River Thames near Reading

High-frequency water quality monitoring of UK rivers

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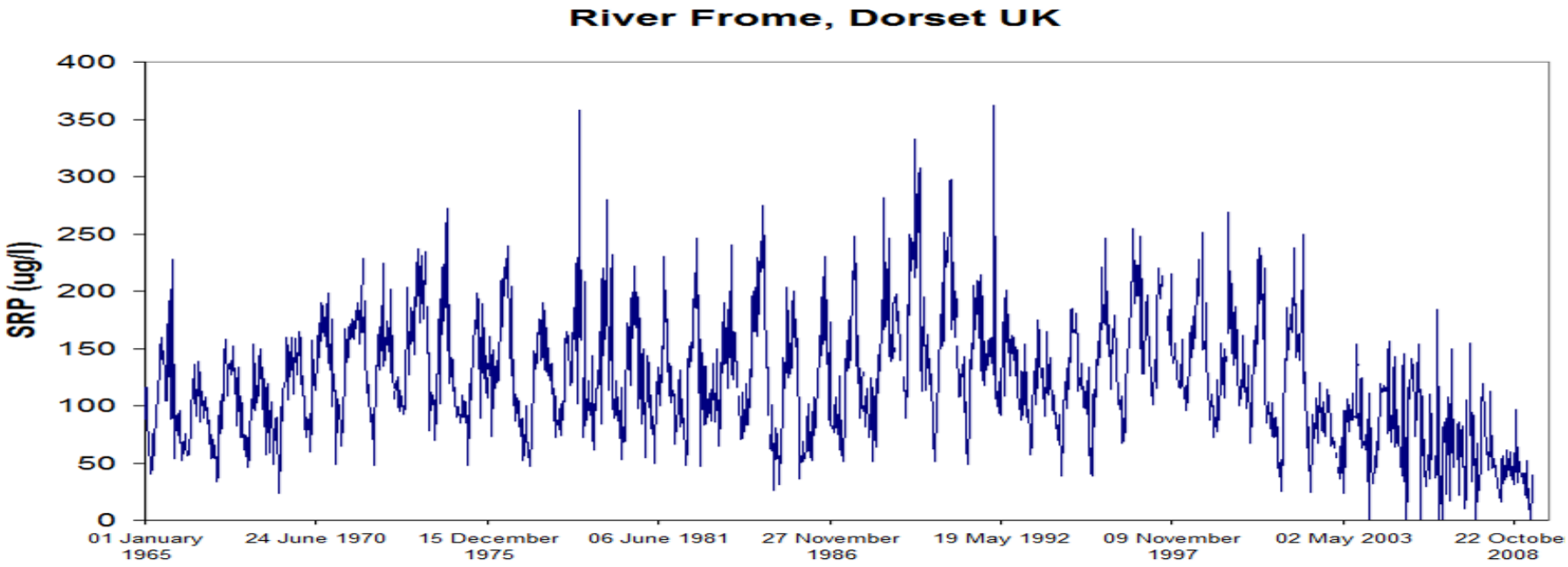
River Frome 44 year weekly data set



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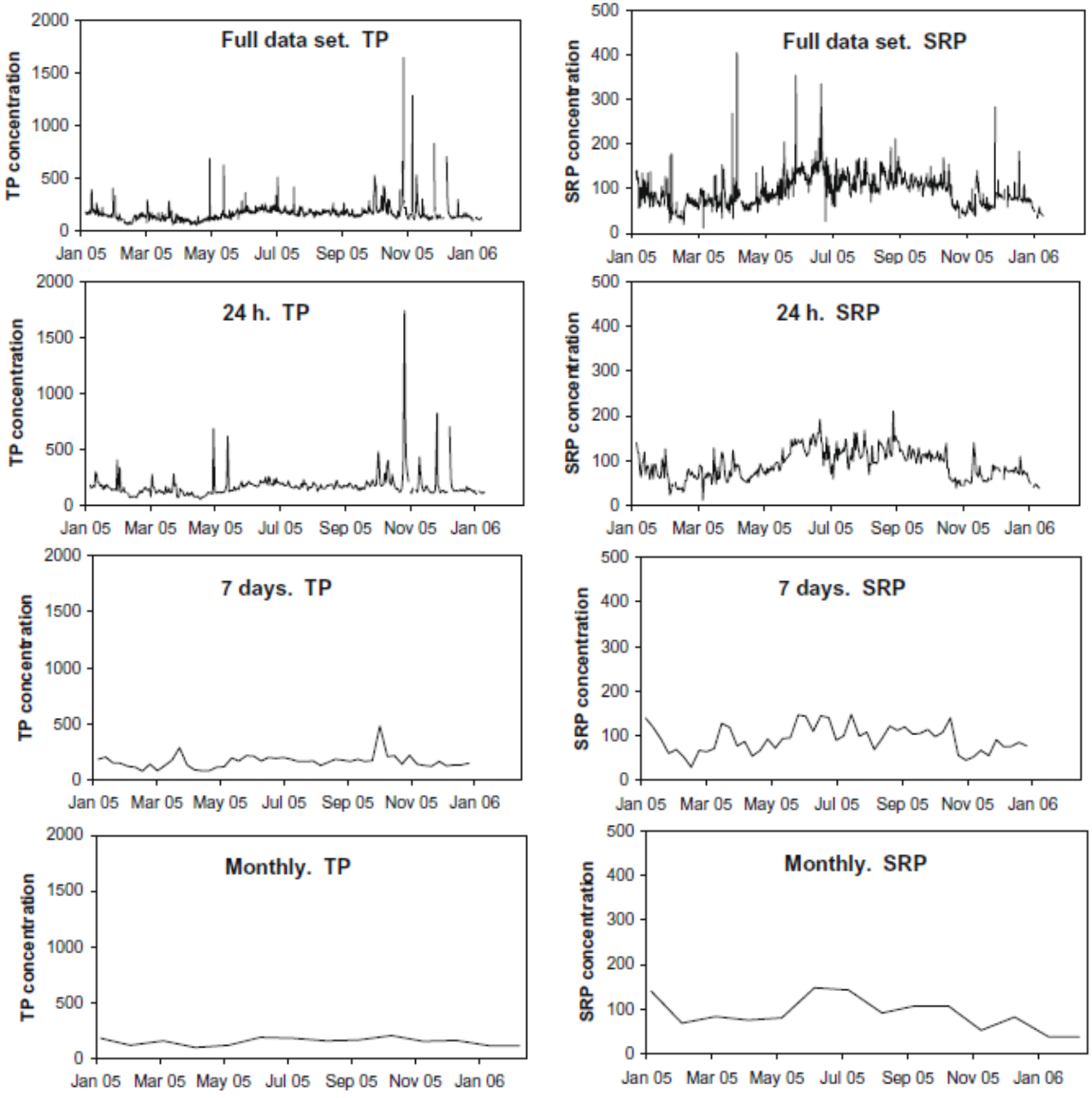
A hidden world…….



- Two-year monitoring of River Frome, southern England, using water samplers and lab analysis of P, N, suspended sediment and Si.
- Stratified sampling to capture storm events (between 2 and 8 samples per day)

Bowes MJ, Smith JT, Neal C. The value of high-resolution nutrient monitoring: A case study of the River Frome, Dorset, UK. Journal of Hydrology 2009; 378: 82-96.

High-frequency monitoring of River Kennet

- Chalk river environment
- Rapid water quality improvements
- Suffers from excessive benthic algal growth and macrophyte loss

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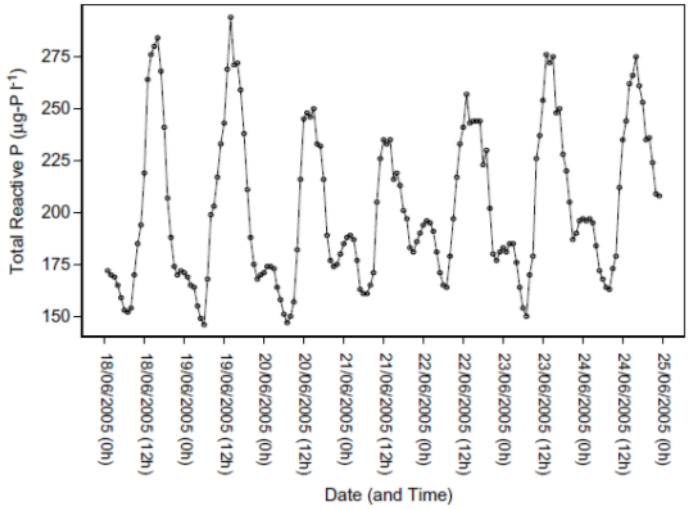
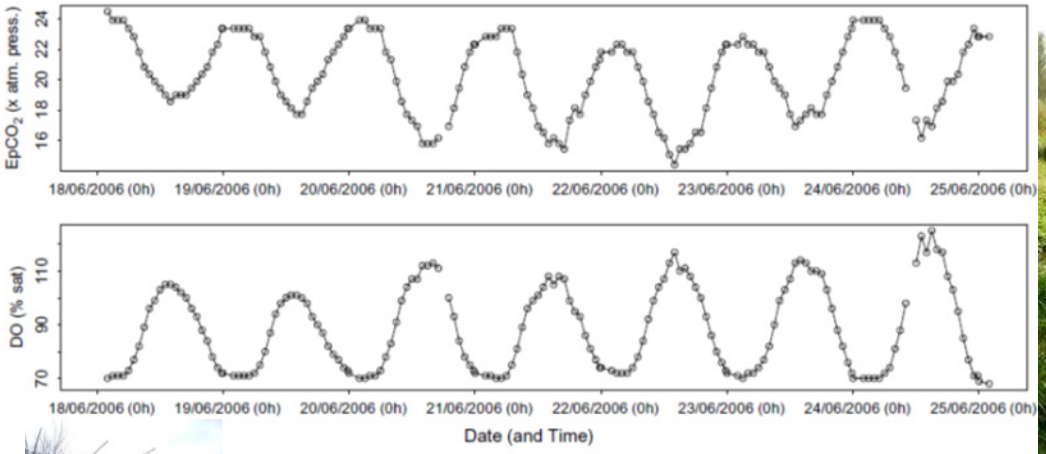
High-frequency monitoring of River Kennet

- Hourly total reactive phosphorus (TRP), DO, conductivity, pH and chlorophyll
- Used to investigate within-stream productivity
- Diurnal TRP concentrations due to sewage treatment works inputs.

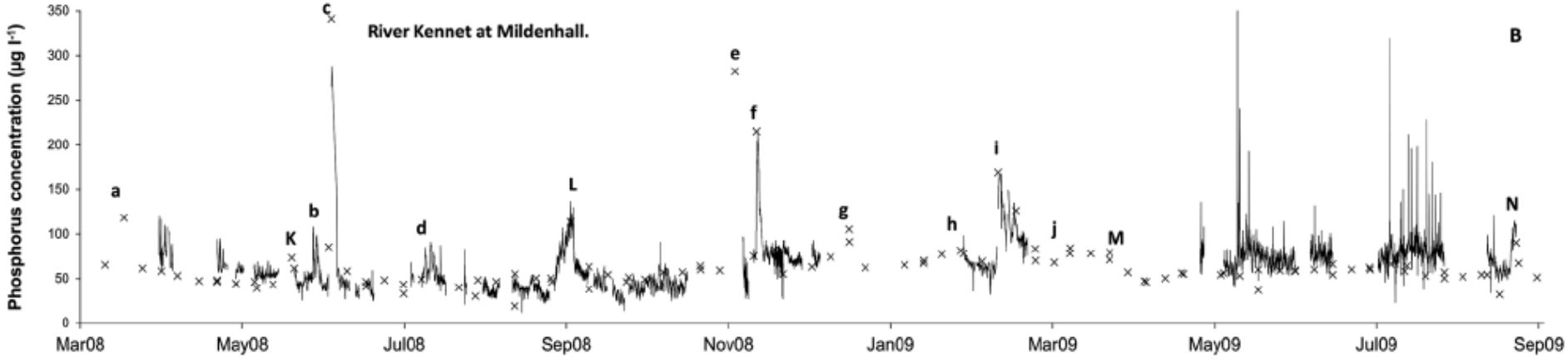




Palmer-Felgate EJ, Jarvie HP, Williams RJ, Mortimer RJG, Loewenthal M, Neal C. Phosphorus dynamics and productivity in a sewage-impacted lowland chalk stream. Journal of Hydrology 2008; 351: 87-97.

High-frequency monitoring of River Kennet

- Was excessive algal growth due to intermittent failures of Marlborough sewage treatment works (STW)?
- Systea Micromac C auto-analysers
- Simultaneous monitoring of Marlborough STW final effluent and downstream river
- 60 min sampling interval (18 months)
- STW operating well within consent
- Equipment problems due to pipe freezing!



Monitoring of River Enborne and The Cut

- LIMPIDS project (Reading and Hull University, EA: EPSRC funded)
- Heated and insulated monitoring stations with reliable power supply
- Hourly sampling for 2 years
  - TP
  - TRP
  - NO3
  - pH, temp, conductivity, DO
- Weekly full WQ

Wade AJ, Palmer-Felgate EJ, Halliday SJ, et al. Hydrochemical processes in lowland rivers: insights from in situ, high-resolution monitoring. HESS 2012; 16: 4323-4342.

Halliday S, Skeffington R, Bowes M, The Water Quality of the River Enborne, UK: Observations from High-Frequency Monitoring in a Rural, Lowland River System. Water 2014; 6: 150-180.

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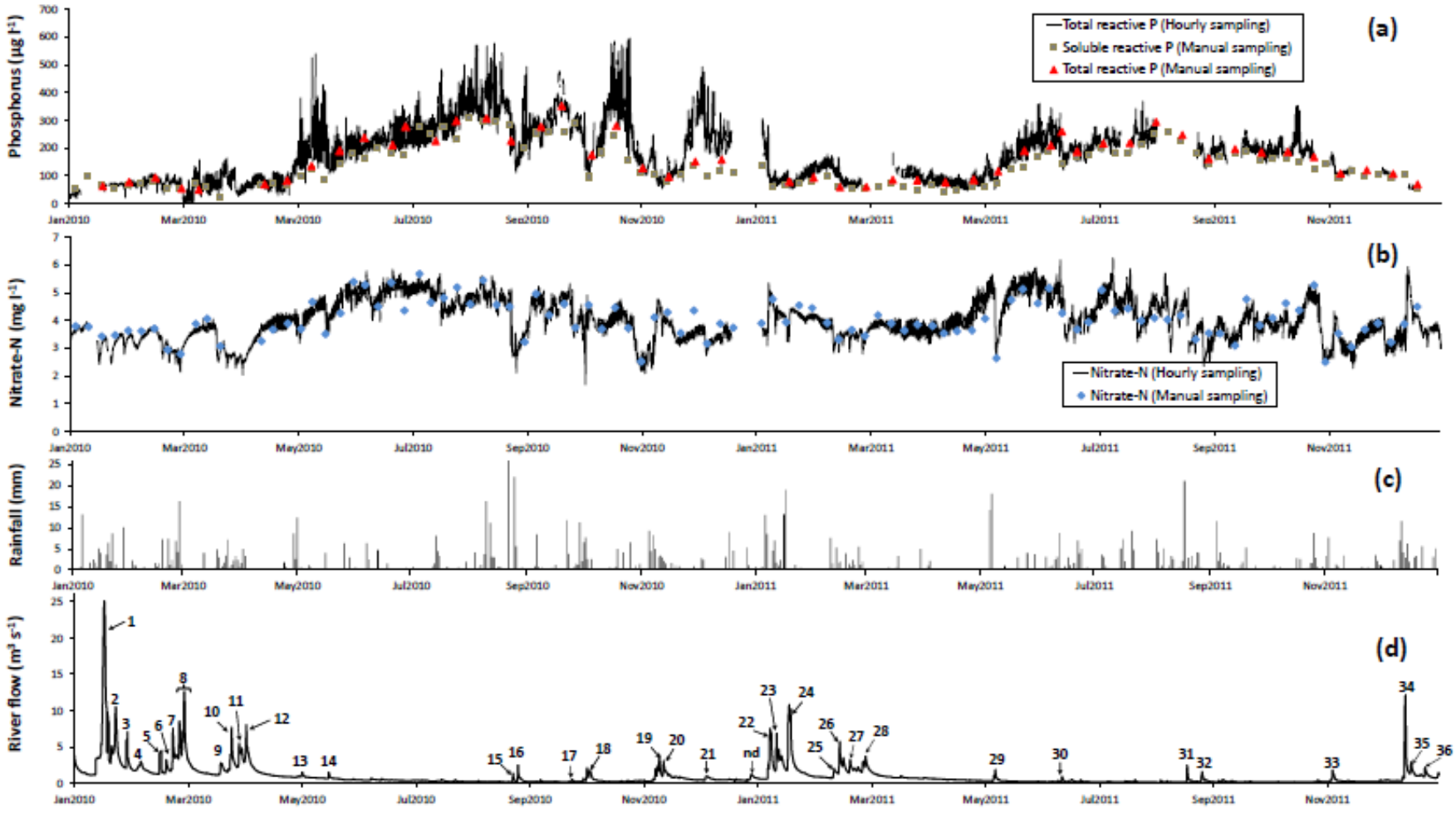
River Enborne nutrient data



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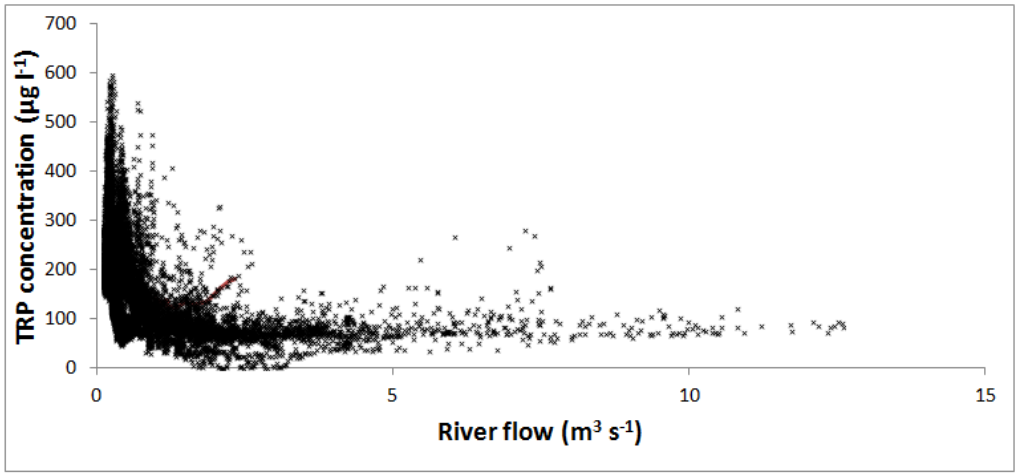
Determining nutrient sources

- Time series analysis (hi-freq and weekly WQ)
- Nutrient / flow relationships
- Hysteresis

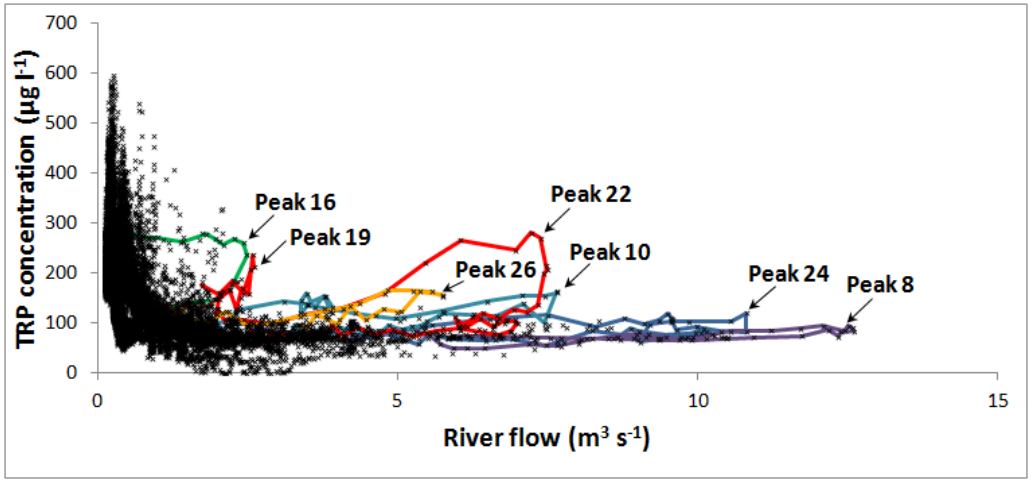
Phosphorus concentration / flow relationships

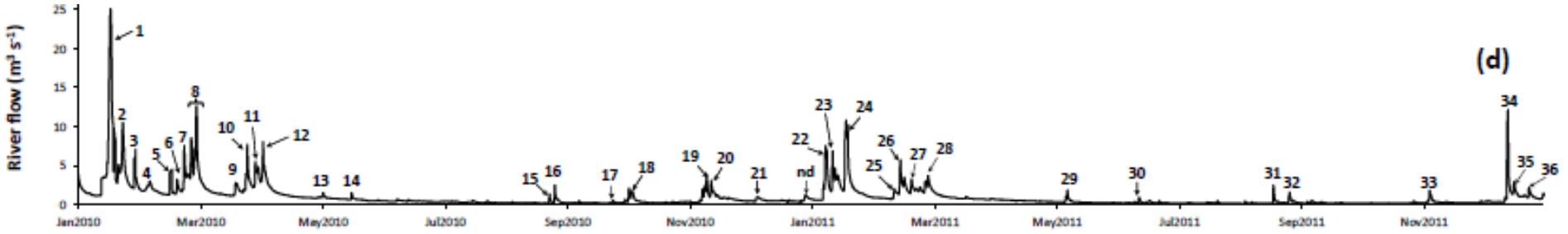
- P dilution curve at low flow (sewage signal)
- Rain-related diffuse signal at high flows
- Some scatter!



Phosphorus concentration / flow

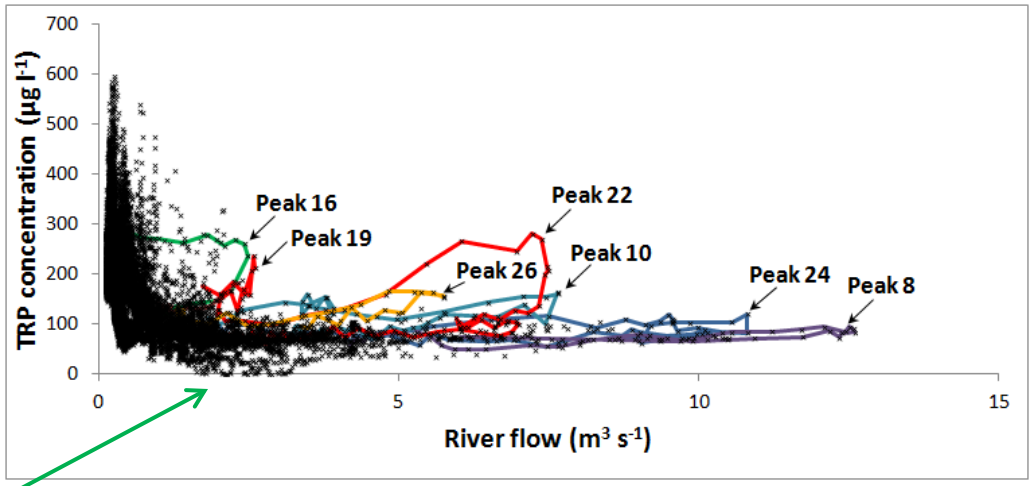
- P dilution curve at low flow (sewage signal)
- Rain-related signal at high flows
- Scatter due to
  - Hysteresis during storm events

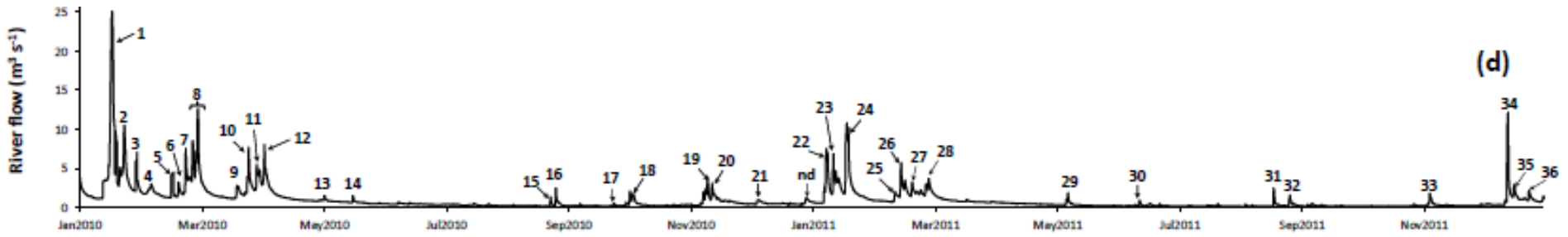




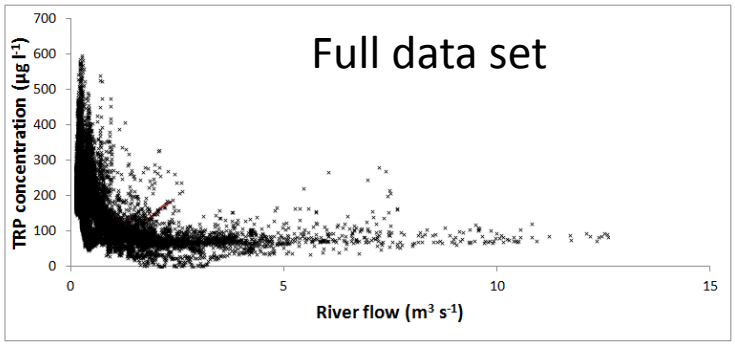
Phosphorus concentration / flow

- P dilution curve at low flow (sewage signal)
- Rain-related signal at high flows
- Scatter due to
  - Hysteresis during storm events
  - Biological uptake (based on chlorophyll and silicon data)



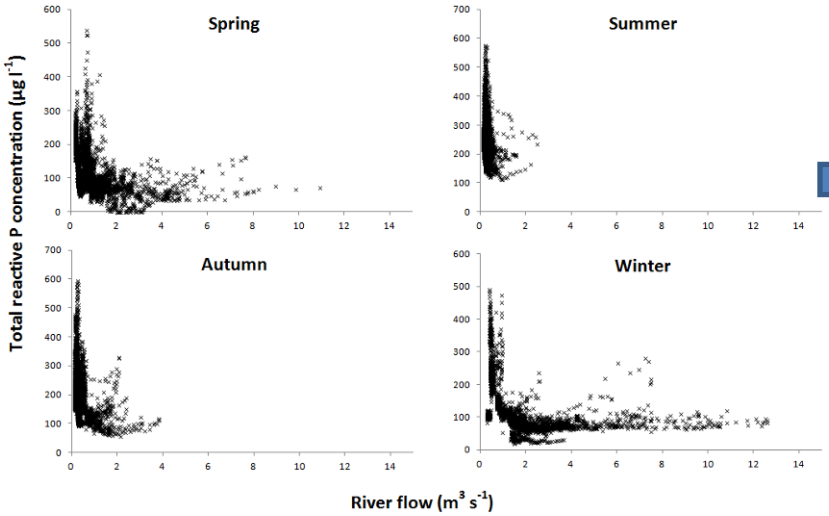


Changes in nutrient sources through annual cycle

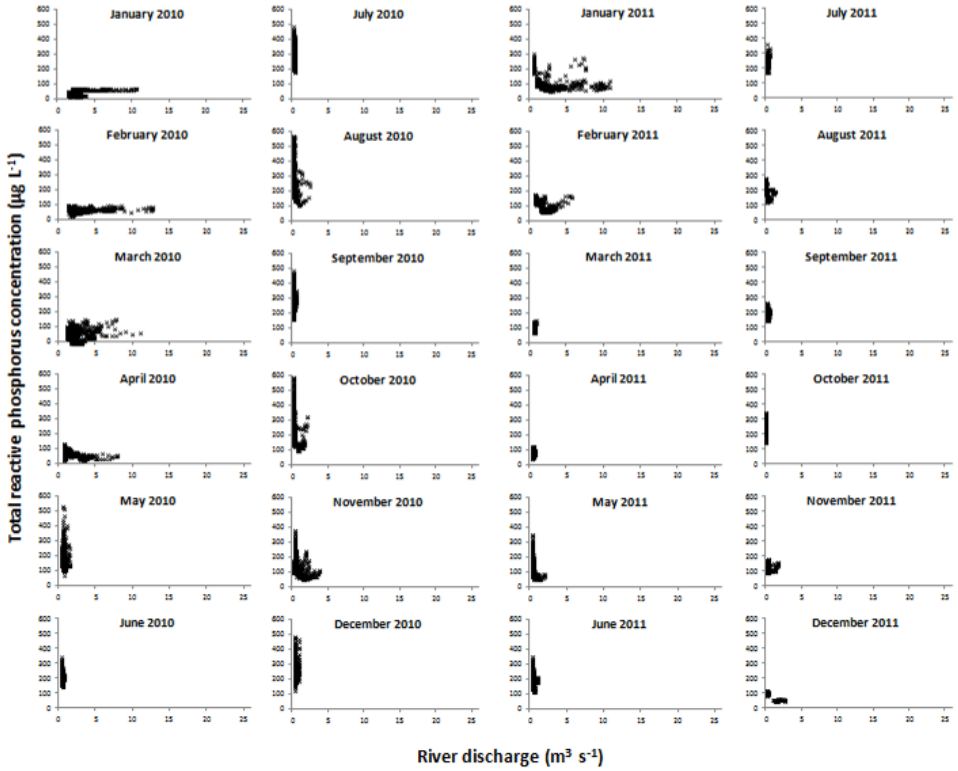


- Phosphorus inputs dominated by sewage inputs in May – October period
- Rain related diffuse inputs in January to April

Data split into seasons



Data split into individual months



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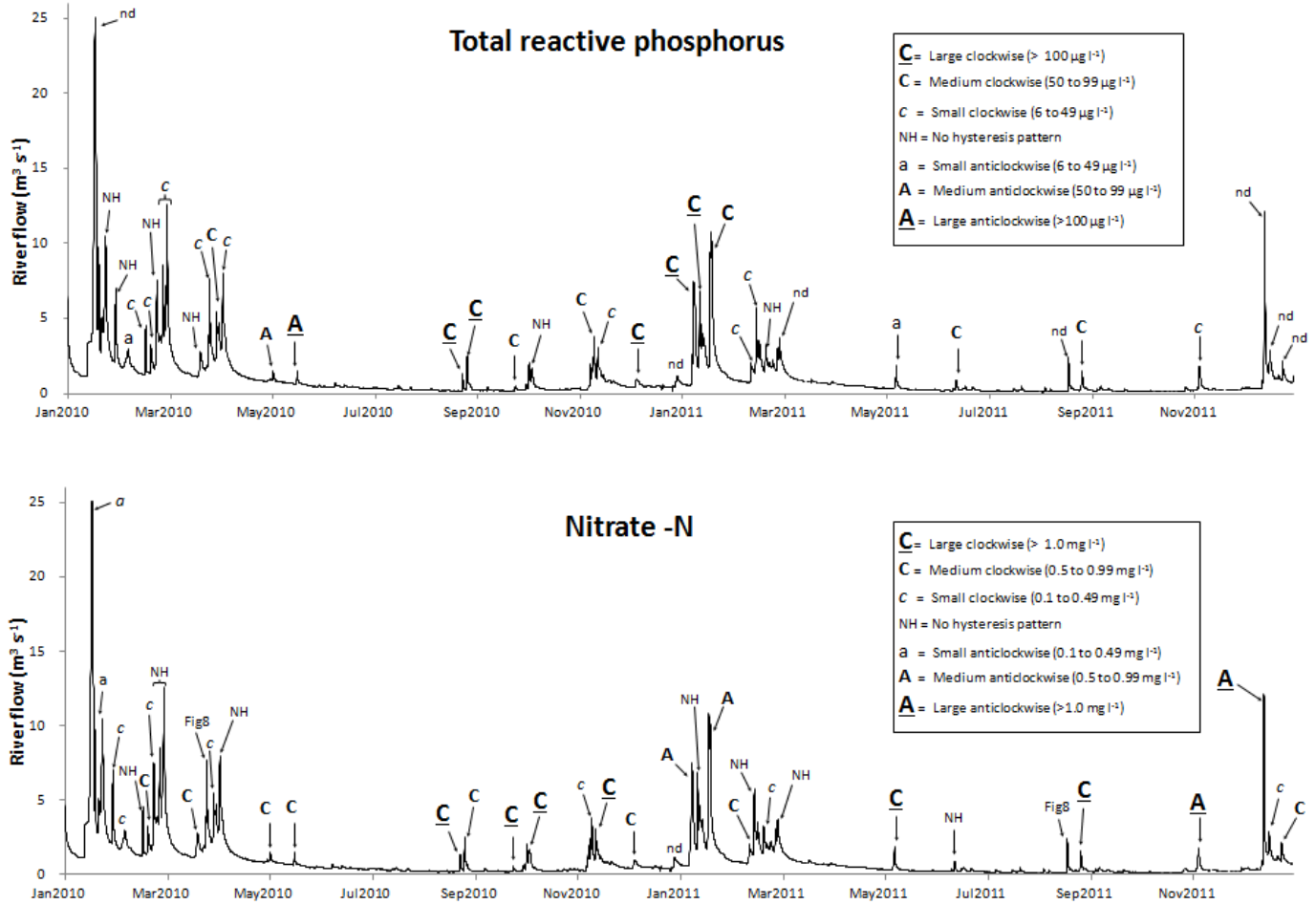
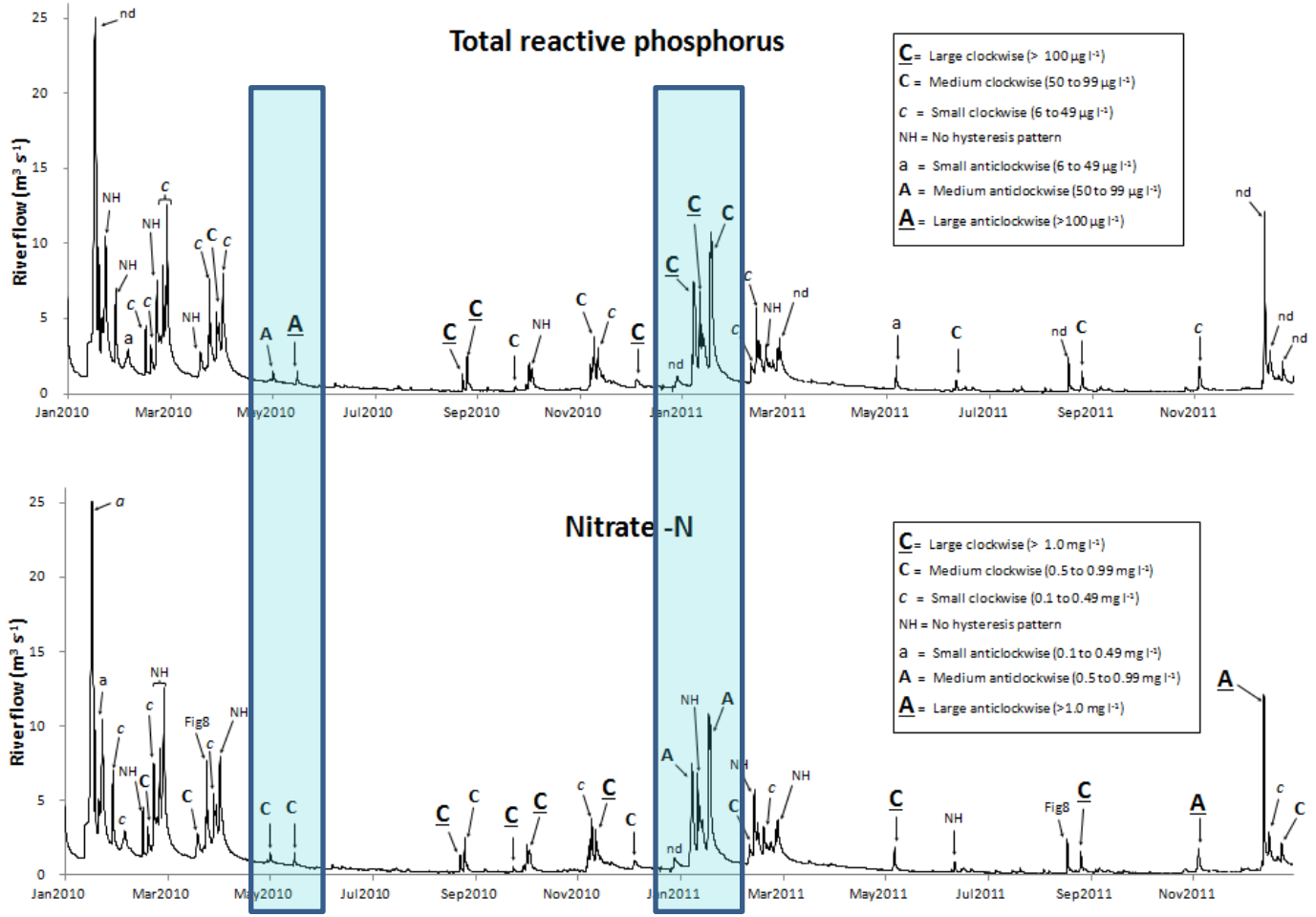
Hysteresis studies

- Predominantly clockwise
  - Fast delivery – field drains and within channel mobilisation



- Nutrient sources or pathways different
- Only “diffuse” P inputs in May
- Largest CW P loops after dry periods, but no NO_3 – mobilisation of bed sediment?



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Bowes MJ, Jarvie HP, Halliday, SJ (submitted) Characterising phosphorus and nitrate inputs to a rural river using high-frequency concentration-flow relationships

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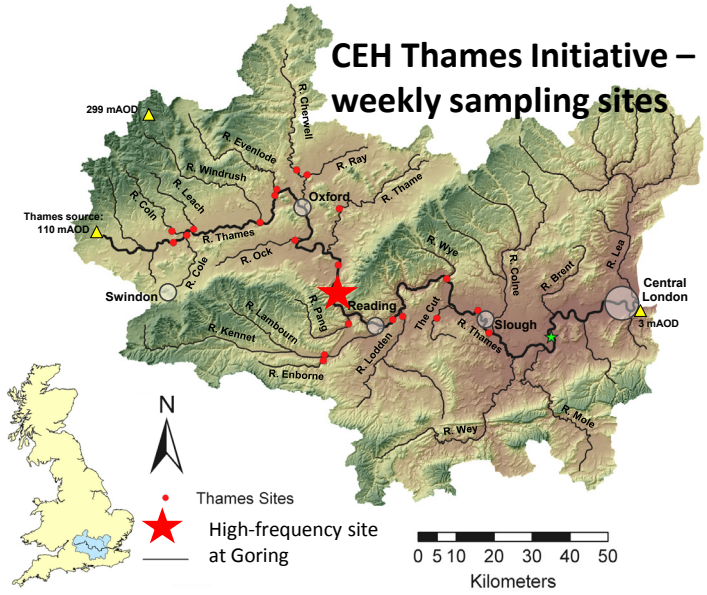
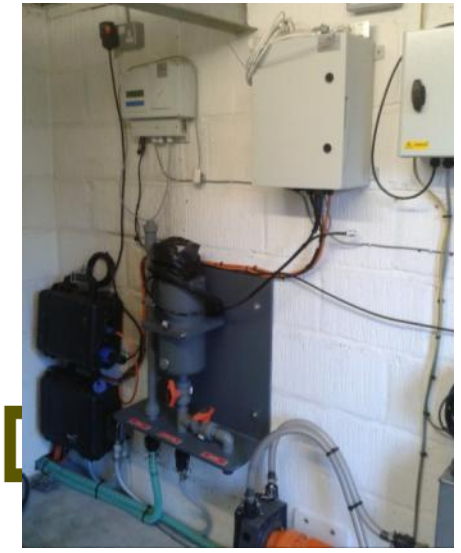
River Thames high-frequency monitoring

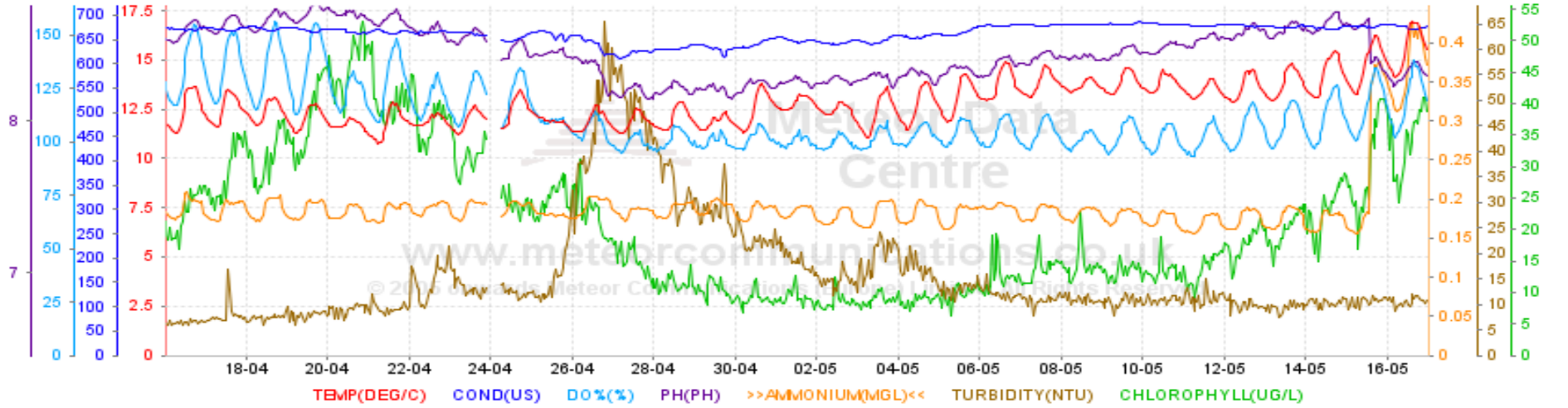
- Began at Goring in March 2014
- Set within 23-site weekly chemical and biological monitoring programme (CEH Thames Initiative research platform)
- High-frequency monitoring of annual algal bloom





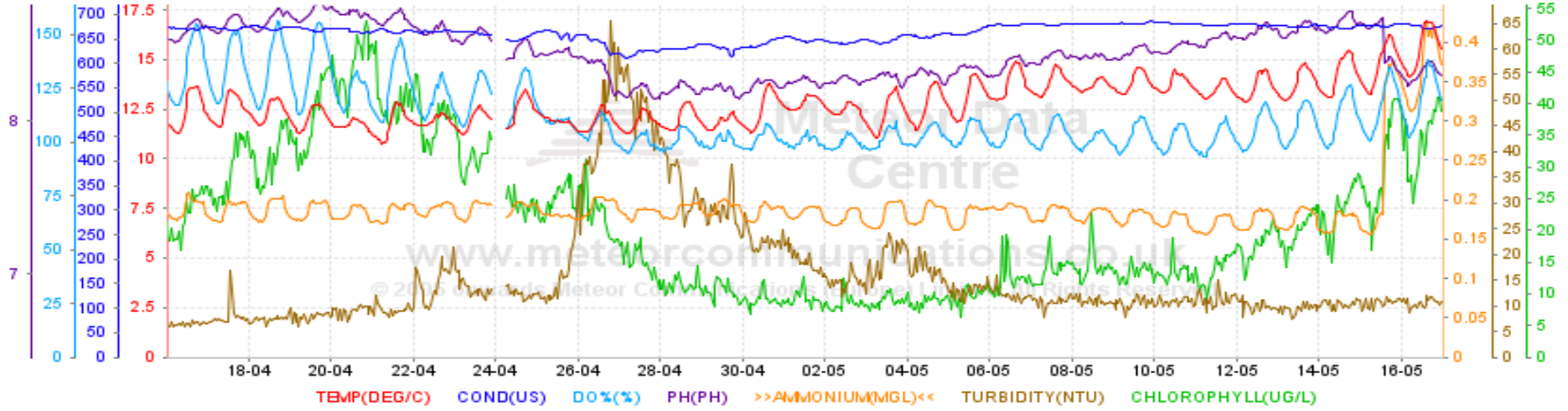
River Thames high-frequency monitoring

- Hourly monitoring
  - Temperature, pH, conductivity, DO, turbidity, chlorophyll (YSI)



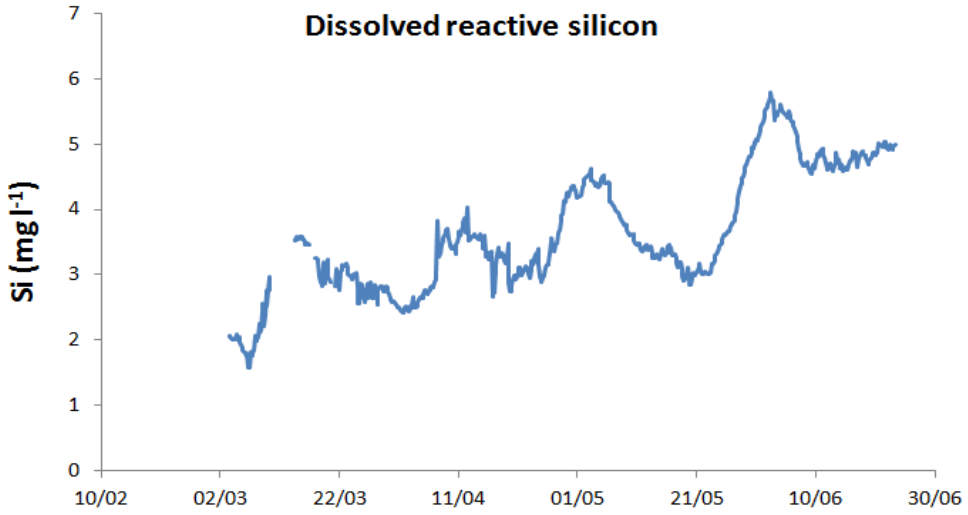
River Thames high-frequency monitoring

- Hourly monitoring
  - Temperature, pH, conductivity, DO, turbidity, chlorophyll (YSI)
  - Total P and total reactive P (Hach Lange Phosphax & Cycle PO4)
  - NO3 and ammonium concentration (HL Nitratax probe)



River Thames high-frequency monitoring

- Hourly monitoring
  - Temperature, pH, conductivity, DO, turbidity, chlorophyll (YSI)
  - Total P and total reactive P (Hach Lange Phosphax & Cycle PO4)
  - NO3 and ammonium concentration (HL Nitratax probe)
  - 4-hourly monitoring
  - Silicon
  - Nitrate
  - Nitrite
  - Chloride



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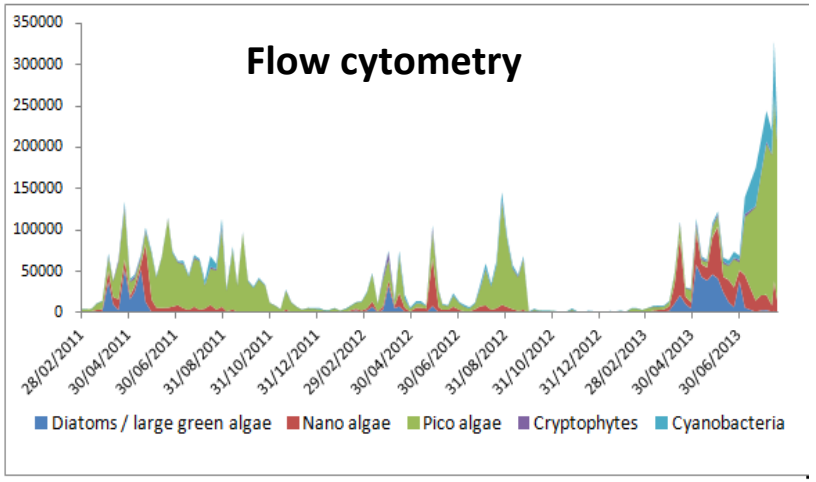
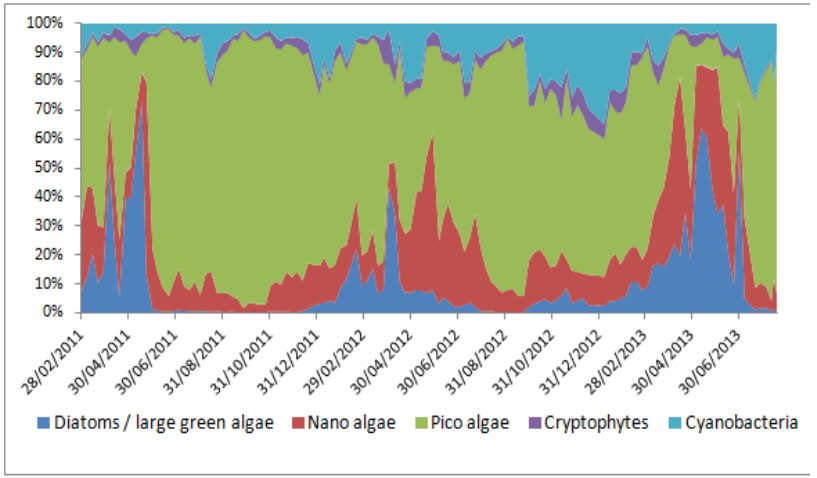
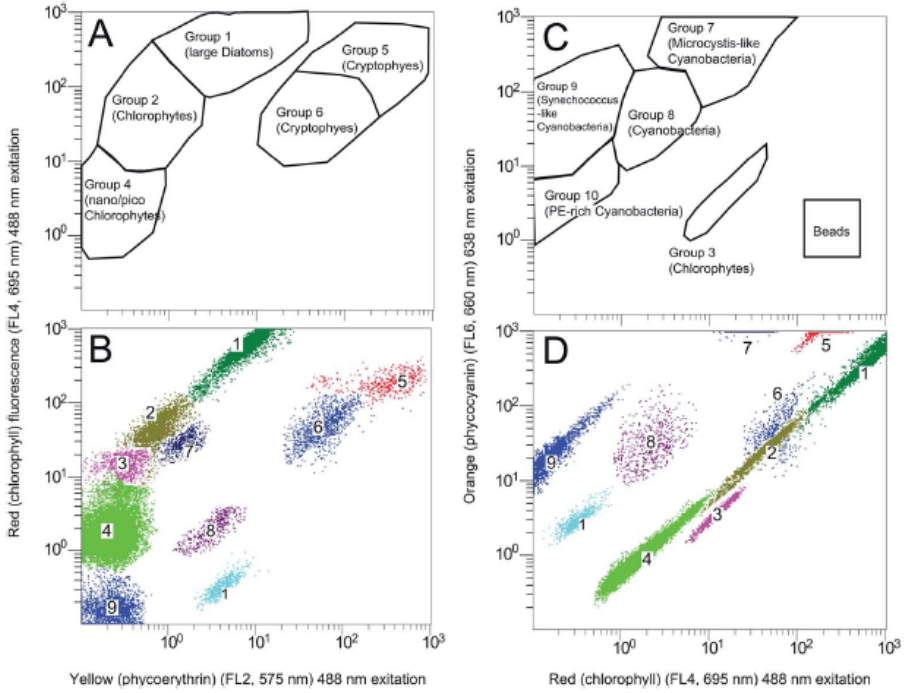
River Thames high-frequency monitoring

- Phytoplankton and bacterioplankton monitoring
  - Community characterisation by flow cytometry at 4-h interval







Read DS, Bowes MJ, Newbold LK, Whiteley AS. Weekly flow cytometric analysis of riverine phytoplankton to determine seasonal bloom dynamics. Environ Sci Process Impacts 2014; 16: 594-603.

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Conclusions

- Generation of good quality high frequency data sets is NOT easy!
- Use the most reliable / proven autoanalysers / probes.
- Correct location / housing critical
- High frequency biological monitoring vital to investigate links between water quality and ecology

Thank you

Acknowledgements

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