School of Geography
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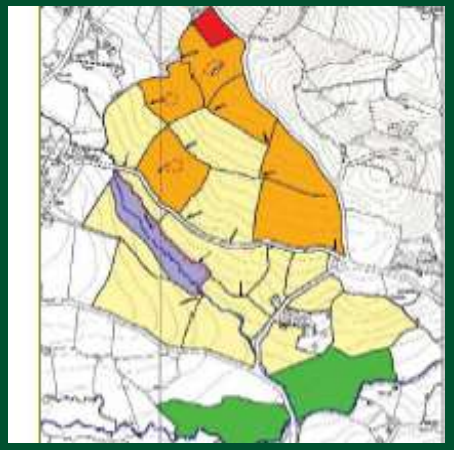
Is agricultural stewardship going to solve the diffuse pollution problem?



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Outline

- Background to rural diffuse pollution and agricultural stewardship
- Do mitigation measures really improve water quality?
- Catchment sensitive farming in Yorkshire's uplands
- Catchment sensitive farming in Yorkshire's lowlands
- Is catchment management working?

Diffuse water pollution from agriculture (DWPA)

- A world-wide problem (most significant in **US, EU and Japan**)
- **Range of pollutants** (nitrogen, phosphorus, pesticides, veterinary medicines, sediment, microbes)
- In the UK DWPA causes 70% of nitrate and 30-50% of phosphorus pollution
- Problematic from **ecological** and **water resource** perspectives (e.g. eutrophication, direct toxicity)

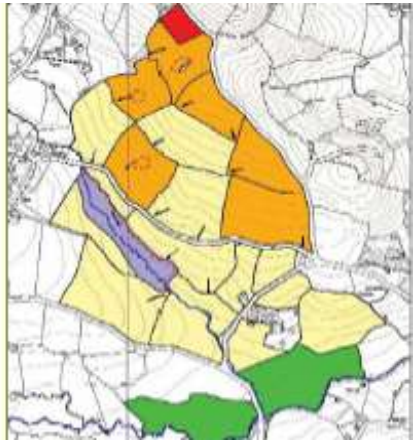


Agricultural stewardship

- A **way of alleviating these problems** with specific management measures to reduce inputs, limit transport and treat pollutants
- Currently **being pursued with more vigour than ever**
- **EU**:
  - Water Framework Directive
  - Reform of the Common Agricultural Policy
  - New Environmental/Countryside Stewardship
- **US**:
  - Agricultural Stewardship Act
  - Agricultural Stewardship Associations
  - US EPA Conservation Security Programme
  - USDA grants
- **Australia**
  - >2500 Landcare groups

NATURAL ENGLAND

Measures available under the Entry Level Scheme (ELS)



Scientific evidence for impacts of CSF

- This work forms part of a wider project to develop an **agricultural land management strategy** for the 25,000 ha that Yorkshire Water owns and to influence other land owners who impact water quality
- **Dissolved organic carbon, nutrients and pesticides** most problematic for Yorkshire Water
- Focus was on identifying the state of the art as to how well we understand the **effects of agricultural stewardship measures on water quality**
- The water company could then **encourage the use of these practices** with the expectation of improvements in water quality occurring, reducing treatment costs


Agricultural Systems

A review of the efficacy of contemporary agricultural stewardship measures for ameliorating water pollution problems of key concern to the UK water industry

Impacts of stewardship measures on nutrients

Input reduction measures

- **Limit nutrient application** to crop requirements
- Limit total nitrogen from manures to **170 kg ha^{-1} yr^{-1}** for arable land and **250 kg ha^{-1} yr^{-1}** for grassland
- Arable **reversion to grassland**

- **Reductions in nitrate leaching of >50 %**
- **Phosphorus** losses likely to require a longer time-scale (**10-20 years**) for effects to be seen due to **build up in soils**
- Reduction in losses negligible in some cases though due to **soil type**, **crop** and **hydrology**
- **Many farmers claim to already be meeting these limits whilst pollution still occurs**

Impacts of stewardship measures on nutrients

Transport reduction measures

- **Incorporation** of slurry/manure and inorganic fertilisers
  - **80-95 % reduction in N and P in runoff** (not where tile drains are present though)
- **Cover crops**
  - One of most effective ways to reduce nitrate leaching – **50 % reduction** compared to winter cereal

- **Soil tilth**
  - Dissolved **P transport reduced by factor of 2-3**
  - Impacts are **site-specific** though

Impacts of stewardship measures on nutrients

Transport reduction measures

- **Direction of drilling and tramlines**
  - P losses reduced by 12-58 %
- **Conservation tillage**
  - N losses reduced by 49-67 % and P by 17-73 %
  - No effect on P in 8 % of studies and increased loss in 23 %
  - Can leave macropores intact

- **Livestock management**
  - N losses reduced by 70 % in extensive systems
  - Difficult to separate reasons out – is this just due to lower fertiliser applications?
  - Livestock exclusion has resulted in reduced losses of N&P (up to 78 %) in some streams but increases (up to 30 %) in others

Impacts of stewardship measures on nutrients

Edge of field measures (buffer zones and wetlands)

- Effects range from **significant reduction** (100 %) in pollution to **increases**
- Effects are highly **seasonal** and **site specific** (e.g. soil properties, vegetation cover, climate, sediment characteristics, physical dimensions)
- Maximum delivery period for nutrients (winter) overlaps with their least efficient time
- **Uncertainties**
  - Long-term management
  - Catchment-scale research
  - Scale of buffer zone or wetland

Impacts of stewardship measures on nutrients

- **How much data is missing?**
  - Lots!
  - For **46 %** of the stewardship measures that could potentially impact N and P losses to waterbodies **no empirical evidence** was available describing their effects

Catchment Sensitive Farming

- Must comply with **Water Framework Directive** (WFD) by 2015, now 2027, (i.e. good water quality) or face legal action from EC
- **ECSFDI** is an attempt to get farmers to reduce diffuse pollution from agriculture voluntarily through **programmes of advice** and **support payments**
- **Priority**, **Associate** and **Partnership** catchments

A Clear solution for farmers
ENGLAND CATCHMENT SENSITIVE FARMING DELIVERY INITIATIVE

Delivering the WFD - Pilot catchments

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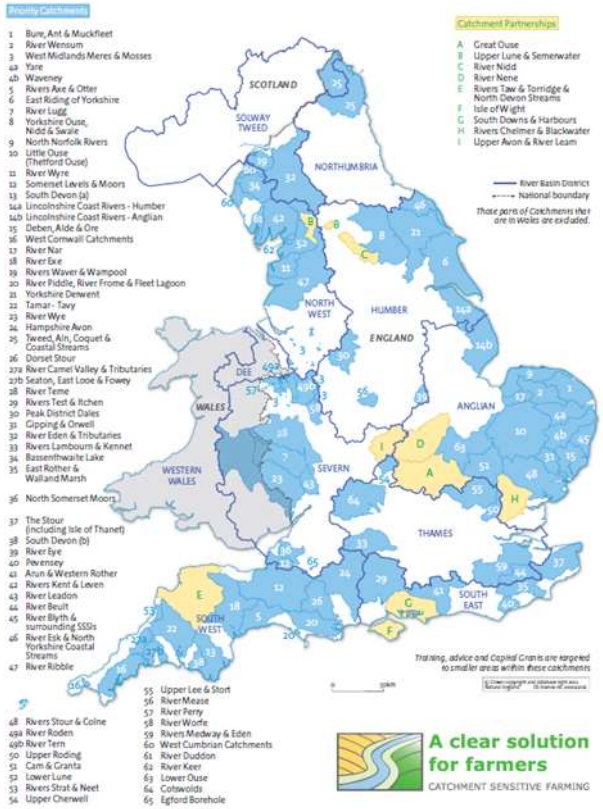
- Since 2005 - Catchment Sensitive Farming (>50 catchments)
- Since 2011 - 25 WFD pilot catchments
  - 41 other catchment initiatives
- Total of £92M Defra funding 2011-14

Catchments hosted by the Environment Agency (EA)	Catchments hosted by other organisations	Organisations
Adur and Ouse	Cam and Ely Ouse	Anglian Water Services
Ewell	Nene	River Nene Regional Park (RNRP)
Lower Lee	Bradford Beck	Aire Rivers Trust
Lower Wyre	Douglas	Groundwork Lancashire West and Wigan
Ribble	Tyne	Tyne Rivers Trust
River Don and Rother	Bristol Avon	Bath & North East Somerset Council and Avon Frome Partnership & Groundwork South West
River Ecclesbourne	Teme	Severn Rivers Trust
River Leam	Eden	Eden Rivers Trust
Upper Tone	New Forest	New Forest National Park Authority
Welland	Frome and Piddle	Wessex Water
	Tamar	West Country Rivers Trust
	Cotswold	Farming and Wildlife Advisory Group South West
	Thames Tidal	Thames 21 & Thames Estuary Partnership
	Wey	Surrey Wildlife Trust on behalf of Wey Valley Partnership
	Tame, Anker, Mease	Birmingham and Black Country Wildlife Trust



Eutrophication of catchment reservoirs

- Algal blooms problematic (fish kills, amenity loss) in 2 of the catchment's 4 reservoirs

Reasons for nutrient pollution






Aim of the Ingbirchworth Catchment Sensitive Farming project

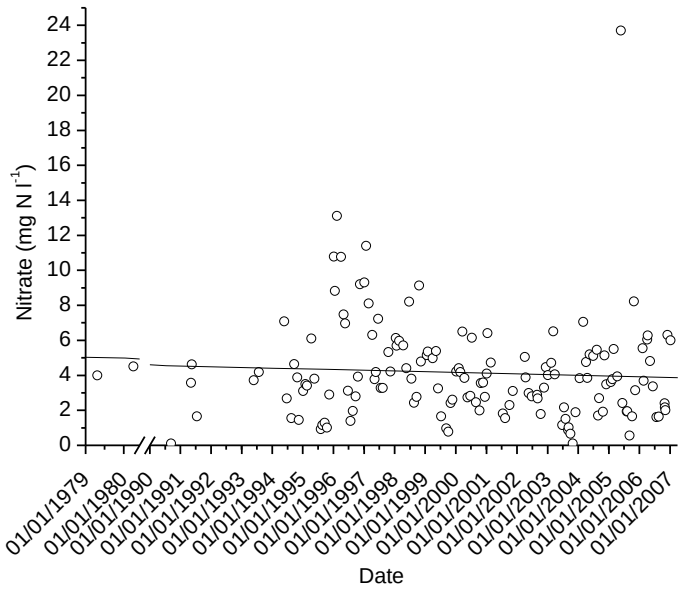
- Farmers already **fully compliant with Nitrate Vulnerable Zone legislation** but **algal blooms still occurring**
- 3 studies indicate that NVZs have not impacted water quality (Kay et al., 2012; Worrall et al., 2009; Lord et al., 2007).
- **Need to take further action** to reduce nutrient pollution

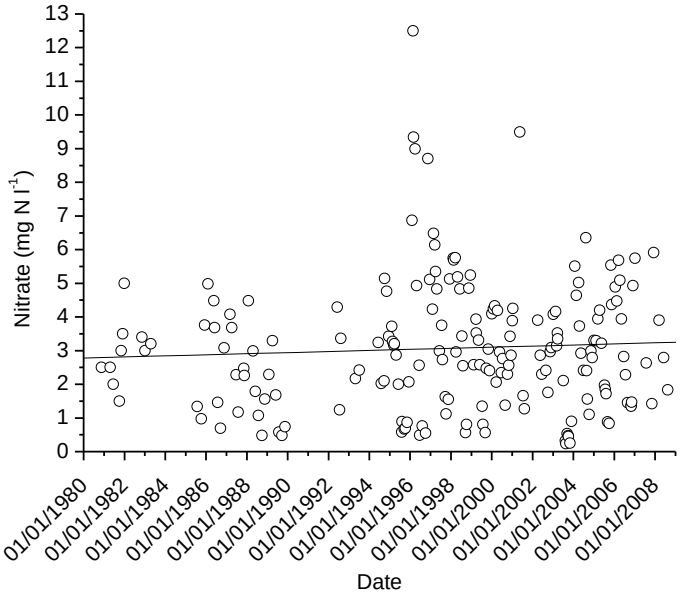
Farm advice

- Introductory meeting
- On-farm workshops
- Farm walks
- Demonstration days
- One-to-one visits

Long-term (30 year) Environment Agency monitoring - nitrate

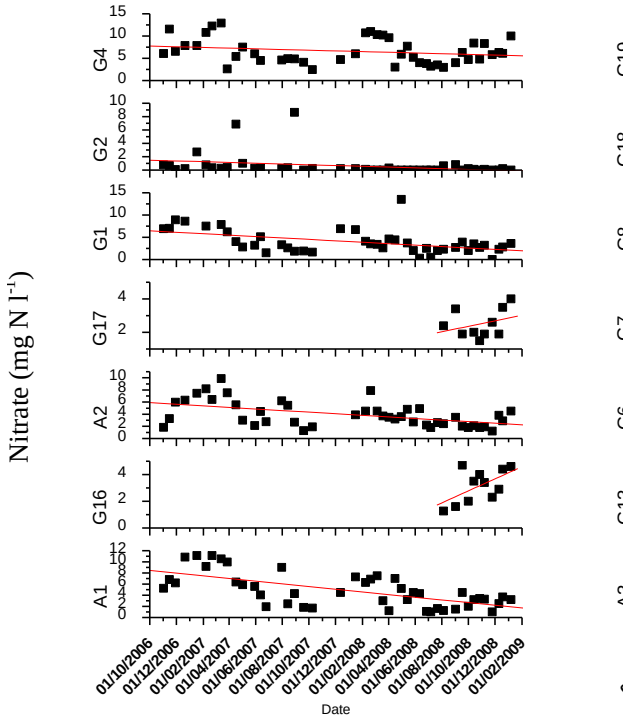
- Nitrate concentrations remained static between 1978 and 2008
- Median concentration = 3-4 mg N l^{-1}
- Peak concentration = 24 mg N l^{-1}

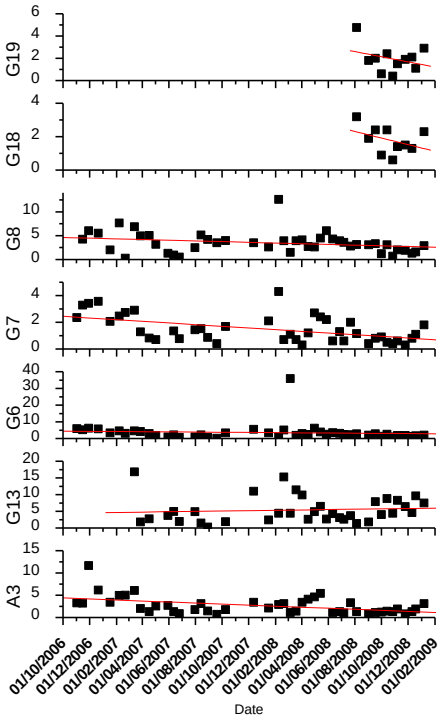


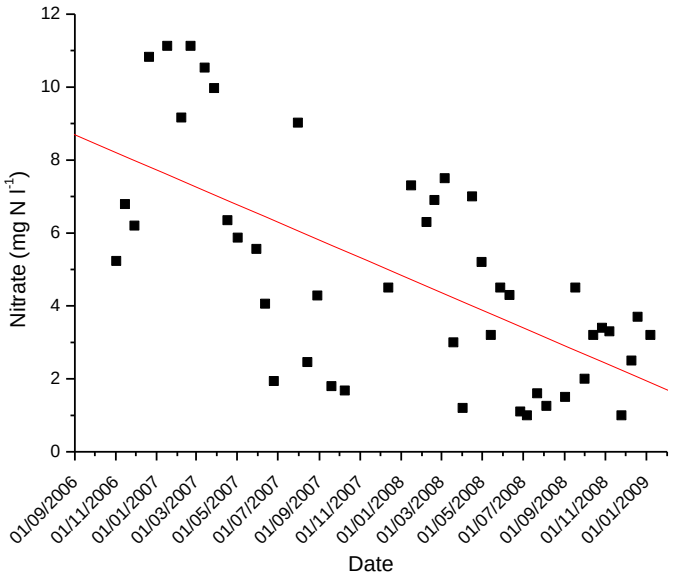


Intensive monitoring 2006-09

- Decrease in nitrate concentrations of up to 50 % throughout the catchment

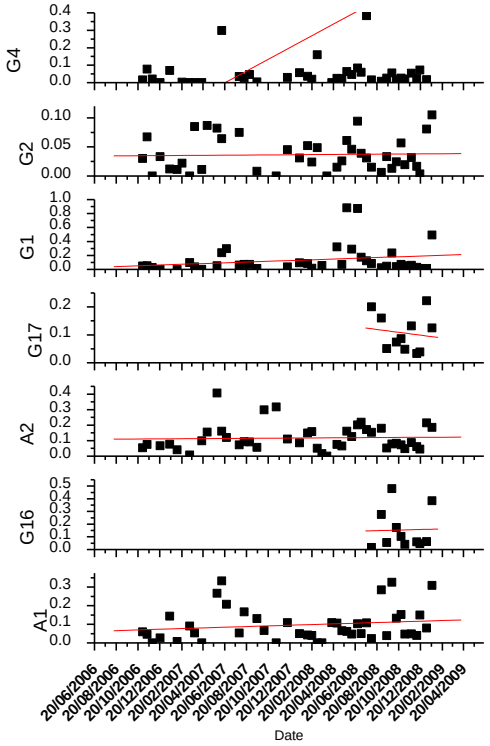


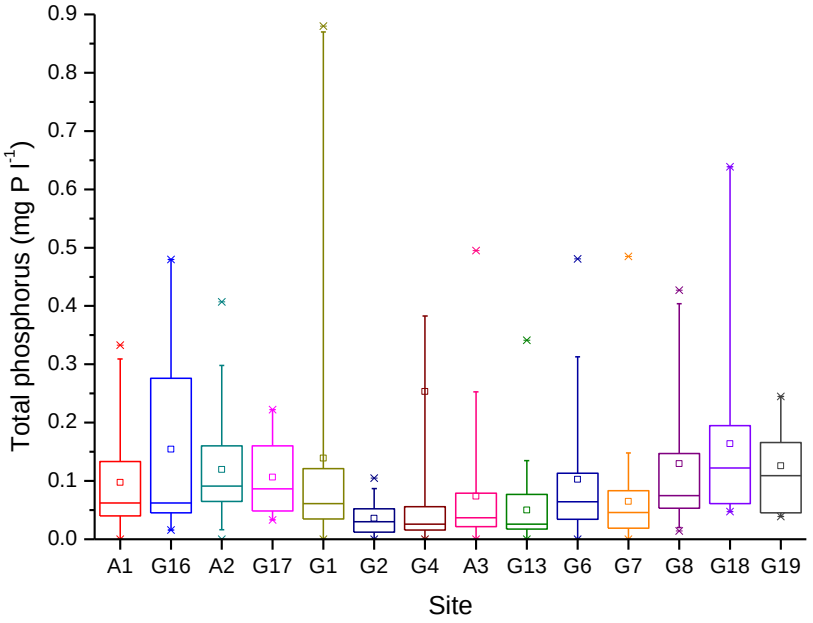




Phosphorus concentrations

- Orthophosphate concentrations **remained static** between 1985 and 2008
- Intensive monitoring showed 0.1 mg P l^{-1} **'high' standard frequently exceeded** (up to 0.87 mg P l^{-1})
- **Mean value above 0.1 mg P l^{-1} in some streams**





Agriculture as the major nutrient source in the Ingbirchworth catchment

- Use **GIS and regression analysis** to determine relationships between land use and water quality
- **Relationship exists between more intensive agriculture and nutrient concentrations**
- **Improved grassland** associated with **higher median nitrate** concs (R_2=0.48)
- As % of **rough grassland** in a subcatchment increases peak **nitrate concs decrease** (R_2=0.61)

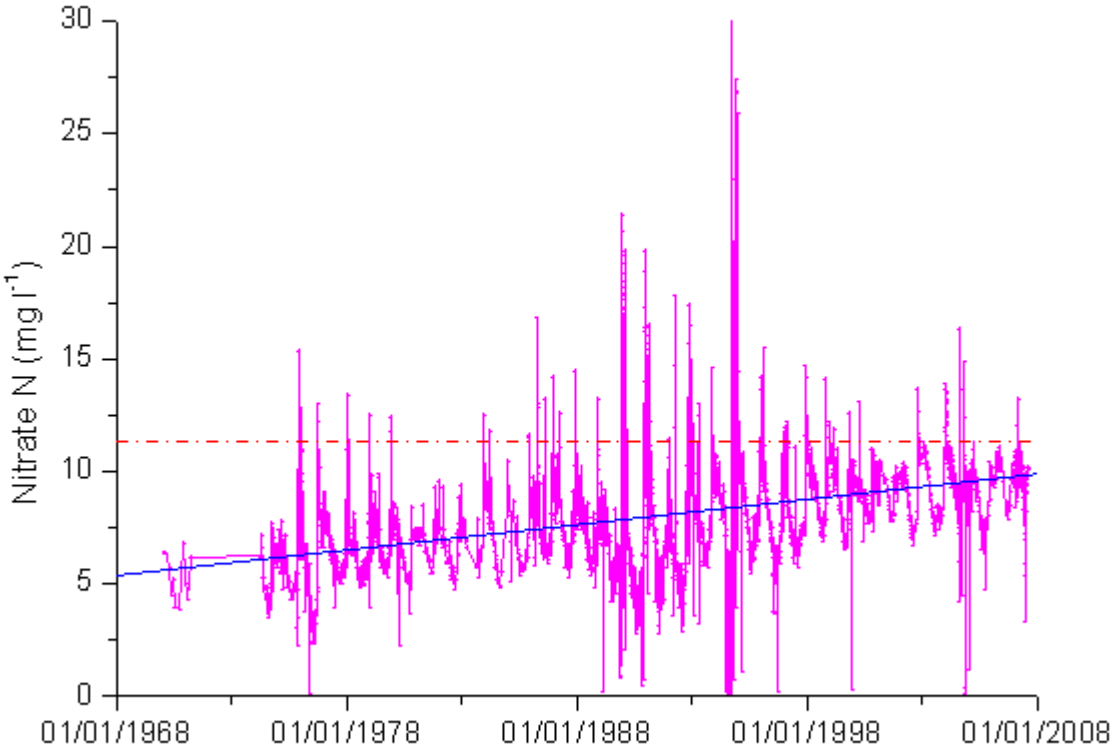
Catchment Sensitive Farming in the lowlands: River Hull, UK

- Northernmost chalk stream in UK
- Important wetland habitats
- Water supply for East Riding
- Main water quality problems are nitrate and sediment

R Hull and Ingbirchworth catchments are very different

- Hull dominated by winter wheat
- Other very intensive crops (e.g. peas)
- Hydrologically very different (i.e. groundwater dominated on the Yorkshire chalk)

Nitrate pollution in the R Hull catchment



Farm advice

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A Clear solution for farmers
ENGLAND CATCHMENT SENSITIVE FARMING DELIVERY INITIATIVE

- Farmer meetings
- Farm walks (e.g. precision farming)
- Demonstration days (e.g. slurry injection, trickle irrigation)
- Entry into the Entry (ELS) and Higher Level Scheme (HLS)

Runoff sources

- All streams are dominated by groundwater
  - Median alkalinity 192 mg l^{-1} $CaCO_3$ (Range 168-286 mg l^{-1} $CaCO_3$)
  - Median suspended solids <1 mg l^{-1} (65 % of samples 0 mg l^{-1})
  - High Sr/Ca ratios
  - Nitrate concentrations decrease during storm events and are highest closest to springs and in unconfined aquifer
- Runoff transit times through the aquifer are c. 30 years
- Farm advice is unlikely to bring about any change in water quality within this time in groundwater dominated catchments.

Evidence of impacts: The catchment approach

- A number of useful projects ongoing but little information available at present
- 22 % of water bodies met Good Ecological Status target by 2015
- Gradual improvement by 2021, 2027?
- Realistically, can catchment management achieve what we want it to, within the context of everything else that we want?

BETTER ECOLOGICAL STATUS

River basin	2012 update (%)	2015* target (%)
Anglian	18	19
Dee	30	38
Humber	18	19
North West	29	33
Northumbria	40	49
Severn	30	34
Solway Tweed	48	55
South East	15	23
South West	32	42
Thames	18	25
Western Wales	35	36
Overall	27	–

* 2009 river basin management plans
Source: Environment Agency 2012 Water Framework

Summary

- Agricultural stewardship is **key to meeting policy objectives** and evidence shows that it could have a big impact
- **Projects to date** often lacking in extensive action on the ground (CSF, RBMPs)
- May need larger scale changes than have been implemented; greater buy-in from farmers needed (through greater financial reward)
- Water quality monitoring is needed
- **Still a long, long way from meeting the Water Framework Directive**
- **Paradigm change away from catchment management in coming decades?**