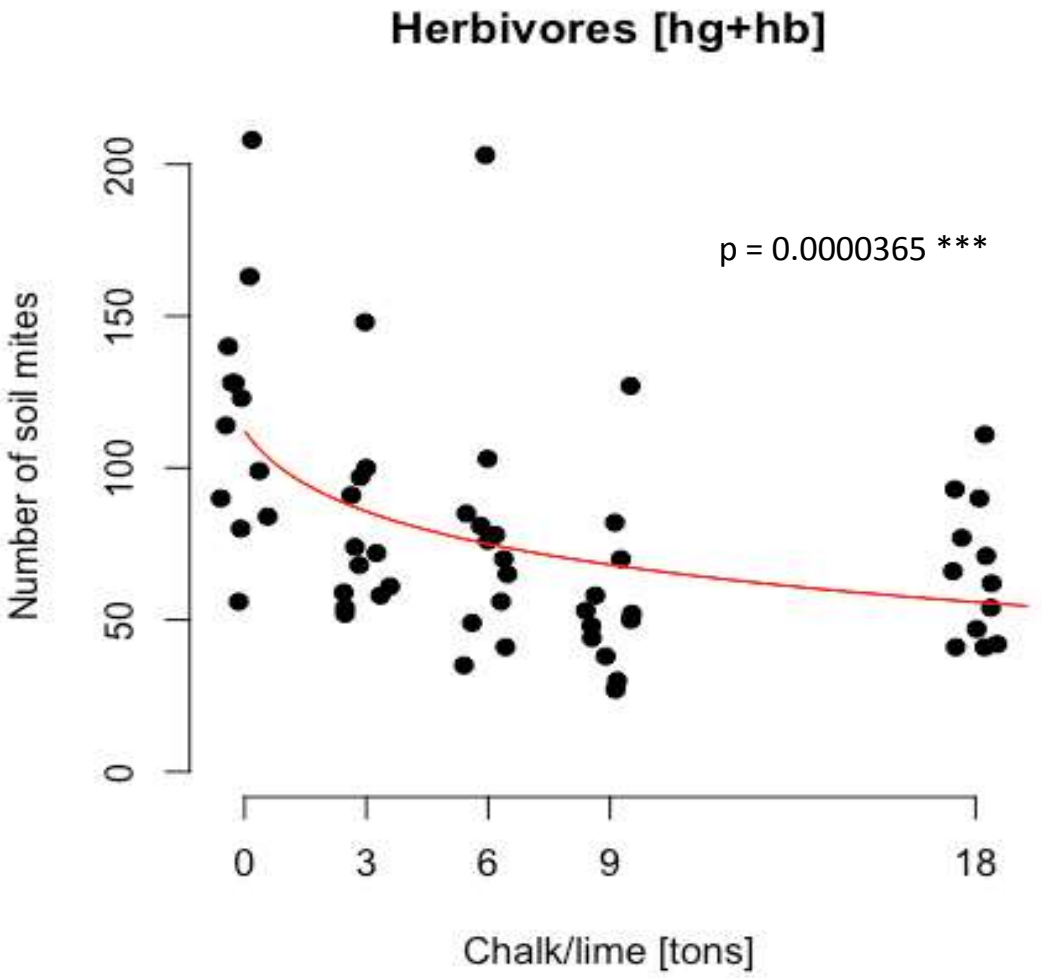
Lime added in 1985 in 20 y old Scotch Pine forest stand on a typic quarzipsamment (afforested former drift sand)

Soluble Al^{3+} and Plant-available P



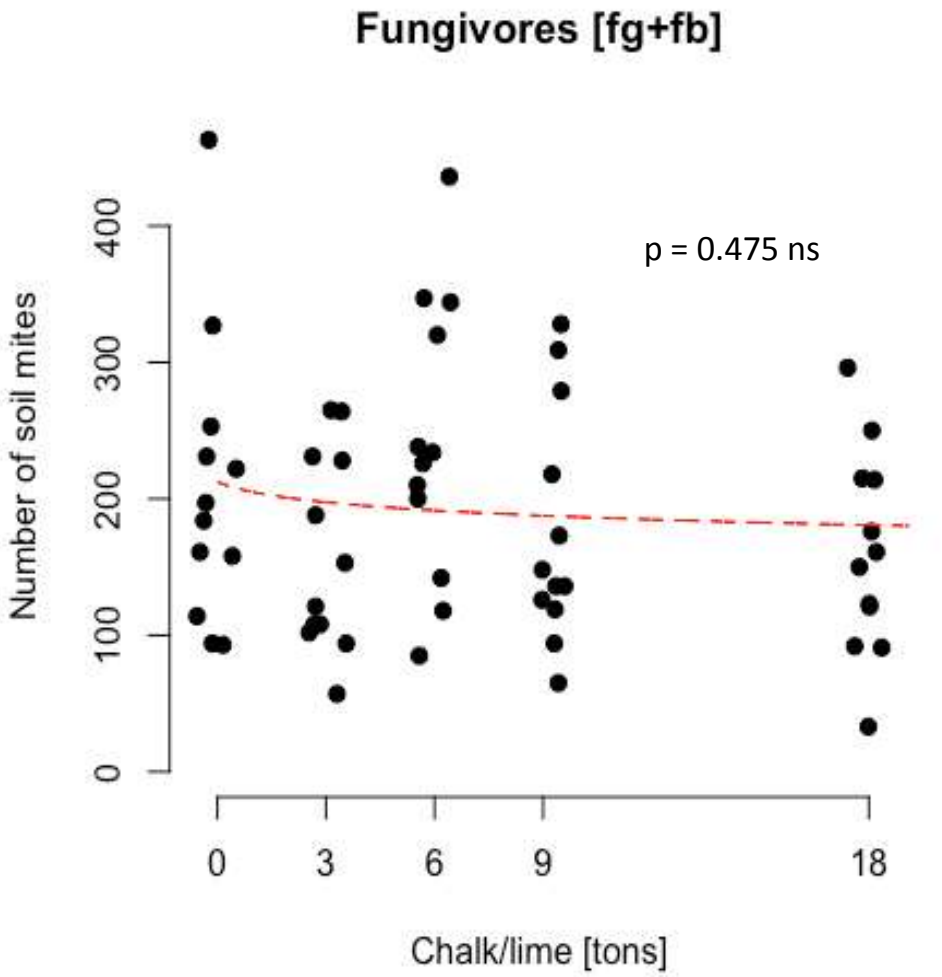


From: Siepel et al. in prep.



Dominant species:
Oribatida:
Atropacarus striculus
Steganacarus magnus
Platynothrus peltifer
Collembola:
Lepidocyrtus lignorum
Symphyla:
Symphylellopsis subnuda

From: Siepel et al. in prep.



Dominant species:
Oribatida:
Eniochthonius minutissimus
Oppiella nova
Punctoribates punctum
Suctobelbella acutidens
Suctobelbella subcornigera

From: Siepel et al. in prep.

In summary: three major causes of insect decline

- Spreading of pesticides into relatively small reserves from the agricultural surroundings
- The agricultural environment of reserves as ecological trap
- Deposition of N, acidification, N:P ratio changes, decrease in food plant quantity and quality; while current remediation (liming) even aggravates the problem

And the solution is....

- Stop with intensive agriculture
  - The use of pesticides is detrimental to biodiversity
  - Frequent tillage reduces predictability and forms an ecological trap for species with a lifetime longer than 4 weeks
  - International treaties (Water Framework Directive, Birds Directive, Habitat Directive, Convention on Biological Diversity, etc.) form an implicit maximum on ground-bound agricultural production
  - If you need this high agricultural production, turn to closed and controlled systems, do not use soil as a disposable stone wool substrate

Thanks for your attention