Water Quality Targets in Broads

Progress over the last 30 years

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Ecology Technical Team

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Key Issue - Eutrophication

- Control of phosphorus & ecosystem response
- Broads long history of consistent monitoring
- What can we learn from last 30 years
  - What would be appropriate phosphorus targets for Broadland ?
  - Can these be achieved ?
  - What are the factors influencing ecological response ?

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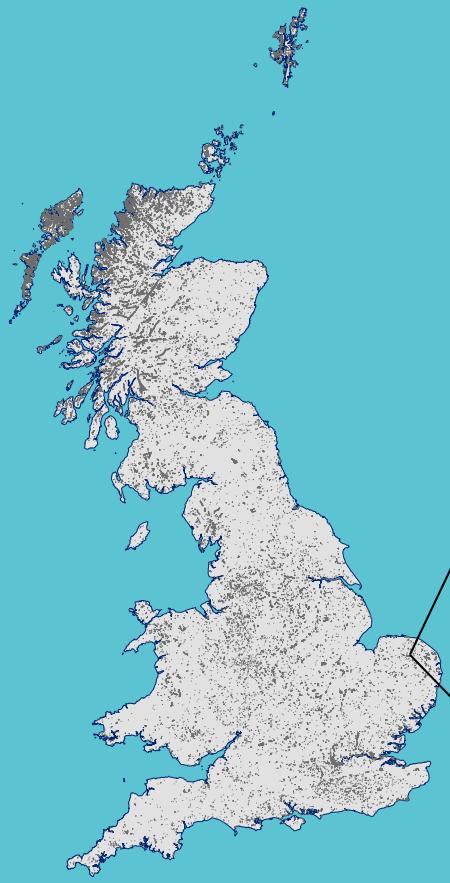
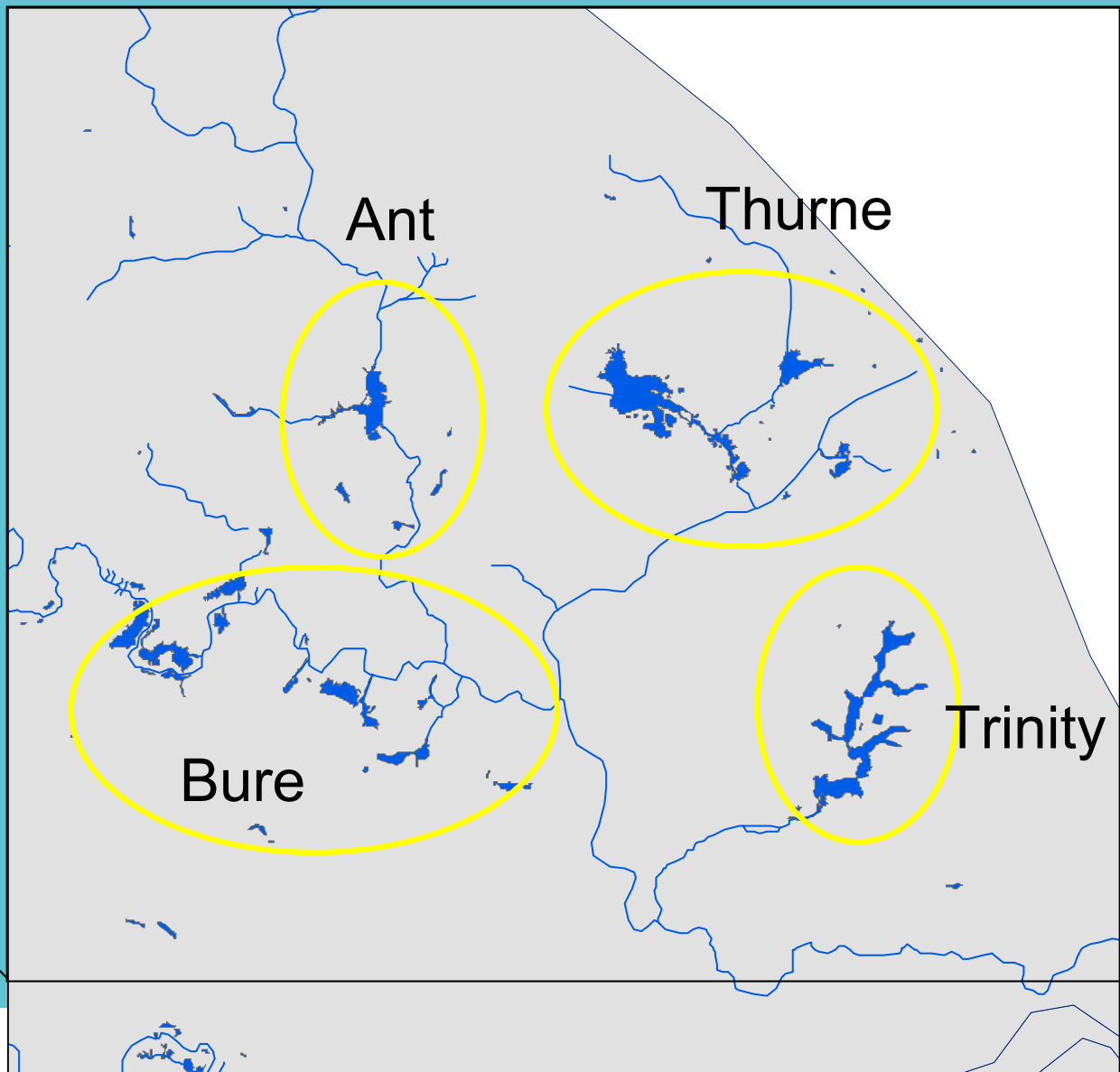
Northern Broads

P control at STW in Ant & Bure
1980 - 1996





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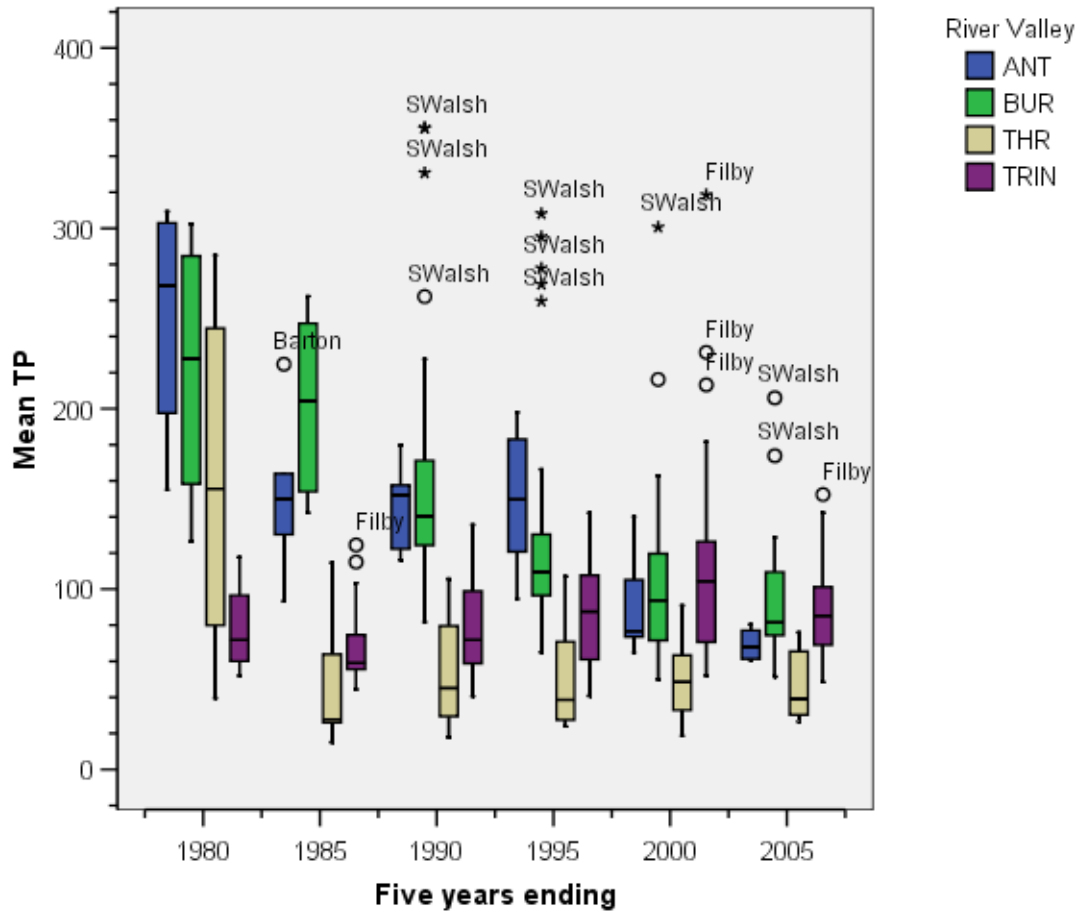
Changes in Total Phosphorus (annual mean)



Reduction in TP in

Ant, Bure and Thurne

Result of point source P control from STW (Ant and Bure)

Loss gull roost in Thurne

Slight increase in TP Trinity

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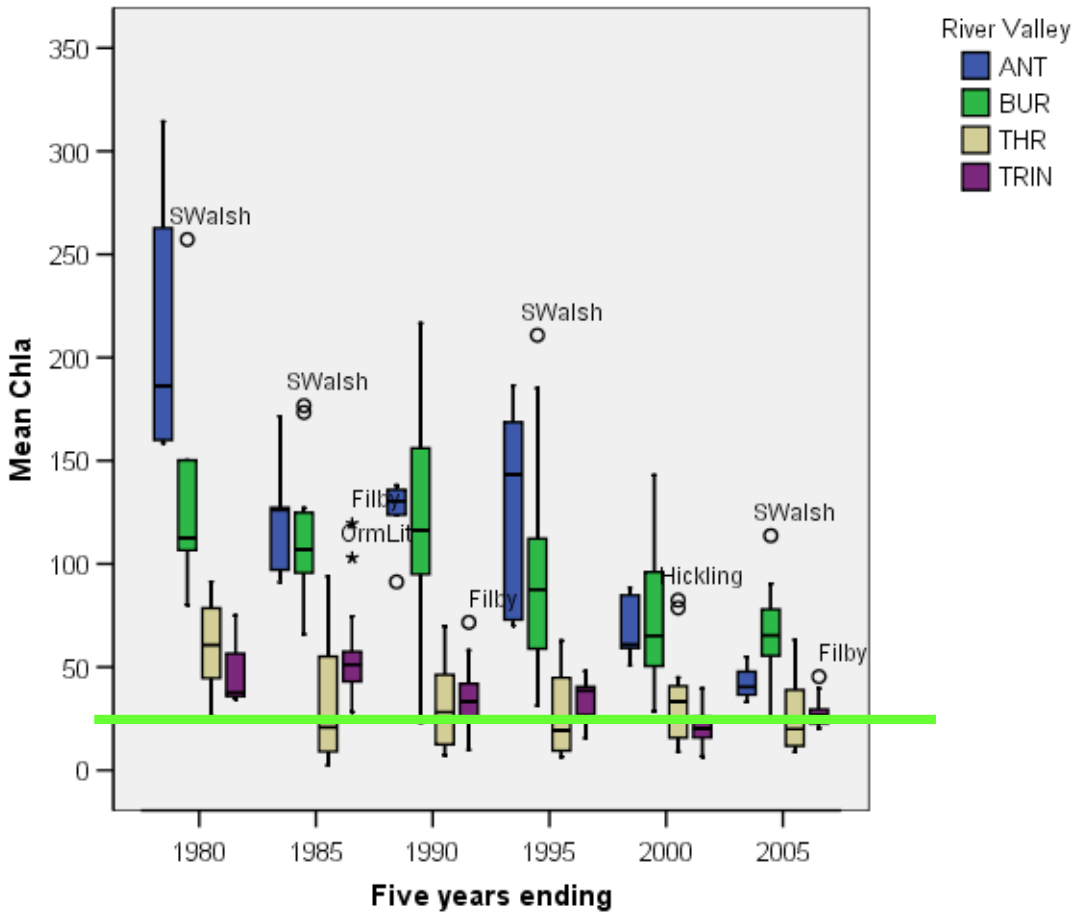
Changes in Chlorophyll (annual mean)



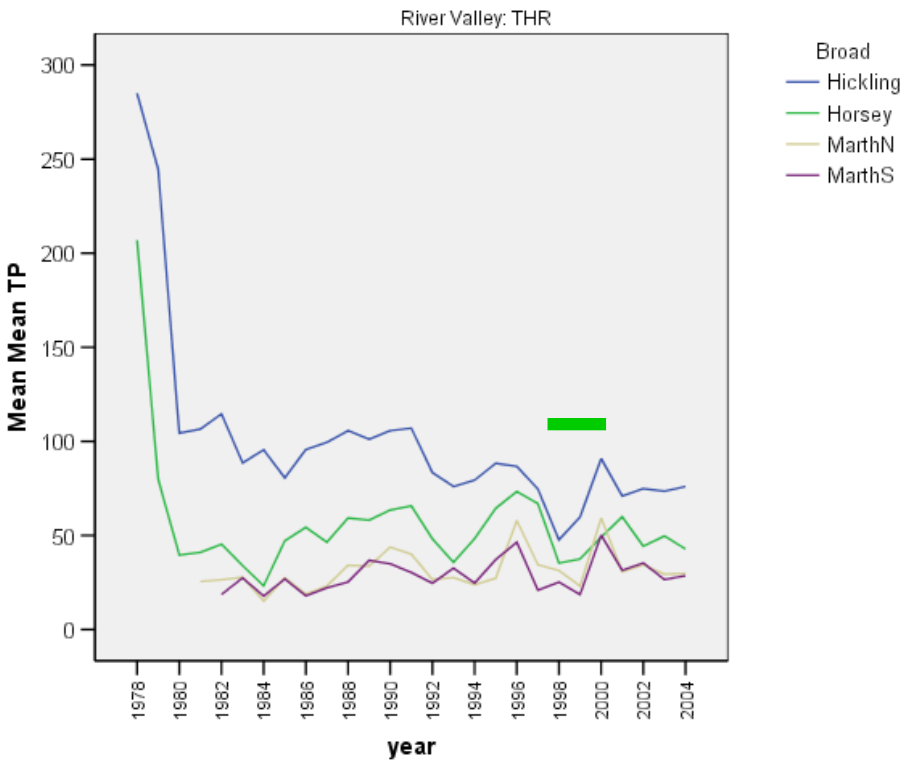
Reduction in Chlorophyll (phytoplankton biomass)

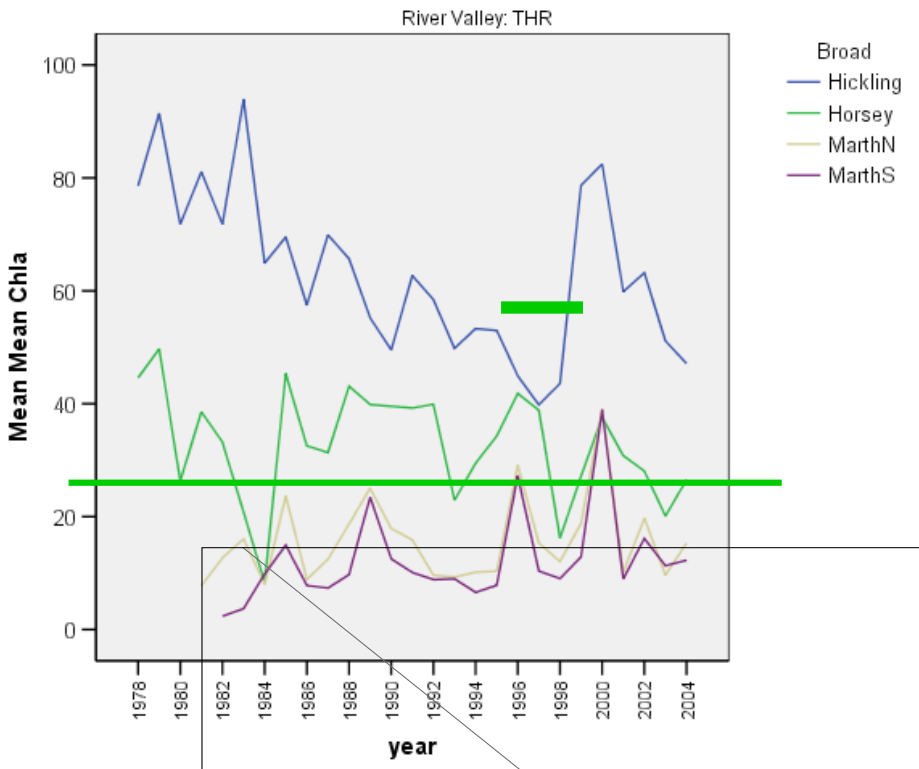
All sites, but less marked in Thurne and Trinity Broads

WFD phytoplankton biomass

Good/Moderate boundary

25 ug/l



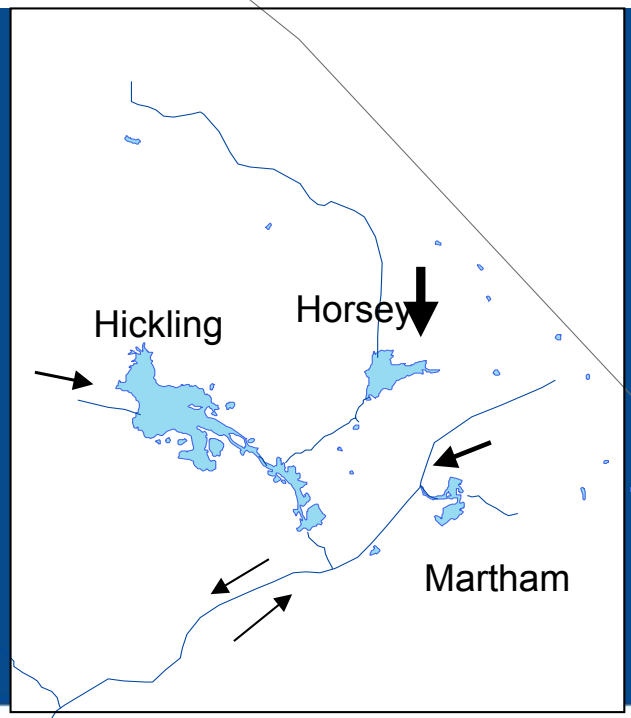


Complex hydrology, driven by tidal mixing and land-drainage.

Minimal change in catchment

Reduction in gull roost – major P reduction

Evidence of cyclical behaviour, P retention by Chara beds 1997 - 2000



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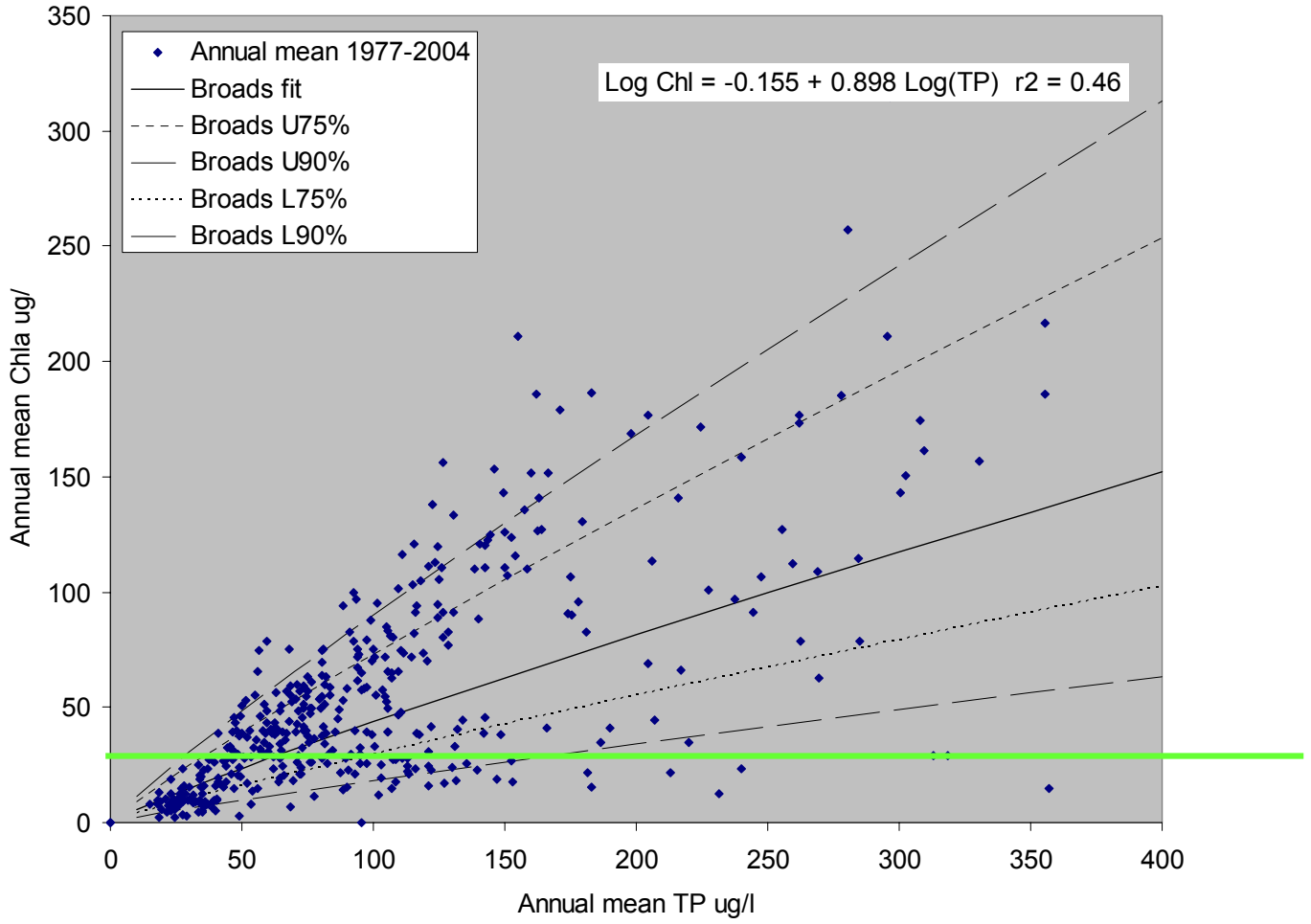
Total P relationship with chlorophyll - Broads



Significant scatter

2 groups of lakes with contrasting Chl/TP ratio

G/M boundary TP could vary from 25-150 ug/l

Depends on level of precaution needed

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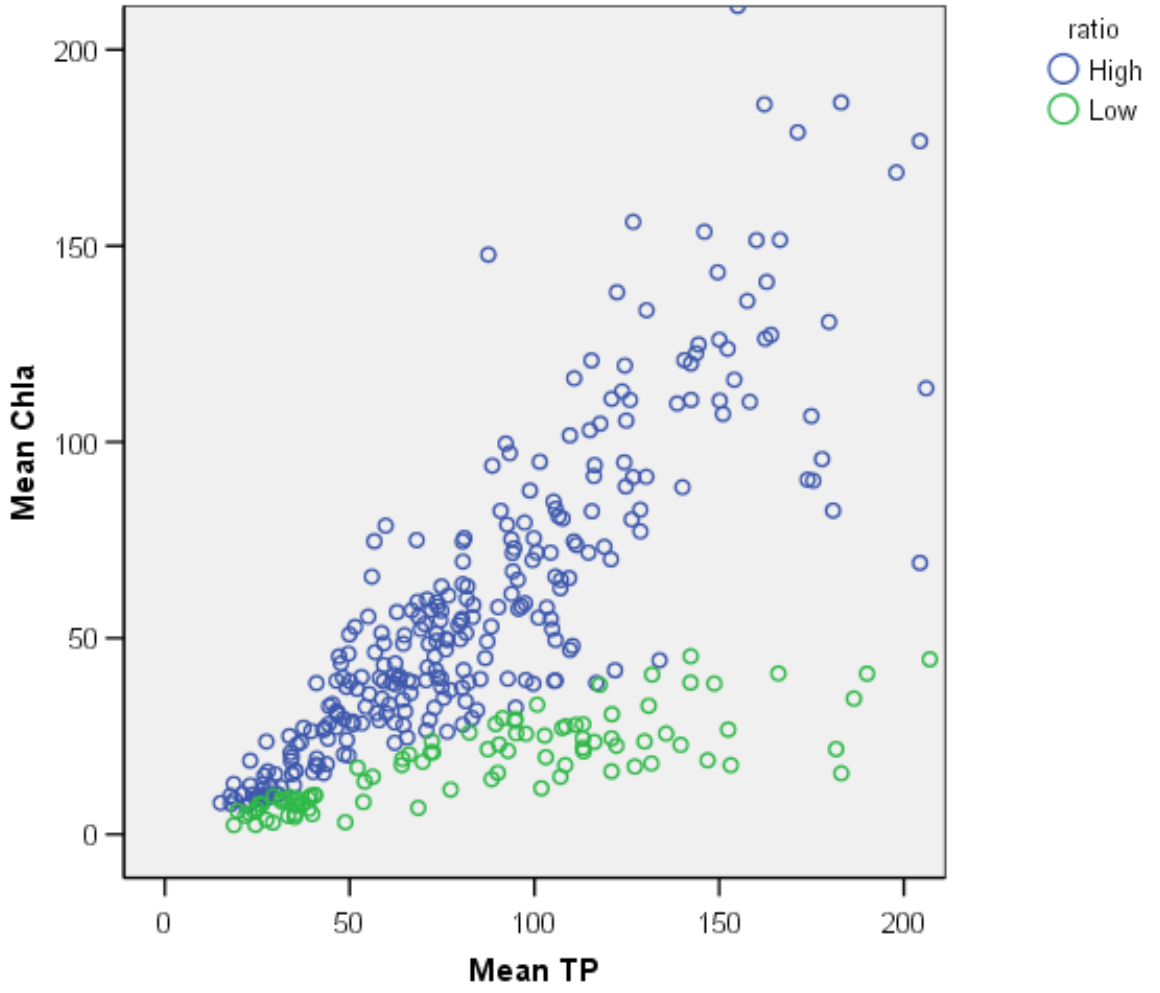

Split broads in 2 groups

High Chl/TP > 0.33

Low Chl/TP < 0.33

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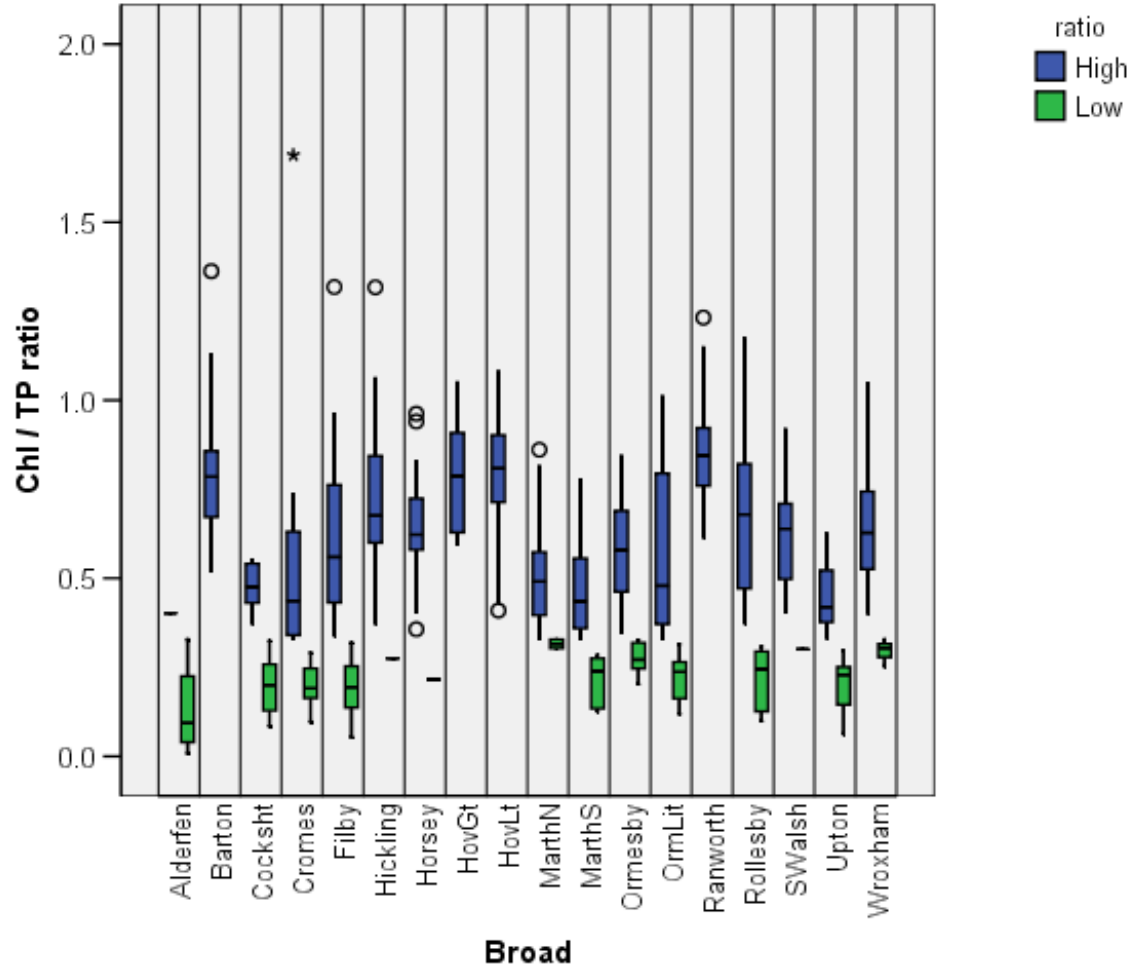
Ratio Chlorophyll / Total P



Sites with low Chl / TP ratio occur in

Isolated or biomanipulated broads

Result of top-down (grazing) control.

Implications for establishing P targets

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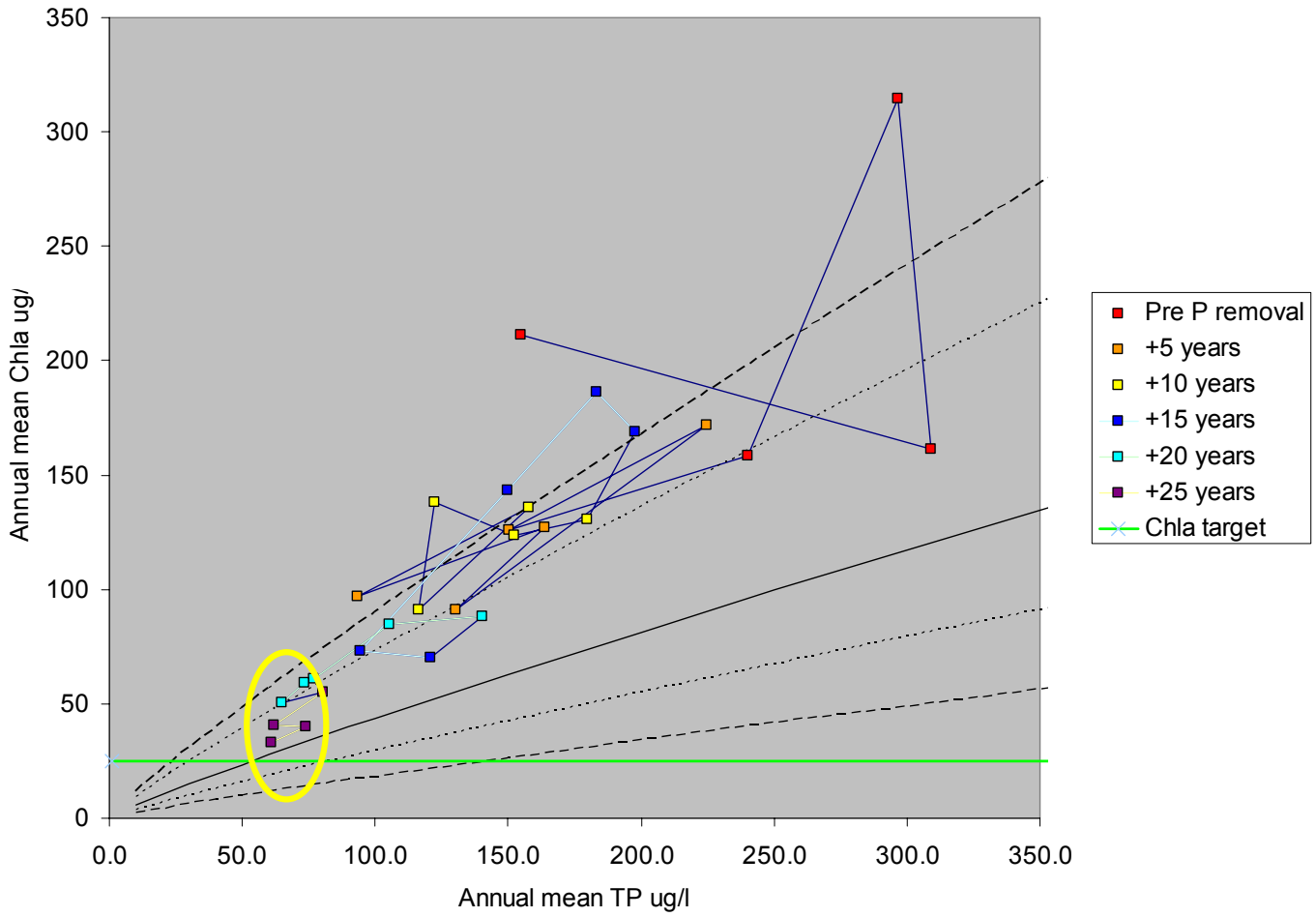
Trajectory of chlorophyll – Barton Broad



Recovery follows upper 90th percentile of regression residuals

25 years to get close to target.

Note change in response, during last 5 years

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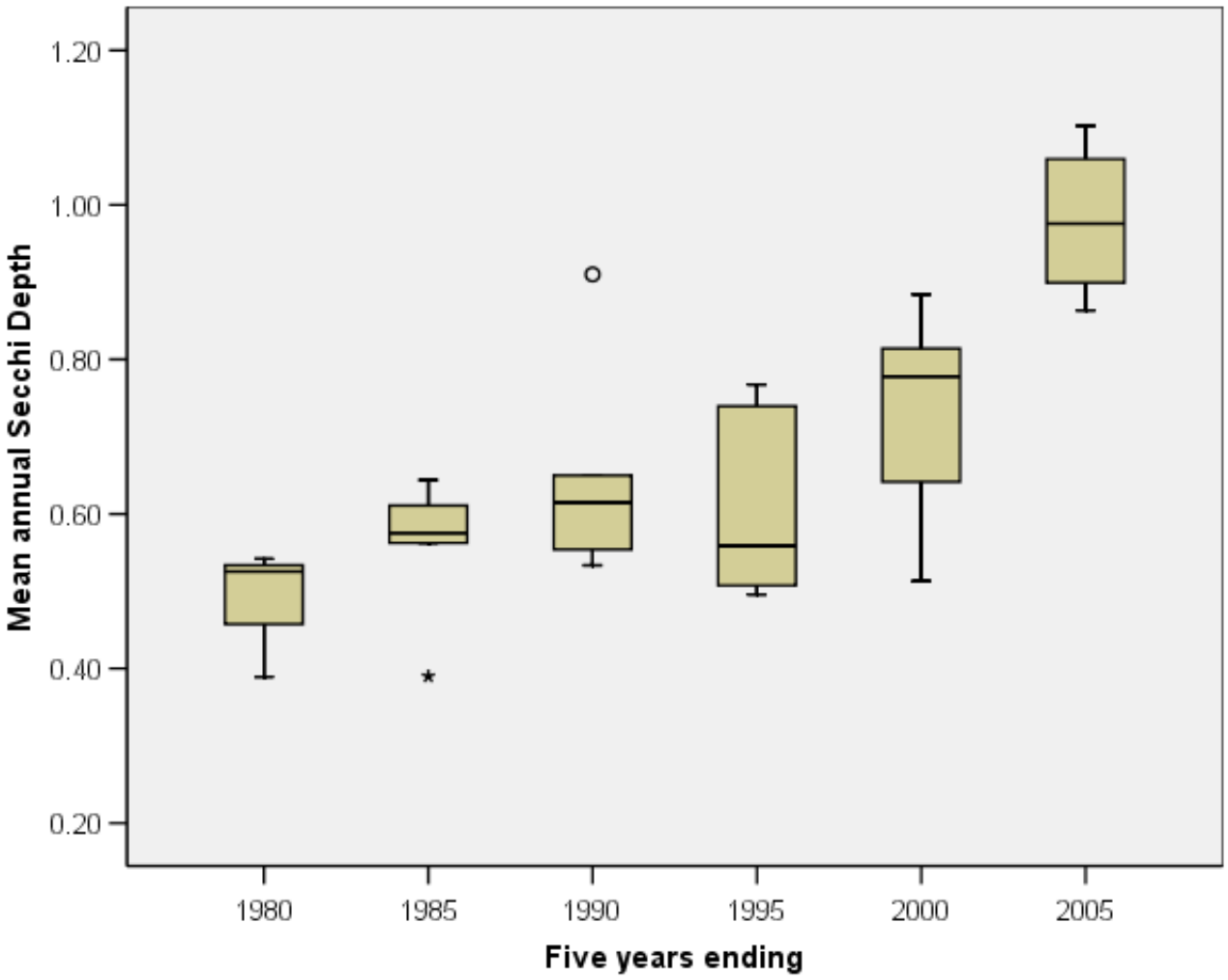
Changes in water transparency Barton Broad



Change in TP/Chl ratio associated with marked increase in Secchi depth

Due to reduction in summer phytoplankton, occurred from +20 years (2000 onwards)

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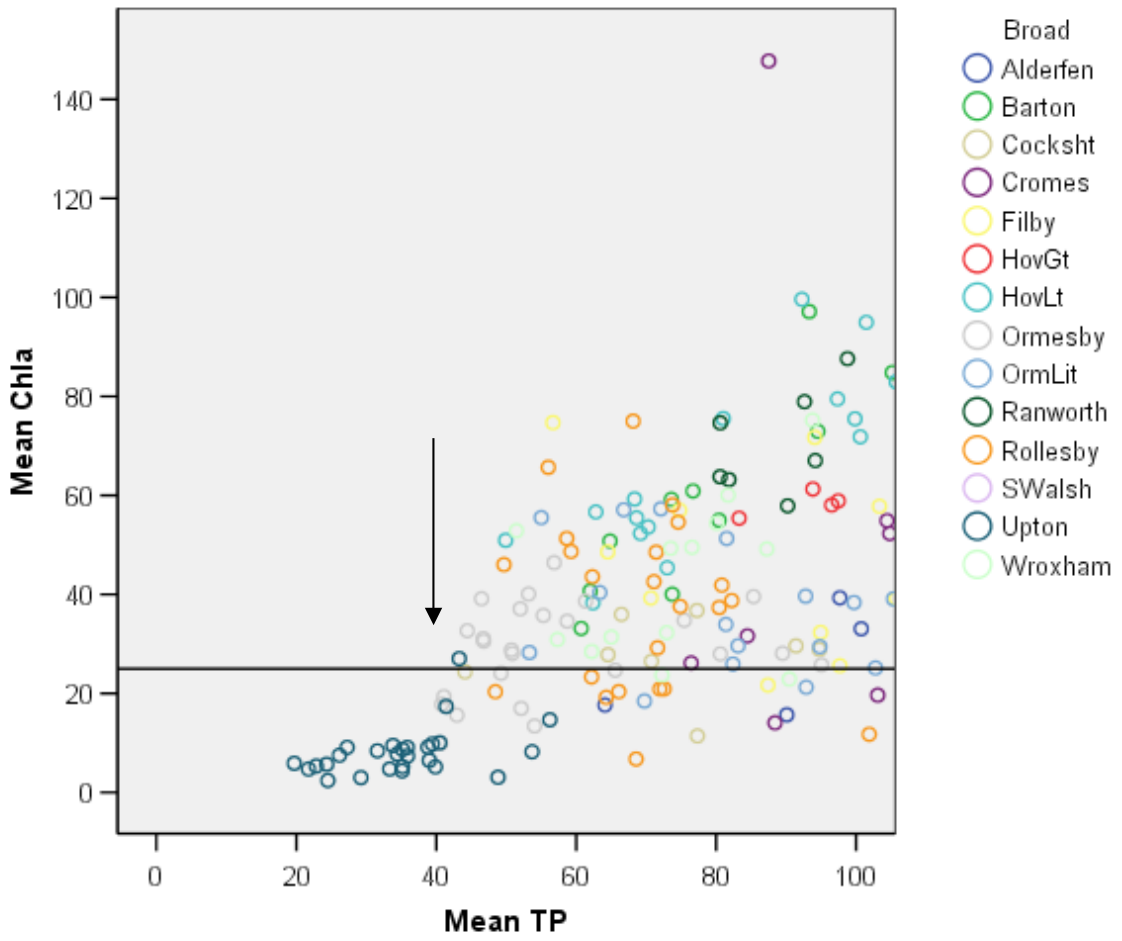
Discontinuity in Tot P v Chlorophyll



From 40 ug/l TP some evidence of an increase in Chlorophyll

Risk boundary for increased phytoplankton ?

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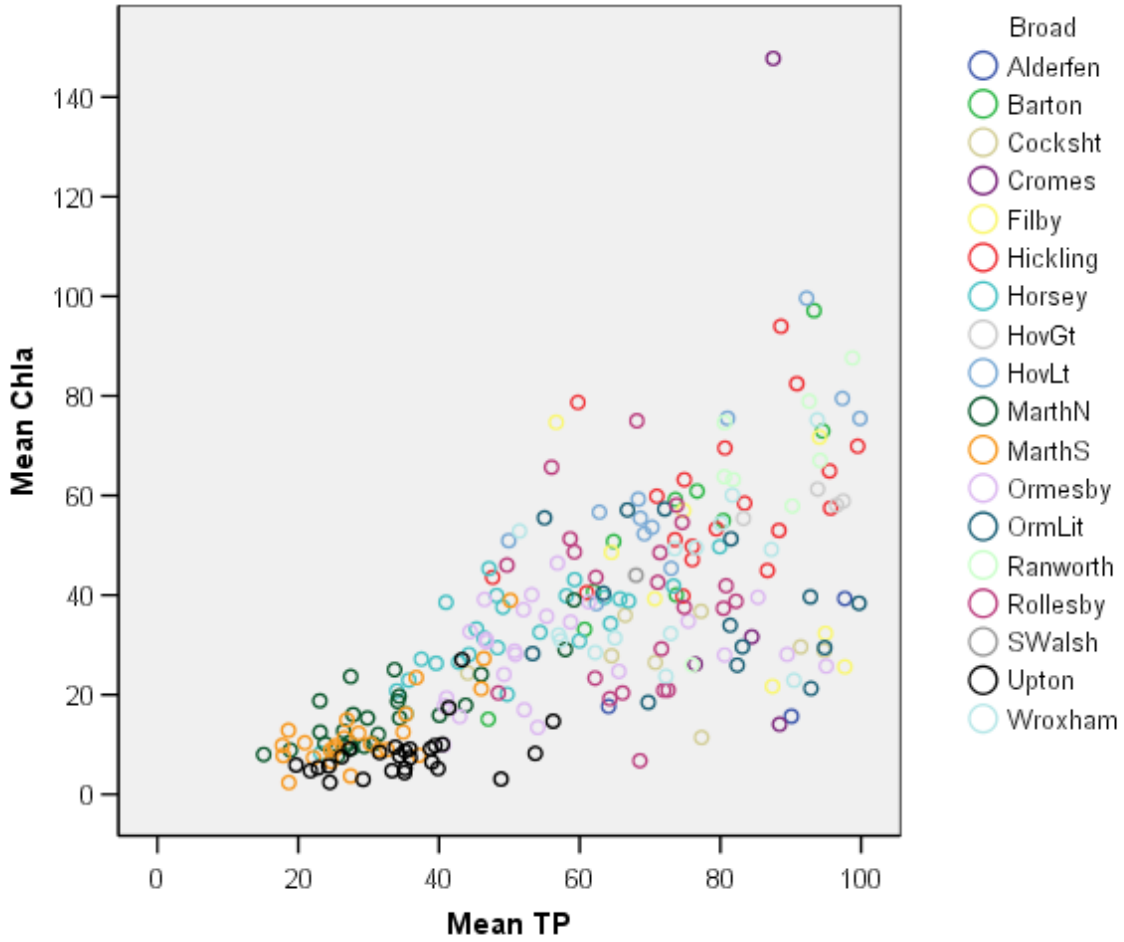
Discontinuity in Tot P v Chloropyll



From 40 ug/l TP some evidence of an increase in Chlorophyll

Risk boundary for increased phytoplankton ?

Less obvious add Thurne broads – saline, reduced grazing

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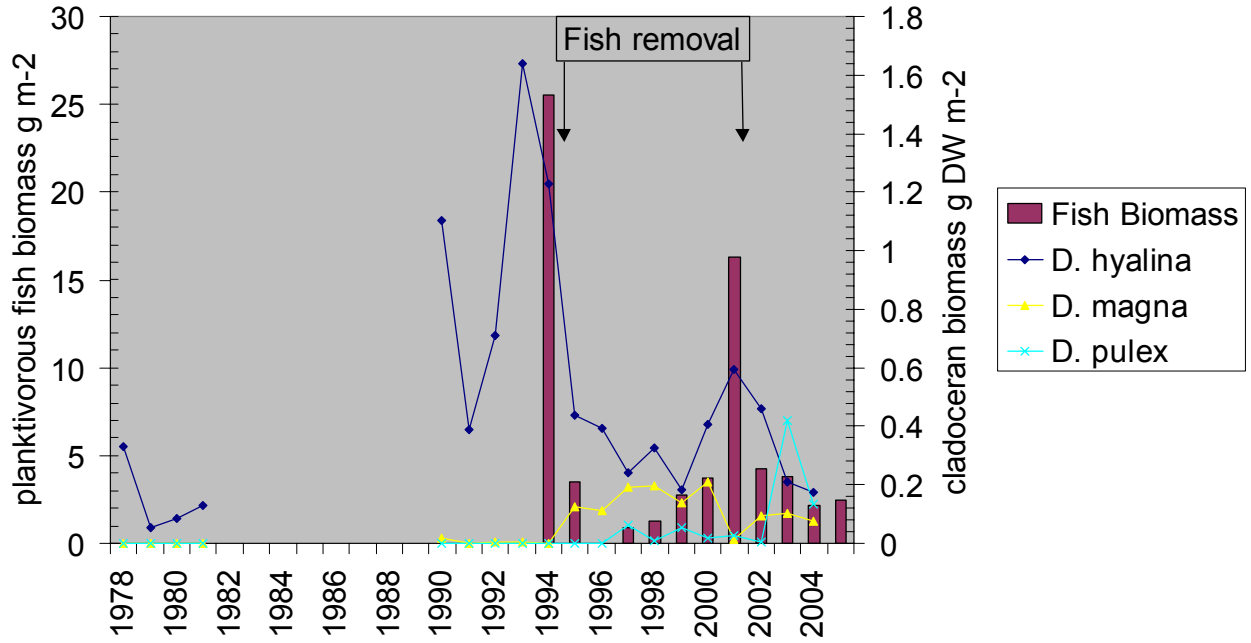
Trinity Broads - biomanipulation

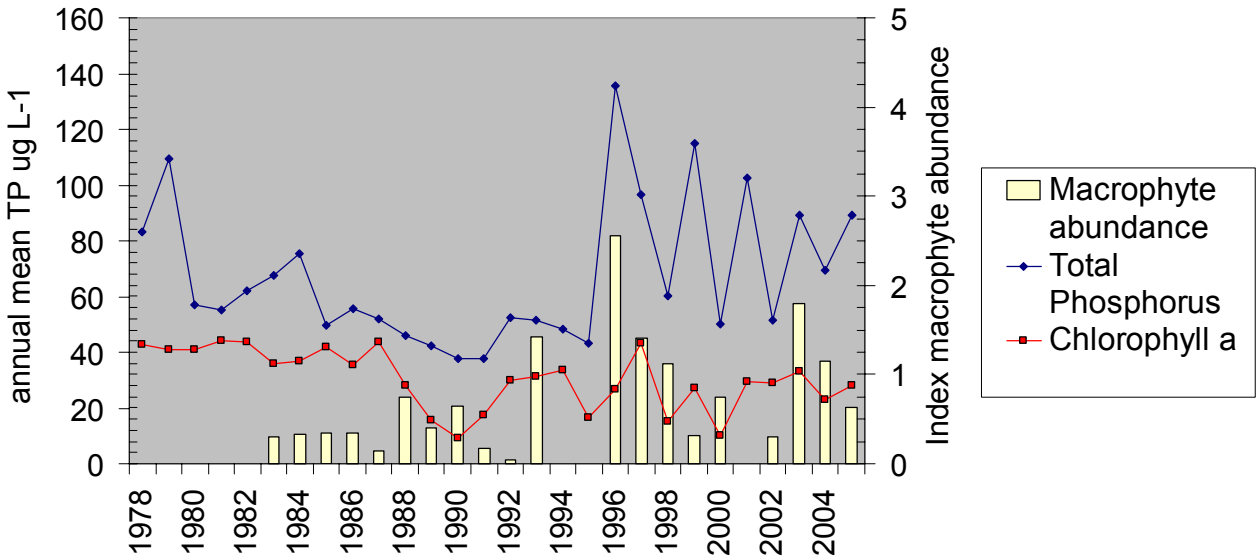
Isolated lakes with no direct discharges from STWs

Fish Removal

Changes in Planktivorous Fish and Cladoceran zooplankton biomass following Fish Removal



Changes in Total P, Chlorophyll a and Macrophyte growth following Fish Removal



Ormesby Broad

Fish removal winter 1994

Increase in body size grazing cladocerans

No increase in cladoceran biomass

No significant reduction in Chlorophyll

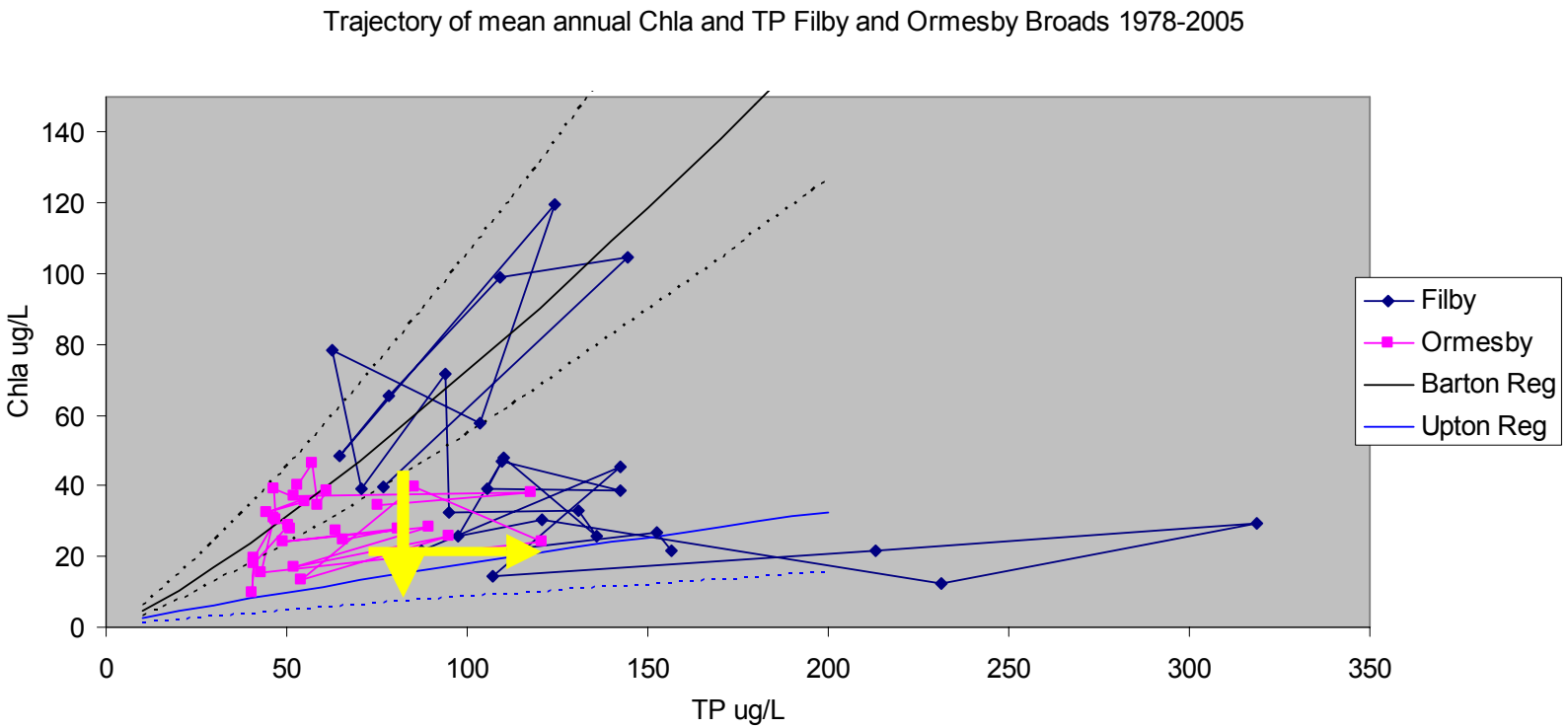
Marked increase in TP

Substantial reduction in Chl/TP ratio

Increase in macrophytes

All indicative of reduced fish predation, increased grazing

Similar pattern in trajectory of change



Switch in response at TP < 100 ug/l

Linked to changes in fish population – increased grazing

Increase in TP – sediment derived

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Summary

- Point source control has reduced level of TP and chlorophyll in many of Broads
- In river Ant and river Bure some of broads may be on track to achieve Chlorophyll targets by 2015
- Minimal evidence of any significant change in ecosystem structure (evidenced by Chl / TP ratio) in Ant/Bure
- Effect of macrophytes on TP – locks up P
- Recycling of TP important issue – influenced by system
- Need to establish TP targets for Broads
  - Supporting element for WFD
  - Key for WQ management

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Total P targets - Broads

- National approach all lakes
- Model to determine lake specific reference value
  - Broads – 35 ug/l
- Good Moderate boundary estimated using a ratio (EQR) determined from response of macrophytes and phytoplankton biomass
  - Broads – 0.58, giving value of 62 ug/l
  - Supported by analysis of macrophyte records – 67 ug/l
- Habitats Directive, very shallow high alkalinity lakes
  - Threshold value 50 ug/l
- Scope for a Broads (Lake District) target

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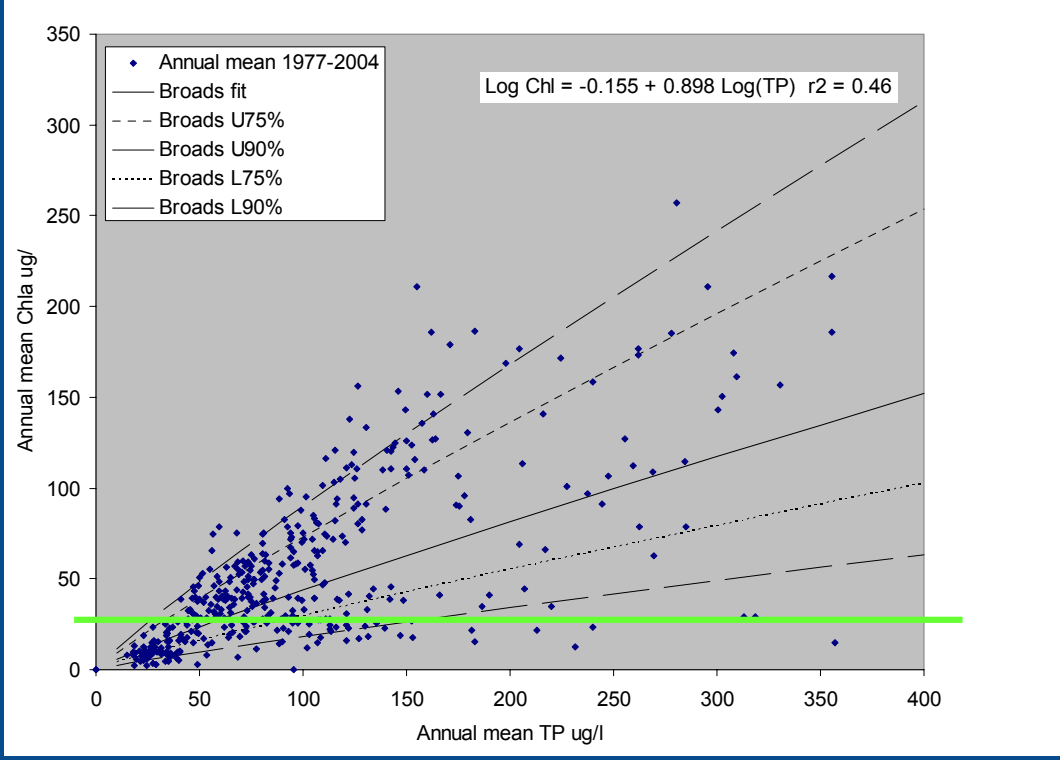
Use of local data to establish TP targets

- Chlorophyll – most sensitive Quality Element
- TP v Chl regression for all sites suggests a TP target of 50 ug/l
  - 50% of lake years would achieve chlorophyll target
- More precautionary approach would suggest a target of 30 ug/l
  - 75% of lake years would achieve chlorophyll target
- Least precautionary approach would suggest a target of 80 ug/l
  - 25% of lake years would achieve chlorophyll target
- Indications of a change around 40 ug/l (minimal data)



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Conclusions – Total P targets

- 50 ug/l is a realistic general target for Broadland
- Ecological status should be determined by biological quality elements – eg Phytoplankton biomass, (chlorophyll a)
- Probability of achieving low chlorophyll biomass increases below 40 ug/l, linked to ecosystem change and top down control
- Probability of higher chlorophyll biomass increases above 80-100 ug/l
- Will not achieve 50ug/l without an ecosystem change – macrophyte establishment and top down control exerting an influence

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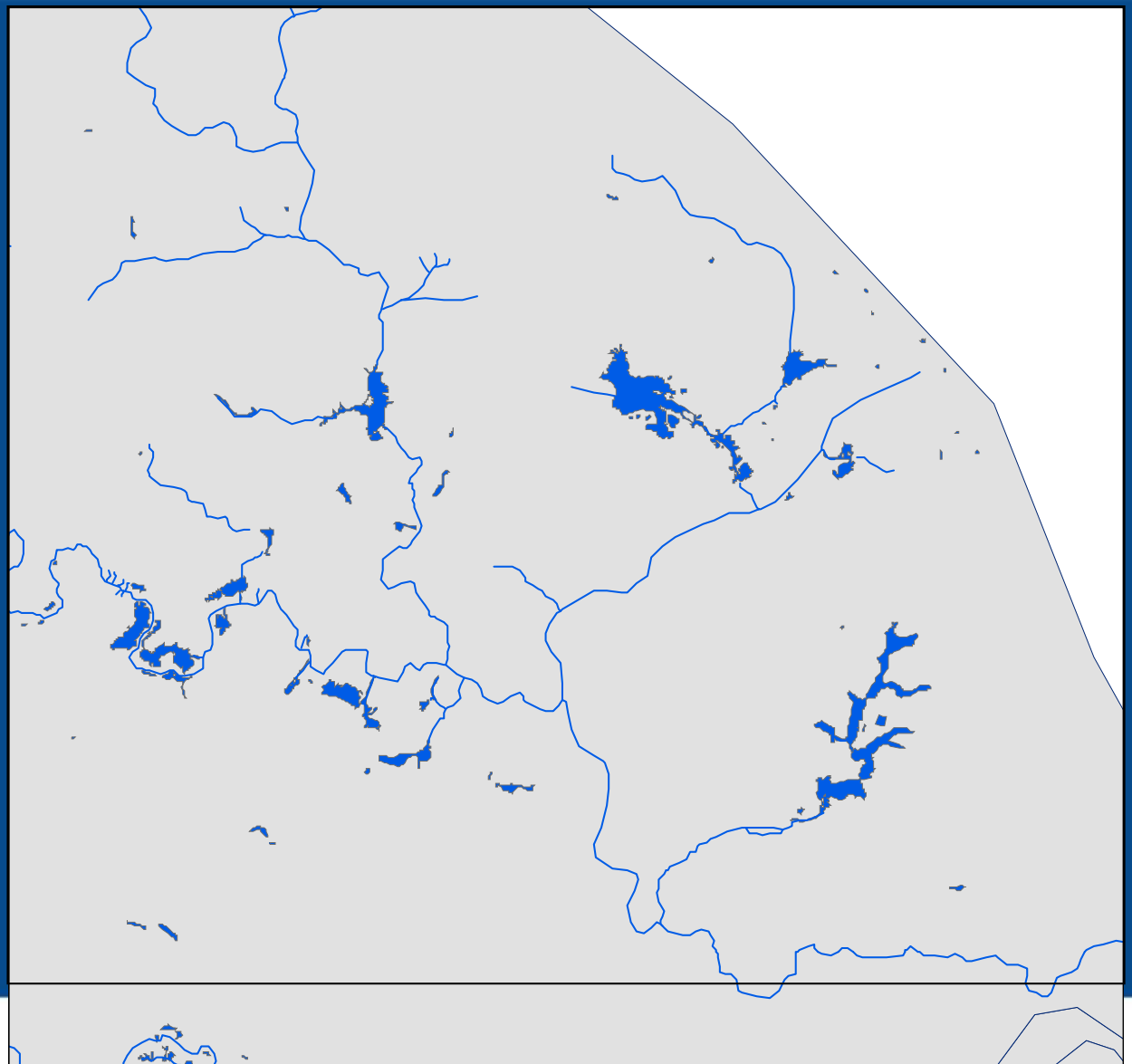
Final Thought



Two types Broad
Isolated lakes
Riverine lakes

Riverine lakes require a whole system response – a single large lake.

Need to be patient and wait for Northern Broads system to change.