LTLS:

Exploring potential implications of spatial and temporal variation in LTLS output for river biodiversity

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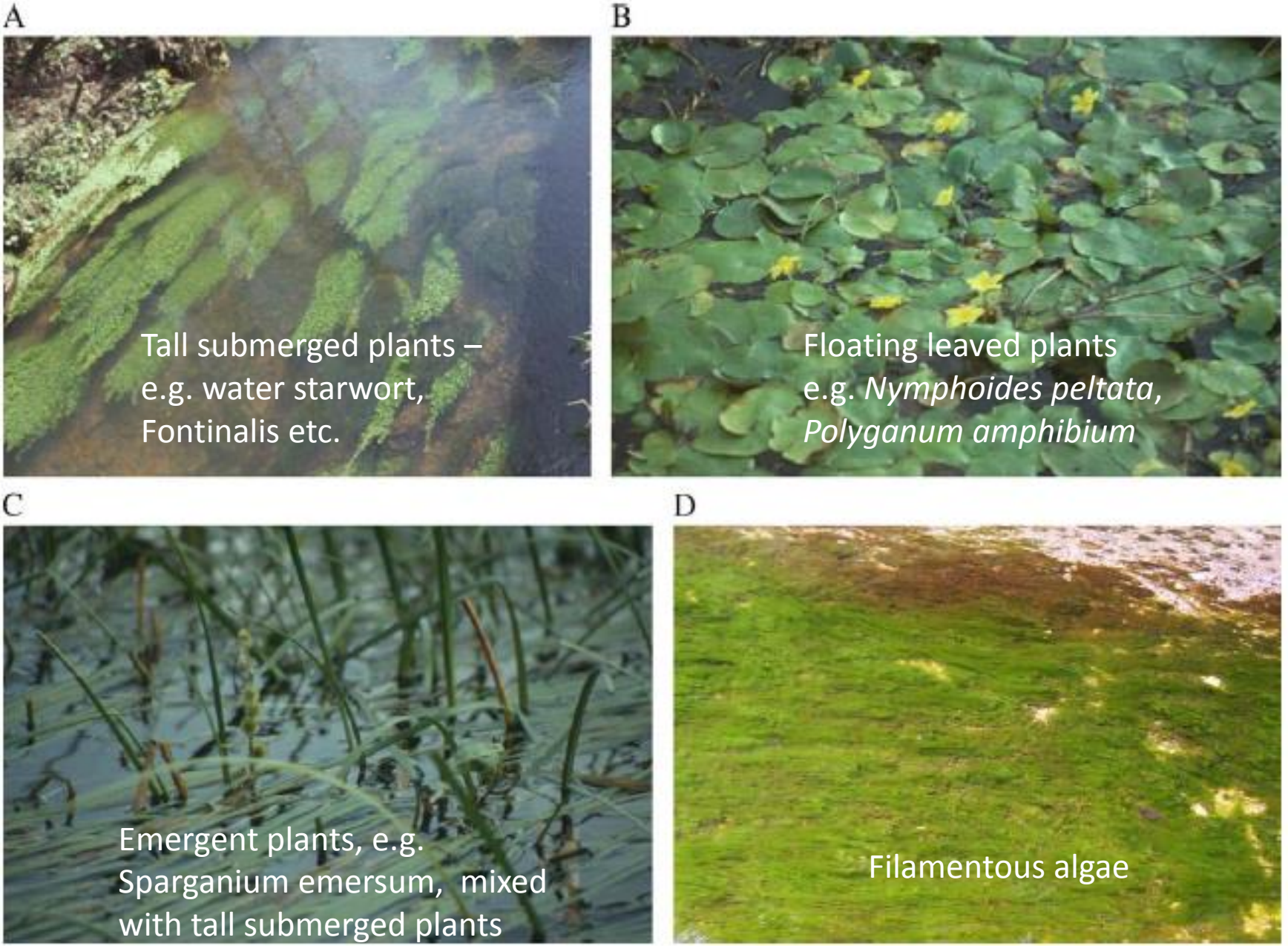
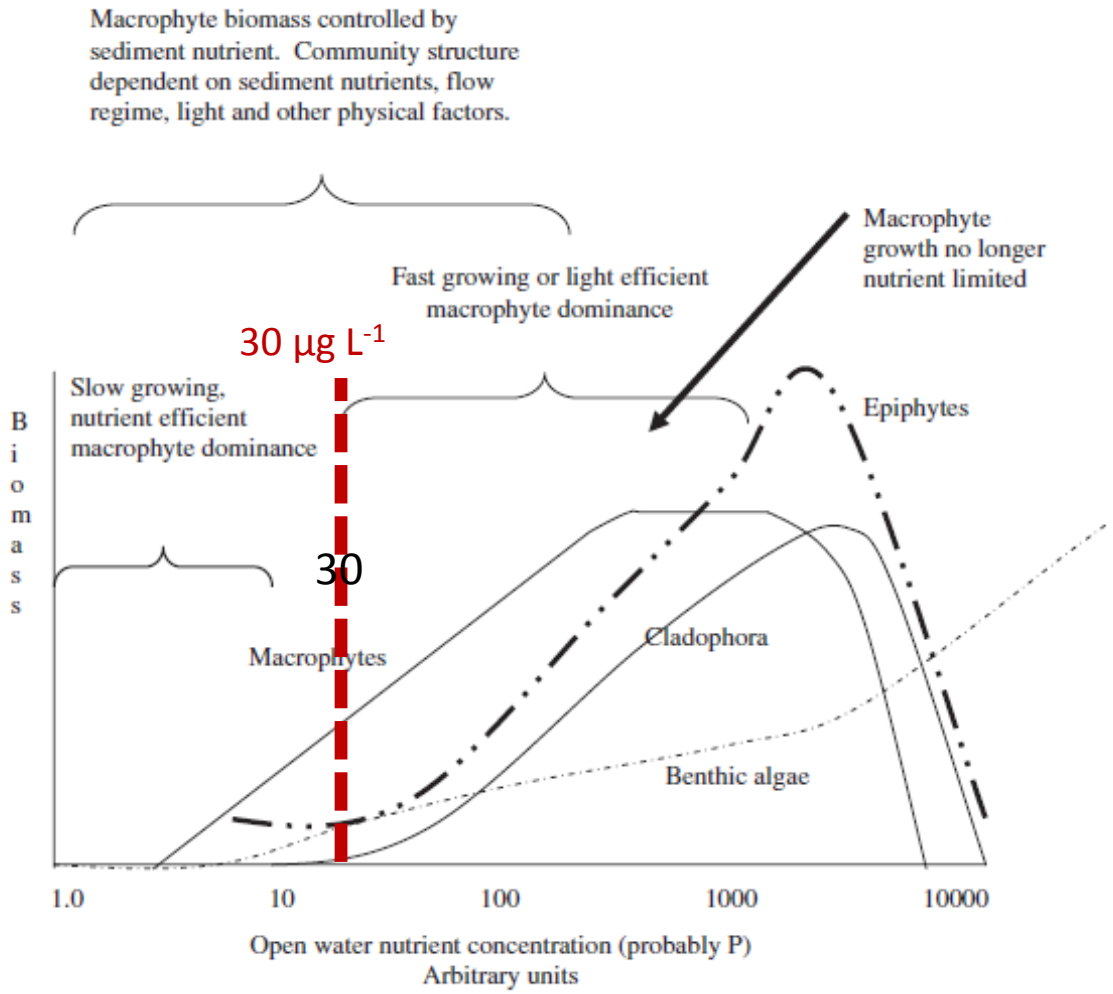
Key questions:

- What are the implications of changes in macronutrient concentrations for stream/river biodiversity in time and space, at regional-national scales?
- Can we exploit known (or develop new) relationships between nutrient chemistry and river biodiversity parameters in order to translate nutrient levels generated by the LTLS model into biodiversity metrics to inform stake holders?

Stages of eutrophication in rivers (from Hilton et al., 2006)





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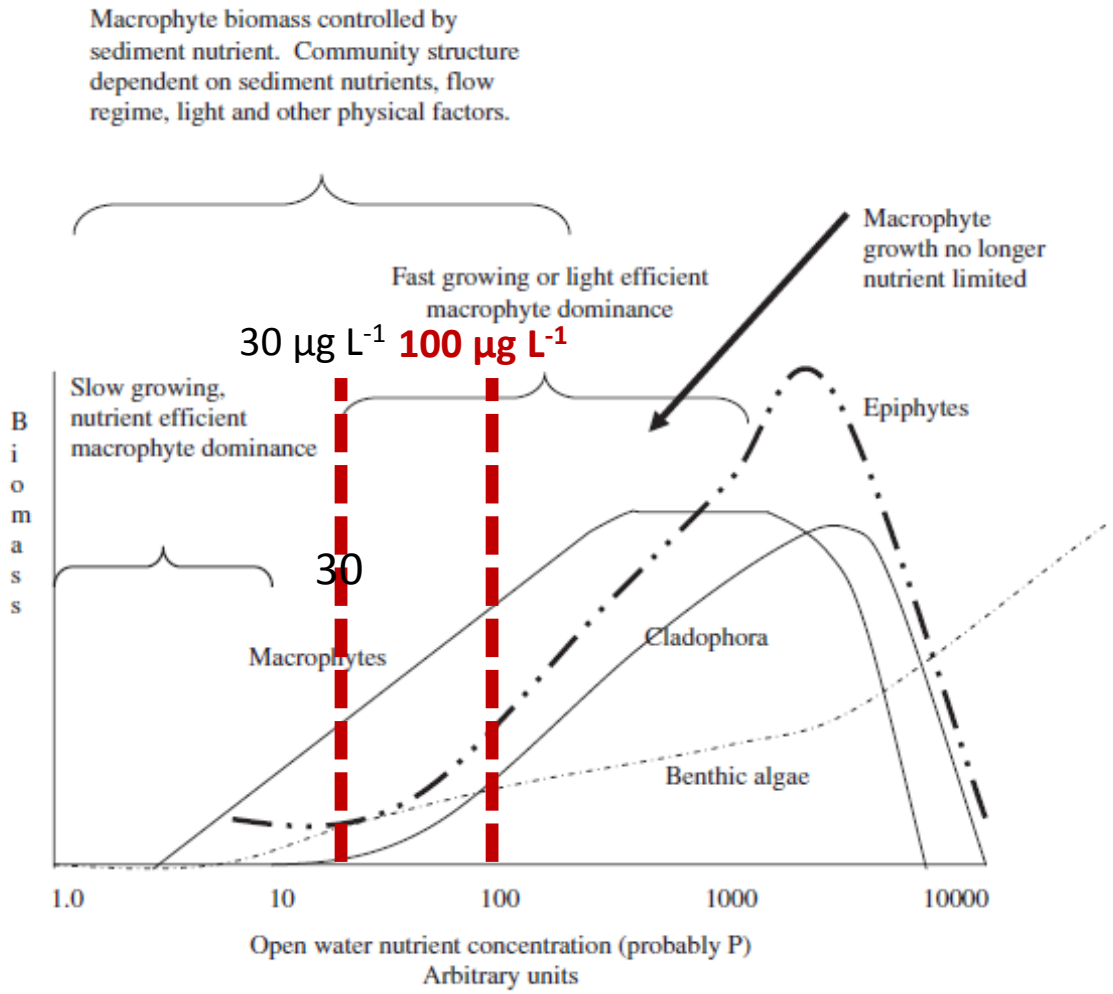

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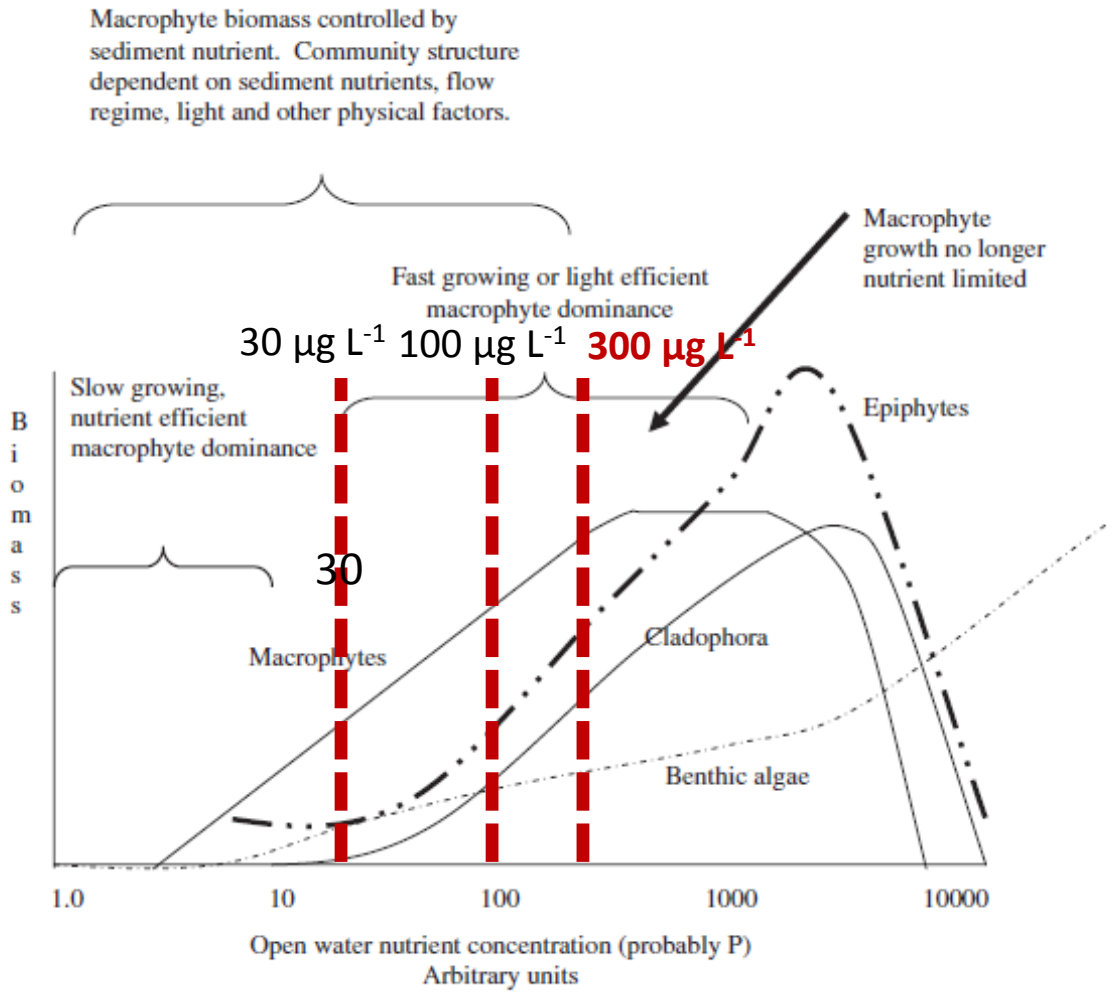
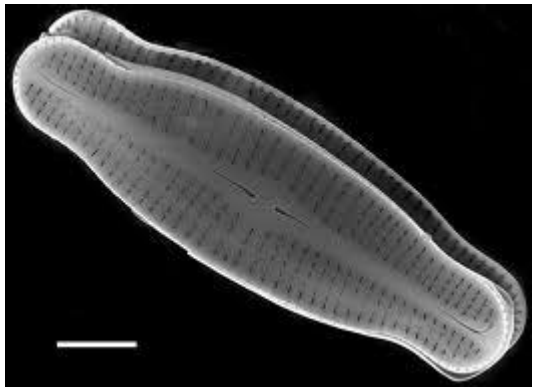
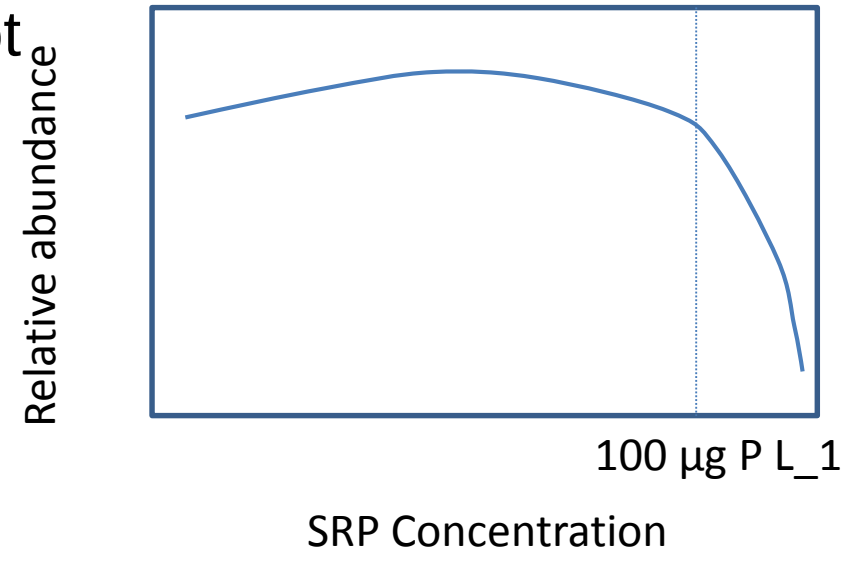

Macrophyte biomass controlled by sediment nutrient. Community structure dependent on sediment nutrients, flow regime, light and other physical factors.
Macrophyte growth no longer nutrient limited
Fast growing or light efficient macrophyte dominance
30 µg L-1 100 µg L-1 300 µg L-1
Slow growing, nutrient efficient macrophyte dominance
Epiphytes
Biomass
30
Macrophytes
Cladophora
Benthic algae
1.0
10
100
1000
10000
Open water nutrient concentration (probably P)
Arbitrary units

algal assessment of nutrient status

- A few ubiquitous diatom taxa show strong relationships with SRP concentration
- Basis of the WFD Trophic Diatom Index Tool
- Relative importance of T & N not always clear due to strong spatial co-variance

Achnanthidium minutissimum

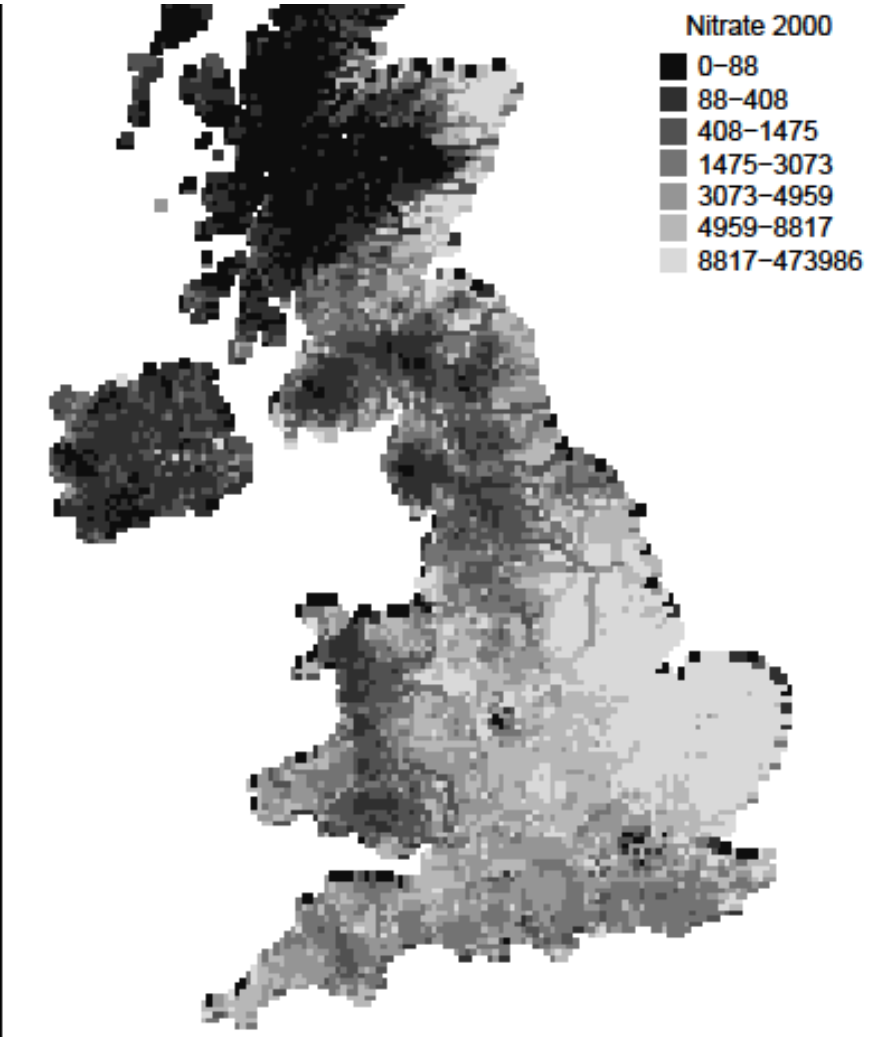


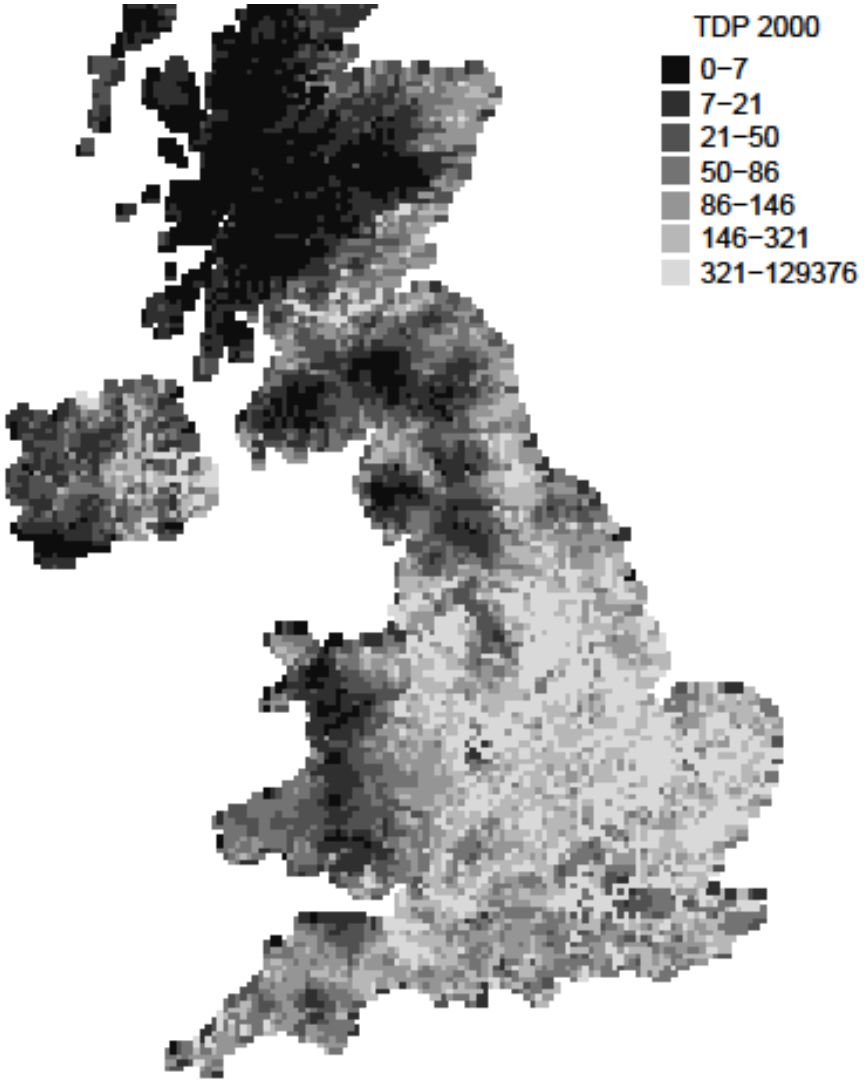


Final Approach

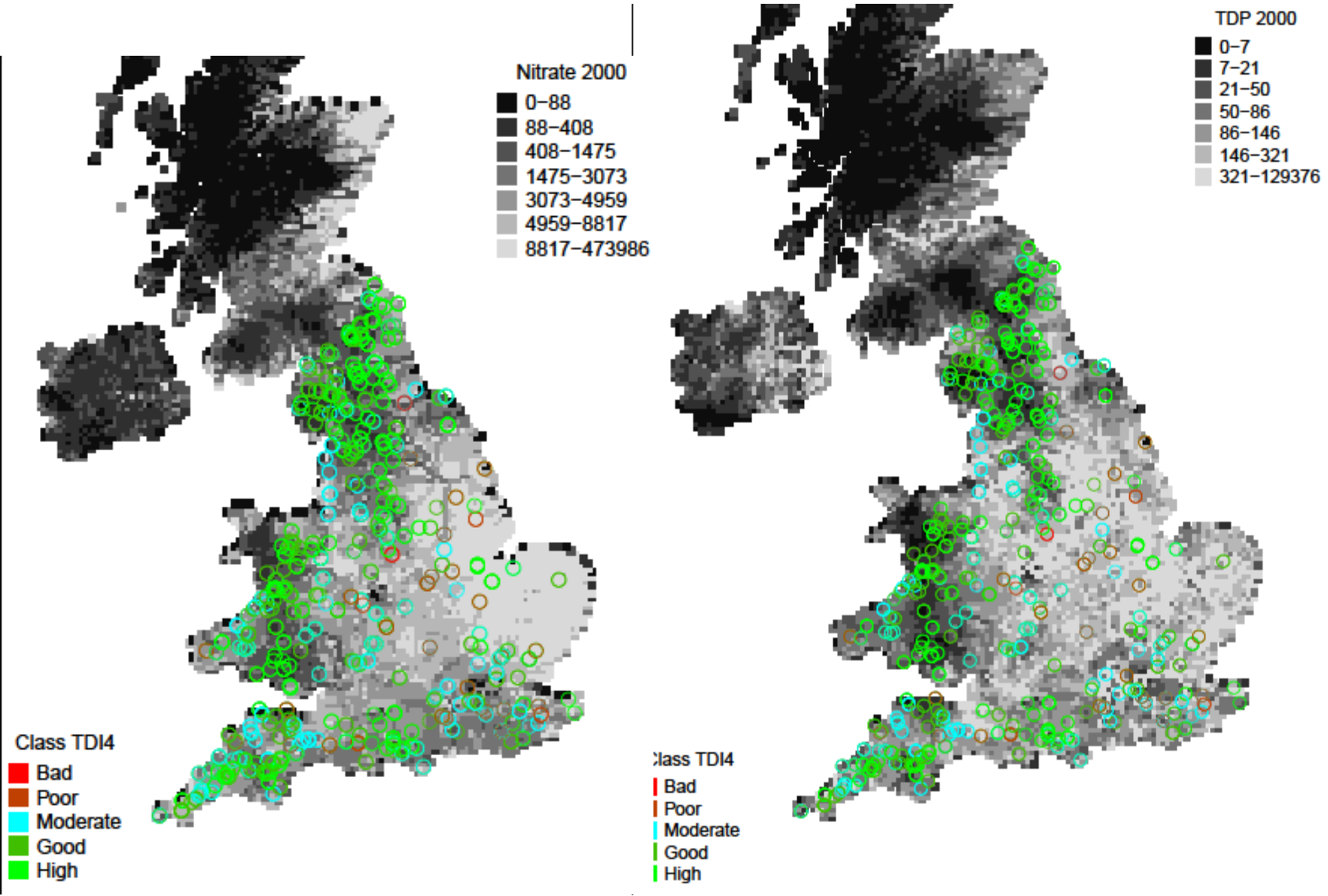
- EA provide diatom WFD metrics (DARES tool) for >1000 river/stream sites in England and Wales
- Includes Ecological Quality Ratio (EQR) estimates – i.e. High/Good/Moderate/Poor/Bad status relative to “unimpacted” condition
- Map diatom (and aquatic macrophyte) metrics onto LTLS 5 km grid of average “modern” Total Dissolved Phosphorus TDP and nitrate mean annual concentration (annual flux/annual flow)
- Assess spatial relationships between diatom and water chemical metrics
- Establish probabilistic relationships between chemical concentrations for each 5 km cell and co-located ecological metrics – i.e. likelihood each stream/river will belong to a particular EQR class on basis of LTLS modelled mean concentration
- Apply probabilistic relationship to model national change in EQR scores from 1850 to present – and to future scenarios

year 2000 mean TDP and nitrate concentrations (LTLS)

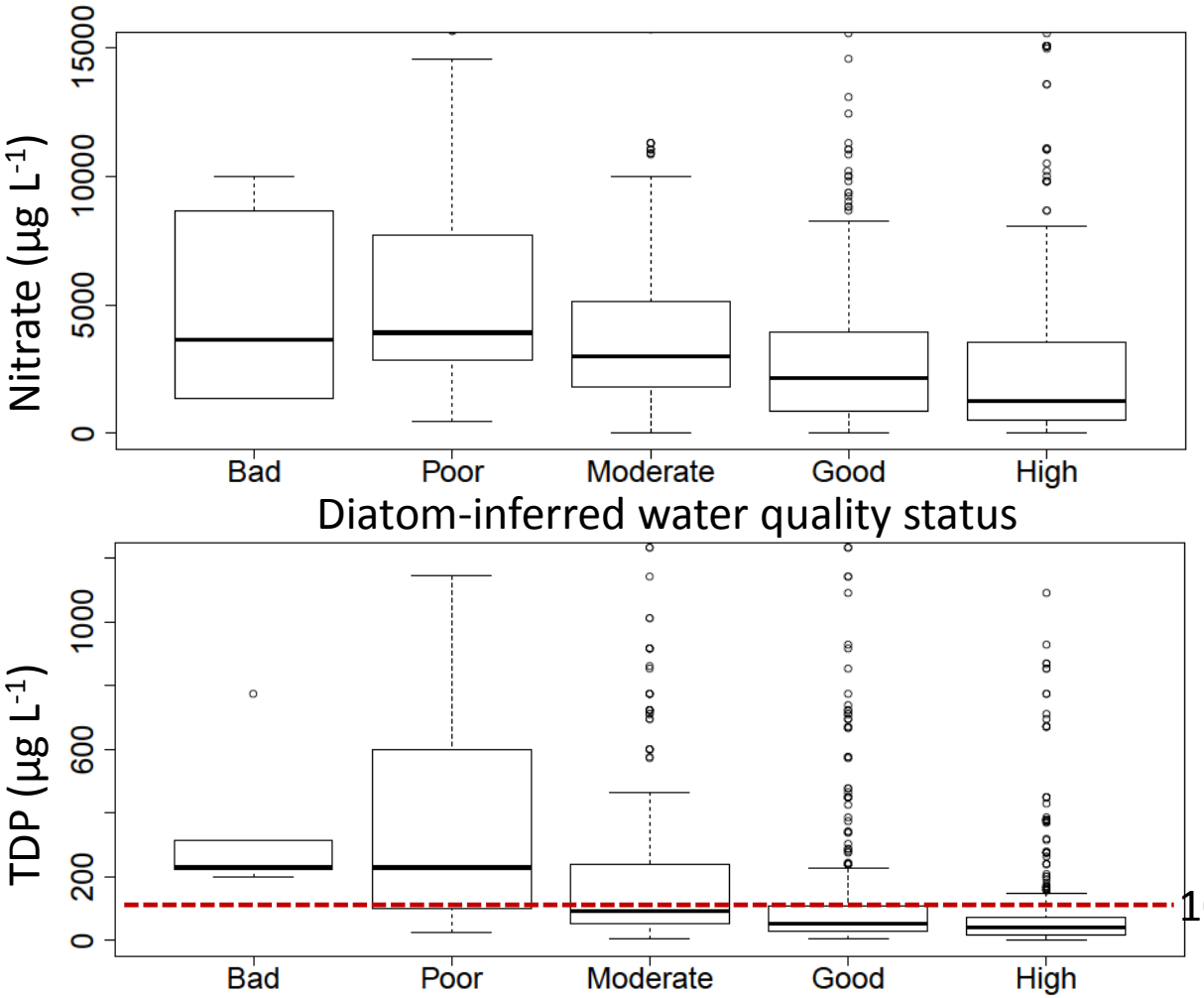




- Diatom-inferred WFD classes overlaid



P & N concentration distributions for 5 km cell specific to river/stream location



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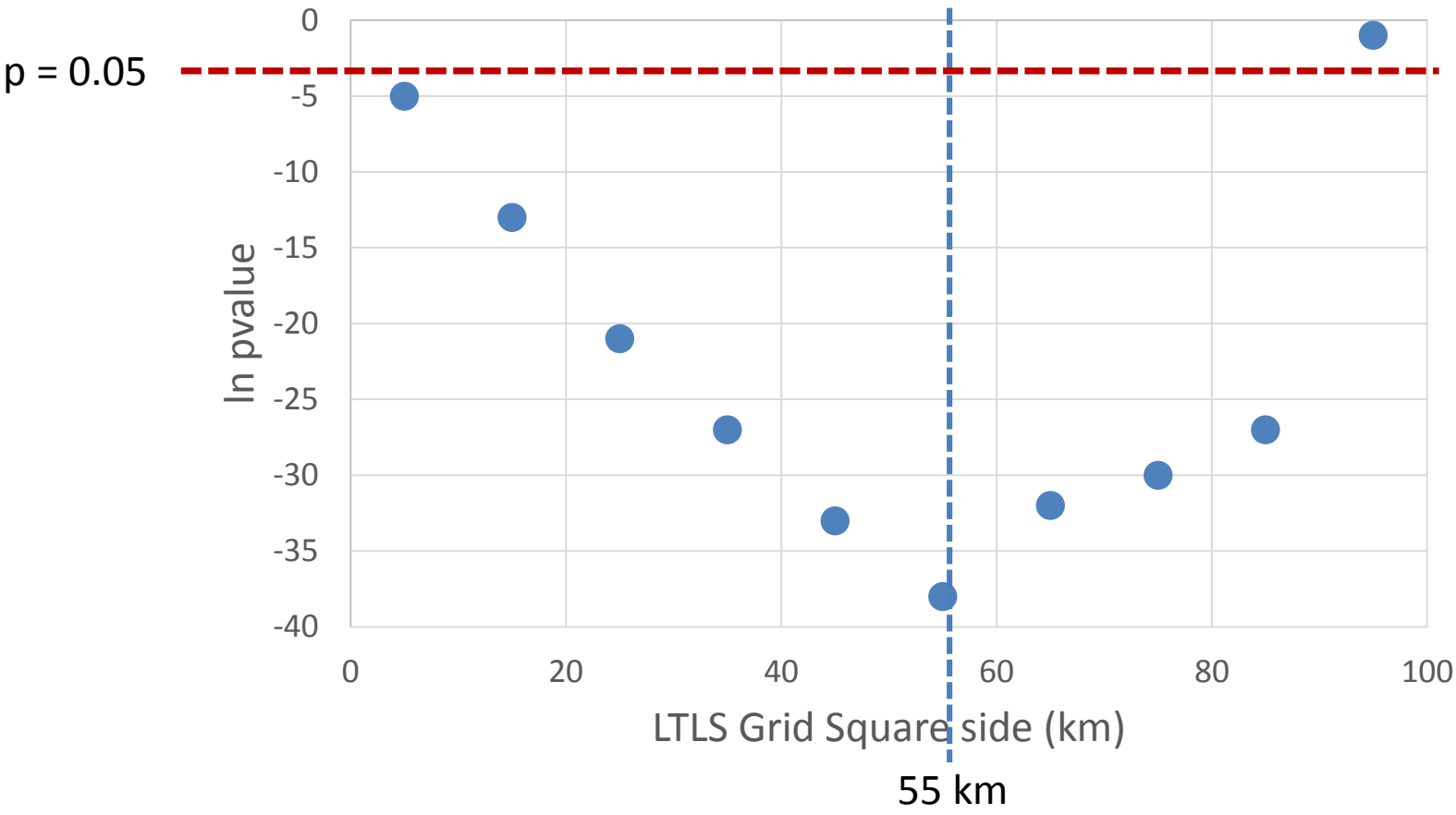
Diatom WFD class vs TDP concentration: scale relationships



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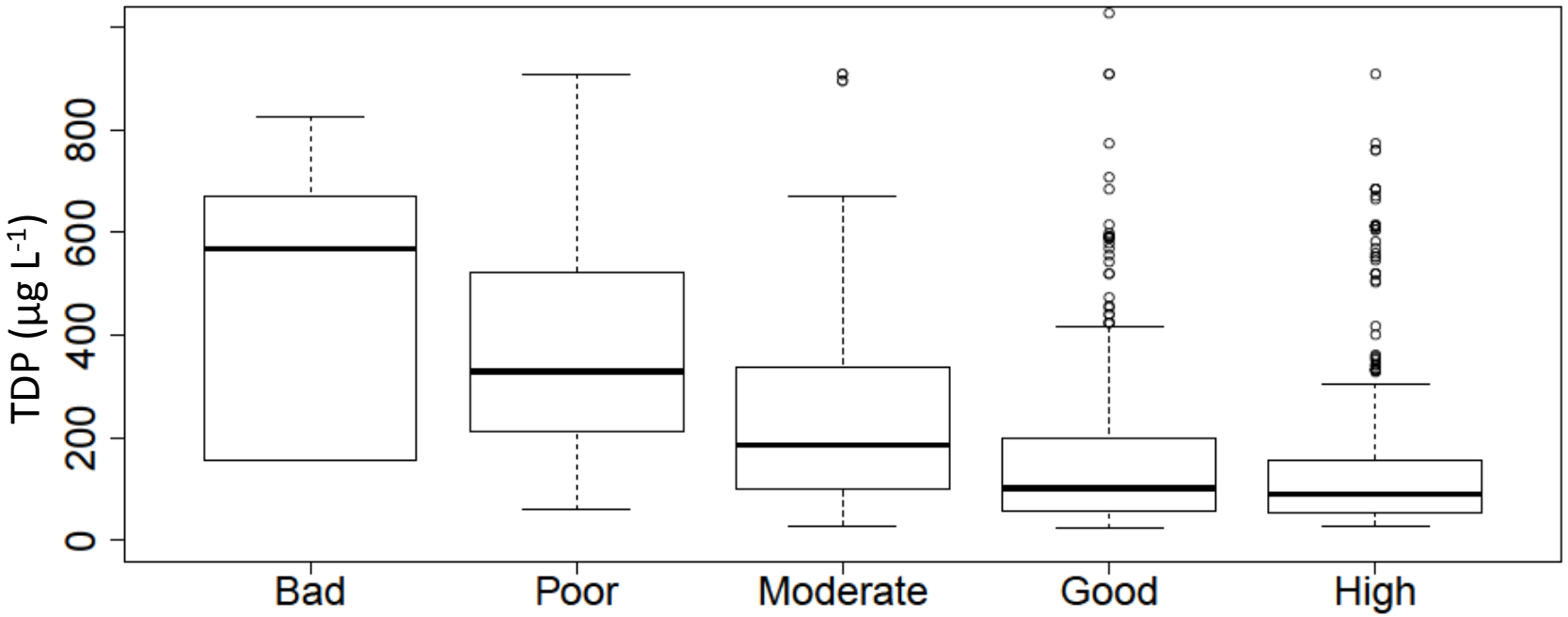
Optimal discrimination (mean TDP in surrounding 55 km^2)



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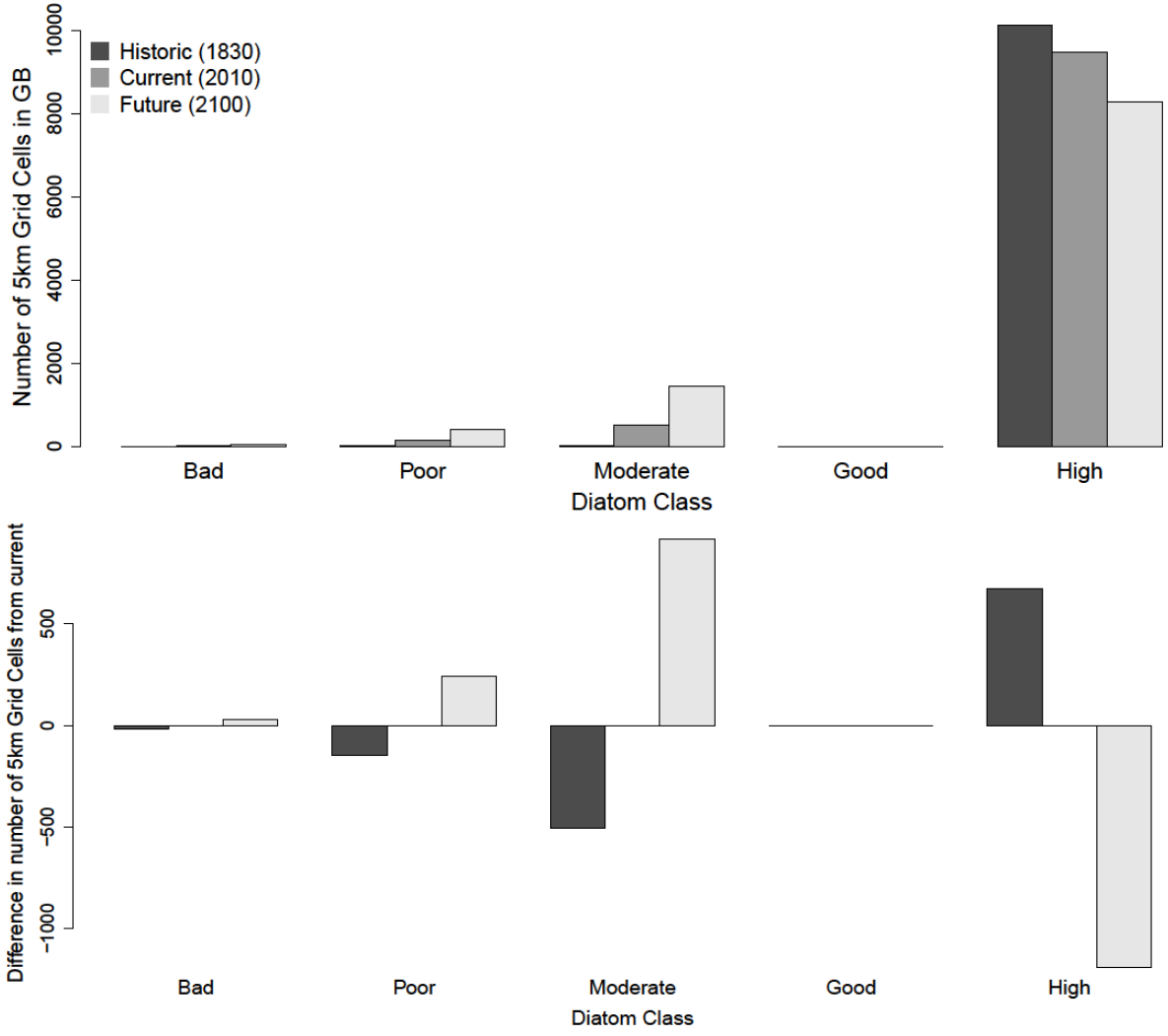
modelling changes in ecological quality



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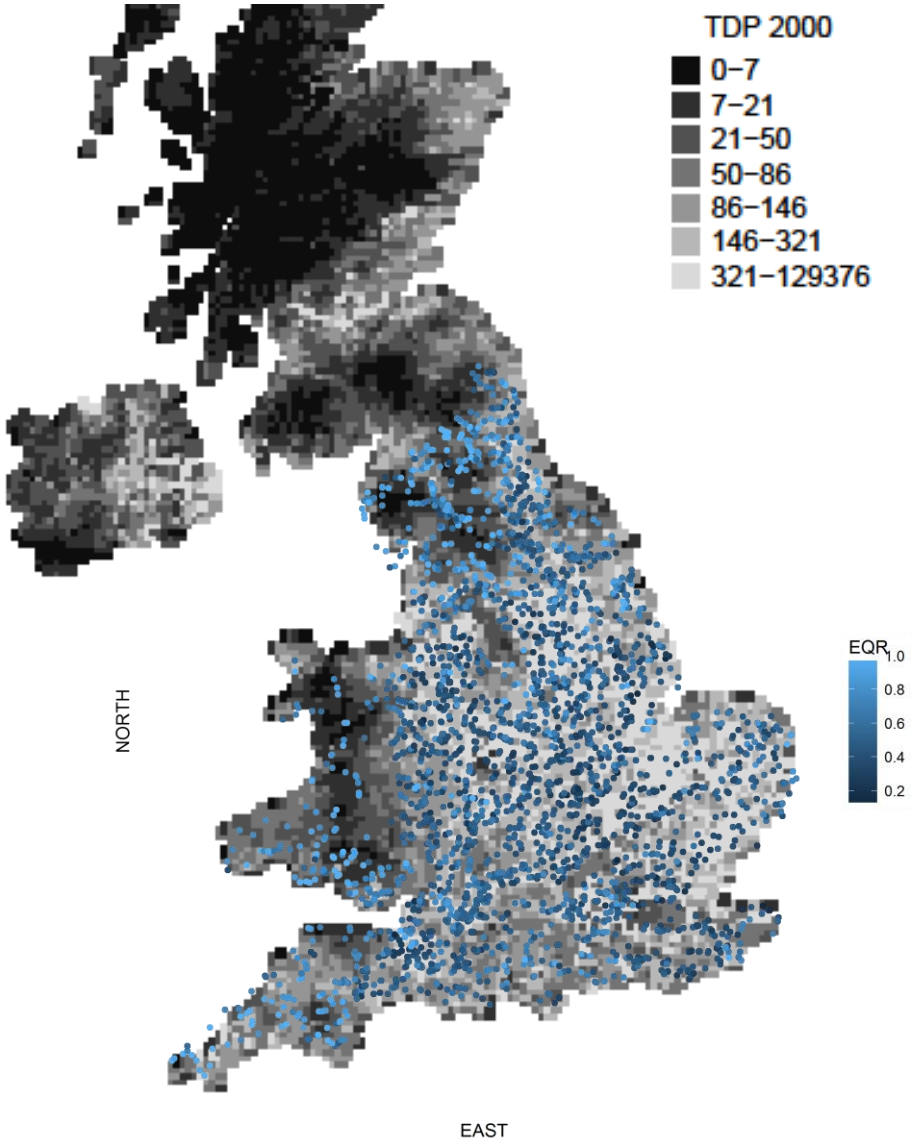
year 2000 mean TDP and aquatic macrophyte EQRs



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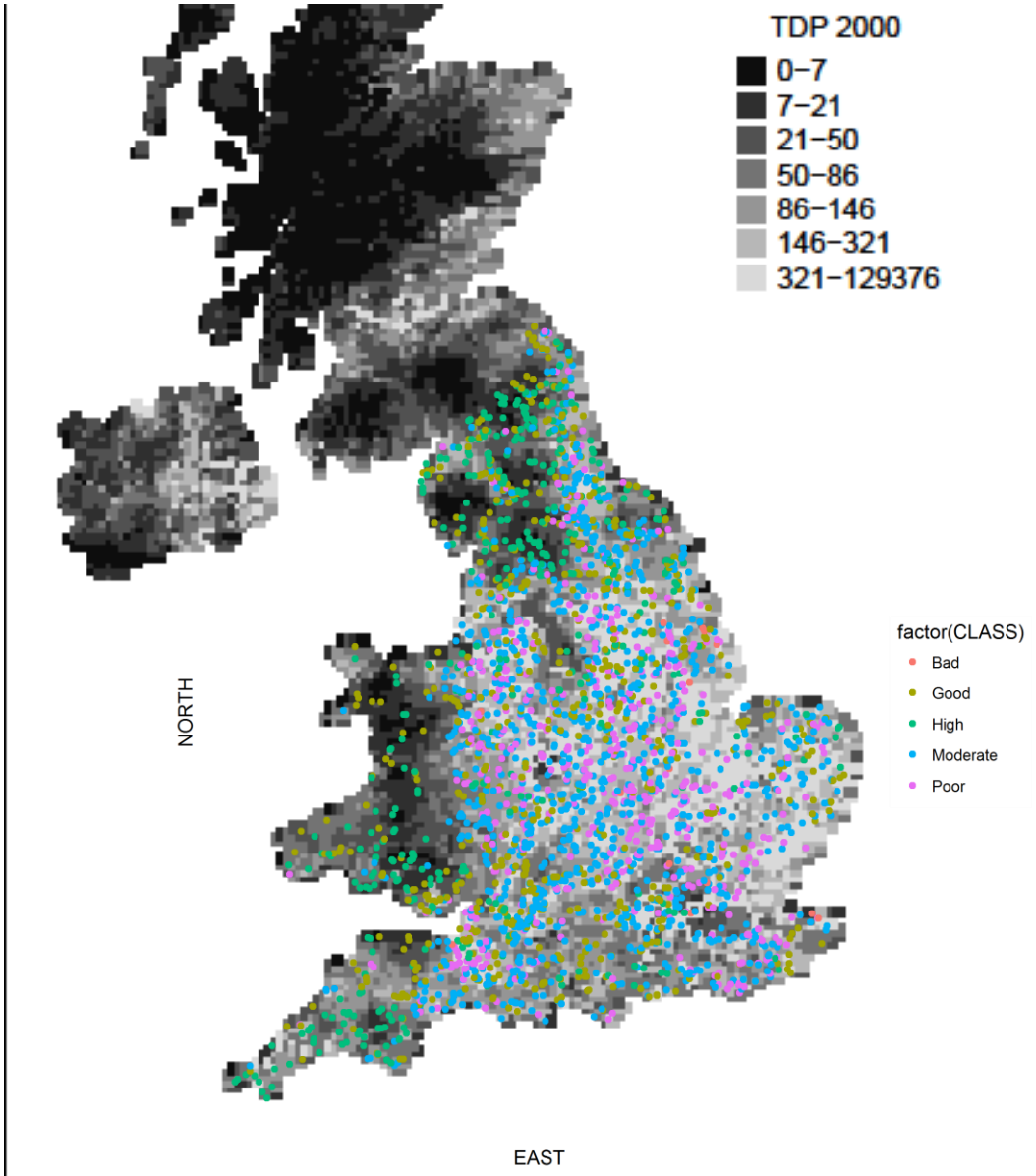

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conclusions

- Diatom and aquatic macrophyte-inferred WFD status of streams and rivers show reasonable agreement with LTLS modelled water chemistry for the co-located 5 km grid square.
- Relationships stronger for total dissolved P than nitrate (more likely due to covariance).
- Good agreement between absolute modelled TDP concentration and “expert opinion” re. key water quality thresholds for diatoms.
- Good agreement (possibly even better) for aquatic macrophyte EQRs and modelled TDP.
- Now possible to produce maps and statistics to assess long term impacts of cultural eutrophication on a key biodiversity metric at a regional/national scales – and weigh up future scenarios.