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中国科学院植物研究所
INSTITUTE OF BOTANY, THE CHINESE ACADEMY OF SCIENCES

Lancaster
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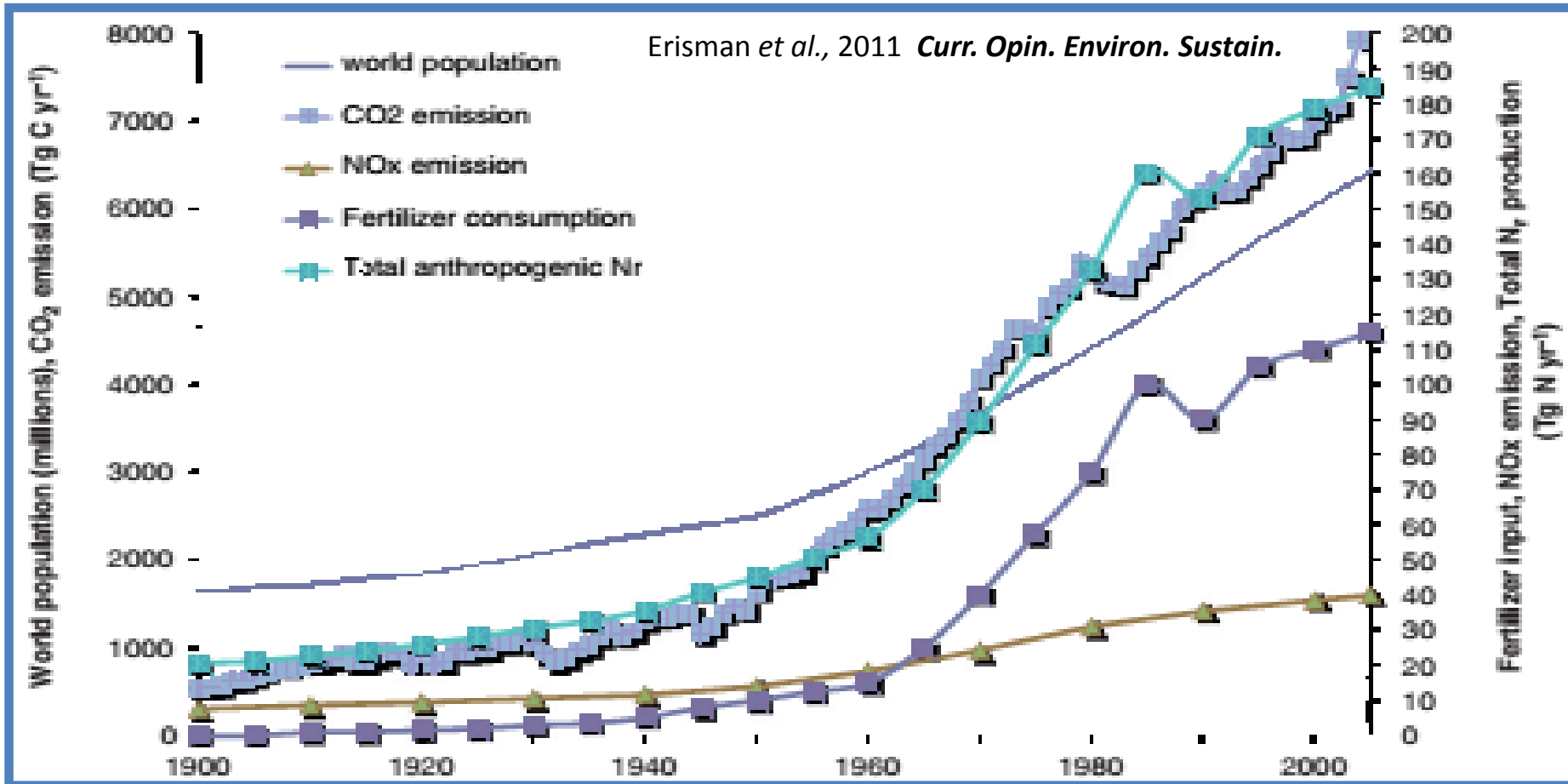


Quantifying the magnitude of species richness and its turnover on ecosystem productivity by the rate of N inputs in a temperate grassland

Yunhai Zhang *et al.*

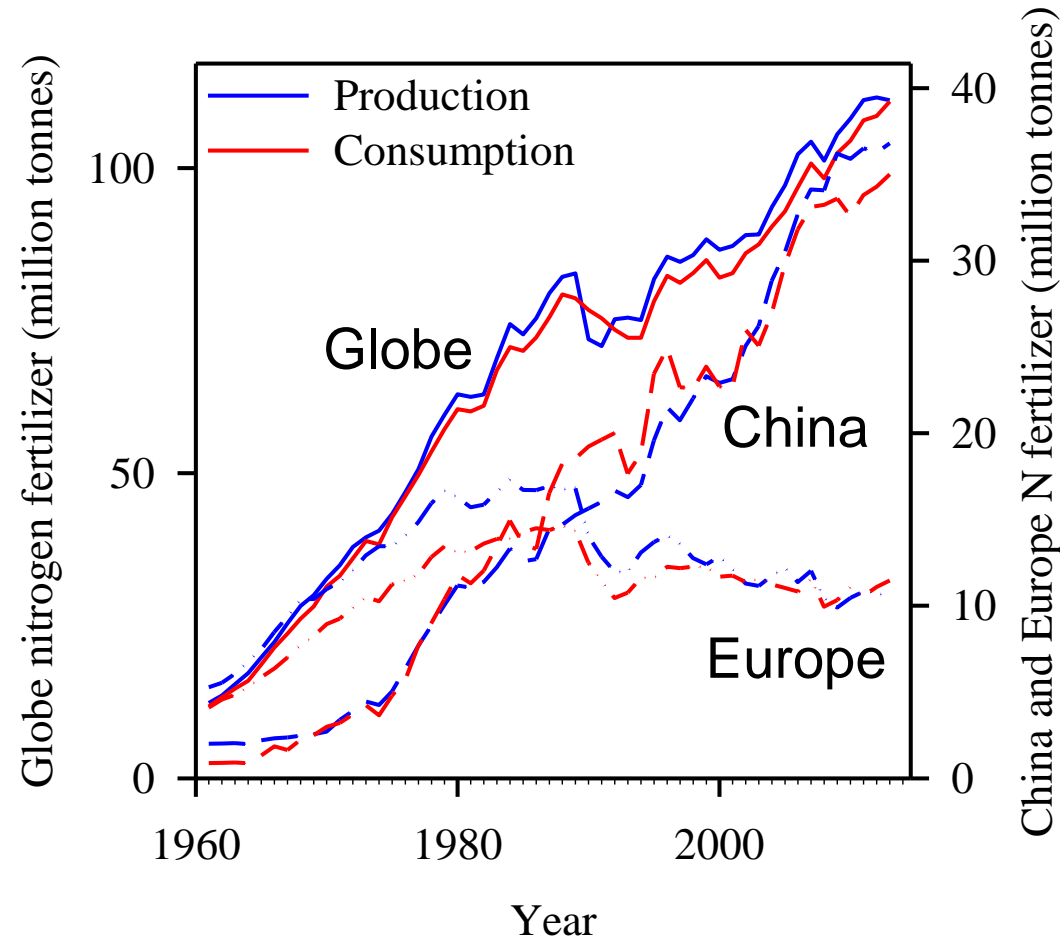
Thursday, June 09, 2016

1. Background



Reactive nitrogen deposition has increased and contributed to widespread changes in the structure and functioning of natural and managed ecosystems.

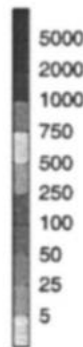
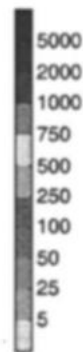
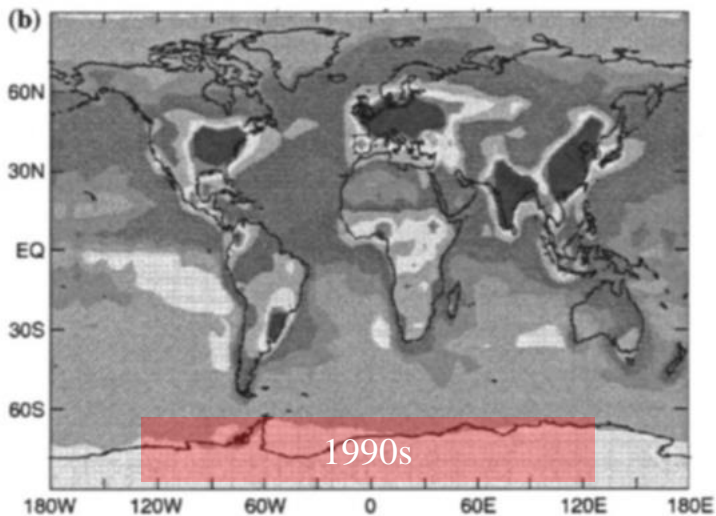
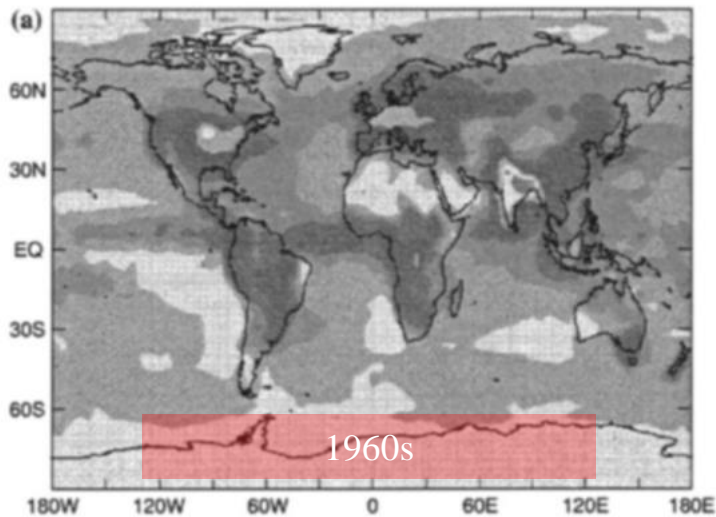
Projections on N deposition



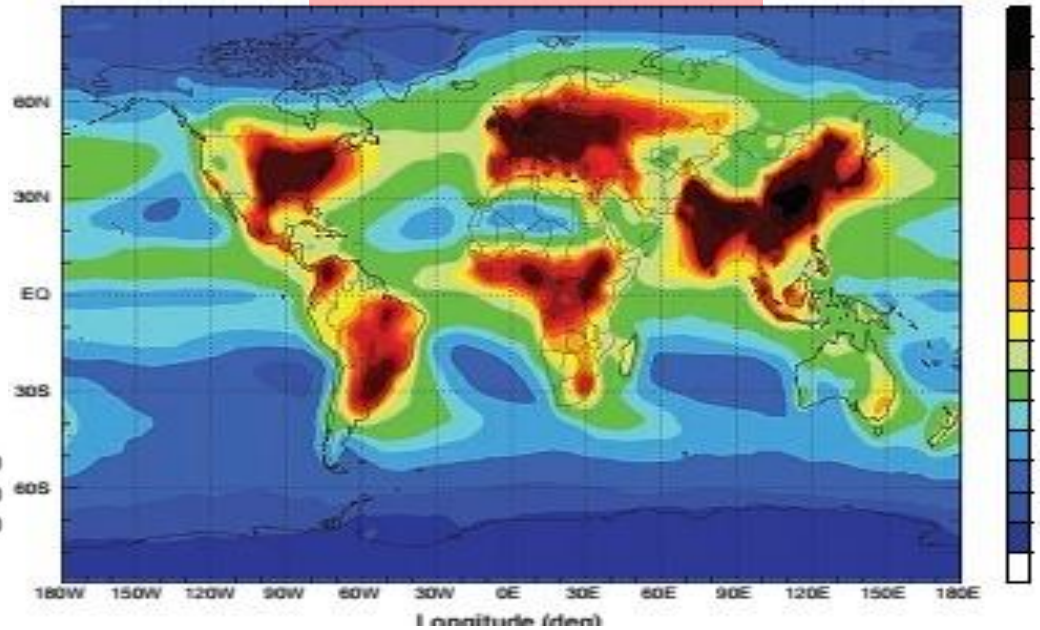
Global average atmospheric N deposition will continue to increase as increasing global N fertilizer production and consumption (data from FAO 2015) due to N fertilizer is the most relative factor to be associated with atmospheric N deposition.

Projections on global N deposition

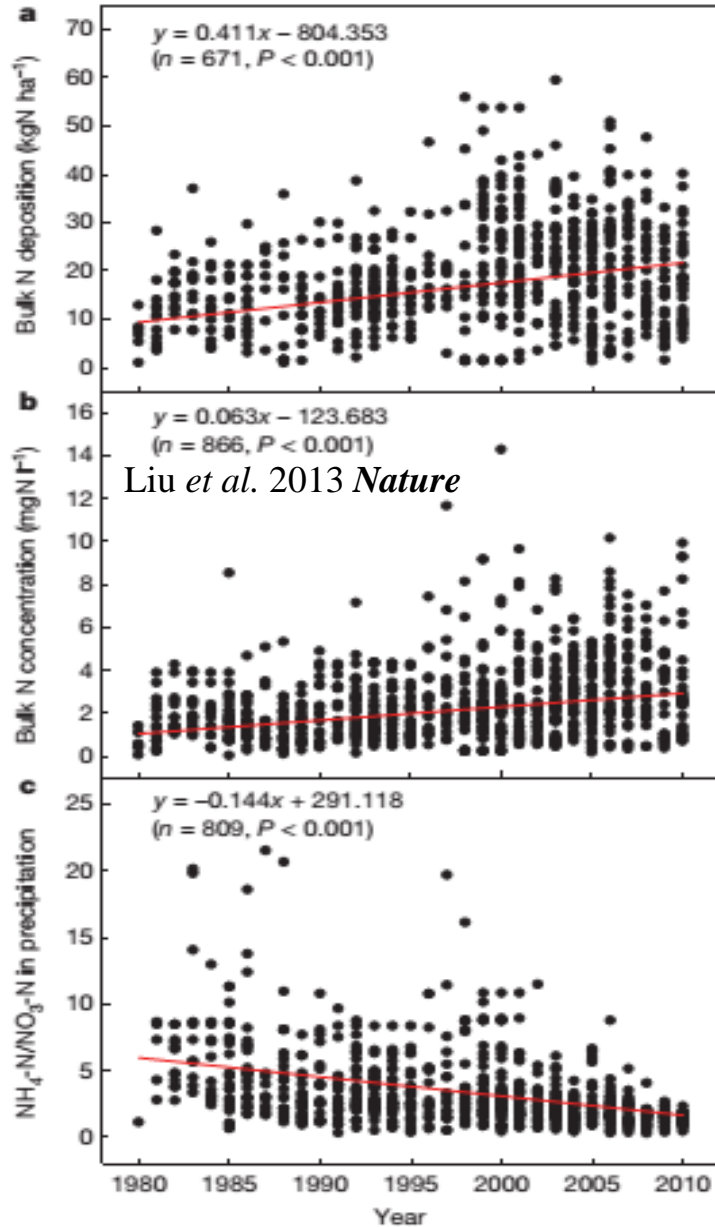
Galloway *et al.* 2004 *Biogeochemistry*



2050s

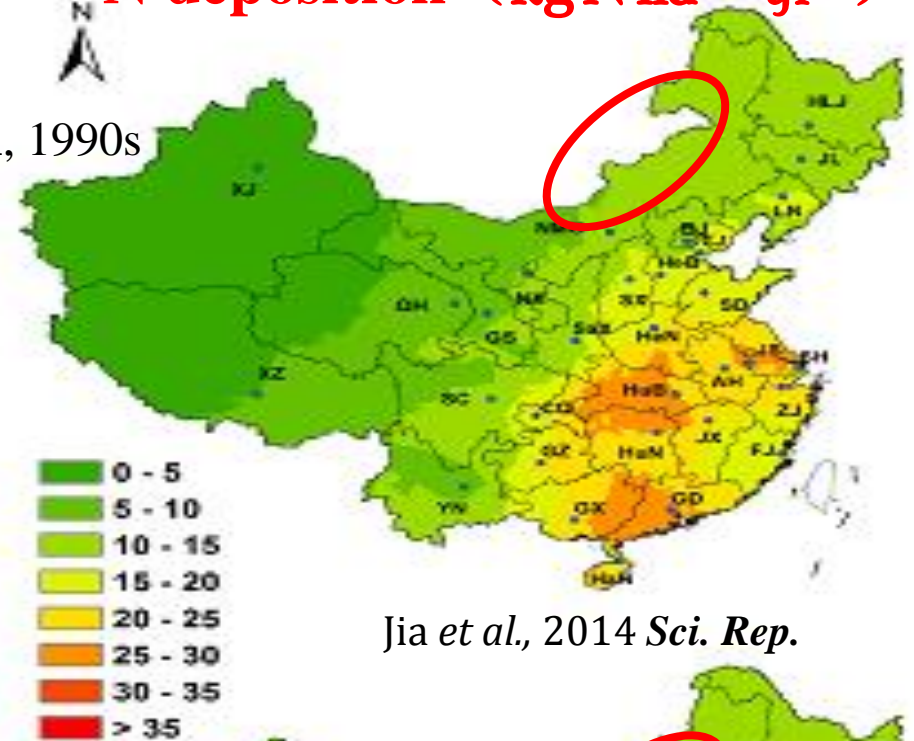


China N deposition



N deposition ($\text{kgN ha}^{-2} \text{ yr}^{-1}$)

A, 1990s



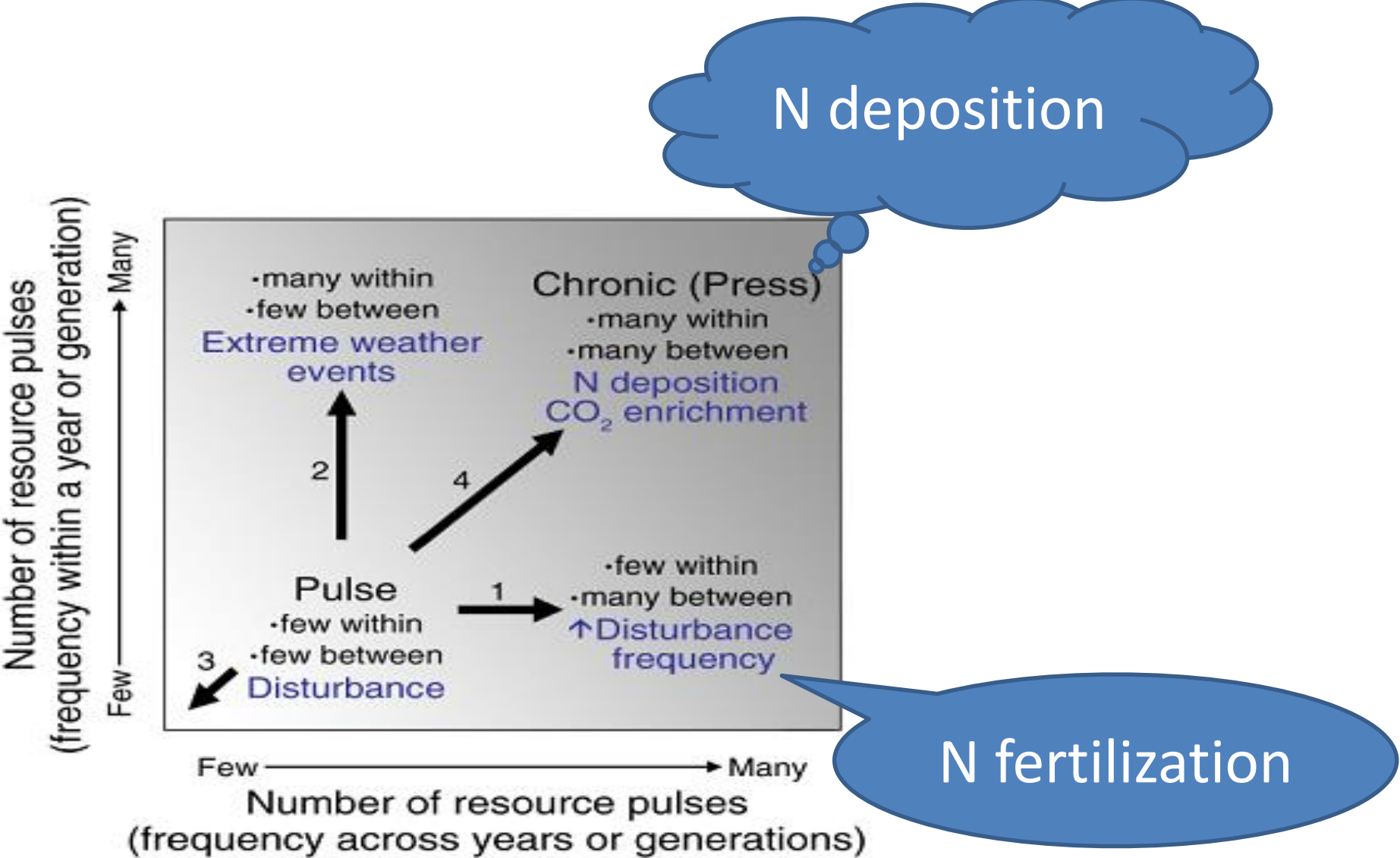
Jia et al., 2014 Sci. Rep.

B, 2000s



It is an idea ecosystem to conduct stimulating N deposition experiments.

Possible pulse effects of nitrogen in theory



Smith et al., 2009 *Ecology*

It may like this.....



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Suddenly.....



High frequency
(more times)

I am hungry!

HEALTHY
AND
HAPPY :)



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Low frequency
(fewer times)

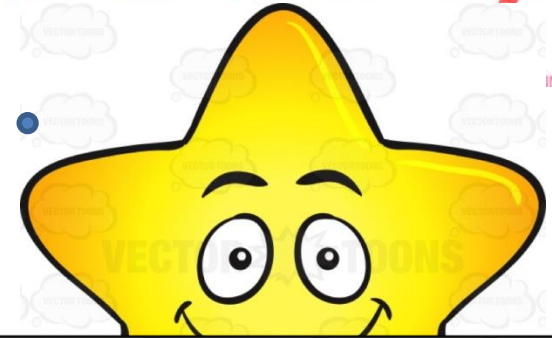




High frequency
(more times)

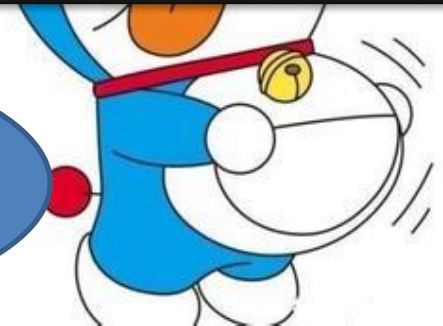
I am hungry!

HEALTHY
AND
HAPPY :)



Does exist same effect on plant diversity,
ecological processes and ecosystem
functioning?

Low frequency
(fewer times)



2. Experiment

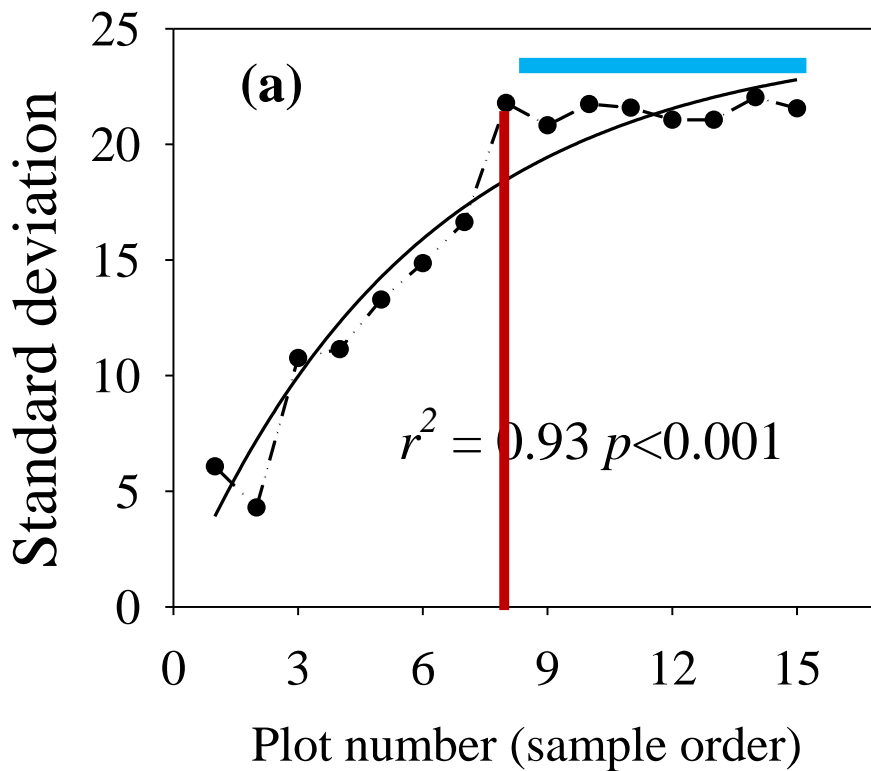
✓ Replicate

✓ The rate of N addition

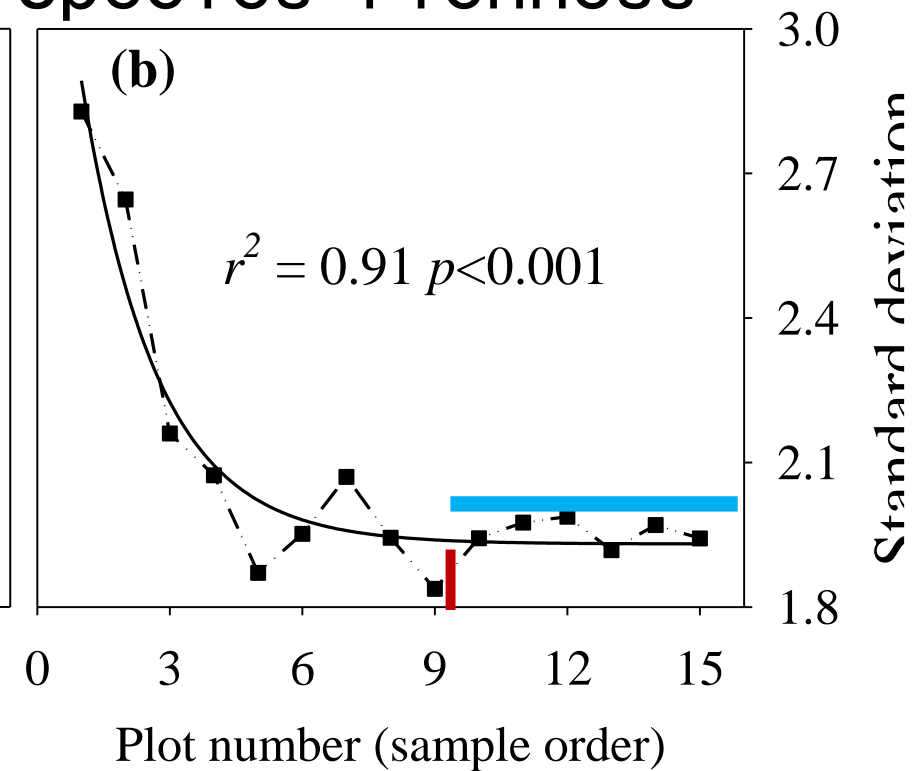
✓ The frequency of N addition

How many replicates?

Aboveground biomass



Species richness



At least 10 plots for every treatment.

The level of nitrogen addition

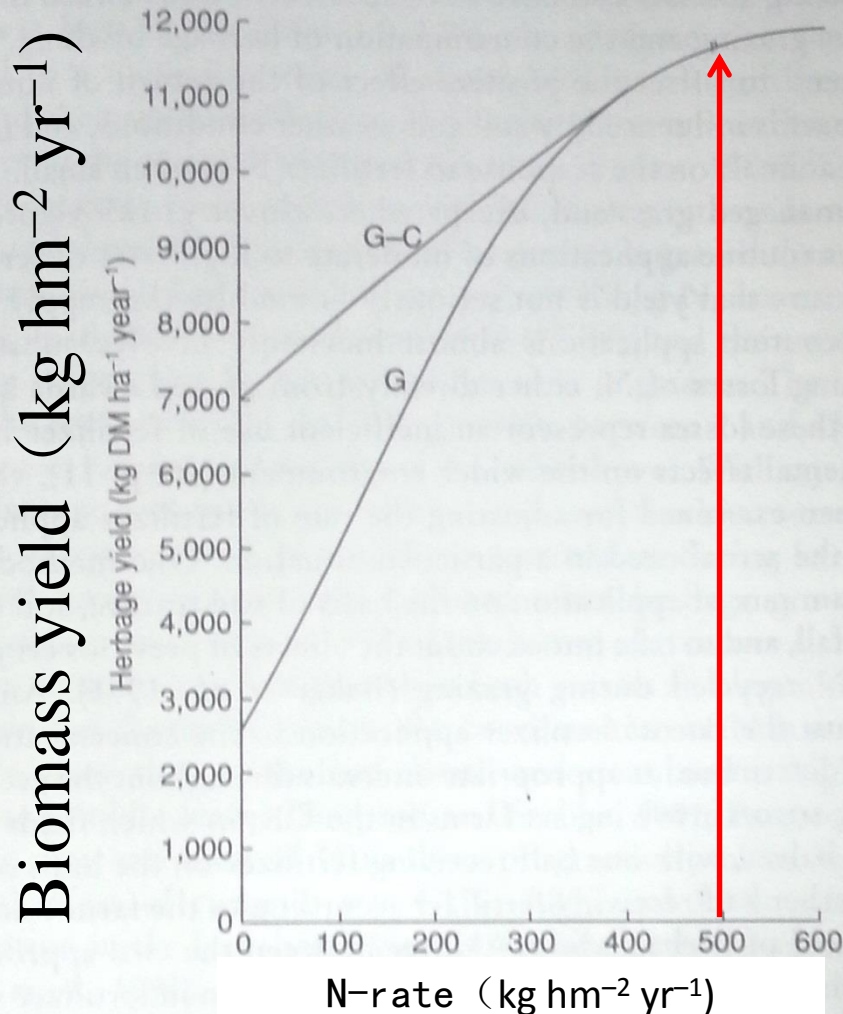


Fig. 5.3. Generalized response to fertilizer N of an all-grass sward (G) and a grass-clover sward (G-C) in conditions similar to those of lowland UK (based on data in Whitehead, 1995).

David C. Whitehead

Year 2000

CABI Publishing

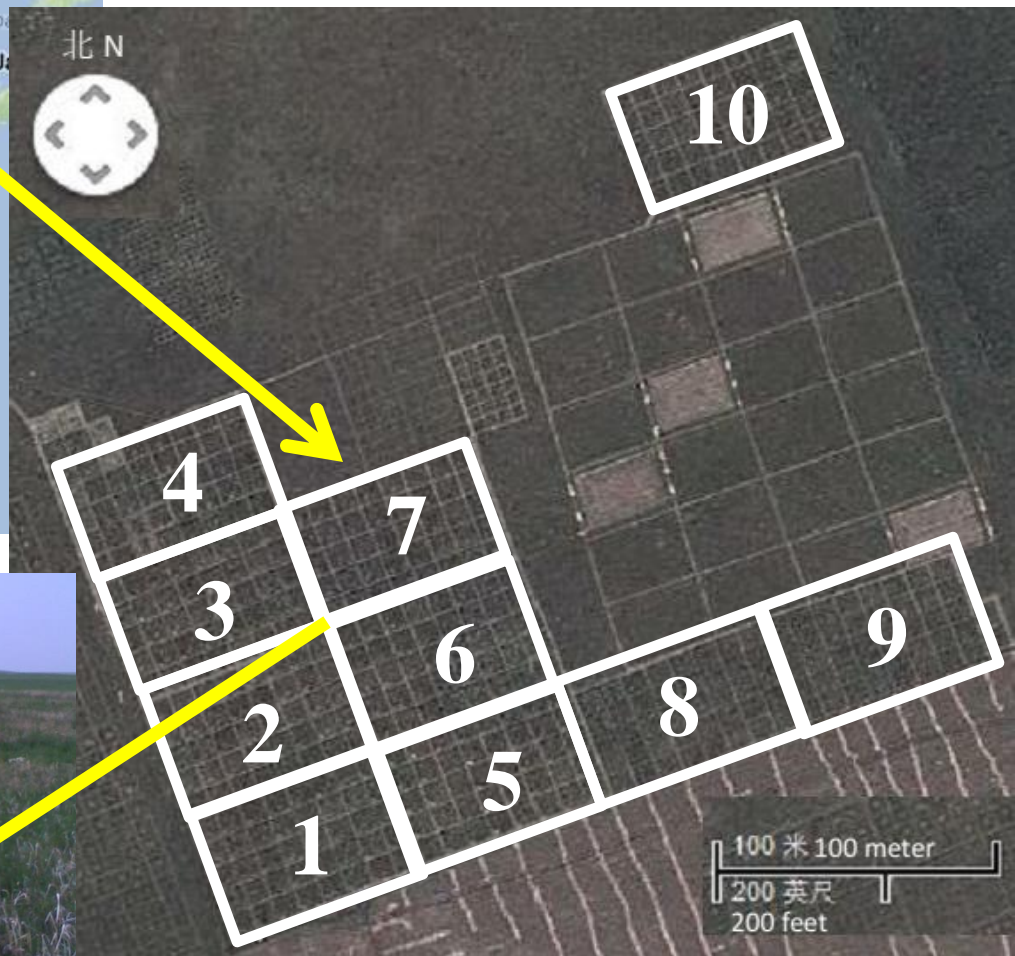
Page 109 Fig. 5-3

The frequency of nitrogen addition

- Two frequency of nitrogen addition,
 - 1). 2 N additions yr⁻¹ (twice year⁻¹)
 - 2). 12 N additions yr⁻¹ (monthly)
- Nine rates of nitrogen addition,
(0, 1, 2, 3, 5, 10, 15, 20, and 50 g N m⁻² yr⁻¹)
- Control and mowing,
(mowing in August for simulation hay management in the region)

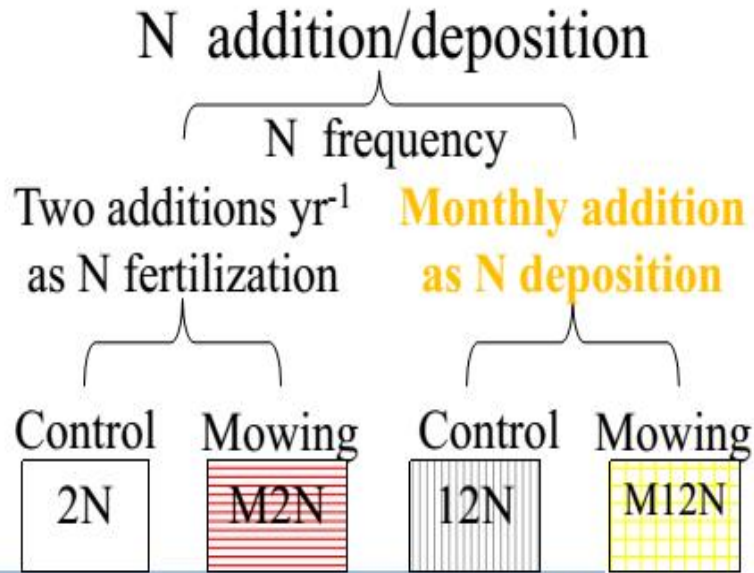


116°14' E
43°13' N



Experimental site

In total, 38 Treatments; 380 Plots



M12N3	M12N0	2N1	2N3	M2N0	M12N2	M2N50	N ↑	
2N2	M12N1	12N15	12N10	M12N10	12N3	M2N3		
2N50	2N20	M2N20	12N2	M12N5	M2N2	12N1		M12N50
12N0	M2N1	MCK	12N5	2N15	M2N10	CK		12N20
M12N15	2N0	M2N15	M12N20	12N50	M2N5	2N10		2N5

Block one for example. CK means no water and no N addition. Number in last indicates N addition rate (g N m⁻² yr⁻¹)



3. Results

3.1 Species richness

3.2 Species gain and lose

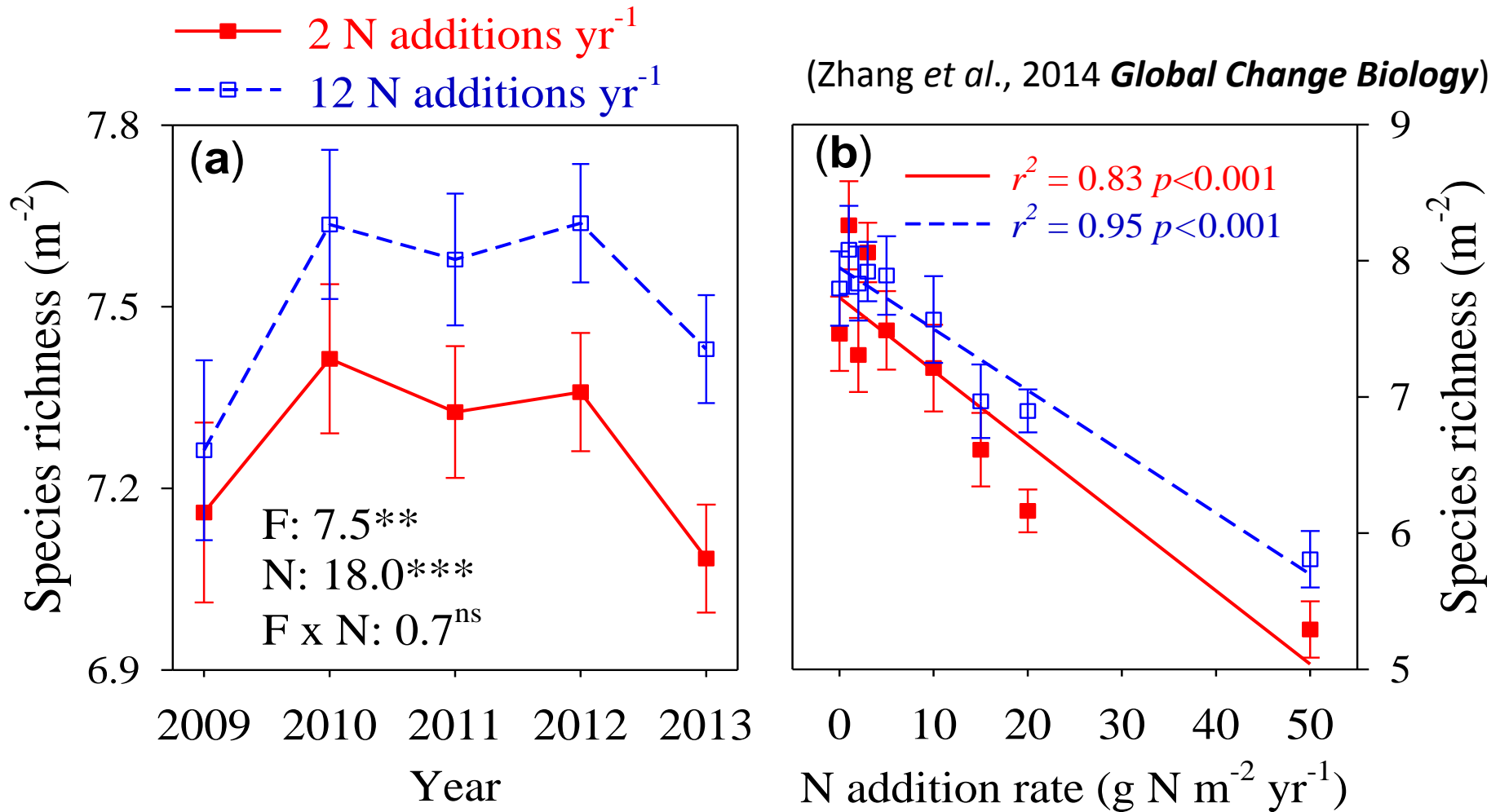
3.3 Ecosystem ANPP

3.4 Species richness contributions to
ecosystem ANPP





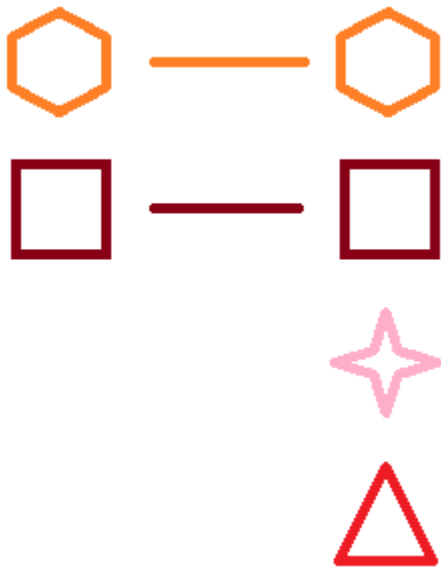
3.1 Species richness



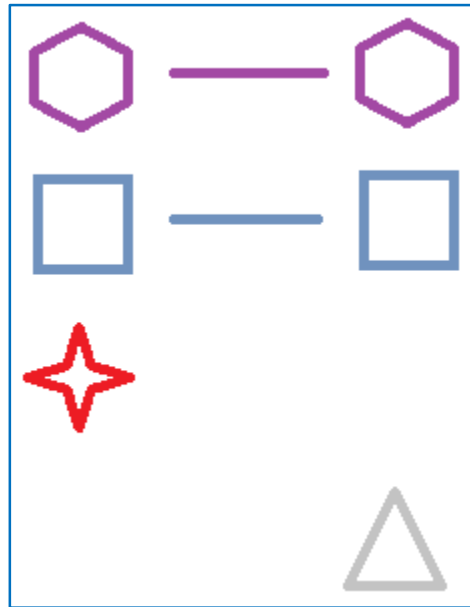
Rapid species loss at high rates and at low frequency of N additions.

3.2 Species gain and lose

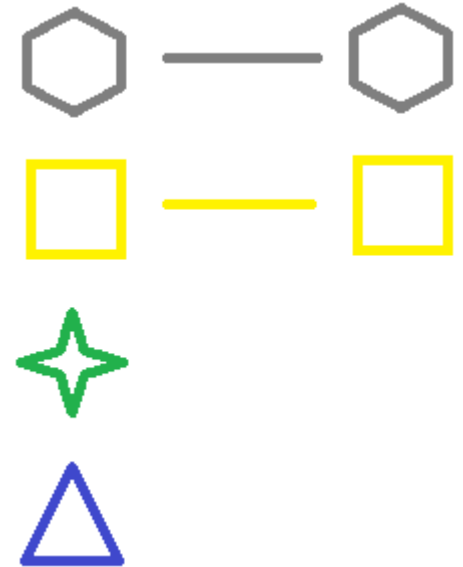
Gains of species



Species richness

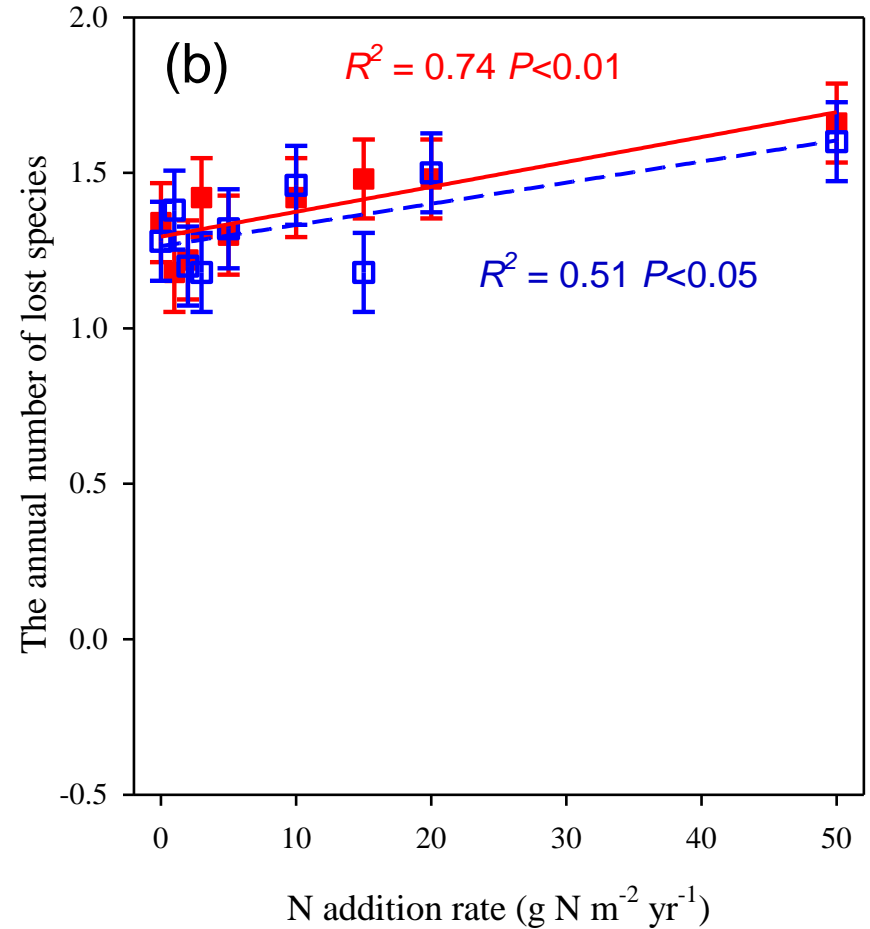
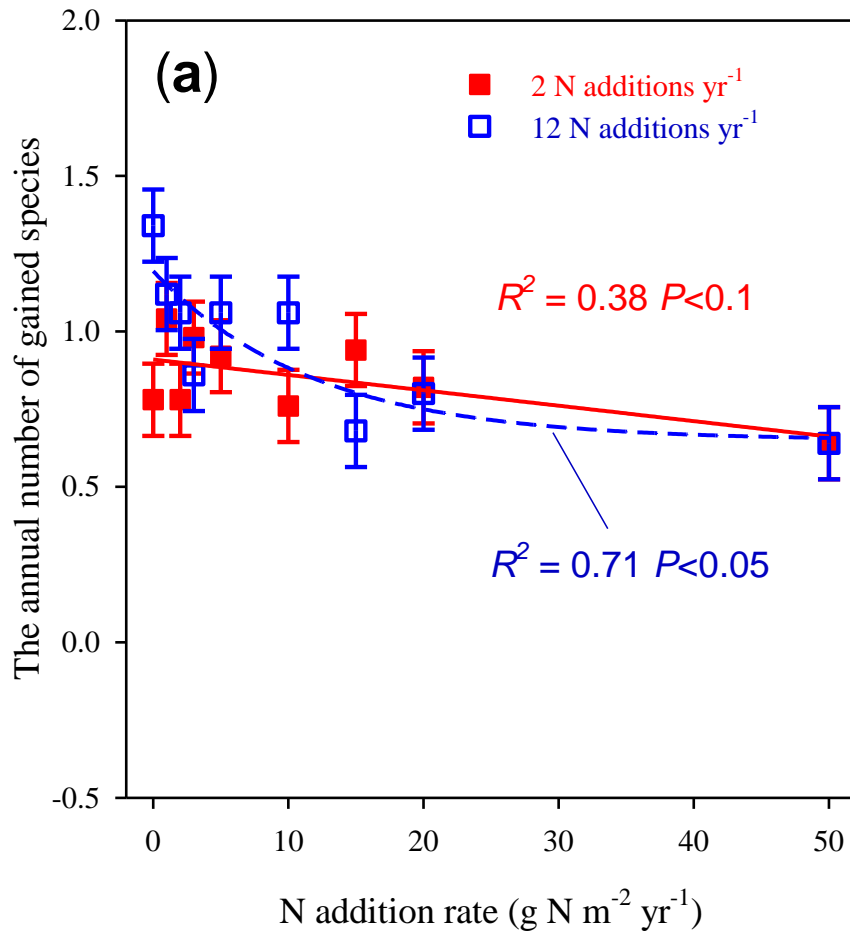


Losses of species



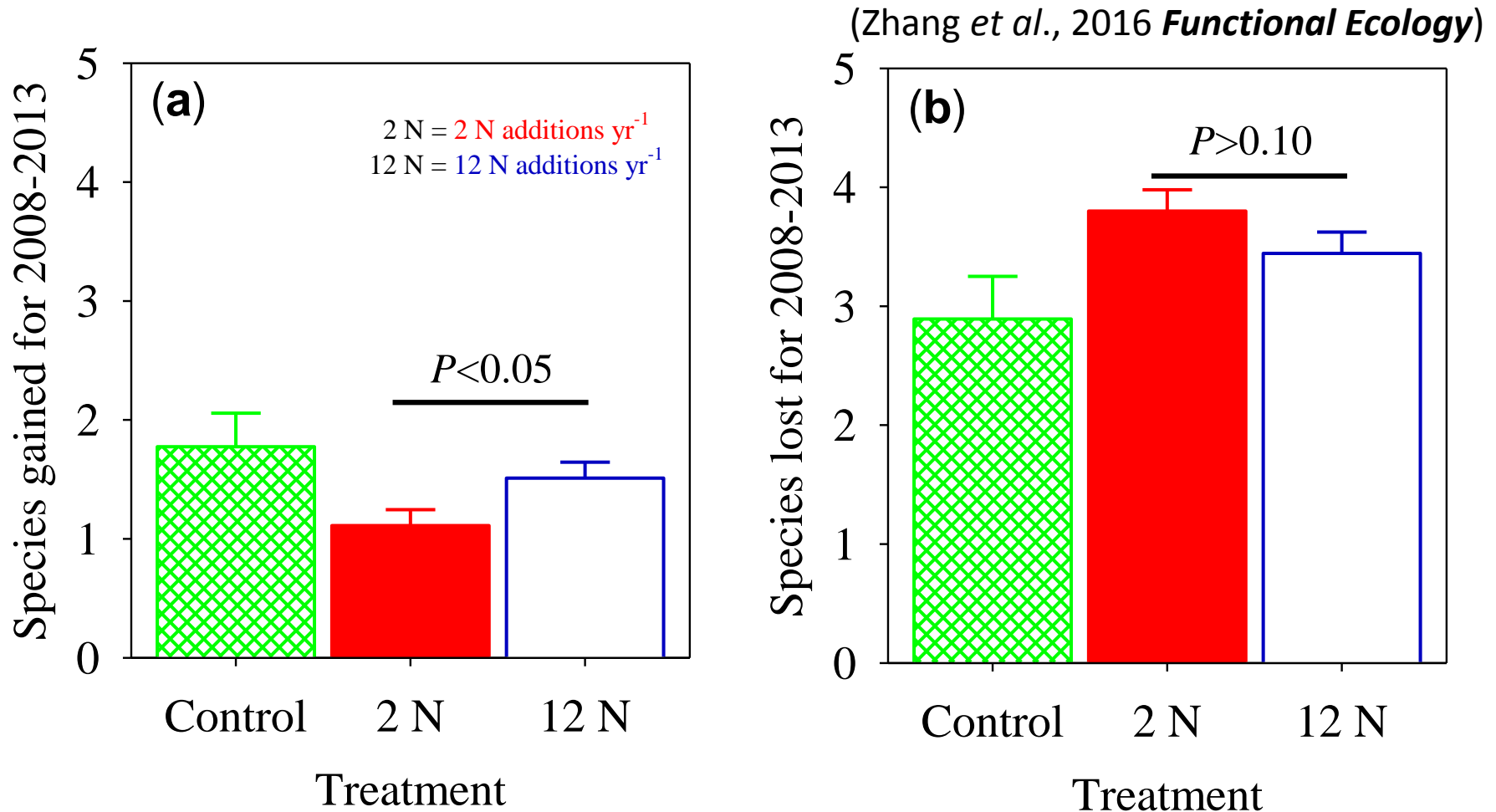
3.2.1 Annual species gained and lost

(Zhang *et al.*, 2016 *Functional Ecology*)



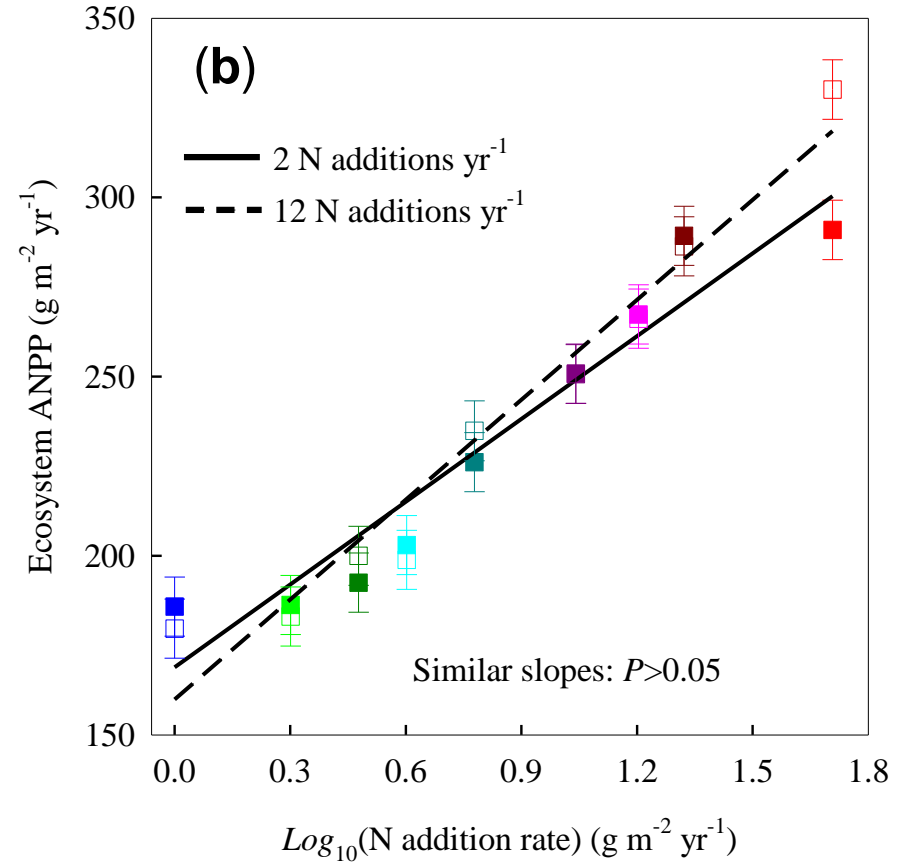
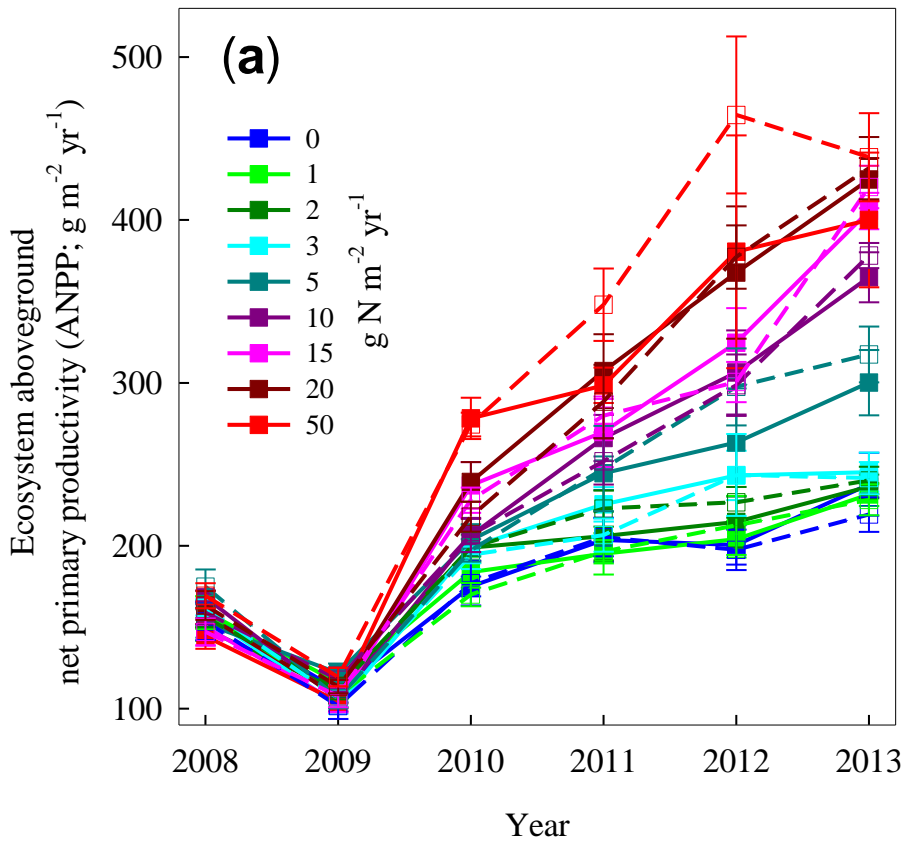
The rate of N addition decreased new gained species and increased lost species.

3.2.2 Cumulative species gained and lost



Fewer new species gained at low frequency of N addition.

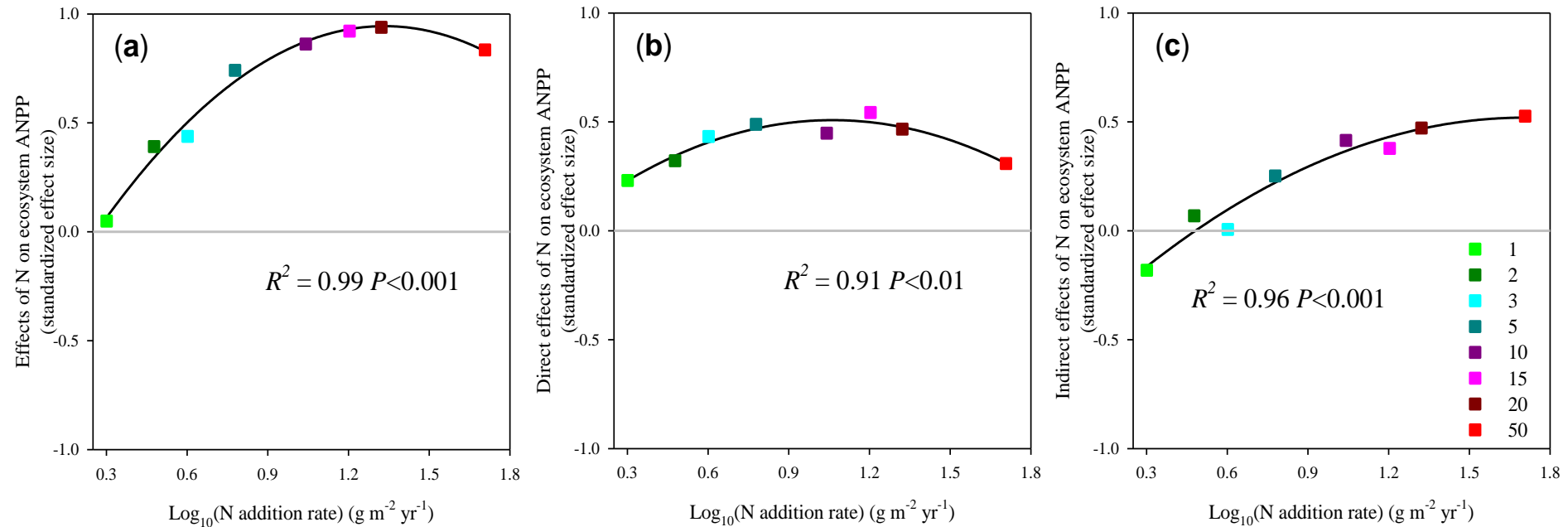
3.3 Ecosystem ANPP



(Zhang *et al.*, 2015 *Scientific Reports*)

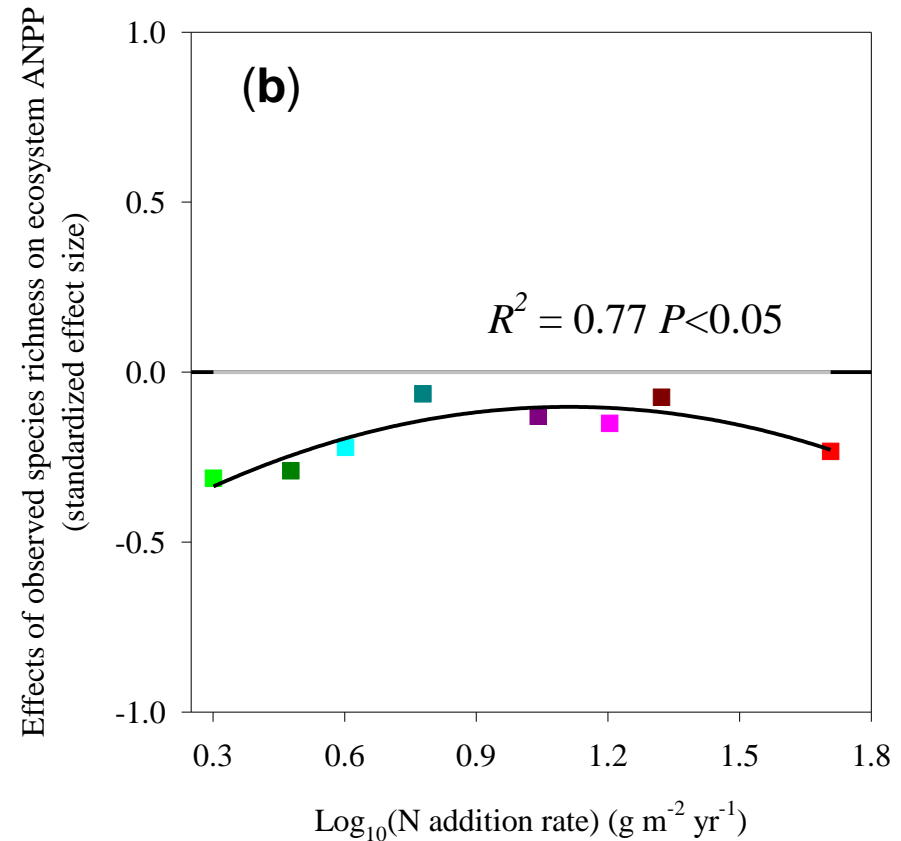
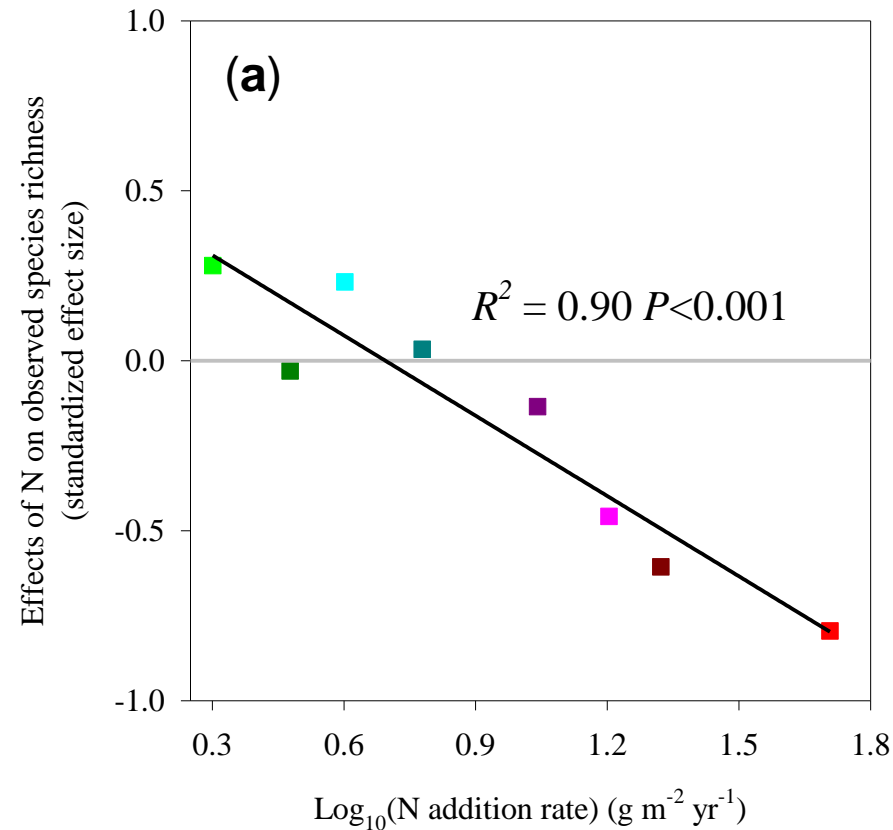
The rate rather than the frequency of N addition affects productivity.

3.4.1 Effect of N on ecosystem ANPP



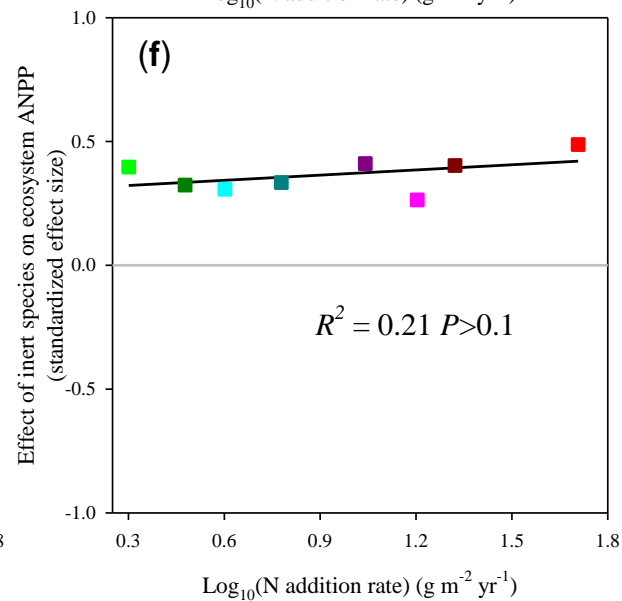
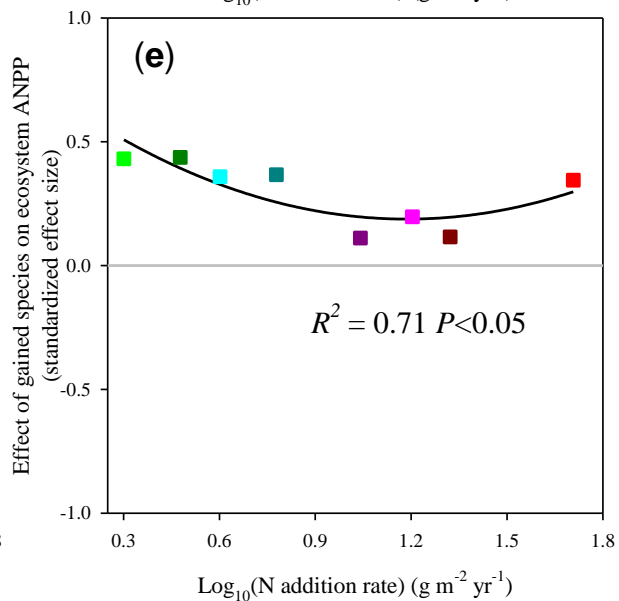
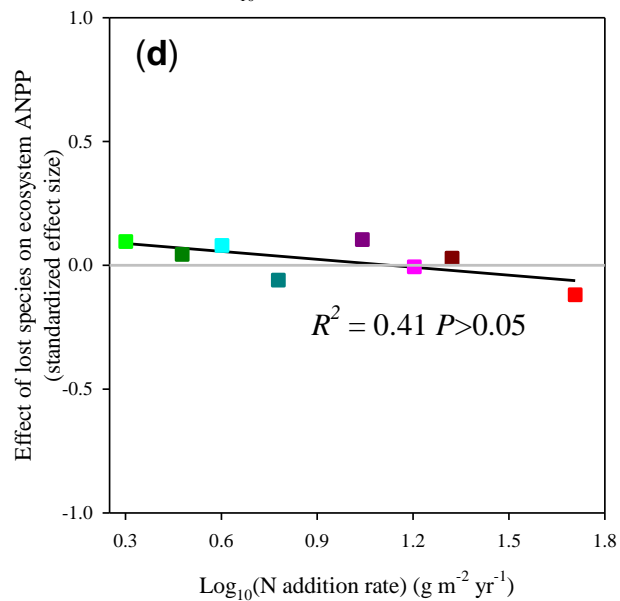
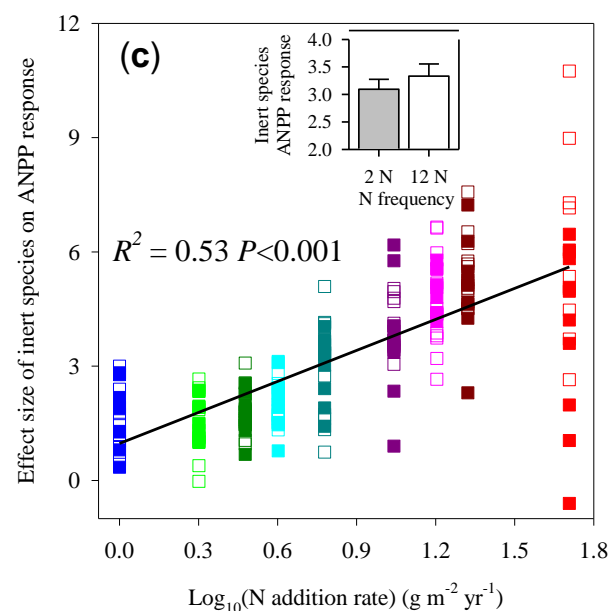
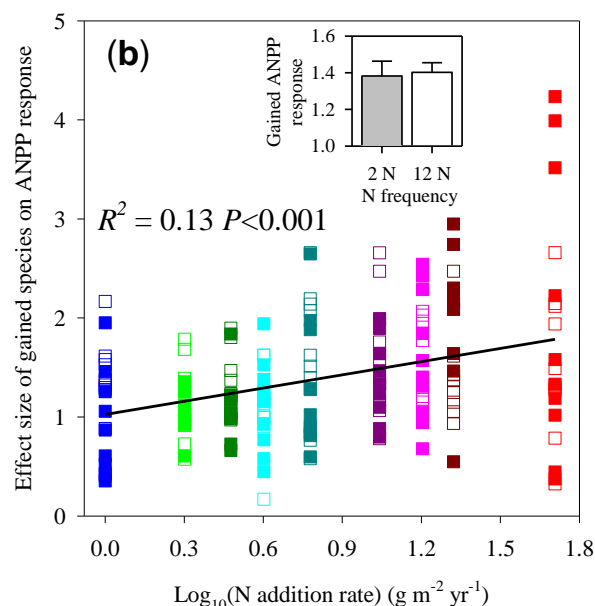
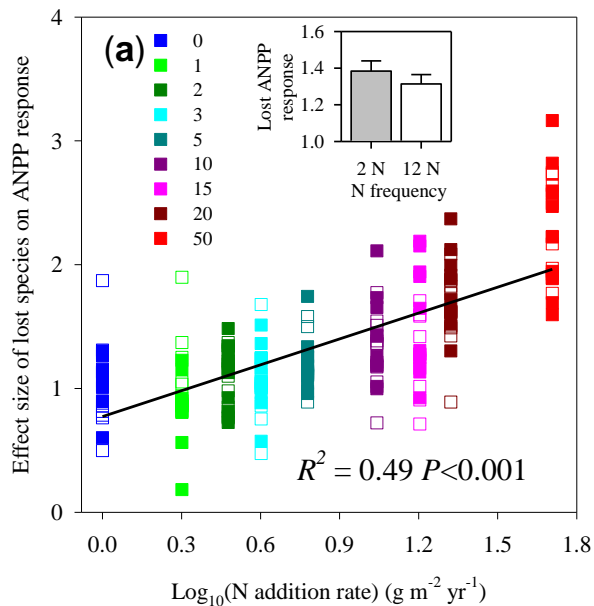
- Nitrogen enrichment directly and indirectly affected ecosystem production.
- Direct effect was smaller than the indirect effect as all rates of N as a whole.

3.4.2 Species richness effect



Effect on ecosystem production from species richness was negative with diminishing return under N-enriched.

3.4.3 Species richness contributions



4. Conclusions

- Both pulse- and cumulative-effects of N affected ecological processes and functioning.
- The contributions to ecosystem production via new gained species decreased with the increasing N addition rate, while the contributions through inert (persisting) species was relative large and constant.

5. ACKNOWLEDGEMENT

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