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# Prioritising designated wildlife sites at risk from diffuse agricultural pollution

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**Number 551**

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# *Executive summary*

Many aquatic sites in the UK are subject to pollution in the form of high loadings of nutrients and ammonia and excessive inputs of sediments. Such pollution can result in nutrient enrichment, siltation, elevated biological oxygen demand (BOD) and toxicity in receiving waters.

Diffuse pollution from agriculture has been identified as a causal factor in observed increases in nutrient levels and silt in waters both nationally and internationally. Diffuse pollution often occurs as a result of farming practices such as overstocking or overgrazing of land, the over application of fertiliser and inappropriate cultivation of soils. Although individual sources of diffuse agricultural pollution may be small; they may act cumulatively to constitute significant loadings at a catchment level.

Certain statutory and non-statutory drivers exist to facilitate policy makers in tackling diffuse pollution issues in the UK and Europe. In England one proposed approach to addressing these drivers is the development of a two-tier grant-aid package comprising a Basic Plan to help address diffuse pollution risks throughout the countryside, and a Plan Plus package covering the catchments of priority water-dependent sites.

This project was commissioned by English Nature to identify and prioritise statutory designated water-dependent sites considered to be most at risk from, or impacted by, diffuse agricultural pollution. The collation and evaluation of evidence and subsequent prioritisation of sites was progressed as distinct phases of work comprising:

1. **Screening process**, comprising identification and rough prioritisation of sites based on information and scores obtained through consultation with English Nature local teams. Compilation of a Stage 1 list including all sites highlighted as 'of concern'.

2. **Site specific assessment**, comprising collation and appraisal of relevant data on 105 higher priority sites and development of scoring system to help refine relative priorities of sites within this group.

3. **Compilation of case studies** for 15 sites where action to tackle diffuse pollution is considered to be appropriate and sufficient information was available to enable case studies to be prepared.

The findings of this study indicate that many water-dependent statutory designated sites in the UK can be considered to be impacted by, or at risk from, diffuse agricultural pollution. Those sites identified as 'higher priority' are the stronger candidates for urgent strategic action to tackle diffuse agricultural pollution. However, the extent to which individual sites could be evaluated was limited in many cases by a lack of relevant information. When considering sites for which specific action to tackle diffuse agricultural pollution is highest priority and most appropriate, this lack of information inevitably restricts the sensitivity with which assessments can be made, and therefore argues for a formal catchment appraisal process to target local strategic action.

Where sites have been identified as being significantly impacted by diffuse agricultural pollution, based on supportable evidence of both diffuse pollution inputs and associated

ecological effects, these sites should be prioritised for targeted catchment-based action, such as that proposed in the 'Plan Plus' package.

Where sites have been identified as being impacted by pollutants typically associated with agriculture, but the significance of diffuse agricultural pollution is not clear, resources should be targeted towards catchment-scale investigations aimed at resolving these issues prior to determining the need for strategic targeted action.

Where evidence of diffuse agricultural pollution exists, but little investigation has been undertaken into the consequences of such pollution for ecological interest features of receiving designated sites, such investigations should form part of the action programme for these sites.

Future research should include the development of parallel risk assessment tools for diffuse pollution sourcing and ecological impacts. These tools would help further refine the prioritisation process and would be of particular value if the 'Plan Plus' approach is extended in the future.

## Contents

# 1. Introduction

Many aquatic sites in the UK are subject to pollution in the form of high loadings of nutrients and ammonia and excessive inputs of sediments. Such pollution can result in nutrient enrichment, siltation, elevated biological oxygen demand (BOD) and toxicity in receiving waters.

## 1.1 Sources of pollution

Pollution may arise from diffuse or point sources. Point source pollution enters the receiving water from a single point of entry and may be continuous, for example an effluent stream from a sewage treatment works (STW) or transient, for example resulting from a one-off pollution event.

Diffuse pollution arises from a larger area and often enters the watercourse via land runoff following rainfall events. Diffuse pollution has been defined (D'Arcy *et al*, 2000) as:

> 'Pollution arising from land-based activities (urban and rural) that are dispersed across a catchment, or sub-catchment, and do not arise as a process effluent, municipal sewage effluent, or an effluent discharge from farm buildings.'

Agriculture is the major source of diffuse pollution in the UK, for example discrete, point source inputs of phosphates (P) to surface waters in England and Wales are currently estimated at 41% compared with diffuse sources of 59%, of which 50% comes from agriculture and 9% is due to natural background levels (DEFRA, 2002).

## 1.2 Causes of diffuse agricultural pollution

The level of diffuse pollution from agriculture has increased dramatically in recent years. This is related to two major changes that have taken place in UK agriculture since the Second World War: (i) intensification and (ii) an increase in average size of farm holding. Between 1960 and 1990 in the UK, the average farm holding size doubled, the area of arable crops and temporary grass increased by 36% (cereal cultivation 60% increase), cattle numbers increased by 70% and poultry by 104% (DEFRA, 2002).

The main compounds of concern relating to diffuse agricultural pollution are nutrients, in the form of nitrates and phosphates, and sediments. The elevated diffuse nutrient loads in receiving waters are primarily the result of a shift, over the past 60 years, towards specialised and intensive farming systems that import significantly more nutrients in feed and fertiliser than are output in produce. Changes in the distribution and management of 'waste' materials arising from intensification and specialisation of livestock production systems are also significant sources of diffuse pollution. Animal manures and slurries spread on arable and grassland are commonly regarded as a waste product, with commercial fertilisers applied without proper account of the nutrient content of manures. Current UK data (DEFRA, 2002) show around 67 M tonnes of animal manure are produced annually from housed livestock and a further 45 M tonnes of excreta is deposited directly by grazing cattle, sheep and pigs.

The management consequences of agricultural intensification, such as overstocking or overgrazing of land and frequent tillage operations with heavy machinery, can lead to soil compaction and exposure of vulnerable soils. Stock grazing on the banks of watercourses may also cause erosion of riverbanks. These factors combined with removal of landscape features such as hedges have increased vulnerability to soil erosion leading to much higher loads of soil particles entering receiving waters.

Although individual sources of diffuse agricultural pollution may be small; they may act cumulatively to constitute significant loadings at a catchment level.

## 1.3 Ecological effects of diffuse pollution

In catchments dominated by agriculture, nutrients and soil may enter aquatic systems in sufficient quantities to disrupt the normal functioning of the aquatic ecosystem. Artificially elevated loads of nutrients and silt can affect a wide variety of aquatic systems, including rivers, lakes, ditch systems, fens, wet grasslands and estuarine/coastal habitats.

An excessive supply of nutrients interferes with the delicate balance between aquatic plant species, favouring a smaller number of vigorous species more able to take advantage of increased nutrient levels resulting in reduced species diversity. In freshwaters, submerged flowering plants are lost and systems become dominated by algae. This can affect a range of animal species, dependent on submerged plants for shelter, food and reproduction. Excessive growths of algae in and on bed sediments can also radically alter sediment conditions, affecting a range of species dependent on the sediment for all or part of their life cycle.

The two main nutrients limiting plant growth are phosphorous and nitrogen. In freshwaters, phosphorus is of greatest concern, as it is generally in short supply relative to nitrogen, whereas the reverse is true in coastal systems. However, there are situations in freshwater systems, for example, fens and wet grasslands, where nitrogen is of particular concern. Likewise in coastal systems where, for example blue-green algae need to be controlled (these algae fix nitrogen from nitrogen gas in solution) phosphorus is likely to be the key management target.

Diffuse agricultural loads of phosphorus are heavily associated with run-off during rainfall and so tend to peak during the winter months. Much of the phosphorus load is in particulate form, the majority of which is not immediately biologically available to plants. This contrasts with point source loads, which are generally more immediately bioavailable and are delivered relatively evenly throughout the year, including the summer period of minimum effluent dilution and maximum plant growth.

The ecological significance of much of the diffuse agricultural nutrient load depends on the extent to which the winter load is retained in receiving waters (by sediment deposition) and is made available in subsequent growing seasons. Retention is high in lakes, sluggish rivers, estuaries and coastal waters, and in seasonally flooded wetlands (in comparison with retention of point source loads). High-energy rivers high in the stream order retain less of the diffuse agricultural load, although siltation problems are possible on any river so that diffuse agricultural sources are never irrelevant.

Diffuse agricultural loads of nitrogen are strongly associated with the autumn period, but since they are in a readily soluble form (nitrate) they are lost predominantly through leaching

into groundwaters. Contaminated groundwaters feed rivers, lakes, fens and coastal waters throughout the year and so the majority of the annual load is very ecologically significant. In situations where soils have been heavily overloaded with P for many years, P can also leach from soils and percolate into groundwaters, greatly increasing the significance of agricultural loads

In addition to carrying large loads of phosphorus, artificially elevated loads of fine particulates (silt) have a major physical effect on aquatic systems, increasing turbidity and smothering river and lake sediments. Increased turbidity reduces light levels in lakes and lead to the loss of rooted submerged plants, as well as impairing the vision of many animals relying on sight for catching prey or avoiding predators. The small size of particles blocks the interstices of coarse sediments in rivers and lakes and prevents proper aeration, which has major consequences for certain rooted plant species and a range of animals with life stages that are dependent on sediments with low levels of silt. In rivers, salmonid fish, which bury their eggs in gravels, are the most prominent animals suffering from siltation problems, but a range of fish and invertebrates and also plants such as water-crowfoot species are affected. In lakes, heavy loads of silt have been implicated in declines of submerged plant communities, by creating an unstable and heavily anoxic rooting medium.

Upland rivers have higher energy and can transport larger quantities of silt than lowland rivers, which tend to naturally deposit considerable quantities of fine sediment. Although this may suggest that high-energy rivers are more resilient to siltation problems than sluggish rivers and still waters, the majority of silt is deposited as river flows recede following rainfall. Thus siltation is also related to the capacity of the river to keep silt in suspension under baseflow conditions. This means that all rivers are at risk from enhanced loads of sediments irrespective of their peak energy levels.

The scale of diffuse agricultural pollution in the UK is such that a large number of water-dependent sites designated for nature conservation in England are at risk from diffuse agricultural loads of nutrients, silt, ammonia and BOD. Many wetland sites included in the national network of Sites of Special Scientific Interest (SSSI), the European network of Natura 2000 sites (comprising Special Areas of Conservation, SAC, and Special Protection Areas, SPA), and other site series such as those designated under the RAMSAR Convention on international wetlands are considered to be impacted by, or at risk from diffuse agricultural pollution.

## 1.4 Tackling diffuse agricultural pollution

Over recent years point-source pollution has been the target of successful, progressive regulation, most recently through the water industry's Asset Management Programme (AMP). As point source pollution has a single outflow it is relatively easy to address through the use of targeted technical solutions and to regulate through issuing of discharge licences. As diffuse pollution occurs over a large area and variable timescales, its sources are often difficult to pinpoint making regulation more difficult.

Until recently, diffuse pollution was viewed largely in terms of its 'nuisance' impact on the quality of freshwaters (loss of conservation value, declining fish stocks, increased water treatment costs). With the exception of the possible links between elevated nitrate concentrations and 'blue-baby syndrome' and stomach cancer, issues of human health and eutrophication were limited (Heathwaite *et al.*, 1996). Recent outbreaks of *Pfiesteria piscidia*

in eastern U.S. and associated human neurological damage have radically changed our perception of the health risks associated with enhanced nutrient concentrations in surface waters. In the U.S. at least, both public and political concern is now focused on P, and manure management in particular, and the requirement for nutrient planning on farms is being legally enforced.

The acceleration of eutrophication due to diffuse nutrient inputs in receiving waters in recent years has resulted in widespread socio-economic impacts on fisheries, tourism and water treatment costs. In parts of the U.S. (e.g. New York State) it is now cheaper to treat the cause of eutrophication rather than its effects, and whole catchment areas are being purchased with this objective in mind. Thus the focus of diffuse pollution remediation has shifted from treating water to managing catchment land use and nutrient inputs.

A range of EU and UK statutory and non-statutory drivers require action to control diffuse agricultural pollution including:

- the EU Habitats Directive, which requires achievement of favourable conservation status for Special Areas of Conservation (SAC);
- the UK government's public service targets for sustainable development, including key 'quality of life' indicators (particularly the achievement of favourable condition on 95% of Sites of Special Scientific Interest by 2010, and 91% of rivers meeting River Quality Objectives, (RQOs) by 2005);
- the UK Biodiversity Action Plan, which requires actions to reverse the decline and restore populations and extent of key species and habitats, mainly by 2010;
- the EU Water Framework Directive, which requires good ecological status for freshwaters by 2015.

To address diffuse agricultural pollution issues at designated sites throughout England it will be necessary to establish a countrywide initiative to reduce loadings of pollutants of concern across all farms. The most vulnerable and sensitive sites will also require a targeted, catchment-based approach. A two-tier grant aid package has been proposed (Dwyer *et al*, 2002), comprising a Basic Plan to help address diffuse pollution risks throughout the countryside, and a Plan Plus package covering the catchments of priority water-dependent sites. This thinking is currently being taken forward in a further phase of R&D.

ECUS have been commissioned by English Nature to prioritise designated water-dependent sites in terms of the level of risk posed by agricultural pollution in order that appropriate sites for targeted action (based on the 'Plan Plus' proposals) can be selected. This document comprises the findings of this prioritisation process. In addition to informing the site selection process for targeted action it is hoped that the results of the study will also serve as an important information source on the nature and magnitude of diffuse agricultural pollution impacts/risks at priority sites.

# 2. Prioritising sites at risk from diffuse agricultural pollution

The collation and evaluation of evidence and subsequent prioritisation of sites at risk of diffuse agricultural pollution was progressed as distinct phases of work comprising:

- *Screening process*, comprising identification and rough prioritisation of sites based on information and scores obtained through consultation with English Nature local teams. Compilation of a Stage 1 list including all sites highlighted as 'of concern'.
- *Site specific assessment*, comprising collation and appraisal of relevant data on 105 higher priority sites and development of scoring system to help refine relative priorities of sites within this group.
- *Compilation of case studies* for 15 sites where action to tackle diffuse pollution is considered to be appropriate and sufficient information was available to enable case studies to be prepared.

These stages are discussed in detail in the following sections. An overview of the prioritisation process is illustrates in Figure 1.

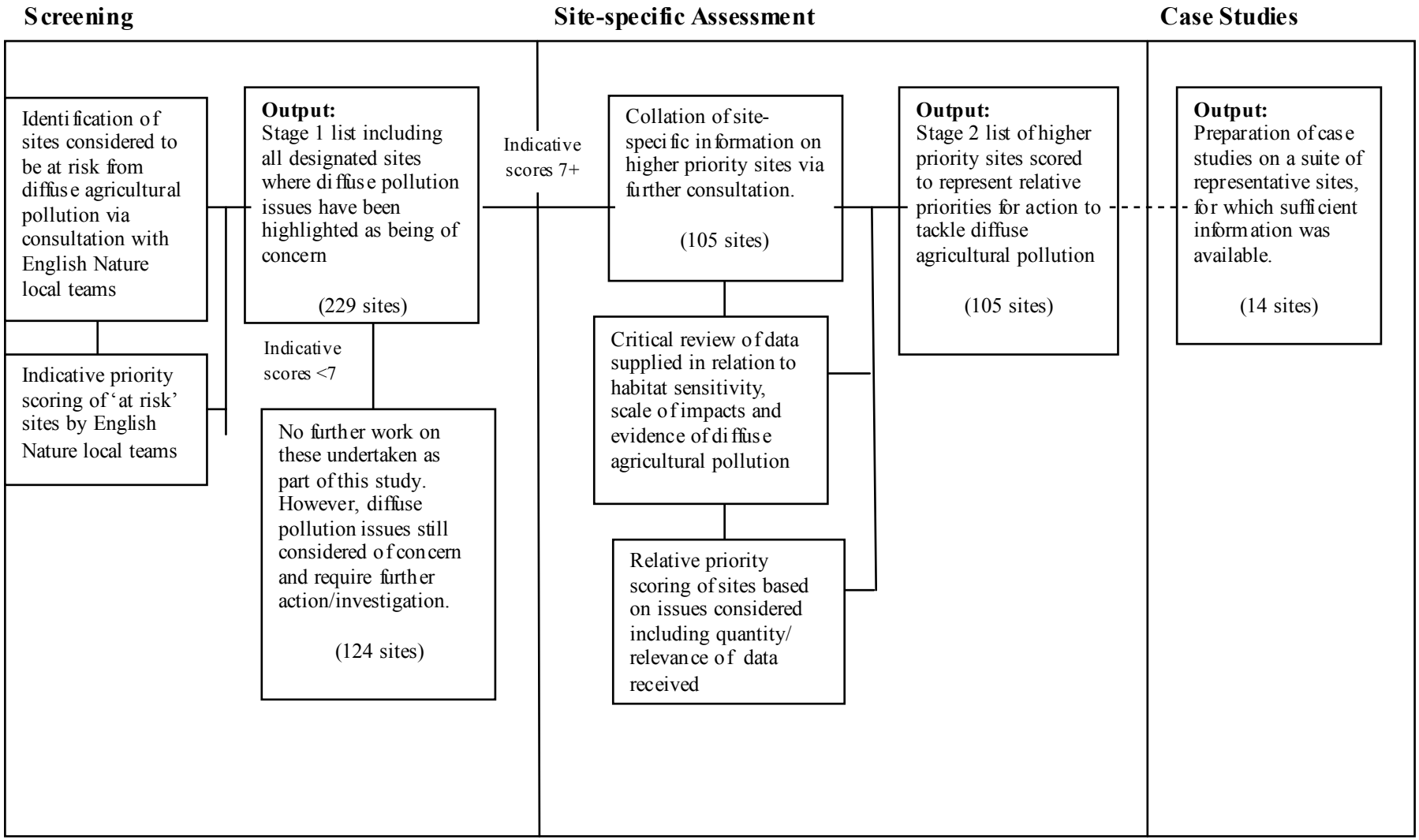


**Figure 1. Overview of the prioritisation process**

# 3. Screening process

A screening exercise was undertaken to identify nationally and internationally designated sites considered to be impacted by and/or at risk from diffuse agricultural pollution. Information was obtained on relevant sites through a preliminary questionnaire, which was emailed to the Freshwater Contact for each of the English Nature local teams on 1 October 2002. The Freshwater Contact was asked to supply details on all sites of concern in their area, and give further information on the 5 sites considered to have the highest priority or cause for concern in respect of diffuse agricultural pollution.

The questionnaire requested the following information:

- site name, statutory nature conservation designation(s) and British national grid reference;
- site specific interest features considered to be impacted by or 'at risk' from diffuse agricultural pollution;
- perceived magnitude of issues relating to water quality parameters commonly associated with diffuse agricultural pollution. Parameters considered were nitrates, phosphate, siltation, BOD, ammonia and other issues highlighted by individual teams. The perceived importance of each parameter was scored on a scale 1 to 10, where 1 represented low perceived importance and 10 represented very high perceived importance);
- the relative priority of the site for action to tackle diffuse agricultural pollution within the local team (scored on a scale of 1-10, sites scoring 10 being considered the highest priority);
- the reasons for concern, and
- any current or proposed actions to tackle diffuse agricultural pollution issues at the site.

The completed questionnaires received from English Nature teams originally highlighted a total of 215 sites as being impacted by or at risk from diffuse agricultural pollution. However, following continuing consultation with English Nature project managers and local teams, 14 additional mire sites in Cumbria were highlighted. These sites were not added to the list until June 2003 and consequently there is limited information regarding these sites in the project due to timescale limitations.

Therefore, during the course of this project a total of 229 nationally and internationally designated sites have been identified as being at risk from or impacted by diffuse agricultural pollution (Appendix 1).

The sites were sorted on the basis of the indicative priority scores assigned by local teams Two site groups were created comprising high scoring sites (7 and above, 91 sites) and lower scoring sites (6 and below, 110 sites). A third group consisted of those sites for which local teams had not allocated a priority score (10 sites).

Due to the arbitrary nature of the indicative scoring system some revision of the high and low scoring groups was required. This was undertaken in consultation with English Nature

project managers and included the addition of Cumbrian mire sites and the reassignment of a number of lower scoring or unscored sites to the higher scoring group.

Following revisions 105 of the 229 sites at risk from diffuse agricultural pollution were included within the higher priority scoring group. These higher priority sites represent a suite of statutory designated nature conservation sites which, on the basis of English Nature priority scorings and initial consultation are considered to be the most sensitive and most at risk from diffuse agricultural pollution.

These sites represent a cross-section of wetland habitats throughout England and include the following habitat types:

- river;
- lake;
- estuary;
- coastal;
- saltmarsh
- open water;
- ditch;
- alkaline fen;
- other fen;
- bog;
- basin mire;
- valley mire;
- wet grassland;
- flood meadows;
- grazing marsh, and
- wet woodland

Further assessment and action is considered to be required in relation to diffuse agricultural pollution on these sites, which were progressed for site-specific assessment (Section 5).

The remaining 124 sites were assigned to a secondary list of sites considered to be of lower priority for action to tackle diffuse agricultural pollution. It should be recognised that this does not necessarily mean that these sites are at low risk, as their inclusion in the initial responses from English Nature local teams is indicative of some degree of recognised risk. In many cases, pollution impacts are not known or have not been assessed but sites are sensitive and subject to drainage from surrounding agricultural catchments with high levels of nutrient inputs and/or a high potential for diffuse export of pollutants, including N, P and sediment loading. To this extent almost all potentially sensitive, water dependent habitats in the UK are at some degree of risk from diffuse agricultural pollution. Where possible all sites highlighted as part of this study including the lower priority sites, should be considered priorities for action to tackle diffuse agricultural pollution impacts.

The complete list of sites, the Stage 1 list, including lower and higher priority groupings is included as Appendix 1 along with the original questionnaire responses.

# 4. Site-specific assessment

Once lower and higher priority groups had been finalised, site-specific assessment of the 105 designated wetland sites identified as higher priority during the screening process was undertaken. This assessment refined the prioritisation of sites within the group, based on the evidence available in relation to diffuse agricultural pollution and its observed ecological impacts at each site.

## 4.1 Data acquisition

The first stage of this process comprised the collation and appraisal of existing information on the 105 sites identified as highest priority during the Stage 1 prioritisation process. Further information on each site was requested from the relevant Freshwater Contact for English Nature local teams. Contacts were requested to provide evidence that the site is either impacted by or at high risk from diffuse agricultural sources of pollution in the form of nutrients, silt, ammonia and/or BOD. Evidence could include:

- research/monitoring data;
- review documents;
- site specific studies/impact assessments;
- catchment studies;
- catchment nutrient modelling;
- site characterisation for review of consents under the Habitats Directive;
- fluvial audit;
- river geomorphological survey;
- ecological monitoring capable of informing assessment of diffuse agricultural pollution, and
- evidence of ecological impacts on specified interest features.

Information on each site was received from English Nature local teams and subsequently from other sources such as local EA representatives. The quantity of data received and the relevance of information to this study varied considerably between sites, reflecting differences in the number and detail of studies undertaken. In general more information was available for larger, internationally designated and/or high profile sites, which have tended historically to attract more funding. Information received for each site is included on a site-by-site basis as Appendix 2.

Data supplied for each site was reviewed and summarised. The results of data review are presented as tabulated summaries (Section 6, Table 4) detailing:

- site name and nature conservation designation(s),
- county,
- NGR,
- habitat type and
- the features of the site most at risk from diffuse pollution.

Where information was provided, the tabulated summary also provides comprehensive details on:

- evidence of pollution impacts,
- evidence of diffuse agricultural pollution and
- current or proposed action for the site.

## 4.2 Relative priority scoring

The key issues considered in assessing the sites in terms of their relative priorities for action to address diffuse agricultural pollution issues were:

- *Habitat sensitivity*: the sensitivity of the site to diffuse agricultural pollution;
- *Evidence of ecological impacts*: the extent to which the ecological interest features of the site are affected by pollution influences such as high nutrient loadings, siltation ammonia and BOD;
- *Evidence of diffuse agricultural pollution*: the level to which observed impacts to ecological features are considered to be due to diffuse agricultural pollution, and
- *Confidence rating*: the level of confidence with which assessments could be made.

Issues were addressed on a site-by-site basis through the development of a scoring system to identify the most sensitive sites suffering the greatest ecological effects where diffuse pollution was considered to contribute substantially to the overall problem.

### 4.2.1 Habitat sensitivity

Different habitat types and species exhibit differing sensitivities to diffuse agricultural pollution. The level of impact that agricultural inputs of pollution may have at individual sites is influenced by parameters such as natural trophic state, soils and underlying geology and hydrological regime. For example, small inputs of nutrients may have a greater impact on the ecological interest features of an oligotrophic mire site, such as Moorthwaite Moss (where the habitats and communities present are associated with extremely low nutrient conditions and have low flow through of water), than the same inputs of nutrients at a lowland clay river site such as the River Blythe.

Naturally eutrophic systems such as the Cheshire Meres may also be particularly sensitive to nutrient enrichment as their buffering capacity may be reduced. As such relatively small inputs of nutrients may cause a switch from eutrophic to hyper-eutrophic conditions, which may impact on the characteristic communities of such sites.

Habitat sensitivity was evaluated through consideration of the vulnerability of the site to diffuse agricultural pollution in terms of its ecological interest features, hydrology; and the level of protection afforded to the site and the species it supports under nature conservation law. Each site was scored on a scale of 1-10 for habitat sensitivity/vulnerability based on hydrology and/or sensitivity of designated features as shown in Table 1 below:

**Table 1: Habitat sensitivity/vulnerability**

| Score | Example |
|---|---|
| 10 | Enclosed surface fed wetland sites with little or slow through flow of water. Naturally oligotrophic systems dominated by/designated for species associated with very low levels of nutrients e.g. standing waters and oligotrophic mires. Score allocated reflects perceived ecological value including position in geographical unit, species diversity and level of designation. |
| 9 | |
| 8 | Sites supporting taxa known to be highly sensitive to nutrient enrichment or siltation e.g. salmon spawning sites. Score allocated reflects perceived ecological value including position in geographical unit, species diversity and level of designation. |
| 7 | |
| 6 | Naturally mesotrophic sites supporting taxa less sensitive to nutrient enrichment or siltation e.g. lowland clay rivers. Score allocated reflects perceived ecological value including position in geographical unit, species diversity and level of designation etc. |
| 5 | |
| 4 | Naturally eutrophic systems, sites with a rapid exchange of water and/or sites with designated features which are relatively tolerant of nutrient enrichment/siltation, such as unenclosed coastal sites; reedbed and waterfowl. |
| 3 | |
| 2 | Sites considered least sensitive of those studied for this review. Predominantly terrestrial sites e.g. wet grassland. Score allocated reflects perceived ecological value including position in geographical unit, species diversity, level of designation etc. |
| 1 | |

### 4.2.2 Evidence of ecological impacts

The second key issue in assessing the higher priority sites was the extent to which the ecological interests of the site are currently affected by pollution. Information supplied by English Nature local teams was examined for evidence of environmental change perceived to be related to nutrient enrichment, siltation ammonia and/or BOD. Evidence of ecological impacts could be either objective or subjective and included:

- Routine water quality monitoring data showing elevated levels of nutrients, ammonia, BOD or suspended solids.
- Habitat and/or macrophyte survey information showing evidence of community changes towards community types associated with high nutrient levels such as increase in ruderal species or excessive growth of algae
- Survey information showing loss or decline of communities or populations of species known to be sensitive to nutrient enrichment
- Fisheries studies showing loss or decline of salmon spawning activity thought to be related to siltation of gravel spawning beds
- Field observations indicating potential pollution issues such as excessive algal growth, high turbidity or increased growth of ruderal species.

Each site was scored on a scale of 1-5 based on the perceived level of impacts of pollution on the ecological interests of the site. Scoring criteria are given in Table 2 below.

**Table 2: Evidence of pollution impact**

| Score | Criteria |
|---|---|
| 5 | Site/designated features very severely impacted due to pollution. Full recovery considered unlikely to be achievable |
| 4 | Site/designated features severely impacted due to impacts caused by pollution. Immediate and substantial management needed |
| 3 | Site/designated features are significantly impacted by pollution. No improvement predicted without appropriate management. |
| 2 | Site/designated features are significantly impacted by pollution, but the situation is currently thought to have stabilised or be improving |
| 1 | No evidence of impacts associated with nutrient enrichment/siltation, However, site is considered 'at risk' of agricultural pollution. |

### 4.2.3 Evidence of diffuse agricultural pollution

For many sites the review of data revealed clear evidence of ecological impacts likely to be associated with pollution. However, in general the extent to which pollution impacts could be attributed to diffuse agricultural pollution relative to other sources was much less clear. Ideally there should be a clear indication that sites selected for action to tackle diffuse agricultural pollution are those where such action is likely to result in significantly reduced pollution loads.

In view of the importance of this issue, sites were scored to reflect the extent to which impacts are thought to be due to diffuse agricultural pollution rather than point sources (including but not limited to STW effluents) on a 10 point scale. A score of 10 represents sites where the only known source of pollution is diffuse agricultural pollution, and 1 represents sites where point sources such as STW are thought to be almost wholly responsible for the perceived ecological effects.

It should be appreciated that sites scoring highly in this category do not necessarily represent those most severely impacted by pollution generally, or those where some form of action is most urgently required. Rather they represent sites where specific action to tackle diffuse agricultural pollution is considered to be most appropriate on the basis of available evidence.

Where sites had been scored highly for problems related to diffuse pollution in the original questionnaire returned by English Nature teams but no additional information was supplied, these sites were given a nominal score of 5 and a low confidence level (see below).

### 4.2.4 Total site scores

For each site the individual scores assigned for habitat sensitivity, evidence of ecological impacts and evidence of diffuse agricultural pollution were summed to give a 'total priority score' of between 7 and 21 for each site. Broadly speaking sites with higher total priority

scores represent those where action to tackle diffuse agricultural pollution is most urgently required and is considered most likely to result in positive environmental change.

### 4.2.5 Confidence rating

The extent to which judgements on the relative priority of individual sites could be made was influenced by the level and quantity of data received, which varied substantially between sites. This meant that the relative priorities of some sites may be either higher or lower than indicated by both the individual and total scores. This was addressed through assigning a confidence rating to each site as an indication of the extent to which the conclusions of data review are considered to reflect accurately the magnitude of ecological risk associated with diffuse agricultural pollution at each site. When considering individual sites included on the higher priority list consideration should be given not only to the individual and total priority scores, but also to the level of confidence.

Levels of confidence were assigned on a simple scale of low, medium and high. Sites with a high confidence level represent those where judgements have been made based on substantial information, often in the form of studies specifically designed to identify and quantify sources of pollution and relate these sources to ecological effects. The assignation of confidence levels has the potential to highlight sites where diffuse pollution may be a major issue, but more information is required. This should ensure that potentially sensitive and/or impacted sites are not excluded from future consideration.

# 5. Priority sites

The 105 higher priority sites, including results of data consultation and scores are presented in Table 3.

For ease of interpretation sites within this group have been sub-divided based on total scores into relative priority groupings. This enables areas and catchments where diffuse pollution is of most concern to be clearly highlighted as shown in Figure 2 (which also shows the location of all other sites of concern as listed in Appendix 1). The sites included in each group are shown in Table 4.

The map shows that on the basis of the scores allocated, many of the highest priority sites are concentrated around the North of England, in particular Cumbria and County Durham, as well as East Anglia and Central Southern England. The River Wye catchment on the Welsh Borders scores highly on the basis of total site score.

Within the group of highest scoring sites there are differing reasons for concern. For example many of the sites in Cumbria and County Durham represent naturally oligotrophic systems considered very highly sensitive to diffuse agricultural pollution. These sites score most highly in the habitat sensitivity criteria, and thus are considered to represent priority sites even where minor ecological effects of pollution are recorded or other sources of pollution are present. Conversely the designated interest features of sites such as Lindisfarne NNR are considered less sensitive to nutrient enrichment (habitat sensitivity score), but are considered to be severely impacted by pollution, of which the predominant source is considered to be diffuse agricultural pollution.

It should be emphasised that judgements on the relative priorities of sites for action to tackle diffuse pollution should not be made on the basis of total site scores alone. The individual scores, particularly for the evidence of agricultural pollution are also of key concern as a site may be highly sensitive and severely impacted by pollution, most of which originates from point sources and still score relatively highly.

It should also be appreciated when considering the scored sites that the variation in the data supplied for individual sites may mean that some sites have been over or under prioritised relative to other sites on the list. For this reason it is advisable to be guided by the level of confidence assigned to a particular site. This is particularly important when considering prioritisation on the basis of total site scores as a 'catch-all' score of 5 has been applied for 'evidence of diffuse agricultural pollution' where no information was supplied. For this reason it is recommended that total scores for sites with 'diffuse agricultural pollution' scores of 5, and a low confidence ratings be treated as highly provisional.

Some degree of critical appraisal is required, particularly in respect of scores for evidence of diffuse agricultural pollution and confidence levels when considering relative priorities of sites. The implications of scores for these criteria can be represented as a matrix, as shown in Table 5.

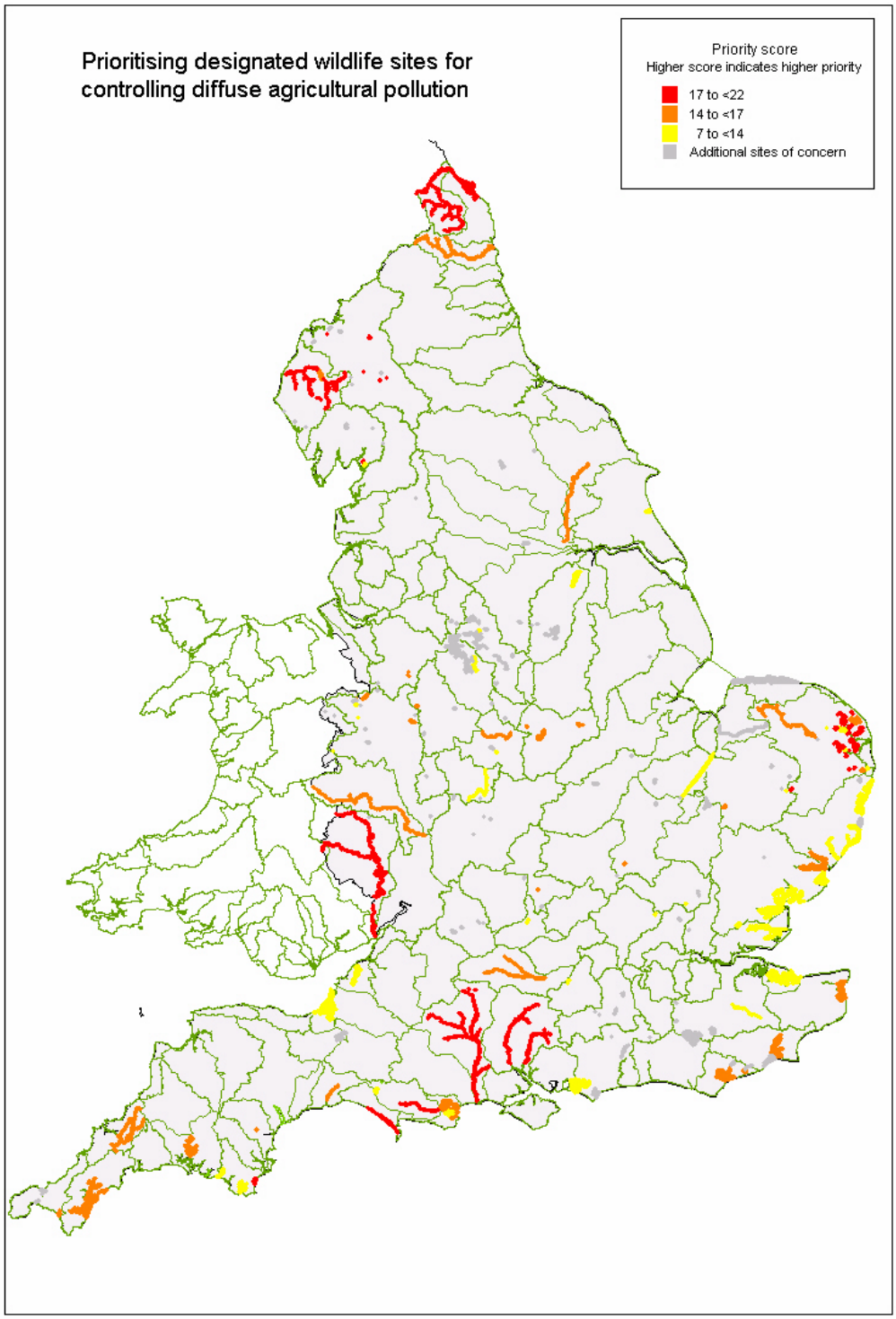


**Figure 2: Catchment-level distribution of sites at risk from diffuse agricultural pollution in England.**

'Lower priority sites' are those highlighted during initial consultation but not progressed for further study at this stage. Sites in this category are included in Appendix 1.

## Table 3. Higher priority sites

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Abberton Reservoir SSSI SPA | Essex | TL 970180 | Reservoir | Migrant wildfowl | Little information supplied.<br><br>Designated SA(E).<br><br>Excessive weed growth (fennel-leaved pondweed) and algal blooms reported | Uncertain.<br><br>River Stour is primary P source for reservoir and STW is primary source for River Stour. However, catchment is largely agricultural. | AMP 4 investigation | 4 | 3 | 4 | low | **11** |
| Alde-Ore Estuary SSSI<br><br>Alde-Ore and Butley Estuaries c SAC<br>Alde-Ore Estuary SPA and Ramsar site | Suffolk | TM 394 575 to TM 358 402 | Estuary | Tidal rivers, estuaries, mud flats, sand flats, lagoons (including saltwork basins), salt marshes, salt pastures, salt steppes, shingle, sea cliffs, islets, waterfowl and wading birds | Estuary is hypernutrified (Elliot *et al* 1994). River becomes anoxic leading to fish kills. Bird interest threatened through decline in invertebrate prey caused by excessive algal growth/mat formation. | The estuary catchment is largely arable cereal agriculture and forest and only has one STW input (Elliot *et al* 1993). Inputs from freshwater sewage analysed and considered small, N:P ratios were high but no well developed signs of eutrophication were observed. Levels of soluble reactive P and dissolved inorganic N showed increases in winter values indicating inputs from land runoff through freshwater catchments.<br><br>Modelling of data indicated possible entrainment from the larger nutrient rich estuaries of the Thames, Humber and Wash. | None specified during the course of this project | 4 | 3 | 5 | medium | **12** |
| Aqualate Mere SSSI, NNR | Staffordshire | SJ770205 | Lake | Open water, reedswamp, fen meadow, carr, acidic marshy grassland. | Lake considered to be highly eutrophic and subject to siltation - resulting in marked shallowing over last 60 years.<br><br>Submerged macrophytes sparse since 1960s. Major fish kills have been reported resulting from slurry pollution incidents. Orthophosphate levels in lake very high (385 ug/l). Organic-N also high (3.9mg/l). High levels of N and P also recorded in feeder streams (Carvalho & Moss 1998, and ECUS 2001). | Site is situated in large agricultural catchment. High P levels in feeder streams considered to derive from Shropshire Union Canal, STW at Norbury and stock wastes from farmsteads. High N levels in feeder streams suggest arable run-off.<br><br>Heavy fish-stocking - including bottom-feeding carp - likely to be causing high turbidity (with consequent impacts to submerged macrophytes) and mobilisation of sediment P. High fish predation on zooplankton may also favour algal growth.<br><br>Sediment analysis in winter 2002-3 indicated high levels of P probably derived largely from agricultural sediment run-off (ECUS 2003). | Proposed silt removal under CMF | 6 | 3 | 5 | medium | **14** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Barnby Broad SSSI<br><br>Broads cSAC Broadland SPA & Ramsar | Suffolk | TM480 910 | Open water | Open water, carr woodland, fen, grazing ditch and marsh systems and associated flora and fauna | Diffuse agricultural pollution in the form of silt and nutrient inputs considered an issue. Nutrient problems judged likely to continue (Hundred drain and landspring). Observational evidence of fish kills in Barnby Broad and discolouration due to sediment.<br><br>High land drains flow across marshes to IDB pump. Water often silty believed to be carrying significant nutrient loading into the ditch system when it overtops the banks. Barnby Broad has suffered from silt deposition and is part of a project to investigate desilting the Suffolk Broads. The silt seemed to be feeding down the Rail Track ditches and into the Broad. | No directly attributable data available/provided within the timescale of this study. Further data may be available for future studies. | Discussions with EA and Rail Track over clearance of the Hundred Drain and the ditches alongside the railway track. | 6 | 3 | 5 | low | **14** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Bassenthwaite Lake SSSI<br><br>River Derwent & Bassenthwaite Lake cSAC | Cumbria | NY 214297 | Lake | Large Mesotrophic Lake, vendace, floating water plantain, | Occasional algal blooms, de-oxygenation of deeper waters and deposition of re-suspended sediment are a significant threat to vendace population. Sedimentation rates very high, threatening vendace spawning areas.<br><br>Little evidence of significant change in aquatic macrophyte assemblage of the lake (Bennion *et al* 1997, 2000) but diatom assemblage suggests increased eutrophication. Hall *et al* (2000) considered establishment of macrophytes impaired by eutrophication and sediment load.<br><br>Eutrophication may be resulting in increased deposition of organic material.<br><br>Cyanobacteria blooms and extensive blanketweed algae Cladophera sp. have been observed in sheltered bays. | Significant amount of research at Bassenthwaite, major findings are:<br><br>P loading increased since 1970's & siltation problem sustained by inorganic material derived from catchment (Bennion *et al* 1997 , Morrison 1997).<br><br>Land use changes between 1972 and 1988 are thought to have resulted in an increase in TP loading from diffuse sources (May *et al* 1995; Bennion *et al* 1997).<br><br>Geochemical analysis of sediments shows marked increases in P, especially since 1970 - largely due to P-output from Keswick STW but increases since 1900 also suggest significant diffuse inputs (Parker *et al* 1999).<br><br>Visual evidence of overgrazing and flood defence works.<br><br>41% (6.8t TP y-1) of TP load estimated to derive from STW, 39% from agricultural runoff (6.5t TP y-1), 14% from leaking septic tanks (May *et al*, 1996).<br><br>P-stripping at STWs has reduced the TP load to the lake by about 26%. Main sources of TP entering the lake are now thought to be from agricultural diffuse sources (52%), STWs (21%) and septic tanks (18%). | Considerable research effort continues into the sediment and nutrient dynamics of Bassenthwaite Lake and other Cumbrian Lakes. This is mostly being conducted by the Centre for Ecology and Hydrology (CEH), under the auspices of a sub-group of the Lake District Still Waters Partnership. This work has included proposals for restoration or remediation of P and sediment impacts upon the lake.<br><br>Site included in Environment Agency NUPHAR Project. | 7 | 4 | 5 | high | **16** |
| Benacre to Easton Bavents SSSI (incl. Benacre Broad NNR)<br><br>Benacre to Easton Bavents Lagoons cSAC Benacre to Easton Bavents SPA | Suffolk | TM 537 855, TM 512 722 | | Swamp, marginal and inundation and standing water habitats supporting internationally important populations of breeding birds<br><br>Saline lagoons and associated invertebrate fauna | Pig slurry flowing into the site under storm conditions. Also believed to be feeding into ground water and thus into the sites.<br><br>Algal blooms on Covehithe Broad | Pig slurry is classified as diffuse but there are known specific sources of nutrients as well. A survey of selected lagoons undertaken in 1998 noted a decline in species diversity in some sites. This was however attributed to altering salinity levels. No direct evidence supplied/available within the timescale of this study. | Education of local pig farmers. EA have an existing sampling point for WQ. Also in process of putting in a new monitoring system for Review of Consents work that considers both flows and pollution | 5 | 2 | 5 | low | **12** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Betley Mere SSSI | Staffordshire | SJ747482 | Lake | Open water, submerged macrophytes, reedswamp, fen (basin mire), carr | Shallow lake, apparently becoming more eutrophic. Ongoing issues with high sediment levels despite presence of silt traps.<br><br>High P and N recorded in inflows - especially in summer when dilution is less. High P in mere (TP = 506ug/l) thought to be derived from inflows, not from internal sediment release. High inflows of N are lost in summer to algal uptake and reedswamp. Algal community typical of heavily eutrophicated lakes.<br><br>No obvious decline in submerged macrophyte flora but under clear threat. (Moss *et al* 1992; Carvalho & Moss 1998, and ECUS 2001)<br><br>Mere is considered hyper-eutrophic and threatened (EA 1997) | Site is situated in intensive agricultural catchment with increased stocking levels since 1930s.<br><br>High nutrient and silt loading considered to arise from combination of stock wastes, run-off from manured pasture and arable land.<br><br>No clear studies to quantify diffuse pollution contributions but diffuse sources seem likely to provide a high proportion of nutrients in the system. Heavy fish-stocking - including bottom-feeding carp - likely to be causing high turbidity (with consequent impacts to submerged macrophytes) and mobilisation of sediment P. High fish predation on zooplankton may also favour algal growth. | Site included in EA's NUPHAR project | 6 | 3 | 6 | medium | **15** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Biglands Bog SSSI | Cumbria | NY 259537 | Mire | Tall fen, marshy grassland, open water, ombrotrophic bog. | Former diverse herbaceous communities supplanted by species poor *Phalaris* stands (e.g. Wheeler & Wells, 1989).<br><br>Biglands Bog receives water from Bampton Beck as overbank flow and from a small ditch to the north. These systems are eutrophic with a high silt load. The distribution of Phalaris marsh, fen meadow and acidic mire reflects the probable extent of flood water. Some eutrophic influences also apparent at the west end of the site (Wheeler, 1990). | Water quality data suggest open water and fen act as a nutrient sink (Gilman, 1989; Wheeler, 1990). Multiple sources of enrichment to the bog. Increased nutrient loading comes from changes in the catchment and the installation of a STW. Large catchment area of improved pasture/silage fields and fertiliser and slurry application are thought to be significant although no specific monitoring has taken place (Mawby, 1997).<br><br>Bampton Beck suffers significant seasonal component DO failures (summer/low flows) possibly caused by the following factors: discharges from Little Bampton STW, the effect of low oxygen conditions in Bampton Bog, a history of septic tank problems affecting tributary of Bampton Beck (probably minor).In addition, it is thought that there is a foot and mouth burial site in the locality (P Fairburn, Environment Agency, pers. comm.).<br><br>Eutrophic water entering from Bampton Beck is affected by high deposition of coarse sediments, which causes obstructions and increases chances of overbank flow. Sediment analysis suggests siltation is caused by soil erosion (Gilman, 1989). | AMP3 improvements to Little Bampton STW<br><br>On-going liaison with land owners and monitoring of the site. English Nature suggest that the site needs a Water Level Management Plan.<br><br>Reedbed filters and buffer strips should be considered to reduce nutrients coming on to the site.<br><br>The feasibility of installing a sediment trap should be investigated. | 8 | 4 | 6 | medium | **18** |
| Birches Barn Meadow SSSI | Warwickshire | SK282021 | Grassland | Alluvial grassland (MG4) | No direct evidence of impacts.<br><br>No studies available. | Surrounded by arable farmland.<br><br>Water supply partly derived from water table in flood plain gravels and flooding from adjacent R. Anker. Much of this water supply will be derived from inputs from adjacent agricultural land. However, the R. Anker also takes sewage outputs from Nuneaton – to be dealt with under AMP4.<br><br>No further information available in the timeframe of this study. | None specified during the course of this project | 1 | 1 | 5 | low | **7** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Black Firs & Cranberry Bog SSSI | Staffordshire | SJ748503 | Bog | Basin mire, dystrophic open water, alder carr | Site very vulnerable to increased nutrient levels.<br><br>Carvalho & Moss 1998, and ECUS 2001: High P recorded in Black Mere (orthophosphate up to 300 ug/l). High P also recorded in periphery drain which is considered to exert strong influence on trophic levels in the lake.<br><br>20% of adjacent acid bog considered to be eutrophicated with extensive cover of nettle and other eutrophic weeds. Black Mere may be hydrologically linked to the groundwater supply feeding Cranberry Bog. | The site is within an intensive agricultural catchment dominated by arable and improved pasture.<br><br>Point sources also considered a problem. There is a long history of pollution at site, sources including farm slurries and septic tank discharges from approximately 30 properties.<br><br>No studies have been undertaken to quantify diffuse pollution contributions. | None | 8 | 3 | 5 | medium | **16** |
| Blackbrook Reservoir SSSI | Leicestershire | SK458173 | Lake | Mesotrophic aquatic macrophytes<br><br>White clawed crayfish | Phosphate levels considered high for mesotrophic water body. Orthophosphate levels vary but include levels up to 0.13 mg/l and mean of 0.82mg/l between 1995-2000. Similarly, levels up to 0.14 mg/l and mean levels of 0.072 mg/l were recorded at the inlet between 1995-2000.<br><br>Slurry pollution noted during the foot and mouth crisis in 2001 (John Smith, Severn Trent Water pers comm). | No information available. | EA have adopted a policy of refusing consents for discharge to the inflow stream, including all private dwellings. | 6 | 3 | 5 | low | **14** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Blackwater Estuary SSSI, SPA | Essex | TL 940070 | Estuary | One of the largest estuary complexes in East Anglia. Mud flats surrounded by saltmash with shingle and shell banks and offshore islands. Associated ancient grazing marsh with fleet and ditch system. The mudflats contain *Zostera* beds and *Enteromorpha* mats that in winter are important feeding grounds for internationally important wildfowl populations. | Inorganic N input in class C-D category: very poor quality. Pollution indicators include reduced species diversity and algal mats. | No further applicable data received/available within the time scale of this study. Data may be available for future work. | EA to undertake SIMCAT modelling to include some interpretation of diffuse sources i.e. Point source vs diffuse for freshwater inputs. Analysis will also be undertaken to quantify diffuse inputs to the estuary. | 5 | 2 | 5 | low | **12** |
| Blo' Norton and Thelnetham Fen SSSI<br><br>Waveney and Little Ouse Valley Fens cSAC | Suffolk | TM 017 790 | Other Fens | Calcareous fens with *Cladium mariscus* and the species of the *Caricion davallianae*<br><br>*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) | River flows through the middle of the SSSI. It regularly floods the fen. This river regularly fails water chemistry and biological standards<br><br>Historically when the silt has been cleared it has been dumped into the fen rather than to agricultural land. Observational evidence by English Nature of proliferation of weed species and reduced flora in riparian corridor | Duck and Goose farming perceived as main nutrient source - Classified diffuse but known point sources exist. | Issue has been raised with EA.<br><br>EA have carried out Water Quality Analysis on river - frequent failure against standards | 5 | 3 | 5 | low | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Bradgate Park and Cropston Reservoir SSSI | Leicestershire | SK533107 | Lake | Mesotrophic aquatic macrophytes | Phosphate levels considered high for mesotrophic water body. Orthophosphate levels up to 0.14 mg/l and annual mean of 0.66mg/l in 1998 and 1999.<br><br>Algal counts in August 1996 up to c.230K.<br><br>Atrazine pollution noted a few years ago (J Smith, Severn Trent Water, pers comm). | Water quality assessment in Swithland and Cropston Reservoirs is complicated by the pumping of water from Swithland into Cropston. The biology suggests eutrophication is a problem but point discharges are not obvious, suggesting the possibility of diffuse sources.<br><br>ENEC report (2000) suggests transfer of water from nearby watercourses may be causing eutrophication in Cropston Reservoir. however, STWs occur (now disused) on some of these watercourses. | Floating reedbed installed in Swithland Reservoir to reduce the phosphate getting into Cropston. | 6 | 3 | 5 | low | **14** |
| Bridgwater Bay (Pawlett Hams) SSSI | Somerset | ST 278483 | Coastal Waters | Over-wintering wildfowl, fresh water invertebrates, aquatic plants | Unclear. Limited information available within the timescale of this review. Site is in River Parrett catchment which is known to have high nutrient levels. Ecological survey of Pawlett Hams, an enclosed ditch system with water pumped from Cannington Brook, which is reported to be eutrophic was undertaken in 2002 (Colombe, 2002). Aquatic plant communities were dominated by species tolerant of some degree of eutrophication such as *Lemna minor, Lemna trisulca* and *Ceratophyllum demersum* | Unknown. Nutrient budgeting for River Parrot is underway but has not yet been completed. Intensive farming occurs within the catchment | WES (S15) | 5 | 3 | 5 | low | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Buddon wood and Swithland Reservoir SSSI | Leicestershire | SK559145 | Lake | Mesotrophic aquatic macrophytes, including emergents.<br><br>Breeding and wintering birds. | P levels considered high for mesotrophic water body. Ortho-P levels up to 4.15 mg/l and annual mean of 1.14mg/l in 1999. Phosphate levels are higher than historic levels and are thought to be also affecting Cropston Reservoir SSSI.<br><br>Algal counts in July 1995 up to c.500K (1.5 million in Aug. 1991). | Water quality assessment in Swithland and Cropston Reservoirs is complicated by the pumping of water from Swithland into Cropston. The biology suggests eutrophication is a problem but point discharges are not obvious, suggesting the possibility of diffuse sources.<br><br>EMEC report (2000) suggests transfer of water from nearby watercourses may be causing eutrophication. However, STWs occur (now disused) on some of these watercourses. | Floating reedbed installed to reduce phosphate in both Swithland and Cropston Reservoirs. | 6 | 3 | 5 | low | **14** |
| Chesil and the Fleet SSSI, cSAC SPA, Ramsar | Dorset | SY496885 to SY683734 | Coastal Waters | Freshwater to brackish tidal lagoon containing: Eelgrass beds, Charophytes, other lagoonal aquatic plants, specialist lagoonal invertebrates and fish | Johnston and Gilliland (2000) state that features of nature conservation importance in the lagoon are considered vulnerable to impacts from high nutrient levels. The effects of nutrient loading are expressed through macro and micro- algal blooms and oxygen sags, compounded by poor flushing rates, shallow water, temperature fluctuations and high pH. Algal blooms in the Fleet in 1994 thought to be the result of diffuse pollution. Detailed site history collected by the Fleet Study Group . The site is designated a Polluted Water under Nitrates Directive - Fleet catchment a Nitrate Sensitive Zone. | Catchment landuse largely intensive agriculture, run-off from which is causing problems with siltation/nitrate loading. Recent report identified agricultural sources as most significant source of nitrates in winter and a significant source of phosphate both summer and winter. STW are also an issue as is the presence of a swannery.<br><br>An annual nutrient budget for Fleet (Mainstone & Parr, 1999) showed diffuse and agricultural sources a significant influence, with up to 84% of the annual load of N and 70% of P from agricultural inputs.<br><br>Johnston and Gilliland (2000) show that N and P peak in the winter due to agricultural run-off and several features of nature conservation importance are considered vulnerable to impacts from high nutrient levels. | Fleet & Wey catchment project – identifying opportunities to implement best management practises to reduce the effects of diffuse pollution.<br><br>Regular nutrient monitoring is undertaken. | 7 | 3 | 8 | high | **18** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Chichester Harbour SSSI<br><br>Chichester & Langstone Harbours SPA and Ramsar<br>Solent Maritime cSAC | Sussex | SU 760 000 | Coastal Waters | Estuaries, *Spartina* sward, Atlantic salt meadows, submerged/tidal sandbanks/ mudflats, coastal lagoons<br><br>Annual vegetation of drift lines, perennial vegetation of stony banks, *Salicornia* and other annuals colonising mud and sand<br><br>Desmoulin`s whorl snail (*Vertigo moulinsiana)* | Observed and measured pollution issues Chichester Harbour. High levels of N and P and high BOD.<br><br>Indirect effect upon birds via invertebrate food supply in the intertidal mud flats (SPA, SSSI feature) | Consultees differ in opinion but the balance of views seem to indicate that the main source of nutrient input is thought to be from STW and hence point source. This is the area where resources are currently being channelled. The site is currently considered at risk from diffuse pollution but has not yet been impacted. Some N2 is highly likely from surrounding agricultural land use and some pesticide drift and run-off have also caused concern. | AMP process<br><br>O/O liaison<br><br>Encourage ESA and/or CS uptake in catchment | 4 | 3 | 4 | medium | **11** |
| Chippenham Fen SSSI, NNR<br><br>Fenland cSAC | Suffolk | TL 648 697 | Other Fens | *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils<br><br>Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* | Winter flooding of North Meadows leads to blanket weed blooms. Botanical surveys in 2002 and 2003 have shown an increase in nutrient-rich plant communities | No directly attributable data available/provided within the timescale of this study. Further data may be available for future studies. | None | 6 | 3 | 5 | low | **14** |
| Clarepool Moss SSSI<br><br>West Midlands Mosses SAC<br>Midland Meres and Mosses RAMSAR | Shropshire | SJ433342 | Transition mires and quaking bogs (Basin Mire) Dystrophic lake | *Sphagnum* mire<br><br>Open water and peatland | Oligotrophic site vulnerable to nutrients surrounded by agricultural land - including arable and semi-improved grassland. | ENRR 252 - Nutrient Reconstruction in Standing Waters (Bennion *et al* 1997):<br><br>Phosphorus reconstruction suggests moderate or low levels of total-P.<br><br>Diatom-analysis of sediments inconclusive and no evidence of nutrient enrichment.<br><br>Bennion *et al* (1997) suggest no evidence of eutrophication.<br><br>No formal studies of nutrient loading from surrounding land. | Countryside Stewardship Agreements in catchment | 9 | 1 | 5 | low | **15** |
| Cliburn Moss SSSI | Cumbria | | Mire | | No information available for this study | | | 9 | 4 | 5 | low | **17** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Colne Estuary SSSI, SPA | Essex | TM 075155 | Estuary | Intertidal sand and mud, saltmarsh | Inorganic N input in class C-D category: very poor quality. Reduced species diversity, algal mats, etc.<br><br>Elliot *et al* 1994: the Colne saltmarshes have recently shown some signs of degradation. | The surrounding land use is predominantly arable.<br><br>Several STW discharge into the Colne estuary and can affect its quality. STW result in elevated SPR and ammonia levels. High nutrient levels are also input from freshwater sources<br><br>No specific attributable data was received/available within the timescales of this report. The inference from the data received was that STW alone did not fully explain the nutrient levels, and as such diffuse inputs may be influential. | None specified during the course of this project | 5 | 2 | 5 | low | **12** |
| Combe Haven SSSI | Sussex | TQ 770102 (tall fen communities are at TQ 777095 and TQ 778103) | Fen communities | Reed bed with open water<br><br>Ditch system | Observed signs of site degradation and algae blooms in ditches. | Most likely source agriculture as there are no SWT on the river indicating diffuse sources of nutrient enrichment (English Nature pers comm).<br><br>A fluvial audit has been undertaken for the river. This should contain details of the rivers geomorphological context and hence discuss sediment loading issues. This document was not available within the timescales of this study but may be useful for future projects. | O/O liaison<br><br>Encourage ESA and/or CS uptake in catchment<br><br>EA/English Nature discussing River Restoration Proposals | 6 | 3 | 7 | low | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Cop Mere SSSI | Staffordshire | SJ802297 | Lake | Open water, reedswamp, fen, carr, marshy grassland. | The mere is clearly eutrophicated by the nutrient-rich R. Sow (Moss *et al* 1992), from unknown sources but probably including excretal point-source(s).<br><br>High P in mere (TP = 315ug/l). High P and N recorded in inflows - both in the R. Sow and in two minor inflows. Retention time in the mere is short (3-4 weeks) but P and N levels remain constantly high fuelling substantial phytoplankton populations. High inflows of N are much reduced in summer by algal uptake and fringing swamps.<br><br>(Moss *et al* 1992; Carvalho & Moss 1998, and ECUS 2001) | Site is situated in large agricultural catchment with marked increase in stocking levels (cattle) since 1930s.<br><br>Major source of nutrients is likely to be River Sow. The river drains agricultural land but sources of nutrient enrichment likely to include excretal point-source(s). High P and N levels in inflows suggests diffuse pollution sources but also probably including STW source(s) (Moss *et al* 1992).<br><br>Low zooplankton populations probably indicate heavy fish predation - reducing control of algae populations by grazing zooplankton. | None | 6 | 3 | 5 | medium | **14** |
| Cothill Fen SSSI<br><br>Cothill Fen cSAC | Oxfordshire | SU456993 | Alkaline fen | Alkaline fen<br><br>Alder woodland | Anecdotal evidence of nutrient enrichment reported in wet woodland adjacent to intensively managed pasture alongside part of site. | No information available within the timescale of this study | None specified during the course of this project | 5 | 2 | 5 | low | **12** |
| Cressbrook Dale SSSI/NNR<br><br>Peak District Dales cSAC | Derbyshire | SK175750 | River | *Thamnobryum angustifolium* (Derbyshire feather moss) | Unclear as no chemical or biological data available. The effect of any changes in water quality on the unique moss species *T. angustifolium* is unknown. | Intensification of agricultural landuse (including paper pulp) in the catchment in recent years, although site is largely within NNR and as such adjacent landuse is subject to controls. No evidence of diffuse pollution from agriculture on basis of information supplied, however, little data available | EA monitoring | 7 | 1 | 1 | low | **9** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Crouch & Roach Estuaries SPA | Essex | TQ 870970 | Estuary | Tidal muds important feeding sites for internationally important populations of waders and wildfowl. Additional interest comes from the diverse invertebrate fauna and outstanding assemblage of nationally scarce plants. | Inorganic N input in class C-D category: very poor quality. Pollution indicators include reduced species diversity and algal mats. | No further data received/available within the time scale of this study. | None specified during the course of this project | 5 | 2 | 5 | low | **12** |
| Cumwhitton Moss SSSI | Cumbria | | Mire | | No information available for this study | | | 9 | 3 | 5 | low | **17** |
| Deben Estuary SSSI<br><br>Deben Estuary SPA and Ramsar | Suffolk | TM 295 504 to TM 330 378 | Estuary | Habitats for the populations of Annex 1 species and the regularly occurring migratory bird species (Avocet & Brent goose), of European importance, with particular reference to intertidal saltmarsh and mudflats. | Perceived damage to invertebrate populations by algal mat and blooms. Elliot *et al* 1994 undertook a nutrient study of the Estuary and found it hypernutrified. | The estuary catchment is largely arable cereal agriculture and forest. N and P loadings are from both estuarine STW and diffuse sources within the estuary catchment. Increased levels of TON are recorded during the winter months indicating increased runoff from land in the river catchments.<br><br>Conductivity readings indicate that in the winter the estuary is heavily freshwater influenced where as in the summer it is largely sea dominated.<br><br>STW point source discharges are from Melton and Bawdsey. Entrainment of nutrient rich plumes from the larger Thames, Humber and Wash estuaries may also be an issue.<br><br>Inputs from freshwater sewage were analysed and considered small, N:P ratios were high but no well developed signs of eutrophication were observed. Modelling of data indicated possible entrainment from the larger nutrient rich estuaries of the Thames, Humber and Wash. (Elliot *et al* 1994) | Issue has been raised with EA. | 4 | 3 | 5 | medium | **12** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Dove Valley and Biggin Dale SSSI (Biggin Dale is also NNR)<br><br>Peak District Dales cSAC | Derbyshire | SK157506 | River | Bullhead, brook lamprey, white-clawed crayfish | Unclear. River interest features susceptible to water quality pollution impacts although extent of impact is unknown.<br><br>Macroinvertebrate data collected as part of a study into declining fish stocks (Williams, 2002) found species intolerant of inorganic pollution e.g. stoneflies. | The River Dove catchment is a fairly intensive agricultural catchment. Point discharges known, but EA study of these suggests further diffuse inputs are having a significant impact. Main pollution sources seem to comprise point sewage and agricultural effluent discharges rather than diffuse sources.<br><br>Macroinvertebrate study considered that deposition of sediments with elevated metal loads more likely to impact fish populations than nutrient enrichment. There is also a history of sporadic pollution events, particularly sheep dip pollution. | EA and English Nature monitoring | 7 | 2 | 2 | high | **11** |
| Erme estuary SSSI | Devon | SX 623 490 | Estuary | Estuarine and saltmarsh habitats supporting important breeding bird communities and providing feeding and roosting grounds for passage and winter birds. | Reports of increased Enteromorpha growth on mudflats. | The River Erme has failed to meet its RQO owing to a single high BOD thought to be caused by a silage or slurry incident (Environment Agency, 1998).<br><br>Climate change studies on saltmarshes and mudflats being undertaken by University of Plymouth but no further information was provided during the timescale of this project. | None specified during the course of this project | 2 | 2 | 5 | low | **9** |
| Exe Estuary SSSI, SPA, Ramsar | Devon | SX 980845 | Estuary | Complex of habitats supporting internationally important numbers of wintering and passage waterfowl, as well as populations of breeding birds and nationally important rare plants and invertebrates | Chemical and biological data collected over the period 1998-2000 indicate that the Exe Estuary is eutrophic (Environment Agency, 2001) and there has been a long-term decline in the diversity of algal species and in the extent of eelgrass (Zostera spp) beds in the estuary (Langston *et al*, 2003). | The Exe Estuary Site Characterisation Report (Langston *et al*, 2003) reviews eutrophication issues, and its main points can be summarised as follows:<br><br>The River Exe appears to be the source of the majority of nutrients in the estuary so introduces contributions from agricultural run-off and sewage discharges higher up in the system. However, sewage discharges direct to the estuary constitute additional loading and result in chronic contamination of the affected areas - Countess Wear STW is implicated as the major point source. Additional diffuse inputs from tributary rivers and streams may also be important, in combination.<br><br>There are also unknown impacts from pesticides and herbicides contained in discharges, run-off and sediment having impacts on invertebrates and fish in the system. | The Exe was investigated as a Sensitive Area (Eutrophic) during 2001. Designation could have facilitated significant reductions in nutrient loadings. However, it was not put forward to DEFRA due to the rapid flushing rate and lack of evidence, therefore it will not be designated in the foreseeable future (Langstone *et al*, 2003). | 4 | 3 | 4 | low | **11** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Fal and Helford cSAC | Cornwall | SW 747261 | Estuary | Large shallow inlets, bays, reefs, estuaries and submerged and tidal sandflats/mudflats. Associated sensitive flora and fauna including invertebrates, fish (estuarine and migratory, esp. early life stages), seabirds, mammals, Zostera and Maerl beds (and associated diverse fauna) | Parts of the system, notably the upper Fal estuary, are subject to eutrophication. Toxic algal blooms occur periodically in more enclosed reaches of Upper Fal Estuary. The most recent incidence, in 2002, also affected Helford Estuary, resulting in invertebrate mortalities (Langston *et al*, 2003). Very little specific information on sensitivity of estuarine macrofauna, or rare species and special interest features within the cSAC, to nutrient enrichment. Nutrient status considered to affect secondary productivity of benthos through effects on sediment and epibenthic flora, including phytoplankton. | Majority of nutrient inputs in cSAC may be due to diffuse sources e.g. agricultural run-off. Temporal trends for N and P indicate alternate seasonality; P loadings high in summer, low in winter and N loadings low in summer high in winter, indicating anthropogenic enrichment. The relative importance of diffuse versus point source inputs appears to be site-dependant in the cSAC, with enclosed areas such as the upper estuary more vulnerable to the effects of waste discharges (Langston *et al*, 2003).<br><br>An appraisal of current nutrient source (Fraser *et al* 2000) indicates relative proportion of nutrient inputs from diffuse sources increased slightly in the Fal over a 60-year period. Inputs to the Helford have not changed significantly.<br><br>Suggested sources of nutrients in the Helford catchment are agricultural run-off and soil leaching (Langston *et al*, 2003). Report by HVMCA (2000) suggests change in farming practice from dairy to arable means run-off may now also contain pesticides, fungicides and herbicides although no data is given. Sewage problems can arise in the summer when visitor numbers peak and fluvial input and water mixing are at a minimum. | In order to construct more meaningful budgets the needs are to determine N and P removal rates to sediment, estuarine mixing behaviour, and to look at export rates from the estuary on suspended particles, at different salinities, tidal states, flow rates and seasons.<br><br>Truro, Tresillian, and Fal Estuaries designated as Sensitive Area (Eutrophic) (under the Nitrates Directive 91/676/EC), which it is hoped will bring about improvements to the nutrient status of the region. However, nutrient enrichment in some of the more enclosed waters of the Helford Estuary is also a cause for concern and warrants further investigation (Langston *et al*, 2003) | 6 | 3 | 5 | high | **14** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Fenemere SSSI | Shropshire | SJ445228 | Lake | Open water, reedswamp, fen, alder carr, wet grassland | Mere shallow, affected by eutrophication and silt. Apparent decline in submerged macrophyte flora noted over recent years. Dense populations of algae and turbidity from disturbed sediment are reported and are likely to inhibit submerged macrophytes.<br><br>Very high levels of P (TP = 485 ug/l) reported from site and high levels of nitrate noted in inflow. There is also possible enrichment in adjacent alder carr resulting from nutrient rich waters from lake at high water.<br><br>(Moss *et al* 1992; Carvalho & Moss 1998, and ECUS 2001) | Site is situated in intensive agricultural catchment with increased stocking levels since 1930s. Main inflow drains agricultural land.<br><br>Bottom feeding fish present (bream and carp) and thought to increase nutrient mobilisation from lake sediments.<br><br>Water supply primarily from groundwater in surrounding glacial sands and gravels, and from adjacent wet grasslands. High TP levels may derive partly from groundwater and internal cycling and do not strongly suggests diffuse agricultural sources. High levels of nitrate in inflows may indicate increased pollution as result of agricultural intensification within the catchment. | Included in the EA's NUPHAR project | 4 | 2 | 3 | medium | **9** |
| Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses SSSI<br><br>Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses cSAC<br>Midland Meres and Mosses Ramsar | Shropshire | SJ488365 | Lowland raised mire | Raised mire<br><br>Open water | Increases in fen vegetation typed observed on margins of oligotrophic moss. | No specific studies undertaken, although concern that nutrient-rich water draining from surrounding agricultural land may be affecting a lagg zone on the oligotrophic moss margins. Inputs from point sources such as septic tank overflows also contribute. | Tree felling and drain blocking, water level manipulation to restore active bog surface.<br><br>But not addressing agricultural pollution. | 9 | 2 | 5 | low | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Flitwick Moor SSSI | Bedfordshire | TL 045 350 | Valley Mire | Large area of wetland and moor and associated flora and fauna. | Field observation indicates that the site is exhibiting negative changes in plant communities. Loss of key bog plant species attributed to increasing eutrophication of the site. Bog species are particularly sensitive to nutrient enrichment and air-borne N (English Nature, pers comm).<br><br>Environment Agency routine monitoring data classifies rivers feeding into the site as having very to excessively high levels of N and P. The biology of these systems is fairly good to good (Environment Agency, pers comm). | None known | None known | 9 | 2 | 5 | low | **16** |
| Frome St Quintin SSSI<br><br>West Dorset Alder Woods cSAC | Dorset | ST585036 | Valley Mire | Lowland valley mire on greensand containing: Wet alder-ash woodland, Rich Fen, Reed swamp, Neutral grassland, Chalk river, Seepages and springs depositing tufa, Wetland Invertebrate assemblage, Lichen and bryophyte assemblage with rare species present | Evidence from plant communities that nutrients are entering the system. Details were not provided during the course of this project. | The site is surrounded by agricultural land on chalk and greensand comprising conventional intensive dairying and arable (maize) and an organic dairy with some arable.<br><br>The valley mire lies on greensand and there is clear evidence from the composition of the plant communities (and poor tree health) present that poor water quality (nutrients) is entering the system (soil and through aerial deposition).<br><br>One dairy disposes of dirty water by spraying and slurry is spread. STWs is situated in the middle if the site, discharging to the River Frome where poor water quality is a concern. (English Nature, pers comm). | EA taking forward investigation into water quality of River Frome and have bid for funds to undertake a hydrogeological survey of the site.<br><br>EA assessment; going forward for AMP improvement | 6 | 2 | 5 | low | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Halvergate Marshes SSSI<br><br>Orfordness to Shingle Street cSAC | Suffolk | TG 448051 | Coastal marsh & ditch system | Salt marsh, vegetated shingle, saline lagoons, annual vegetation of drift lines and perennial vegetation of stony banks.<br><br>Habitats for the populations of the regularly occurring Annex 1 bird species and migratory bird species of European importance, with particular reference to grazing marsh, saltmarsh, intertidal mudflat and shallow coastal waters.<br><br>Species include avocet, sandwich tern, little tern, ruff, redshank, lesser black-backed gull | No information available within the timescale of this study | Large proportion of catchment comprises agricultural land. No directly attributable data available/provided within the timescale of this study. Further data may be available for future studies. | None specified during the course of this project | 3 | 2 | 5 | low | **10** |
| Hamford Water SSSI, SPA, cSAC | Essex | TM 235255 | Estuary | Saltmarsh, intertidal sand and mud with *Zostera* beds. The site is important for overwintering wildfowl and contains shingle spits with internationally important numbers of little terns. | Inorganic N input in class C-D category: very poor quality. Reduced species diversity, algal mats, etc. | No further data received/available within the time scale of this study. Data my be available for future work. | None specified during the course of this project | 5 | 2 | 5 | low | **12** |
| Hanningfield Reservoir SSSI | Essex | TQ 730980 | Reservoir | Migrant wildfowl | Unclear. Hanningfield Reservoir is a SA(E). Reservoir is pumped storage from the Chelmer River. Reports of algal blooms affecting benthic macrophytes. Reservoir is believed to be destratified to try to decrease algal production. Little information available within the timescale of this study | Unknown. Several STW discharge to River Chelmer in vicinity of abstraction point for Hanningfield Reservoir. | None specified during the course of this project | 4 | 3 | 4 | low | **11** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Hatfield Chase Ditches SSSI | Lincolnshire | SE748070 | Ditch System | Aquatic and emergent vegetation. | Unclear. SSSI is a series of agricultural drainage ditches partly fed by acid runoff from areas of raised mire. Aquatic macrophyte communities typical of nutrient rich communities. RCS undertaken in 1995 on North Engine Drain recorded low algal growth, although communities were dominated by species tolerant of nutrient rich waters. No more recent survey information or water quality data for ditches within the SSSI was available in the time frame of this study. However, future work should not necessarily disregard this study. | SSSI is a series of agricultural drainage ditches surrounded by intensive agriculture | Trying to establish 10m grassland strips as a buffer zone. | 4 | 2 | 5 | low | **11** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Hawes Water SSSI<br><br>Morecambe Bay Pavements cSAC | Lancashire | SD 478766 | Lake | Hard oligo-trophic waters with benthic vegetation of *Chara* spp. | Aquatic plant surveys show Chara beds to be restricted compared to previous (1984) surveys (Newbold, 1999). There has been an increase in more typically eutrophic species. Algal blooms have also been reported (Petley-Jones, pers comm).<br><br>Apparent four-fold increase in sedimentation rate since 1970 but cause is unclear (Goldsmith *et al*, 2003). | Lake TP concentrations of 20.6 ugl-1 reported, although these are lower than expected. High TP (86.8 ugl-1) concentrations in inflow suggest nutrients may be a problem on site (Goldsmith *et al*, 2003). Phosphate levels low in recent water samples (J Marshall, pers comm).<br><br>Newbold (1999) suggests that the most likely cause of nutrient enrichment is septic tank discharges.<br><br>No other sources of nutrients and Goldsmith *et al* (2003) identified catchment sources as a major concern, suggesting that the problem of diffuse pollution is widespread in the area and should be addressed.<br><br>Bennion *et al* (2002 - quoted in Goldsmith *et al*, 2003), using export coefficient modelling, estimate current TP loadings to be 51.27 kg/yr and hindcast loadings (1931) to be 49 kg/yr. | English Nature local team currently bidding for funds with RSPB and EA for a catchment study to explore and identify possible solutions.<br><br>Goldsmith *et al* (2003) suggest the following:<br><br>Address farming practice in the catchments<br><br>Investigate Challam Hall cesspit and ensure improvements if necessary<br><br>Regular monitoring of water quality & lake flora<br><br>Paleoecological studies on plant macrofossils to allow past environmental conditions to be inferred. | 9 | 3 | 7 | medium | **19** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Hornsea Mere SSSI/SPA | Humberside | TA 190470 | Lake | Shallow lake (120 ha) with reedswamp, fen and carr woodland.<br><br>Internationally important population of wintering wildfowl (gadwall). | Hornsea Mere is eutrophic. There are incidents of blue-green algae and other algal blooms that may be affecting aquatic plant communities and bird communities.<br><br>High TP levels at 360 ug/l, resulting in dense algal blooms and heavy growth of filamentous algae. In shallower areas, where turbidity is not limiting, eutrophic conditions also appear to encourage dense submerged macrophyte growth. (Carvalho & Moss 1998)<br><br>EA routine monitoring data 1999-2002 show high orthophosphate levels with annual mean ranging from 270 ug/l to 435 ug/l. (EA 2003) | Site is situated in intensive agricultural catchment. Other pollution sources are present, including sewage effluent from Seaton Sewage Pumping Station.<br><br>Farm-based nutrient budget for 75% of catchment demonstrated reasonable farming practice and no great surplus of phosphate for export to the Mere although no account taken of phosphate from storage in agricultural soils. Unquantified problems were considered to arise from the use of poultry and pig-farm manures. (FWAG 2002). EA review of consents found point pollution sources from septic tanks (Denice Coverdale pers comm).<br><br>Studies undertaken by University of Hull found potential issues from historically polluted lake sediments. Large populations of benthic feeding fish result in significant re-suspension of sediments, with associated turbidity and nutrient mobilisation.<br><br>Although diffuse pollution is not the major issue the site is considered vulnerable (Denice Coverdale pers comm).. | Ongoing liaison with Estate to promote good farming practice. Funds needed to encourage practical measures to tackle diffuse pollution.<br><br>Good uptake of Countryside Stewardship in some areas of catchment. | 3 | 3 | 3 | medium | **9** |
| Hunsdon Mead SSSI | Essex/Herts | TL 418110 | Mesotrophic grassland | Mesotrophic grassland | The site is in an agricultural context and it is understood that all the surrounding watercourses have elevated nutrient levels. There is a reduced species diversity in areas subject to flooding or seepage from the river & canal. English Nature considers that Hunsdon Mead is in unfavourable, maintained condition (Water Level Management Plan for Hunsdon Mead SSSI, 2001). | There is infrequent winter flooding from the Old River on to the site and input from the Stort Navigation through seepage through the towpath. The flooding of the Navigation introduces nutrient-enriched water and leads to increased grass grown and loss of diversity at the southern end of the site (Water Level Management Plan for Hunsdon Mead SSSI, 2001). | English Nature to maintain site to prevent flooding<br><br>British Waterways has undertaken towpath repairs but it is not yet known whether this will provide a long-term solution. | 4 | 2 | 5 | low | **11** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Lathkill Dale SSSI, NNR<br><br>Peak District Dales cSAC | Derbyshire | SK200660 | River | SAC Features: Bullhead, Brook lamprey, White-clawed crayfish<br><br>SSSI Features: Aquatic inverts & aquatic plant assemblage | Unclear. However, English Nature officers report an increase in P-dependent plants in seasonally-dry sections of riverbed. P levels may not be significantly high enough to affect cSAC species, but may impact SSSI features i.e. invertebrates and vegetation. | Data supplied suggests maintenance of flow to be major issue here. Water quality in River Lathkill may be impacted by polluted cave system (Knotlow) upstream in the catchment. EA have attempted to trace pollution source for a number of years but whether the source is point or diffuse remains unclear. | Being considered under EA review of consents | 7 | 2 | 4 | medium | **13** |
| Leighton Moss SSSI, SPA, Ramsar | Lancashire | SD 483749 | Lake | Large areas of open water surrounded by extensive reedbeds in which areas of willow scrub and mixed fen vegetation occur.<br><br>The site is of importance for a number of wetland birds especially Bittern *Botaurus stellaris*. | Decrease in number of bittern males thought to be linked with decreasing water quality. Lack of macrophytes in dykes and open water thought to be linked with poor water quality may impact fish & eel populations, the bittern's primary food source (RSPB, 2001).<br><br>Algal blooms recorded from some pools and dykes in recent years | Sediment core samples suggest that TP has increased rapidly in the last 15 years, reflecting inputs from the catchment or cycling process in the upper sediment. This work also shows that the site had nutrient levels above 0.1mg/l P since at least 1911 (Parr, 2001).<br><br>Water quality analysis of water feeding onto the site found that TN and TP were high at 2 ditches and 1 spring, and in some cases reached well above the level considered to be hypereutrophic, e.g. TN is reported to have a peak mean of 3169 ug/l and TP 256.2 ug/l. These high levels come from water courses adjacent to heavily fertilised land (RSPB, 2001).<br><br>Problem is considered to be at least partially internal. Sediment in the pools acts as a sink for previously accumulated phosphate, which may be re-released under certain conditions (RSPB, 2001). | The RSPB are in the process of updating the water quality sampling and results should be available soon (Horner R, pers comm).<br><br>Harding (2002) recommends that catchment study and export coefficient modelling be carried out. From this nutrient targets can be set and remediation measures be implemented.<br><br>Hawes Water flows into Leighton Moss and the water quality there may influence water quality here. | 4 | 3 | 4 | medium | **11** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Lindisfarne NNR, SSSI and SPA<br><br>Berwickshire and North Northumberland Coast SSSI, cSAC and SPA | Northumbria | NU 105 422 | Coastal Waters | Extensive beds of eelgrass.<br><br>Over-wintering waterfowl light – bellied brent geese (68% of the global population of this sub species).<br><br>Intertidal mudflats and sandflats | Excessive growth of Enteromorpha leading to a reduction of mudflats available for feeding birds (BTO report) and smothering of eelgrass. Coverage of Enteromorpha has increased since 1995 to 25% cover in 2000 (Peaty and Lillie, 1998; CSA(E)/PW(E) Form E).<br><br>Lindisfarne NNR was designated as polluted waters under the Nitrates Directive in 2001. N & P levels substantially elevated compared to adjacent sea water, both exceeded DoE criteria for eutrophic waters in the majority of recent samples (CSA(E)/PW(E) Form F). | Only 2 small STWs in catchment (which will have P removal under AMP3). Only around 6% N estimated to arise from STWs. Up to 32 %P estimated to arise from STW. (CSA(E)/PW(E) Form E). Large proportion of N & P loadings (up to 95%) are from diffuse sources via feeder streams (e.g. River Tweed) to intertidal areas. | EA review of consents.<br><br>Encouraging farmers to apply for Countryside stewardship Schemes.<br><br>Precautionary approach adopted to new developments<br><br>P-stripping considered pending further assessment and AMP3 for STWs. | 5 | 4 | 8 | high | **17** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Loe Pool SSSI | Cornwall | SW 647250 | Lake | Largest freshwater lagoon in Cornwall providing scarce habitat not found elsewhere in Cornwall with rare species of higher plants, bryophytes and algae, together with many rare and local insect species. | The original mesotrophic lake is now an algal dominated system in an advanced stage of eutrophication and is currently in 'unfavourable declining' condition. It has a TP concentration of 145ug/l (PO4-P). Loe Pool exhibits the classic symptoms of potentially toxic algal blooms and an almost complete lack of submerged macrophytes. Stewart (2000) gives a detailed account of vegetation changes thought to be caused by eutrophication e.g. the complete disappearance of the rare Nitella hyalina. Fish kills have also been reported. (Carvalho & Moss, 1998; Wilson & Dinsdale, 1998; Stewart, 2000; Dinsdale, 2003) | Not quantified. The main cause of enrichment is Helston STW and the implementation of the UWWTD will significantly reduce P inputs. After this contributions from Culdrose STW and agricultural run-off may become more significant.<br><br>Arable agriculture is a main land use within the catchment but the vegetation changes may also be caused by historical intensive mining in the catchment causing increased siltation in the River Cober and then the lake, fluctuations in the water level and salinity associated with the building up and periodic breaching of the Loe Bar and the unnatural water level management plan (natural seasonal fluctuations are to be implemented 2000-2004). | Restoration of water quality is the key focus of the Loe Pool Management Forum - the site is designated under the fisheries directive and UWWTD. Sediment and nutrients from farms are tackled by the creation and implementation of Farm Buffer Zone Options (Haycock *et al*, 1999). Dinsdale (2003) describes several initiatives to tackle lake restoration. | 8 | 4 | 3 | medium | **15** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Marton Pool SSSI | Shropshire | SJ296027 | Lake | Open water, reedswamp, aquatic flora | Eutrophication issues unclear. Site subject to blue-green algal blooms, with blooms noted during 1990s (ECUS, 2001). Frequent changes occur in abundance of submerged vegetation and possible decrease in diversity (Carvalho & Moss 1998).<br><br>Mean orthophosphate levels are 63 ug/l. Some eutrophication may be suggested from a single sample at 120ug/l m. Limited chemical data may suggest some enrichment but may result from slow flushing rate and internal P-cycling from lake sediments | No studies to determine nutrient sources have been undertaken, although site receives runoff from agricultural catchment.<br><br>Observed variation in abundance/ diversity of macrophytes considered to be primarily due to increased turbidity/wave action resulting from power-boating activity (Carvalho & Moss, 1998). | None specified during the course of this project | 4 | 2 | 5 | medium | **11** |
| Minsmere-Walberswick Heaths and Marshes SSSI<br><br>Minsmere to Walberswick Heath and Marshes cSAC Minsmere to Walberswick SPA and Ramsar | Suffolk | TM476 645 TM467 772 | Mere and Marsh | The site includes mudflats, shingle beaches, reedbeds, heathland and grazing marsh that are of particular interest for wetland birds in particular waders and wildfowl including Avocet (Recurvirostra avosetta), Bittern (Botaurus stellaris), Nightjar (Caprimulgus europaeus), Little tern (Sterna albifrons), Gadwall (Anas strepera), Teal (Anas crecca) and European White-fronted goose (Anser albifrons).<br><br>Also important are the species and habitats and species associated with heathland including natterjack toads. | Frequency of outdoor pig units surrounding the site and several incidences of run off onto the site. | Pig unit run-off is classified as diffuse although these are known specific point sources. No further information on this site was made available during the timescale of this project. | Meetings with pig owners/farmers. | 2 | 2 | 5 | low | **9** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Moorthwaite Moss SSSI | Cumbria | NY 511510 | Basin Mire | | No information available for this study | | | 9 | 4 | 6 | medium | **19** |
| Muckfleet catchment (Hall Farm Fen, Hemsby SSSI, Trinity Broads SSSI and Burgh Common and Muckfleet Marshes SSSI)<br><br>Broads cSAC Broadland SPA & Ramsar | Norfolk | TG4615 | Fen<br>Open water | Meso-eutrophic lakes and ditch systems, chalk-rich fens, alder woodland, bogs, marshy grasslands. | Eutrophication of five broads | Balance of diffuse to point sources currently uncertain. Estimated at 78% P and 97% N from diffuse sources based on 1996 data (Pitt *et al* 1996).<br><br>For the EA review of consents SIMCAT modelling will be carried out but even with P-stripping nutrient status likely to be high. The situation will be reviewed following completion of P-stripping. It is likely that dealing with agriculture will be most economically viable approach. As part of scoping the EA have undertaken site characterisation (hydro-ecological review, ENTEC) but report not available at present. | No STW's in catchment. This century Chara lakes degraded to eutrophic algal communities with some macrophytes.<br><br>EU LIFE Lake restoration site. Currently partly biomanipulated. Some nutrient partition work undertaken.<br><br>PWS site | 6 | 3 | 8 | medium | **17** |
| Newton Reigny Moss SSSI | Cumbria | | Basin Mire | | No information available for this study | | | 9 | 4 | 6 | medium | **19** |
| North Somerset Moors:<br><br>Biddle Street SSSI<br>Puxton Moor SSSI<br>Tickenham Nailsea and Kenn SSSI<br>Gordano Valley SSSI | Somerset | ST423648<br><br>ST412630<br><br>ST440700<br><br>ST435730 | Wet Grassland | Lowland wet grassland with ditches.<br><br>Aquatic invertebrates<br><br>Aquatic plants | Aquatic invertebrate survey of all SSSI except Gordano Valley (Godfrey, 1999) recorded excessive algal growth in a small number of ditches although insufficient previous survey data was available for trends to macroinvertebrate populations to be comprehensively assessed. Aquatic macrophyte survey of all SSSI (Nisbet, 2000) recorded increased frequency of algae dominated ditches within Tickenham, Nailsea and Kenn SSSI. Site visit carried out by English Nature in December 2002 raised concerns about nutrient levels (Steve Parker, pers comm) | It is thought that water quality across this system is very variable.<br><br>This is a very site with a mixture of influencing factors.<br><br>Some of the main feeder rivers (River Brue and King's Sedgmoor Drain) are known to have water quality issues.<br><br>In some places the cause of the concern is land management, i.e. high input of fertilisers. But in other areas the problem may be ditch or river management i.e. weed cutting or dredging.<br><br>In some areas there is clearly a problem with run off from roads or farmyards.<br><br>Other activities that can cause water quality problems include: peat cutting, the drainage of the site (high solids content), Withy Industry, high usage of pesticides and herbicides. | On site (SSSI) management agreements with landowners to lower or stop fertiliser input on fields: use of buffers.<br><br>New WES (S15) and Countryside Stewardship | 6 | 2 | 5 | medium | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Orwell Estuary SSSI<br><br>Stour and Orwell SPA and Ramsar site | Suffolk | TM 170 415 TM 260 343 | Estuary | Habitats for the populations of the regularly occurring migratory bird species of European importance, with particular reference to intertidal mudflats and saltmarsh, grazing marsh.<br><br>Species include black-tailed godwit, dark-bellied Brent goose, dunlin, grey plover, redshank, ringed plover, shelduck, turnstone | The situation is unclear from the information/data supplied. Losses to saltmarsh plants in Stour in recent decades | Large proportion of catchment comprises agricultural land. There are a range of other potential pollution sources (associated with urban and industrial catchment) that may be as important as those from agriculture (English Nature pers comm).<br><br>The Stour estuary has a high level of freshwater nutrient input but the sewage derived freshwater nutrient input is small (Elliot *et al* 1994).<br><br>Herbicide run-off has been shown to cause stress to the Stour's saltmarsh plants, which may account for losses in recent decades (Mason, *et al*, 2003). Found that herbicides from agricultural found to run-off reduce photosynthetic efficiency of diatoms and higher saltmarsh plants. Sediments become less stable due to the reduction in the film of diatoms covering the substrate surface (Mason *et al* 2002) | Stour and Orwell Estuaries European Marine Site Management to influence and improve farming practice<br><br>Site will be reviewed by EA for Water Framework Directive and Nitrates Directive<br><br>Review of risks/impacts in joint study by English Nature/EA/CCW<br><br>ESA boundaries may change after talks between Defra and the Management Group | 4 | 3 | 7 | high | **14** |
| Ouse Washes SSSI, cSAC, SPA, Ramsar | Cambridge | TL 393747 to TL 571987 | Wet grassland | Extensive washland habitat (unimproved neutral grassland communities, aquatic vegetation of associated dykes and rivers) supporting large numbers of wildfowl and waders.<br><br>Spined loach, associated with river/drain habitats. | Increases in swamp communities typical of eutrophic waters and consequent decreases in inundation grassland communities. Ditch flora surveys indicate a marked decline in pollution sensitive species, following a predictable eutrophication process (Newbold, 1999).<br><br>Spined loach is absent from the Wash ditches which is attributed to high nutrient loading (Entec, 2001). The Washes have a history of late summer fish kills due to low DO, possibly caused by algal growth promoted by nutrient enrichment (English Nature, pers comm). | EA monitoring data shows nutrients to be the only water quality issue in the Ouse Washes. P-loadings are the major problem (Entec, 2001). Summer slacker intakes of water for the site come from the Bedford Ouse which has anything up to 10 times the conservation objective targets for P & N.<br><br>Nutrient loadings are seasonably high. N levels highest in winter when indigenous IDB drainage from arable land is actively discharging. Orthophosphate values are low most of the year, being elevated only in the summer. A hydro-ecological review of the site (Entec, 2001) estimates that approx. 80% of total P is derived from STWs, the remainder diffuse. However, such figures are not based on detailed modelling and are much disputed by (English Nature, pers comm).<br><br>Winter drainage of agriculture into the Ouse Washes causes silt build ups/ stratification of silts which may be unfavourable for the spined loach (JNCC Website, 2003). Further, increased siltation affects the flood waters extending the duration of flooding which has a detrimental affect on the ecology of the washes (Entec, 2001). | P reduction will be considered under UWWTD and water quality will be monitored to assess favourable conditions (Entec, 2001). The relationship between water quality and the ecology of the washes is being investigated by English Nature and results will be available soon (English Nature, pers comm).<br><br>Independent investigation into most recent (August 2002) fish kill. EA and English Nature are providing evidence for this investigation.<br><br>Site listed on AMP4 but no action to tackle diffuse pollution. | 6 | 4 | 3 | medium | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Pevensey Levels SSSI<br><br>Pevensey Levels Ramsar | Sussex | TQ 650070 | Wet meadows and ditch system | Flora & Fauna of ditches, (SSSI and Ramsar features), wet grassland (SSSI feature).<br><br>Of particular is the aquatic macrophyte assemblage and the outstanding invertebrate populations, especially the *Mollusca* and *Odonata, which are sensitive to pollution.*<br><br>The site also contains the invasive alien species floating pennywort (*Hydrocotyle ranunculoides*), parrots feather (*Myriophyllum aquaticum*) and New Zealand stonecrop (*Crassula helmsii*). | Observed and measured pollution issues in Pevensey Levels.<br><br>The Environment agency have detailed and ordered records for this site/catchment including:<br><br>extensive water quality data for 22 chemical sites and 10 biological sites;<br><br>macrophyte and diatom surveys for 8 sites 1999 to 2001;<br><br>site Issues Briefing summary of pollution issues and,<br><br>Intereg Bid for Eutrophication Control Action Plan (ECAP) work. | Diffuse pollution is thought to be a significant issue but no directly attributable data has been generated. Current EA data focus on point source discharges. P and BOD are mostly likely from STW (so point) and will be addressed in AMP. Some N2 is highly likely from surrounding agricultural land use.<br><br>The site has problems with invasive alien aquatic plant species thought to be made worse by diffuse pollution (EA Jo Simmons pers comm).<br><br>The EA hold a significant amount of data on the levels though not specifically relating to diffuse sources. This data was not available within the timescales of this study but will be of use for future work. | The Pevensey Levels Study - to identify long term ecological changes;<br><br>The EA has put in an application for funding from INTEREG for Eutrophication Catchment Action Plan (ECAP) work part of which shall be focused on assessing the influence and extent of diffuse pollution within the levels. | 6 | 3 | 5 | high | **14** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Poole Harbour SSSI, SPA, Ramsar | Dorset | SZ 000890 | Coastal Waters | Large natural harbour with areas of intertidal marshes and mudflats supporting large numbers of wintering wildfowl and waders. | Eutrophication is thought to be the main cause of proliferation of macroalgae (Ulva lactuca, Enteromorpha intestinalis) effectively blanketing large areas of the harbour resulting in very low-diversity communities.<br><br>Gradual disappearance of the once widespread Zostera beds thought to be caused by thick blankets of Enteromorpha spp. Impacts therefore on invertebrate prey for birds and fish. Nutrient-associated water quality problems recorded for several decades including macroalgal, and to a lesser extent, microalgal blooms and periodic oxygen sags. Effects to other biota are largely unresearched (Langstone *et al*, 2003). Nutrient enrichment implicated in shellfish mortalities and occurrence of ASP and DSP toxins in shellfish (leading to shellfishery closures and near collapse of the local industry) | Much of the marine site is subject to eutrophication, the majority of nutrient inputs are probably due to diffuse inputs from tributary rivers and streams are significant but may also be enhanced by STW discharges, e.g. Hanrahan *et al* (2001) using export coefficient modelling of the Frome catchment area predicted that diffuse sources made the most significant contribution to the total load (65%) with 35% coming from STWs. | The problem of hypereutrophication has lead to the designation of Poole Harbour as a Sensitive Area (Eutrophic) & "Polluted Waters" (Eutrophic) and its catchment area a Nutrient Vulnerable Zone (NVZ), which, it is hoped, will herald significant reductions in nutrient loadings from both point, and diffuse sources. | 6 | 4 | 6 | medium | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Redgrave and Lopham Fens SSSI, NNR<br><br>Waveney and Little Ouse fens cSAC<br>Redgrave and South Lopham Fens Ramsar site | Suffolk | TM 050 797 | Other Fens | Calcareous fens with *Cladium mariscus* and the species of the *Caricion davallianae*<br><br>*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) | Anecdotal observations of increased reed domination in stands and simplification of riverine communities although results of studies undertaken by Wheeler and Shaw (2000) and Pitt (2001) into the nutrient status of Redgrave and South Lopham Fens were relatively inconclusive due to complex hydrology of site.<br><br>While the groundwater conditions maybe considered 'normal' for a lowland site they may still prevent the establishment of the oligotrophic conditions the site is recognised for. | Wheeler and Shaw (2000) concluded that as large areas of these fens are fed by drift groundwater it is highly likely they are enriched by agricultural activities including grazing.<br><br>Outdoor pig rearing and the disposal of poultry manure are widespread land uses within the catchment. The soils are dominated by sands in the valley bottom (hence their history of use for slurry disposal). Nutrient enrichment may also result from the decomposition of peat. | Investigations have been undertaken by the Environment Agency. | 8 | 3 | 6 | medium | **17** |
| Rempstone Heaths SSSI (there are also other less clear-cut examples on the Dorset heaths including Sandford Heath and Horton Common)<br><br>Dorset Heaths and Studland Dunes (Purbeck and Wareham) cSAC | Dorset | SZ 976 845 | Valley Mire | Valley mire, comprising important habitat for Rhynchosporion. | Vegetation shows that ditches running through mire systems are clearly enriched – this is preventing restoration of mires through blocking of these ditches (English Nature, pers comm). | Water originates from fields at top of catchment. There are no known point sources within the vicinity of the site however, further evidence was not provided during the timescale of this project. | Proposed construction of new pond to reduce nutrient levels. | 6 | 2 | 5 | low | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Ant catchment (East Ruston Common SSSI, Broad Fen Dilham SSSI, Smallburgh Fen SSSI, Ant Broads and Marshes SSSI)<br><br>Broads cSAC Broadland SPA & Ramsar | Norfolk | TG3620 | Fen<br>Open water | Meso-eutrophic lakes and ditch systems, chalk-rich fens, alder woodland, bogs, marshy grasslands. | Eutrophication of waterbodies including Barton Broad.<br><br>Some evidence of nutrient enrichment in floodplain fen habitat | Balance of diffuse to point sources currently uncertain. Estimated at 30-95% from diffuse sources (Whitehead *et al* 2002).<br><br>For EA review of consents, SIMCAT modelling will be carried out but even after P-stripping nutrient status will be high. EA have undertaken site characterisation for review of consents but not available for this study. | P stripping undertaken at all major and moderate STW's under Amp2 and 3.<br><br>Barton Broad is included in EA's NUPHAR project. 5 year project to mudpump Barton Broad undertaken at a cost of £2.4m. English Nature Lake restoration project site. | 6 | 3 | 7 | medium | **16** |
| River Avon System SSSI<br><br>River Avon cSAC | Wiltshire and Hampshire | SZ 163923 to SU 073583 | River | Ranunculus vegetation of plain and submontane areas<br><br>Sea lamprey, brook lamprey, Atlantic salmon<br><br>Bullhead<br><br>Desmoulin's whorl snail | The Avon cSAC supports diverse plant, invertebrate and fish communities. Recent evidence suggests river is eutrophic and suffering excessive siltation. Visual observations of increased turbidity and silted gravels, declines in trout and salmon, reduced hatches of fly-life, and frequent occurrence of benthic and filamentous algal growth. Number of water quality issues, particularly in upper catchment are considered to potentially affect SSSI/cSAC designated features. Parameters of concern include siltation, eutrophication, BOD, RQO compliance issues and occasional peaks in pesticide residue levels. | Concerns expressed that capacity of the Avon to assimilate diffuse agricultural pollutants likely to be low as they are low energy river systems fed by clear groundwater<br><br>Diatom sampling of entire river (1998) showed nutrient enrichment in headwaters and small tributaries only affected by runoff from agricultural land.<br><br>WRc (1998) calculated 94% N load to Upper Avon from diffuse sources. Marked decrease in N loading in dry years although unclear if direct leaching or contamination of groundwaters is major source of N. WRc calculated 57% P loadings from diffuse sources in Upper Avon but continuous point sources may have greater ecological input as a major nutrient source during growing season.<br><br>Mean N loadings have increased steadily in last 25 years with highest rate of increase in upper catchment. Historic data show concentrations doubled over last 40 years. Highest mean loading in Eastern Avon (7.6 mg/l). P concentrations increased to between 0.2 and 0.3 mgl-1, around 4 times higher than the target level set for the river (approximately equivalent to the levels recorded in the 1950s). | EA Landcare project encouraging best practice amongst adjacent landowners<br><br>Production of Integrated Farm Management Plans<br><br>PSYCHIC modelling to identify high and low risk areas | 8 | 4 | 8 | high | **20** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Axe SSSI, cSAC | Devon | ST325023 To SY259927 | River | Macrophyte assemblage including *Ranunculus* community<br><br>Invertebrate assemblage<br><br>Fish fauna – including salmon, brown trout, bullhead and lamprey | *Potamogeton pectinatus* and *Zannichellia palustris* recorded in 1997 indicating unfavourable condition for *Ranunculus* community (Grieve *et al*, 2002). Some change in species richness apparent in lower reaches (ENTEC, 2003). The proposed SAC P standard for the Axe (0.06mg/l) is breached throughout much of the catchment. History of algal blooms. Diatom assessment indicates elevated nutrient concentrations along River Axe, with a gradual increase in trophic score from head to mouth (Kelly, 2002).<br><br>Suspended sediment levels in the catchment can become highly elevated with concentrations exceeding 100mg/l. Siltation of river gravels causing concretion and localised smothering thought to be affecting salmonid spawning. Historic loss of salmon populations. | Intensive dairying and maize growing in catchment. Suspended sediment levels in the catchment thought to be sediment run-off from maize growing in the upper catchment (Daldorph, 2002).<br><br>Modelling of phosphate transport in catchment shows diffuse inputs dominate in the headwaters. whereas point sources dominate in the lower reaches.<br><br>Diffuse agricultural pollution has been highlighted as being a contributory factor for elevated BODs in 13 of the 16 BOD non-compliant stretches. (Entec, 2003) | Axe Valley enhancement project just launched to address. | 7 | 3 | 6 | medium | **16** |
| River Beult SSSI | Kent | TQ865425 to TQ693502 | River | Characteristic clay river flora and fauna. | High concentrations of *Lemna* spp. reported from River | No formal studies undertaken.<br><br>However catchment is largely agricultural with sheep and cattle pasture, orchards and arable land. Site considered to be subject to phosphate and nitrate enrichment from agricultural run-off. | Part of pilot water fringe scheme (FRCA now DEFRA). 30% of river banks included with buffer strips. Phosphate stripping at 13 STWs discharging to the Beult under AMP3 (2002 – 2005) | 4 | 2 | 5 | low | **11** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Blythe SSSI | Warwickshire, West Midlands | SP 109729 - SP 212916 | River | Characteristic clay river flora and fauna. | Vegetation re-survey has shown increases in silt and consequent changes to macrophyte community composition and distribution. Siltation may also be affecting invertebrates and fish spawning and nutrient releases from silt though to be resulting in eutrophication. | River drains an area of agricultural land.<br><br>Eutrophication considered to be resulting both from agricultural fertilisers and from discharges from sewage works.<br><br>Siltation from agricultural and urban run-off also considered a problem. | Draft conservation strategy produced by English Nature/EA 1999 | 4 | 2 | 5 | low | **11** |
| River Bure catchment (Crostwick Marsh SSSI, Bure Broads and Marshes SSSI)<br><br>Broads cSAC Broadland SPA & Ramsar | Norfolk | TG3317 | Fen<br>Open water | Meso-eutrophic lakes and ditch systems, chalk-rich fens, alder woodland, bogs, marshy grasslands. | Eutrophication of waterbodies including Hoveton Great Broad and Cockshoot Broad. Some evidence of nutrient enrichment in floodplain fen habitat and certainly reed swamp dieback | Balance of diffuse to point sources currently uncertain. Estimated at 42% P and 78% N from diffuse sources based on 1996 data (Johnes, 1996).<br><br>For the EA review of consents SIMCAT modelling will be carried out but even with P-stripping nutrient status likely to be high. The situation will be reviewed following completion of P-stripping. It is likely that dealing with agriculture will be most economically viable approach. As part of scoping the EA have undertaken site characterisation (hydro-ecological review, ENTEC) but report not available at present. | Under Amp2 and 3 all major and moderate STW's now P stripped.<br><br>English Nature Lake restoration project site | 6 | 3 | 7 | medium | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Camel SSSI, cSAC | Cornwall | SX 060707 | River | Rivers Camel & Allen and associated tributaries, associated woodlands, carr, fen, heath and wet meadows. Species of key conservation importance include otter, Atlantic salmon, bullhead, sea trout and sea lamprey. | Study of benthic diatoms (Kelly,1998 in Thurley & Hazlehurst 2002) found evidence of nutrient enrichment in the headwaters of the river Camel. An EA follow up study (Martyn and Geatches, 2000) where assessments were made against the zonal system of the GQA scheme found no evidence that soluble reactive P levels were elevated in the Camel headwaters. There was some evidence of increasing TON concentrations.<br><br>The diatom aspect of the work indicated high nutrient concentrations in the Starapark tributary (SX 1214 8728, outside the SAC boundary) and in the Camel at Springfield (SX 1310 8802) and Hendra Barn (SX 1125 8670). | The River Camel Conservation Strategy (Thurley & Hazlehurst, 2002) identifies diffuse sources of silt; nutrients from slurry, silage, fertiliser and waste spreading; and agri-chemicals as being of concern in the catchment. However, English Nature have no quantitative information on whether diffuse nutrient sources are implicated in the status of the SAC.<br><br>A study of the provenance of interstitial sediment retrieved from salmonid spawning gravels identified channel bank erosion as contributing 97 % of sediment loading (Walling and Collins, 2001). Localised bank erosion was thought to be promoted by a number of factors including ditching in the moorland areas of the upper Camel and widespread poaching and degrading of channel margins by livestock. | Existing initiatives and proposed action focus on farm practice improvements such as the FWAG nutrient budgeting to reduce fertiliser application and farm visits/projects to identify areas which would benefit from fencing. | 8 | 3 | 5 | medium | **16** |
| River Coquet and Coquet Valley Woodlands SSSI | Northumbria | NU 031015 | River | Salmon, all three species of British lamprey, otter, Ranunculus (water-crowfoot) habitat. | Six out of thirteen water chemistry monitoring sites failed to meet RQO due to elevated BOD. Chemical water quality data shows that although N and P objectives are usually met, BOD has increased substantially over the past 10 years. | No quantitative data available. Few STW in catchment and in 2000, six out of thirteen water chemistry monitoring sites failed to meet RQO due to elevated BOD. Chemical water quality data shows that although N and P objectives are usually met, BOD has increased substantially over the past 10 years. | Encouraging farmers to apply for Countryside stewardship Schemes and English Natures Wildlife Enhancement Scheme. The Environment Agency are committed to a programme of ecological monitoring for 2003 within the Tweed/Till to investigate failures | 7 | 3 | 6 | medium | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Derwent & Tributaries SSSI<br><br>River Derwent & Bassenthwaite Lake cSAC<br><br>(NB - The site overlaps with, or adjoins, the following existing SSSIs: Buttermere Fells, Honister Crag, Lodore-Troutdale Woods, Great Wood, The Ings, Bassenthwaite Lane, Buttermere) | Cumbria | NY 261207 | River | Large oligotrophic river with high water quality and a natural channel. Site interest includes Atlantic Salmon *Salmo salar*, River Lamprey *Lampetra fluviatilis*, Brook Lamprey *Lampetra planeri*, Sea Lamprey *Petromyzon marinus*, Otter *Lutra lutra*, Floating water-plantain *Luronium natans* and Vendace *Coregononus albula*.<br><br>The River Marron and Sandy Beck tributaries of the River Derwent included on basis of salmon spawning and nursery areas | Environment Agency water quality monitoring and SIMCAT modelling indicates that both the River Marron and Sandy Beck tributaries are not currently meeting RQO RE1. Both have problems with small STWs but diffuse agricultural pollution is also a problem. River Marron is failing to meet RQO upstream of the highest WwTW. The River Derwent upstream of Bassenthwaite has P problems (English Nature, pers comm). | SIMCAT data exists for the River Marron and Sandy Beck showing diffuse pollution problems. However, this information was not provided during the time scales of this project. Any future review should not disregard this site | EA addressing STW discharges under the Habitats Directive and input into AMP4 but diffuse pollution not being addressed (English Nature, pers comm). | 8 | 3 | 6 | low | **17** |
| River Derwent SSSI, cSAC | Humberside | SE 627287-SE 825757 | River | Ranunculus (water crowfoot) macrophyte community bullhead, river and sea lamprey | Recent macrophyte survey has shown that the water crowfoot community is under threat and personal observation suggest that this may be related to increased siltation resulting from recent severe flood events. | CATNAP modelling concludes that the STWs are one causal factor in the nutrient status of the River Derwent. Recent CATNAP nutrient modelling of the Lower Derwent has shown that even with the implementation of P removal from the major STWs under AMP3 the likely P targets for the river will not be met.<br><br>For the river to meet EA targets for DAIN/P targets levels above the Malton STW need to be reduced and this must be from small point source discharges and diffuse sources. Trends in orthophosphate levels taken for GQA's show increases in winter periods indicating. Further investigation recommended | AMP3 P removal is being undertaken at Malton, Stamford Bridge and Pocklington STW. The EA review of consents under the Habs Regs is investigating whether further P removal is required from other STWs. This work should lead to a better understanding of the contribution of diffuse pollution to the problem. | 7 | 3 | 5 | high | **15** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Eye SSSI | Leicestershire | SK781183 | River | White legged Damselfly<br><br>Macrophyte assemblage | The site shows signs of enrichment (simplification of communities and dominance by species associated with high nutrient levels). Reported siltation of gravel beds indicates siltation also an issue.<br><br>River aquatic macrophyte assemblage is typical of a nutrient rich lowland river. Species include: yellow water lily (*Nuphar lutea*), branched bur-reed (*Sparganium erectum*), reed sweet-grass (*Glyceria maxima*) and arrowhead (*Sagittaria sagittifolia*). Bankside vegetation also dominated by species associated with nutrient enrichment i.e. nettle and greater willow herb. | No other relevant data was received/available within the timescales of this project. | Nutrient budgeting carried out on it as part AMP3 work. P - stripping proposed at all sewage works within the catchment for 2005.<br><br>As part of a flood alleviation scheme silt traps have been installed in the main tributary of the river and the river itself up stream of the SSSI | 6 | 3 | 5 | low | **14** |
| River Frome SSSI | Dorset | SY700908 to SY927871 | River | | In 1998 salmon were at favourable conservation status but have since changed significantly. Fishery data show egg deposition on the Frome dipping below its Conservation Limit for the first time in many years. It is likely that 2002 will also be below the CL. 3 consecutive years below the limit would constitute a failure according to Agency protocols (A Stevens, EA, pers comm).<br><br>English Nature also concerned with P levels in the system but no evidence of impact provided during the course of this project. | EA data show that spawning gravels are 'on the limit' of fine sediment loading for successful salmon spawning (EA, 1998). High sediment inputs from some tributaries perceived to be due to arable especially maize cultivation, intensive dairy and ploughing on steep slopes in upper catchment producing very silty runoff (English Nature, pers. comm). University of Exeter (1994) report indicated the source of silt was from out-with the channel.<br><br>The impact of P perceived as negative but actual effects not stated in this project. Hanrahan *et al* (2001) used export coefficient modelling and predicted that diffuse sources made the most significant contribution to the total load (65%) with 35% coming from STWs. Predicted annual TP load of 25605 kg/yr compared with a measured load of 23400 kg/yr. Model indicated that P stripping at STWs reduced P levels in discharged waste waters to 2 mg l-1 and would reduce total P loading to the catchment by at least 15%. | Agency to identify and control sources of silt ingress to the river using similar approach as with the Hampshire Avon Landcare Project.<br><br>Agency to promote agri-environment schemes in the area - nutrient budgeting by FWAG and CSS.<br><br>AMP improvements to some STWs (not specified which).<br><br>The Frome is to be included in the NERC LOCAR project for sediment pathway modelling. | 8 | 3 | 7 | high | **18** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Itchen SSSI SAC | Hampshire | SU589274 SU56353 SU599324 to SU439153 | River | Classic chalk stream features incl Ranunculus, southern damselfly, otter, crayfish, water vole bullhead, brook lamprey, Atlantic salmon. | High ecological status of River Itchen cSAC is considered to be threatened by eutrophication. Increases of 17-25% in nitrate concentrations have arisen between early 1980s and 1990s. Itchen sustainability project examined salmon spawning and found gravel pores are becoming blocked by fine sediment from organic sources (livestock waste) with a subsequent increase in BOD, DO decreases and fish life suffers. There also concerns that high nutrient loadings are promoting excessive weed growth (EA, Hampshire and Isle of Wight Area) | Diffuse pollution highlighted as an issue in EA LEAP documents. Catchment vulnerability mapping identified areas in catchment prone to soil erosion. Itchen sustainability project considered it likely that diffuse pollution is contributing most to this as monitoring from point sources measures against actual amount of sediment - big difference.<br><br>Watercress beds contribute sporadic input to suspended solid and research study on sediment loadings in Test catchment found that soil to water connectivity was an important factor in sediment transfer.<br><br>Nutrient studies found that nitrate levels were highest in the river in early spring indicating that nitrate load is related to catchment wide agricultural runoff. Modelling of P transport in catchment (Daldorph, 2002) found primary sources of P were fish farms in upper catchment and STW below Harestock STW. | EA Landcare project encouraging best practice amongst adjacent landowners; funding for 1 year only. | 8 | 3 | 6 | high | **17** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Kennet SSSI | Berkshire Wiltshire | SU203692 to SU572667 | River | Flowing water:<br><br>Chalk river with *Ranunculion fluitantis-Callitricho-Batrachion* vegetation<br><br>European protected species - including fish and invertebrates - especially Desmoulin's snail *Vertigo moulinsiana*. | Excessive sedimentation and turbidity in places. Suppression of aquatic plant growth over large sections.<br><br>NERC Lowland Catchment Research (LOCAR) project data suggests higher than average background levels of P, N.<br><br>Reductions in macrophyte species-richness/diversity - Ranunculus now dominates where 7-8 spp occurred before.<br><br>Localised increase in turbidity and loss of macrophytes downstream of connections to Kennet and Avon Canal (R. Money pers comm, P Johnes pers comm)<br><br>Extensive studies of water quality functioning and nutrient modelling have confirmed very high nutrient levels (STE 2002) | National Condition Assessment - agriculture contributes to impacts even with point sources of pollution (STW) (G Stevens pers comm). Interaction with Kennet & Avon Canal may provide additional diffuse loading.<br><br>LOCAR project - high P and N impacts not necessarily diffuse pollution as not all point discharges remediated.<br><br>Models - 60-70% of nutrients derive from diffuse sources. SRP levels highest (up to 548ug/l) in low flow conditions, prior to P-stripping. Post stripping, highest levels were 134ug/l, during high flows in the upper catchment, closest to diffuse sources of pollution. Following P-treatment, diffuse sources of SRP estimated to contribute 45% and 29% of total loads downstream of STW. Study also suggests that in-stream nutrient recycling is not a significant factor in levels of SRP and particulate phosphorus (Jarvie *et al* 2002).<br><br>N export (long term modelling) - significant increase in N transport to the river system from increased fertiliser application and livestock levels within the catchment (Whitehead *et al* 2002).<br><br>But no data from areas not affected by point sources – above Marlborough water quality problems are likely to be related to diffuse agricultural pollution, but below Marlborough the impact of point and diffuse sources are difficult to disentangle (R. Money pers comm). Internal nutrient recycling may also be a significant factor, and low flows and river vegetation management could also be implicated in ecological changes | Target area for Countryside Stewardship.<br><br>FWAG Landwise Project in Upper Kennet catchment.<br><br>Project Officer employed by FWAG to raise awareness, offer advice, promote good soil management through production of farm plans.<br><br>AMP 3 and AMP 4 priority to reduce inputs from STWs. | 7 | 3 | 5 | high | **15** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Lambourn SSSI<br><br>River Lambourn cSAC | Berkshire | SU322798 to SU490672 | River | Flowing water:<br><br>Chalk river/winterbourne with *Ranunculion fluitantis-Callitricho-Batrachion* vegetation<br><br>European protected species - including Bullhead *Cottus gobio* and Brook lamprey *Lampetra planeri*. | Excessive sedimentation and turbidity in places. Suppression of aquatic plant growth over large sections.<br><br>NERC Lowland Catchment Research (LOCAR) project data suggests higher than average background levels of P, N.<br><br>Reductions in macrophyte species-richness/diversity- Ranunculus now dominates where 7-8 spp occurred before (P. Johnes pers comm) | River flows mainly through agriculturally improved pasture and arable fields.<br><br>Recent National Condition Assessment - expresses concern that agriculture is contributing to problems, even though STWs are also a major concern (G. Stevens pers comm).<br><br>Currently it is difficult to disentabgle the impact of diffuse agricultural pollution from other factors affecting the river's condition (R. Money pers comm.)<br><br>Issues likely to be similar to R. Kennet. | Target area for Countryside Stewardship.<br><br>AMP 3 and AMP 4 priority to reduce inputs from STWs. | 7 | 3 | 5 | medium | **15** |
| River Lugg SSSI<br><br>River Wye cSAC | Hereford & Worcestershire | SO431631 | River | cSAC and SSSI features:<br>Salmon | Lower catchment of River exceeds N and P targets. Decline in Ranunculus growth in middle Lugg due to siltation of gravel beds (Wright, date unknown). Limited data on ecological effects available within the time frame of this study. However, In 2000 the River was not considered to represent a very high risk area when considered nationally (Wadsworth *et al*, 2000). | EA modelling, indicates significant diffuse P inputs. New SIMCAT awaited as part of AMP3 modelling. Modelling work carried out in behalf of English Nature (Quest Environmental, 1996) indicated significant inputs of N and P from diffuse agricultural sources in the River Lugg. However, Leominster STW was found to contribute 7% of all P exported from catchment.<br><br>Farm nutrient budget work with FWAG show excessive P application within catchment, particularly the use of chicken manures (Adas, 1998). Soil P status likely to be increasing as a result – impact on river from P rich sediment and from P runoff.<br><br>Modelling study of soil loss from agricultural land within the Lugg catchment (ITE/ADAS) indicated scale of soil loss to be 5x that of a pristine catchment. | As for Wye.<br><br>Psychic project using Wye as one of test sites to develop control mechanisms<br><br>Also River Lugg WES used by English Nature to demonstrate some measures to control diffuse pollution.<br><br>Development of Nutrient Management Plan (NMP) for the Lugg catchment (Adas, 1998) | 8 | 3 | 7 | medium | **18** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Mease SSSI, cSAC | Leicestershire | SK 272114 | River | Water courses of plain to montane levels with the *Ranunculion fluitantis and Callitricho-Batrachion* vegetation<br><br>Species of key conservation importance include: spined loach; bullhead; white-clawed crayfish, and otter | Increased frequency of flood events, relating to change in land use to arable farming (including potato farming) and increase in number of hard standings within the catchment. | Adjacent landuse is arable/improved pasture. SIMCAT modelling undertaken for the EA indicate that diffuse agricultural run-off is the dominant source of phosphate in the river.<br><br>No other data was received/available within the timescales of this project. | EA assessing site.<br><br>The major sewage works in the system is being put forward for inclusion in AMP4 as part of UWWTD driver and the conservation driver. | 7 | 2 | 5 | low | **14** |
| River Teme SSSI (includes River Clun SAC ) | Hereford & Worcester, Shropshire | SO 121848 – SO 850525 | River | Flowing water:<br><br>*Ranunculion fluitantis-Callitricho-Batrachion* vegetation<br><br>European protected species- including otter, fish and invertebrates - especially freshwater pearl mussel *Margaritifera margaritifera*. | Remaining population of freshwater pearl mussel confined River Clun. Believed that sediment/and or sheep-dip pollution is implicated in its decline elsewhere on river. Highly vulnerable to sediment impacts from upstream land management practices. | No specific studies undertaken, however site is situated in intensive agricultural catchment. Eutrophication considered to be resulting from high P and N inputs to agriculture. Siltation problem from agricultural run-off.<br><br>Upstream domestic STWs also believed to give a significant nutrient loading.<br><br>FWAG - Nutrient Budgets Project may be relevant - but no information for this site. | Sustainable agricultural management is being promoted via production of Whole Farm Plans, ESA and<br><br>Countryside Stewardship Agreements, especially on land adjoining River Clun SAC.<br><br>Review of Consents /AMP 4. | 8 | 3 | 5 | medium | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Test SSSI | Hampshire | SU533498 to SU367150 SU361145 | River | Classic chalk stream features incl Ranunculus, southern damselfly, otter, crayfish, water vole bullhead, brook lamprey, Atlantic salmon. | River Test designated SA(E) in 1994 due to high levels of nutrients, in particular P downstream of Andover. P-stripping carried out at STW and in 1998 P loading substantially reduced although WQ concerns remained. Increases of 17-25% in nitrate concentrations have arisen between early 1980s and 1990s. Concerns that excessive siltation is affecting salmon spawning success and high nutrient loadings are promoting excessive weed growth (EA, Hampshire and Isle of Wight Area) | Diffuse pollution highlighted as an issue in EA LEAP documents. Catchment vulnerability mapping identified areas in catchment prone to soil erosion and research study on sediment loadings in Test catchment found that soil to water connectivity was an important factor in sediment transfer. Nutrient studies found that nitrate levels were highest in the river in early spring indicating that nitrate load is related to catchment wide agricultural runoff. P-loadings were lowest at this time and are felt to result primarily from point source discharges | EA Landcare project encouraging best practice amongst adjacent landowners; funding for 1 year only. | 8 | 3 | 6 | high | **17** |
| River Thurne catchment (Upper Thurne Broads and Marshes SSSI, Shallam Dyke Marshes, Thurne SSSI)<br><br>Broads cSAC Broadland SPA & Ramsar | Norfolk | TG4321 | Fen<br>Open water | Meso-eutrophic lakes and ditch systems, chalk-rich fens, alder woodland, bogs, marshy grasslands. | Eutrophication of waterbodies including Hickling Broad and Horsey Mere.<br><br>Reed swamp decline | Balance of diffuse to point sources unknown as no data currently available. For the EA review of consents SIMCAT modelling will be carried out. It is likely that influencing agricultural practice will be most economically viable approach. As part of scoping the EA have undertaken site characterisation (hydro-ecological review, ENTEC) but report not available at present. | No STW's in catchment. This century Chara lakes degraded to eutrophic algal communities. Some marked improvement in recent years. Land drainage pump inputs, English Nature lake restoration site | 6 | 3 | 8 | medium | **17** |
| River Till SSSI<br><br>River Avon cSAC | Wiltshire | SU051452 to SU068368 | River | Flowing water:<br><br>Chalk river/winterbourne with *Ranunculion fluitantis-Callitricho-Batrachion* vegetation<br><br>European protected species - including Bullhead *Cottus gobio,* Desmoulin's whorl snail *Vertigo moulinsiana,* Atlantic salmon *Salmo salar and* Otter *Lutra lutra* | Concerns extrapolated from Avon work. | Diffuse agricultural pollution is considered to be the major water quality issue facing the catchment (EA 2002). | | 8 | 4 | 7 | medium | **19** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Waveney catchment (Stanley and Alder Carrs SSSI, Geldeston Meadows SSSI)<br><br>Broads cSAC Broadland SPA & Ramsar | Norfolk | TM4393 | Fen<br>Open water | Meso-Eutrophic ditch system, alder woodland, mesotrophic grassland | Eutrophication of floodplain fens, and ditch communities. Some loss of fen meadow interest but could be due to abstraction/drought effects. | Balance of diffuse to point sources unknown as no data currently available. For the EA review of consents SIMCAT modelling will be carried out but even with P-stripping nutrient status likely to be high. The situation will be reviewed following completion of P-stripping. It is likely that dealing with agriculture will be most economically viable approach.<br><br>As part of scoping the EA have undertaken site characterisation (hydro-ecological review, ENTEC) but report not available at present. | Believe that highest nutrient levels are in the headwaters where there are with outdoor pigs units located on sandy soils. Typically water quality improves in the rivers middle reaches where the wildlife sites are located. | 6 | 3 | 6 | medium | **15** |
| River Wensum catchment<br><br>River Wensum SSSI<br>River Wensum cSAC | Norfolk | TF 942246 to TG 250078 | | Type III lowland chalk and oolite rivers with generally stable flow regimes becoming Type I "lowland rivers with minimal gradients on mixed geology in England" in downstream section.<br><br>Wet, unimproved meadow, fen, scrub and alder carr.<br><br>European features include Ranunculus vegetation, bullhead, brook lamprey, Desmoulin's whorl-snail and white-clawed crayfish. | Eutrophication of River Wensum with associated impacts on the Ranunculus vegetation. Siltation also considered an issue.<br><br>Impacts on the terrestrial habitats e.g. grasslands and fens etc. are not known.<br><br>ESA scheme includes only limited information regarding the favourable condition of the river. | Balance of diffuse to point sources currently uncertain. Estimated at 21% P and 73% N from diffuse sources (Whitehead *et al* 2000).<br><br>SIMCAT modelling will be carried out for EA review of consents but even with P-stripping nutrient status likely to be high. The situation will be reviewed following completion of P-stripping. It is likely that dealing with agriculture will be most economically viable approach.<br><br>As part of scoping the EA have undertaken site characterisation (hydro-ecological review, ENTEC) but report not available at present. Sources of silt are thought to be agriculture, run off from development etc. There has been some suggestion that a move to contract farming has resulted in higher levels of sediment reaching the rivers. | P input has been tackled under AMP3 at Fakenham and East Dereham STWs.<br><br>No current action to tackle diffuse sources of pollution. | 6 | 3 | 7 | medium | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| River Wye SSSI cSAC | Hereford & Worcestershire | ST539940 | River | cSAC and SSSI features: Salmon, Allis and twaite shad, | EA spawning data show severe declines of salmon population. Many factors implicated, including reduction in spawning habitat through siltation of gravel beds.<br><br>Potential impacts on shad, although less data available. However, siltation also considered likely to affect this species, although less demanding spawning conditions may mean impact is less severe.<br><br>Anecdotal evidence of impact on Ranunculus. Recreational users suggest growth has increased in response to greater nutrient loading.<br><br>Anecdotal evidence of impacts on invertebrates. Supported by re-surveys for rare diptera, which have failed to record them. | Farm nutrient budget work with FWAG show excessive P application within catchment, particularly the use of chicken manures. Soil P status likely to be increasing as a result – impact on river from P rich sediment and from P runoff.<br><br>PSYCHIC project using Wye as one of test sites to develop control mechanisms.<br><br>Number of studies showing bad soil management (Hereford Trust etc). Photographs of cultivation up to river bank etc.<br><br>Visual observation of silt on river bed, reports from anglers etc.<br><br>Land use change statistics – increase in potato cultivation and decline in river valley grassland (CPRE reports and MAFF/DEFRA statistics). | Psychic project – national research site.<br><br>Support for FWAG Nutrient Budgets (part local funding, part diffuse pollution challenge funding).<br><br>Targeting of CS to rivers – buffer strips etc.<br><br>Liaison with FWAG and EA propose to develop a Wye Landcare project.<br><br>Support for Wye Grazers project to explore options to add value to livestock enterprise (to provide alternative to cultivation). | 8 | 3 | 7 | medium | **18** |
| River Yare catchment (Yare Broads and Marshes SSSI, Breydon Water SSSI)<br><br>Broads cSAC Broadland SPA & Ramsar | Norfolk | TG3218 | Fen<br>Open water | Meso-eutrophic lakes and ditch systems, chalk-rich fens, alder woodland, bogs, marshy grasslands, intertidal mud | Eutrophication of both fen and water bodies. | Balance of diffuse to point sources unknown as no data currently available. SIMCAT modelling will be carried out for EA review of consents but even with P-stripping nutrient status likely to be high. The situation will be reviewed following completion of P-stripping. It is likely that dealing with agriculture will be most economically viable approach.<br><br>As part of scoping the EA have undertaken site characterisation (hydro-ecological review, ENTEC) but report not available at present. | Major STW's for Norwich only recently P stripped. This reduced P loading by 77%. | 6 | 3 | 4 | medium | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Salcombe to Kingsbridge Estuary SSSI | Devon | SX 746 406 | Estuary | Rich and diverse intertidal and sub-tidal flora and invertebrate fauna.<br><br>Certain communities considered outstanding examples of their type in the north-east Atlantic. | Concerns about sedimentation as streams feeding the estuary are discoloured following periods of heavy rain, leaving to discolouration of the estuary.<br><br>Red Tides from 1999-2001 (*Prorocentrum* spp) raised concern over potential release of toxins and low oxygen levels in estuary. High bacteria levels occurred within shellfish in 2002, potentially causing PSP and DSP.<br><br>Reported increases of *Enteromorpha* spp. on mudflats. | Little scientific information regarding the eutrophication of the estuary but Environment Agency monitoring indicates that the overall water quality in the estuary is good, but elevated chlorophyll levels associated with high levels of TON occur. On the available information, the major landward source of nutrients to the estuary is riverine, presumably from agricultural sources (EA, 1998). The growth of Enteromorpha is more pronounced where STW effluents discharge (N Mortimer, pers comm)<br><br>Concern about possible significant inputs of agro-chemicals. The recent algae problems are thought to be linked to nitrates although further research is required to quantify. (N Mortimer, pers comm). | Various schemes within catchment including pro-active advice given to local farmers through the Countryside Stewardship Scheme.<br><br>Soil conservation events organised for local farmers, lobbying of 'responsible' organisations and presentation at Institute of Professional Soil Scientists conference on issues.<br><br>A Salcombe to Kingsbridge Environmental Management Plan is being developed. | 2 | 2 | 5 | low | **9** |
| Sandwich Bay to Hacklinge Marshes SSSI<br><br>Sandwich Bay cSAC<br>Thanet Coast and Sandwich Bay SPA and RAMSAR | Kent | TR353585 | Grazing marsh Ditches Saltmarsh Coastal Waters | Grazing marsh ditches with nationally scarce and RDB and plants/invertebrates | High and increasing cover of *Lemna*, *Enteromorpha* and filamentous algae recorded in ditches.<br><br>Other floristic changes and species-impoverishment suspected. | Ditch system receives drainage from intensive arable agricultural catchment. No additional information available/supplied in the course of this study | Botanical surveys of ditches proposed 2003<br><br>Limited funding obtained to investigate diffuse pollution | 6 | 4 | 6 | low | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Slapton Ley SSSI | Devon | SX 826 441 | Lake | Largest natural freshwater lake in SW England. Lower Ley is open water with a macrophyte flora fringed by reed bed. Higher Ley consists largely of rich fen and willow carr vegetation. These habitats support a very diverse flora and fauna, including the only known British locality for strapwort Corrigiola littoralis, the largest population of Cetti's warbler and over 2,000 species of fungi. | Quantity of macrophytes greatly reduced in some years, concurrent with increased water turbidity caused by proliferation of algae in highly nutrient-enriched conditions. This results in de-oxygenation which can result in fish kills. Status of *Corrigiola litoralis* on the Ley shores is fragile as it has become damaged by large scale deposition of algal mats on exposed shore. In the last 20 years the bird and fish populations have declined. Sedimentation is leading to severe siltation of spawning grounds, affecting the brown trout.<br><br>Geochemical analysis of sediment cores suggests productivity of lake increased considerably over last 70 years (Foster *et al* 1998). | Nutrient export coefficient modelling for 1925-1986 found N & P loadings related to distribution/intensity of agricultural production in catchment (Johnes & O'Sullivan, 1989). Mean annual concentrations N and P in inflow waters increased by average of 0.14 mg NO3-N/l and 5 ug PO4-P/l p.a. from 1971-1986 (Johnes & Heathwaite, 1997). Mean annual concentration N predicted to exceed European levels by 2060. TP could reach 150 ug/l.<br><br>Sediment core analysis suggests erosion and transport of agricultural topsoils are dominant sources of sedimentation and P enrichment in Lower Ley.<br><br>Marked changes in diatom sp. composition since 1850 (R Dils, pers. comm). Diatom analysis suggests increase in TP since c. 1910 and continued. Enrichment associated with change from arable farming to intensive livestock production c. 1920, and post-war agricultural intensification from 1945 (Johnes & Wilson, 1996). In 1960s-1970s enrichment related to expanding population connected to sewage system. Increase post 1980s related to high input agricultural systems and increased soil erosion. | Environment Agency piloting ECAP (intention to produce a plan only)<br><br>AMP 3 removal of inputs from sewage works by 2005 | 8 | 4 | 9 | high | **21** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
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| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Somerset Levels and Moors SPA, Ramsar - SSSIs include:<br><br>Catcott, Edington and Chilton Moors<br>Curry and Hay Moors<br>King's Sedgemoor<br>Moorlinch<br>Shapwick Heath<br>Southlake Moor<br>Tealham and Tadham Moors<br>West Moor<br>West Sedgemoor<br>Westhay Heath<br>Westhay Moor<br>Wet Moor | Somerset & Gloucestershire | ST390420<br>ST323273<br>ST400330<br>ST390360<br>ST430403<br>ST370300<br>ST420450<br>ST420220<br>ST361258<br>ST415422<br>ST455445<br>ST448244 | Wet Grassland | Lowland wet grassland with ditches.<br><br>Aquatic invertebrates<br><br>Aquatic plants | The Somerset Levels and Moors comprise areas of grazing marsh and rhynes in the catchments of the Rivers Brue and Parrett. Water levels in the system are tightly managed and the hydrological regimes of the river, drain and rhyne systems are interconnected and highly complex (Carvalho & Moss 1998).<br><br>Very high nutrient levels present in main feeder rivers (Dawe, 2001). The system is naturally eutrophic with P levels between 0.2 to 1.0 mg L-1 in routine monitoring. Recent surveys suggest slight ongoing decline in invertebrate interest (Godfrey, 1999). Aquatic macrophyte survey of ditches carried out in 1999 (Nisbet 2000) recorded increased algal growth since 1982, particularly at Moorlinch SSSI. There are also reports of frequent fish kills related to extensive growth of duckweed and poor water quality. | Water quality variable throughout the system and influenced by a combination of factors including point source discharges on feeder rivers (Dawe, 2001) and septic tanks which feed in to the system (Carvalho & Moss, 1998). Diffuse pollution is considered to be an issue as part of the site is subject to intensive farming, but the extent to which this impacts on the ecology of the site is difficult to determine.<br><br>In some areas ditch or river management such as weed cutting and dredging are considered to be major factors influencing water quality within the levels. In some areas there is also a problem with run off from roads or farmyards. Peat cutting and leaching of fertiliser, pesticides and or herbicides from farms or industrial works may also affect water quality. | On site (SSSI) management agreements with landowners (via ESA and English Nature Section 15) to lower or stop fertiliser input on fields: use of buffers.<br><br>Additionally there on going work by the Environment Agency investigating the water quality issues.<br><br>There is also the Parrett Catchment Project, a catchment wide project with part of its remit to reduce run off of silt. | 5 | 3 | 5 | medium | **13** |
| Sprat's Water and Marshes SSSI | Suffolk | TM 507 921 | Other Fens | Spring fed mixed fen, freshwater habitats | Unknown | No directly attributable data available/provided within the timescale of this study. Further data may be available for future studies. | Some minor investigations of the sources of the water. | 6 | 2 | 5 | low | **13** |
| Stanford End Mill & River Loddon SSSI | Berkshire | SU709642 | River Flood meadows | Loddon pondweed *Potamogeton nodosus*<br><br>Snake's head fritillary *Fritillaria meleagris* | *Potamogeton nodosus* is thought to be sensitive to high nutrient levels and excessive sedimentation. Fennel-leaved pondweed *Potamogeton pectinatus* and other indicators of eutrophication are also frequent along the river. | System impacted by point sources such as STWs (e.g. Basingstoke).<br><br>No assessment undertaken to date of likely diffuse pollution loadings. | Improvements being implemented at Basingstoke STWs to reduce P levels. | 6 | 3 | 4 | low | **13** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Stour Estuary SSSI, SPA, cSAC | Essex | TM 180330 | Estuary | Intertidal sand and mud & saltmarsh communities | The situation is unclear from the information/data supplied.<br><br>Inorganic N input in class C-D category: very poor quality. Pollution indicators include reduced species diversity and algal mats.<br>The evaluation of risks and impacts of eutrophication in estuaries is currently the topic of a joint English Nature/EA/CCWs study.<br><br>Draft hydro-ecological reviews of selected European Sites within the Agency's Anglian Region have been done for the Stour (Dec. 2001) and the Orwell (Feb. 2002) – these will inform the Review of Consents for the Environment Agency. Elliot *et al* 1994. | A large proportion of catchment comprises agricultural land. There are a range of potential pollution sources (associated with urban and industrial catchment) that may be as important as those from agriculture (English Nature pers comm)<br><br>Herbicide run-off has been shown to cause stress to the Stour's saltmarsh plants, which may account for losses in recent decades (Mason *et al* 2003).<br><br>The Stour estuary has a high level of freshwater nutrient input but the sewage derived freshwater nutrient input is small. Mason *et al* 2002: Herbicides from agricultural run-off reduce photosynthetic efficiency of diatoms/higher plants. Sediments become less stable due to reduction in the diatom film covering substrates. | None | 5 | 2 | 7 | medium | **14** |
| Stover Park SSSI | Devon | SX833751 | Lake | Large lake rich in invertebrates with many rare and local species, and high floristic diversity of aquatic macrophytes. | Decline in macrophyte and invertebrate species over the last 10 years, resulting in an almost total loss of macrophytes and invertebrates from lake (e.g. Newbold, 2001) | Water quality data indicates that Stover Lake is mildly eutrophic. Sources of nutrient enrichment are likely to be crude foul discharges to the feeder stream via overloaded sewerage, a nearby industrial estate, run-off from the A38 road and wild fowl on Stover itself. There is a potential agricultural run-off in rural stretches of the feeder streams (Rose, 2003).<br><br>Newbold (2001) raises concern about sedimentation as during a site visit the main inflow stream was very turbid. | English Nature have the intention to run joint project with the Environment Agency. No further details were provided during the timescale of this project. | 8 | 5 | 3 | high | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Studland and Godlingston Heaths SSSI<br><br>Dorset Heaths (Purbeck & Wareham) and Studland Dunes cSAC<br>Dorset Heathlands SPA<br>Ramsar<br>Poole Harbour SPA, Ramsar | Dorset | SZ 030 845 | Lake | Oligotrophic waters containing very few minerals on sandy plains | Site contains probably the least impacted large oligotrophic lake in lowland England. Chemical water quality shows very low N but relatively high P suggesting ecosystem is N limited. | Lake considered highly vulnerable to enrichment from new diffuse N inputs e.g. from changes in land use or discharges to inflow stream. P source(s) unknown.<br><br>Part of catchment includes rural residential properties and agricultural grassland. But no further evidence provided during the timescale of this project. | Macrophyte survey and further chemical analysis under English Nature lake restoration project.<br><br>Review of EA discharge consents in catchment.<br><br>Survey of inflowing stream catchment to identify point discharges and potential diffuse pollution risk areas. | 10 | 1 | 5 | low | **16** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Sweat Mere and Crose Mere SSSI<br><br>Midland Meres and Mosses RAMSAR | Shropshire | SJ432304 | Lake | Open water, reedswamp, alder carr, wet grassland | Evidence on eutrophication impacts is unclear and conflicting. Bennion *et al* (1997) considered Crose Mere to be naturally eutrophic, but with current flora characteristic of highly eutrophic system. Aquatic macrophyte vegetation has undergone large changes during the 1970s, consistent with eutrophication. However studies by Carvalho and Moss (1998) found no clear evidence of eutrophication problem.<br><br>High P levels (TP = 215 ug/l) historically in Crose Mere but probably groundwater derived (Moss *et al* 1992); N levels fairly low and may be limiting.<br><br>Total P reconstruction from lake sediments suggest that TP has declined in recent decades to pre-enrichment levels (TP in 1993 = 85 ug/l) Water chemistry data for 1995-6 give a slightly higher index of TP at an annual mean of 111 ug/l (range 10-204 ug/l). Algal growth may be inhibited by grazing zooplankton. | Moss *et al* 1992 suggest P is groundwater derived and unlikely to result from diffuse agricultural run-off. However, no clear studies to determine nutrient sources.<br><br>Longer term eutrophication occurring since the 1850s, thought to be due to land use changes. Catchment is largely agricultural, although past agricultural inputs may have been reduced. Canada geese also considered to be a problem. | CSS in part of catchment<br><br>This site is included in the EA's NUPHAR project | 3 | 4 | 2 | low | **9** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Tamar-Tavy Estuary SSSI<br><br>Tamar Estuaries SPA<br>Plymouth Sound and Estuaries cSAC | Cornwall | SX 436711 and SX 474650 to SX 435591 | Estuary | Submerged/tidal sandflats and mudflats, estuaries, reefs, large shallow inlets and bays. Saltmarsh communities containing extensive and varied faunal communities and providing important feeding and roosting areas for large numbers of wintering and passage waterbirds. | Upper estuaries are subject to nutrient enrichment -low levels of dissolved oxygen have occurred periodically in the upper Tamar and may be responsible for salmonid deaths. There is very little specific information on sensitivity of estuarine macrofauna, or on the rare species and special interest features within the cSAC, to nutrient enrichment.<br><br>The sparse evidence suggests seagrass beds in the cSAC are relatively impoverished/ declining, potentially due to nutrient enrichment. Nutrient status considered to affect secondary productivity of benthos through effects on sediment and epibenthic flora, including phytoplankton. Invertebrates within the estuary likely to be affected by relatively high levels of PAHs, and certain pesticides recorded from some sediments. | Modelling of relative contributions of diffuse and point sources of nutrients to the Tamar Estuary (Fraser *et al* 2000), shows increases from 95.3% to 97.7% and 85.3% to 89.7% in diffuse sources of N & P respectively over 60 years. N export to the Tamar Estuary increased at a more rapid rate than P export (194% and 52% respectively). This is likely to be related predominantly to increases in stocking densities of cattle and sheep on grazing land (Langston *et al*, 2003). However, conversion of unfertilised moorland/rough grazing to intensively fertilised agricultural grazing land, and changes in fertiliser application rates may also contribute. Studies indicate levels of some pesticides and herbicides are elevated in sediments. (Langston *et al*, 2003)<br><br>Calculated relative loadings of N show STW sources to be an order of magnitude lower than freshwater loadings, which inputs from the River Tamar dominate (EA, pers comm). However, sewage discharges do constitute additional loading resulting in chronic contamination of affected areas, and nutrient-associated water quality problems. | Nutrient modelling work suggests that point sources should not be the primary focus in the development of eutrophication control action plans for this catchment. (However, in the tidal estuary point source inputs may be more important locally) | 6 | 3 | 6 | high | **15** |
| Teesmouth and Cleveland Coast SPA and Ramsar<br><br>Durham Coast SSSI/cSAC | Northumbria | NZ 455407 | Coastal Waters | Over-wintering waterfowl | Excessive growth of Enteromorpha leading to a reduction of mudflats available for feeding birds. Seal Sands designated as an Area Sensitive to Eutrophication under UWWTD. Monitoring work carried out by the Environment Agency gives summer loadings of N in the River Tees of 3000 kg/day. | Based on modelling results for the area, 50% of nutrient loading in the estuary is estimated to come from STW. The remainder is considered likely to be due to agricultural pollution. | The area has been designated an NVZ. Nutrient removal carried out at STWs. Further nutrient removal will be required in the future under the Habitats Directive. | 5 | 4 | 5 | high | **14** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Temple Sowerby Moss SSSI | Cumbria | | Mire | | No information available for this study | | | 9 | 4 | 5 | low | **18** |
| The Swale SSSI<br><br>The Swale SPA and RAMSAR | Kent | TR000670 | Grazing marsh Ditch System Estuarine habitats - mudflats, saltmarsh | Grazing marsh ditches with nationally scarce and RDB and plants/invertebrates | Ditch system receives drainage from large agricultural catchment, including pasture and arable.<br><br>Perceived increases in cover of *Lemna* and filamentous algae. | Limited water quality data from 10 sampled ditches in 1995 - may suggest P and N levels higher on some margins of the site, adjacent to agricultural land. TP at 35 ug/l in one sampled ditch in 1993 not strongly suggestive of eutrophication (Carvalho & moss 1998).<br><br>English Nature RR 167 (1995) - Survey of Ditch Flora of North Kent Marshes: Extensive plant/invertebrate field survey data but little supporting chemical data. High cover of Lemna and filamentous algae in many areas during the summer months.<br><br>However, no data to link directly to diffuse agricultural pollution. | English Nature management agreements with owners in North Kent Marshes ESA, including buffer strips.<br><br>EA desk review of rare invertebrates - determining susceptibility to WQ. | 4 | 2 | 5 | low | **11** |
| Toller Porcorum SSSI<br><br>West Dorset alder Woods cSAC | Dorset | SY 550995 | Wet Woodland | Wet alder-ash woodland W5, W7, W8 | Unknown impact on plant and animal communities but probable negative to plant health e.g. alder die-back (English Nature, pers comm). | Water quality failing in River Hooke, this is thought to be due to agricultural run-off. However, no further information was supplied during the course of this project. | EA assessment | 2 | 1 | 5 | low | **8** |
| Tweed Catchment Rivers – England: Till catchment SSSI<br>Tweed Catchment Rivers – England: Lower Tweed and Whiteadder SSSI<br><br>River Tweed cSAC | Northumbria | NT 870429 To NT 837301<br><br>NT 790379 | River | Salmon, all three species of British lamprey, otter, Ranunculus (water-crowfoot) community. | Tweed estuary highlighted by English Nature as having potential for designation as a polluted area (eutrophic) under the Nitrates directive . Condition assessment carried out on Tweed catchment Rivers in 2002 found all units in Lower Tweed and Whiteadder SSSI and the majority of sites in Till catchment SSSI to be in unfavourable condition in terms of water quality. Failures commonly due to biological class (GQA) and elevated BOD. | SEPA produced modelling action plan report for the River Tweed and some tributaries (SEPA), which indicates that 96% of N loadings are from diffuse sources and 43% of P (upriver of Norham).<br><br>The Conservation Strategy for the Tweed Catchment Rivers (NES, 1998) considers that pollution leading to eutrophication of the Tweed is likely to be predominantly runoff from agriculture. | Encouraging farmers to apply for Countryside stewardship Schemes and English Natures Wildlife Enhancement Scheme.<br><br>The Environment Agency are committed to a programme of ecological monitoring for 2003 within the Tweed/Till to investigate failures against River Quality Objectives for parameters such as BOD and nutrients possibly associated with diffuse agricultural run off. | 7 | 3 | 9 | high | **19** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Walland Marsh SSSI | Kent | TQ960240 | Grazing marsh Ditch System | Field dykes and larger waterways, including brackish and freshwater<br><br>Botanically rich dykes and rich invertebrate fauna | Observation of algal and *Lemna* blooms, particularly on main drains which flow from arable land onto the SSSI. Fish kill reported in the Royal Military canal.<br><br>High nutrient levels recorded in main drains high. TP concentration in 1993 of 290ug/l in Guldeford/Petty Drain and 590 ug/l in Pump Sewer Drain (Carvalho & Moss 1998). | Ditch system receives drainage from intensive arable agricultural catchment. Large area of former grazing marsh ploughed to arable since 1930s.<br><br>High TP levels may be the result of water pumped into site from the Union Channel in dry summers in 1990 and 1991. This water derives ultimately from the R. Rother which is subject to high levels of P input from STWs. | Management agreements with SSSI owners for on-site pollution.<br><br>Royal military canal is subject to AMP3 studies for STWs pollution, but agricultural pollution remains a problem.<br><br>Nutrient modelling 2003 | 6 | 4 | 5 | low | **15** |
| Water End Swallow Holes SSSI | Hertfordshire | TL 230043 | | Site has geological important sinkholes in chalk with an adjacent willow carr/swamp of biological importance | Main problem is excessive silt transportation and deposition by the Mimmshall Brook. The silt is deposited in the basin surrounding the swallow holes, where it both chokes existing holes and restricts formation of new ones. Surrounding grassland now comprises mainly tall ruderal vegetation, obscuring topography and creating unsafe conditions.<br><br>There has been a gradual change in the basin from predominately grassland areas in the 1940's to areas of ruderal and short perennial vegetation now dominated by nettles (Roberts, 1989, G Wyatt, pers. comm). This is attributed to the combination of increased sedimentation and high nutrient content of the sediment. | Roberts (1989) concludes that there is enough evidence to suggest that the swallow holes have a reduced capacity to accept the discharge of the Mimmshall Brook, and the causes of this relate to changes in the catchment. The silt derives from bank erosion, urban run-off and from agricultural run-off owing to increased urbanisation and conversion of grasslands to arable with subsequent increased field drainage and straightening/dredging of the headwaters (Sear *et al*, 1994). | Most work carried out has focused on predicting potential impacts of various flood defence schemes rather than attempting to tackle sources of silt from the catchment. | 4 | 2 | 6 | medium | **12** |

| Site Name & Nature Conservation Designation(s) | County | NGR | Habitat Type | Features at Risk | Evidence of Pollution Impacts | Evidence of Diffuse Agricultural Pollution | Current / Proposed Action | Habitat Sensitivity | Evidence Scores | | Confidence Rating | Site Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Pollution impacts | Diffuse agricultural pollution | | |
| Weston Fen SSSI<br><br>Waveney and Little Ouse fens cSAC | Suffolk | TL 981 787 | Other Fens | Calcareous fens with *Cladium mariscus* and the species of the *Caricion davallianae Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)<br><br>Desmoulin's whorl snail *(Vertigo moulinsiana)* | Algal growth in fen after flooding incidents. | Site is surrounded by agricultural land. It has been suggested that the surrounding soils could feed nutrient rich water onto the site. The channel running through the site also drains arable land, but is mainly composed of outflow water from an adjacent STWs.<br><br>No directly attributable data available/provided within the timescale of this study. Further data may be available for future studies. | None. | 8 | 3 | 5 | low | **16** |
| Yealm Estuary SSSI, Plymouth Sound and Estuaries cSAC | Devon | SX 550 050 | Estuary | Communities characteristic of different salinities supporting extremely rich marine flora and fauna. | There are reports of elevated siltation levels by local mariculture (English Nature, pers comm).<br><br>Environment Agency monitoring data show high P concentrations (average 0.39mg/l) and high concentrations of nitrate (up to 27.86mg/l) were recorded in the Yealm . 56% of all mean annual nitrate values are above the 1mg/l effects level suggested by Deegan *et al* (1997) as responsible for poor habitat quality for estuarine fish populations, (due in part to cloaking effects of macroalgal mats on Zostera beds). The Yealm also experiences low DO levels. (Langston *et al*, 2003).<br><br>There is very little specific information on sensitivity of estuarine macrofauna, or on the rare species and special interest features within the cSAC, to nutrient enrichment. | Relative loadings of N have been calculated which show that STW sources are lower than freshwater loadings.<br><br>The nature of the catchment means the majority of nutrient inputs in the system may be diffuse sources such as agricultural run-off but sewage discharges constitute additional loading and result in chronic contamination of the affected areas (Langston *et al*, 2003). | Environment Agency to investigate sources of diffuse pollution | 4 | 3 | 6 | low | **13** |

**Table 4: Priority scores and confidence ratings for 105 higher priority sites**

| Site Score 17-<22: Highest priority sites | | | | | Site scores 14-<17 | | | | | Site Scores 7-<14 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Name | Site scores | | | Confidence Rating | Site Name | Site scores | | | Confidence Rating | Site Name | Site scores | | | Confidence Rating |
| | A | B | C | | | A | B | C | | | A | B | C | |
| Slapton Ley | 8 | 4 | 9 | high | Bassenthwaite Lake | 7 | 4 | 5 | high | Blo' Norton and Thelnetham Fen | 5 | 3 | 5 | low |
| River Avon System | 8 | 4 | 8 | high | Black Firs & Cranberry Bog | 8 | 3 | 5 | medium | Bridgwater Bay (Pawlett Hams) | 5 | 3 | 5 | low |
| Hawes Water | 9 | 3 | 7 | medium | Combe Haven | 6 | 3 | 7 | low | Frome St Quintin | 6 | 2 | 5 | low |
| Moorthwaite Moss | 9 | 4 | 6 | medium | Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses | 9 | 2 | 5 | low | Lathkill Dale | 7 | 2 | 4 | medium |
| Newton Reigny Moss | 9 | 4 | 6 | medium | Flitwick Moor | 9 | 2 | 5 | low | North Somerset Moors | 6 | 2 | 5 | medium |
| River Till | 8 | 4 | 7 | medium | Poole Harbour | 6 | 4 | 6 | medium | Ouse Washes | 6 | 4 | 3 | medium |
| Tweed Catchment Rivers | 7 | 3 | 9 | high | River Ant catchment | 6 | 3 | 7 | medium | Rempstone Heaths | 6 | 2 | 5 | low |
| Biglands Bog | 8 | 4 | 6 | medium | River Axe | 7 | 3 | 6 | medium | River Yare catchment | 6 | 3 | 4 | medium |
| Chesil and the Fleet | 7 | 3 | 8 | high | River Bure catchment | 6 | 3 | 7 | medium | Somerset Levels and Moors | 5 | 3 | 5 | medium |
| River Frome | 8 | 3 | 7 | high | River Camel | 8 | 3 | 5 | medium | Sprat's Water and Marshes | 6 | 2 | 5 | low |
| River Lugg | 8 | 3 | 7 | medium | River Coquet and Coquet Valley Woodlands | 7 | 3 | 6 | medium | Stanford End Mill & River Loddon | 6 | 3 | 4 | low |
| River Wye | 8 | 3 | 7 | medium | River Teme | 8 | 3 | 5 | medium | Yealm Estuary | 4 | 3 | 6 | low |
| Temple Sowerby Moss | 9 | 4 | 5 | low | River Wensum catchment | 6 | 3 | 7 | medium | Alde-Ore Estuary | 4 | 3 | 5 | medium |
| Cliburn Moss | 9 | 4 | 5 | low | Sandwich Bay to Hacklinge Marshes | 6 | 4 | 6 | low | Benacre to Easton Bavents | 5 | 2 | 5 | low |
| Cumwhitton Moss | 9 | 3 | 5 | low | Stover Park SSSI | 8 | 5 | 3 | high | Blackwater Estuary | 5 | 2 | 5 | low |
| Lindisfarne | 5 | 4 | 8 | high | Studland and Godlingston Heaths | 10 | 1 | 5 | low | Colne Estuary | 5 | 2 | 5 | low |
| Muckfleet catchment | 6 | 3 | 8 | medium | Weston Fen | 8 | 3 | 5 | low | Cothill Fen | 5 | 2 | 5 | low |
| Redgrave and Lopham Fens | 8 | 3 | 6 | medium | Betley Mere | 6 | 3 | 6 | medium | Crouch & Roach Estuaries | 5 | 2 | 5 | low |
| River Derwent & Tributaries | 8 | 3 | 6 | low | Clarepool Moss | 9 | 1 | 5 | low | Deben Estuary | 4 | 3 | 5 | medium |
| River Itchen | 8 | 3 | 6 | high | Loe Pool | 8 | 4 | 3 | medium | Hamford Water | 5 | 2 | 5 | low |
| River Test | 8 | 3 | 6 | high | River Derwent | 7 | 3 | 5 | high | Water End Swallow Holes | 4 | 2 | 6 | medium |
| River Thurne catchment | 6 | 3 | 8 | medium | River Kennet | 7 | 3 | 5 | high | Abberton Reservoir | 4 | 3 | 4 | low |

| Site Score 17-<22: Highest priority sites | | | | | Site scores 14-<17 | | | | | Site Scores 7-<14 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Name | Site scores | | | Confidence Rating | Site Name | Site scores | | | Confidence Rating | Site Name | Site scores | | | Confidence Rating |
| | A | B | C | | | A | B | C | | | A | B | C | |
| | | | | | River Lambourn | 7 | 3 | 5 | medium | Chichester Harbour | 4 | 3 | 4 | medium |
| | | | | | River Waveney catchment | 6 | 3 | 6 | medium | Dove Valley and Biggin Dale | 7 | 2 | 2 | high |
| | | | | | Tamar-Tavy Estuary | 6 | 3 | 6 | high | Exe Estuary | 4 | 3 | 4 | low |
| | | | | | Walland Marsh | 6 | 4 | 5 | low | Hanningfield Reservoir | 4 | 3 | 4 | low |
| | | | | | Aqualate Mere | 6 | 3 | 5 | medium | Hatfield Chase Ditches | 4 | 2 | 5 | low |
| | | | | | Barnby Broad | 6 | 3 | 5 | low | Hunsdon Mead | 4 | 2 | 5 | low |
| | | | | | Blackbrook Reservoir | 6 | 3 | 5 | low | Leighton Moss | 4 | 3 | 4 | medium |
| | | | | | Bradgate Park and Cropston Reservoir | 6 | 3 | 5 | low | Marton Pool | 4 | 2 | 5 | medium |
| | | | | | Buddon wood and Swithland Reservoir | 6 | 3 | 5 | low | River Beult | 4 | 2 | 5 | low |
| | | | | | Chippenham Fen | 6 | 3 | 5 | low | River Blythe | 4 | 2 | 5 | low |
| | | | | | Cop Mere | 6 | 3 | 5 | medium | The Swale | 4 | 2 | 5 | low |
| | | | | | Fal and Helford | 6 | 3 | 5 | high | Halvergate Marshes | 3 | 2 | 5 | low |
| | | | | | Orwell Estuary | 4 | 3 | 7 | high | Cressbrook Dale | 7 | 1 | 1 | low |
| | | | | | Pevensey Levels | 6 | 3 | 5 | high | Erme estuary | 2 | 2 | 5 | low |
| | | | | | River Eye | 6 | 3 | 5 | low | Fenemere | 4 | 2 | 3 | medium |
| | | | | | River Mease | 7 | 2 | 5 | low | Hornsea Mere | 3 | 3 | 3 | medium |
| | | | | | Stour Estuary | 5 | 2 | 7 | medium | Minsmere-Walberswick Heaths and Marshes | 2 | 2 | 5 | low |
| | | | | | Teesmouth and Cleveland Coast | 5 | 4 | 5 | high | Salcombe to Kingsbridge Estuary | 2 | 2 | 5 | low |
| | | | | | | | | | | Sweat Mere and Crose Mere | 3 | 4 | 2 | low |
| | | | | | | | | | | Toller Porcorum | 2 | 1 | 5 | low |
| | | | | | | | | | | Birches Barn Meadow | 1 | 1 | 5 | low |

A: Habitat sensitivity score
B: Pollution impacts score
C: Diffuse agricultural pollution score

**Table 5: The relationship between evidence of diffuse pollution scores and confidence ratings**

| Confidence rating | Score for evidence of diffuse agricultural pollution | | |
|---|---|---|---|
| | **High (6+)** | **Medium (5)** | **Low (<5)** |
| High | Site evaluation based on substantial empirical evidence such as detailed studies indicates diffuse agricultural pollution is the main or only known source of pollution. These sites represent those where actions to tackle diffuse pollution is considered most appropriate on the basis of existing information | Site evaluation based on substantial evidence indicates diffuse agricultural pollution is a significant issue at this site. However, other threats or pollution sources have also been identified and action may equally be required to address these issues. | Site evaluation based on substantial evidence indicates diffuse agricultural pollution is unlikely to constitute most significant risk to ecological interest features. |
| Medium | Site evaluation based on strong anecdotal or limited empirical evidence indicates diffuse agricultural pollution is the main or only known source of pollution. Further investigation either through the commission of specific studies or further collation of data is advised prior to action | Site evaluation based on strong anecdotal or limited empirical evidence indicates diffuse agricultural pollution is a significant issue at this site. Further investigation either through the commission of specific studies or further collation of data is advised prior to action to confirm significance of diffuse contributions. | Site evaluation based on strong anecdotal or limited empirical evidence indicates diffuse agricultural pollution is unlikely to constitute most significant risk to ecological interest features. Further investigation either through the commission of specific studies or further collation of data is advised before site is excluded from high priority list. |
| Low | Unconfirmed or anecdotal information indicates that primary risk factor is likely to be diffuse agricultural pollution, but no empirical data available within the timeframe of this study. Further investigation should be undertaken to inform future decision making | Little or no quantitative information on sources of pollution available within the timescale of this study. It is not possible to assess the scale of diffuse pollution impacts on the evidence available. Score allocated are highly provisional and further investigation or data review is required | Unconfirmed or anecdotal information indicates diffuse agricultural pollution is unlikely to be primary risk factor but no empirical data available within the timeframe of this study. Site should not be excluded from priority action unless further investigation excludes major diffuse pollution issues. |

# 6. Discussion

## 6.1 General

The findings of this study clearly indicate that diffuse agricultural pollution is of widespread concern in England, with 72 of 156 (46%) of English river catchments containing designated wetland sites considered to be impacted by or at risk from diffuse agricultural pollution (Figure 2). This distribution is skewed by both the levels of information available and the distribution of designated wetland sites throughout the UK, and current thinking is that virtually all wetland sites in the UK are impacted by diffuse agricultural pollution to some extent (Penny Johnes pers. comm).

The highest and medium scoring sites that have high scores for evidence of diffuse agricultural pollution and high confidence levels represent those where action to tackle diffuse agricultural pollution is considered to be the most urgent and appropriate, based on available information. However, all sites highlighted during this study, particularly those on the higher priority list are considered to be at risk and require some form of action. The study has highlighted several key difficulties in prioritising sites, the majority of which are associated with the availability and relevance of information that can be used to make clear judgements.

All aquatic systems are subject to a range of environmental stresses, and the state of the biological community is, in part an expression of their combined effects. Key stresses other than diffuse agricultural pollution include physical habitat modification, changes in hydrological regime (caused by abstraction and/or impoundment) and toxic pollution, from both point and diffuse sources (including pesticides from agriculture, such as sheepdip). Since the biological effects caused by combinations of stresses can differ from the effects of individual stresses, it can be very difficult to isolate the influence of each stress on overall biological change. Even where demonstrable ecological effects of some form of habitat deterioration exist, it can be very difficult to determine the extent to which these are due to diffuse agricultural pollution rather than some other cause.

The situation is further complicated by the fact that neither ecosystem responses to increased nutrient levels, nor their responses to nutrient reduction programmes, are easily predictable. This is due to the range of factors influencing competitive interactions between plant (higher plant and algal) species. The relationship between ecological state and nutrient levels is therefore probabilistic and not deterministic (unlike most toxic impacts). A further management difficulty is the lag-time often occurring between the imposition of catchment management controls on nutrient inputs, and evidence of changes in the nutrient status and/or ecology of the receiving habitat.

The difficulties in linking 'cause with effect' in relation to diffuse agricultural pollution are clearly highlighted in the evidence gathered for this study. Many cases of suspected diffuse pollution lack clear evidence for impacts and often cannot be directly linked to evidence relating to the contributions made by diffuse agricultural sources. Further problems relate to sites where some form of nutrient reduction has been implemented at point sources (e.g. the impact of P stripping from sewage treatment works discharges on Bassenthwaite Lake); often the effects of P removal have not been translated quickly into an amelioration of the impact on receiving waters.

## 6.2 The need for catchment-level appraisal

In order to determine the contribution to pollution made by agriculture and to understand the mechanisms of diffuse pollution and generate effective means of tackling pollution sources and their impacts, it is essential to focus attention at the catchment scale. Only at this scale of appraisal is it possible gain an overview of catchment issues that will allow informed and targeted action at a site-specific level whilst ensuring integrated delivery of national, regional and local policy objectives. Although catchment-scale investigations have already been undertaken at some of the sites highlighted during this study, there are many other sites where such work is urgently required.

The information required to account comprehensively for diffuse pollution sources and transport at the catchment scale requires a range of spatial data, which is not available for many sites including:

- land use distribution data - including crop types and locations, number and distribution of livestock by type and tillage practice;
- soil properties, both physical and chemical;
- climate data - including atmospheric deposition of N and P;
- land management practices, including information on inorganic fertiliser applications; biosolids applications and nutrient content; manure spreading; grazing animal management, excreta output and nutrient content; crop and livestock nutrient removal.

A summary of the potential datasets used for the current DEFRA PE0202 project 'Development of a risk assessment and decision-making tool to control diffuse loads of phosphorus and particulates from agricultural land' (the so-called PSYCHIC project) is given in Table 6 below. These datasets are common to many diffuse pollution studies at the catchment scale and could be more widely utilised to characterise the diffuse pollution and risk on a catchment scale.

**Table 6: Summary of potential datasets used for DEFRA PE0202 project**

| Dataset | Use |
|---|---|
| BGS geology maps | Demarcation of areas of variable hydrology/soil type interaction |
| SSLRC soil map | Differentiate soil type |
| CEH digitised river network/surface water boundaries | Quantifying catchment hydrology via stream density/length and surface water boundaries |
| HOST class | Derived dataset for classifying surface and sub-surface flow based on soil type |
| ADAS Magpie | Quantifying land use and animal numbers |
| Population statistics | Quantifying any point source contribution. |
| OS or CEH DTM | Differentiating slope/flow pathway analysis |
| AGROMET climate | Quantifying hydrologically effective rainfall |
| NSRI National Soils Inventory | Rationalising soil TP and Olsen-P status with land use/soil type/geology |
| DEFRA RSSS | Rationalising Olsen-P status with land use/soil type/geology |
| OS NTF | Identification of preferential connectivity pathways/field sizes/hedge positions/road/track density |
| BGS groundwater boundaries | Identify catchment boundaries |
| EA catchment water quality/archives | River water quality class data available on GIS |
| EA gauged data | Routine water quality monitoring data |
| NSRI erosion risk map | Demarcating areas of variable erosion risk |

## 6.3 Limitations of current knowledge

There are three key limitations to current knowledge concerning the risk of diffuse agricultural pollution. These are:

- quantifying actual nutrient delivery from agricultural sources to watercourses, as opposed to using models to predict delivery, or relying on empirical experiments at the plot or field scale and extrapolating from these to inputs to water;
- evaluating the impact of these inputs in terms of in-stream processes and nutrient recycling, and
- understanding the ecological processes and interactions which result in (or mitigate) actual biological impacts in particular ecosystems or sites, as opposed to generalised accounts of expected ecological impacts.

For example, it is known that excess P is reaching watercourses where it may promote changes in ecosystem structure, and that much of this P comes from diffuse agricultural sources. DEFRA has funded considerable research that has highlighted the potential diffuse and small point sources of agriculturally-derived nutrients reaching watercourses (e.g. MAFF NT10 R&D), and the transport routes they may follow within the landscape. However, quantifying P delivery to water has thus far eluded researchers and hinders the effective mitigation of P losses from land. This is because the delivery function is a landscape-scale feature that cannot be wholly described by small-scale, site-specific studies.

Whilst the PSYCHIC project (see below) is being developed as a pragmatic means of bridging the gap between site-specific studies and landscape-scale processes, new research is needed to meet the limitations of current knowledge. This will require field and modelling research to investigate the key landscape functions controlling nutrient delivery. Part of the difficulty in doing this is that the risk of diffuse agricultural pollution often depends on co-location of a number of factors. For example, total sediment transport or P loss is greater if high-risk crops are placed in high-risk situations (river banks, steep slopes) than if they are confined to low-risk areas. Assessment therefore requires good knowledge of the spatial distribution of critical factors but such information is often lacking at the resolution needed to accurately quantify diffuse nutrient delivery to water. Consequently, many catchment-scale models, especially those intended for policy use, work at scales of 1 km or coarser, using probabilistic determinations of fine-scale factors that cannot be estimated directly because of these data limitations. Even these relatively coarse-scale measures of nutrient loss and delivery have so far only been applied in a small number of catchments.

There is also a need for further research in relation to the impacts of agricultural pollution in particular ecosystems and sensitive sites. Whilst the general principles of ecological impacts from eutrophication and excessive sedimentation are well known and documented, the complex ecological interactions which follow delivery to particular water bodies are varied and poorly understood. The major pollutants (P, N, and fine sediment in terms of both the physical properties and the contaminants adsorbed onto sediment surfaces) often coincide in impacted systems and their biological impacts vary with the water chemistry of receiving waters and with physical habitat characteristics and processes - including habitat structure, soil and geology types, substrate character and hydraulic properties.

For example, moderately elevated inputs of nutrients and silt in fast flowing streams may not result in obvious ecological impacts - especially in upper catchments, (e.g. R. Tweed SSSI) - since nutrients and sediments are rapidly exported downstream. Impacts may be more apparent downstream where sediment deposition and nutrient pressures may accumulate. Upper catchments tend to be more at risk from chronic point sources than from rainfall-related land sources. However, there is scope for siltation in small energetic rivers, where even small-scale deposition of nutrient-rich particles in low-energy zones may constitute ecologically significant loadings.

Lowland river systems tend to be naturally more eutrophic (e.g. River Bure catchment - Crostwick Marsh SSSI and Bure Broads and Marshes SSSI) and high in silt deposition and as such it can be difficult to detect clear indications of ecological change resulting from diffuse pollution impacts. Although some sites, for example the Cheshire Meres (Carvalho & Moss, 1998) appear to be naturally eutrophic, they may be adversely enriched by diffuse agricultural pollution towards the upper end of eutrophy or into hypertrophy. At some lakes nutrient-rich bed sediments, originating from either point or diffuse sources may be resuspended by benthic cyprinids resulting in greater ecological effects than would occur if the sediments were undisturbed.

In estuarine or coastal sites, there is evidence that near-coastal zones characterised by mudflats are suffering from eutrophication, resulting in the growth of dense algal mats. Excessive algal growth can interfere with invertebrate communities and feeding by internationally important bird assemblages (e.g. Lindisfarne NNR, SSSI and SPA and Berwickshire and North Northumberland Coast SSSI, cSAC and SPA). However, such ecosystems are naturally highly productive and usually receive inputs from extensive inland catchments as well as from adjacent seawaters. It is often very difficult to model the contribution of nutrients from different sources in such circumstances, or to understand their biological impacts. Such cases are often further complicated by the fact that the major inland watercourses are themselves affected by an unquantified mixture of point and diffuse pollution sources (e.g. Exe Estuary SSSI, SPA). An additional difficulty in assessing sources of pollution in estuaries is the extent to which elevated nutrient levels may be a result of entrainment from adjacent estuaries. This was particularly highlighted during this study when investigating the Essex estuaries where although research to identify sources of pollution has been undertaken it has not been possible to quantify the influence of the Thames and Humber estuaries and the Wash.

During the course of this study it has generally been most difficult to assess the level and effects of diffuse agricultural pollution at those habitats that are water-dependent rather than aquatic, such as wet woodland or grassland and washland areas (e.g. Toller Porcorum, Hunsdon Mead and Birches Barn Meadows SSSI). This was due to the limited information available on either evidence of diffuse pollution and evidence of ecological effects at the majority of these sites. As these habitats are not strictly aquatic there is often little research specifically into their hydrology or diffuse agricultural pollution in their feeder waters, which means that it is difficult to pinpoint the causes of perceived declines on their condition.

Whilst considerable action has been undertaken in many catchments to address point sources of pollution, there has often been little or no action to specifically address diffuse agricultural pollution at either catchment or site levels in many instances. Even where some actions to tackle diffuse pollution are planned these are generally in the form of very low-key advice with limited likelihood of significant land management change

Specific studies have been undertaken at some sites, for example at Slapton Ley, model forecasting has been carried out to determine the optimum catchment-based strategy for the Slapton catchment (Johnes, 1996; Johnes and Heathwaite, 1997). This found that relocating higher risk land uses and livestock to areas away from the riparian zone with greater nutrient retention would reduce the nutrient loading on Slapton, with no net reduction in the intensity of agricultural production in the catchment. Studies of this type have been particularly useful during the prioritisation process as they combine the key elements of evidence of ecological effects and diffuse pollution and also propose mechanisms by which the problems can be addressed. This enables both financial and physical effort to be targeted in those areas where they are most likely to achieve significant results.

It should be noted that research carried out at Slapton also highlighted the need for lake restoration works if the conservation interest of the site is to be restored. This is likely to be the case for a large number of sites, particularly slow-flowing and still water habitats, where problems such as accumulations of nutrient-rich sediments may continue to impact on water quality after the inputs themselves have been controlled. It is likely that although actions to tackle diffuse pollution will help prevent further deterioration, some form of habitat management activity will be required at many sites before a demonstrable improvement in ecological state is attained.

## 6.4 Research development needs

Diffuse pollution modelling requires accurate and sensitive treatment of spatial data over catchment or landscape-scale units. The spatial variations in catchment characteristics may be modelled using lumped, distributed or topological representations. The extent to which models based on any of these representations may be validated depends on the quality of the available data. Distributed models require detailed field data to accurately capture the true variation in the catchment, while lumped approaches assume the point scale collection of catchment data are representative of internal catchment processes which are not calibrated. Topological representations of catchment hydrology are becoming more popular through the construction of GIS-based models of catchment structure and function for use as decision support systems for catchment management (e.g. Heathwaite, 2003). More recently, this topological approach has also been applied to diffuse nutrient pollution and may assist in refining the modeling of nutrient loading and transport at a catchment scale (Heathwaite *et al.* 2003).

Future research needs to tackle the following key areas:

- addressing diffuse agricultural sources of pollution in a strategic way as required by the EC Water Framework Directive (WFD);
- devising measures to protect sites designated for freshwater wildlife that are at high risk from diffuse agricultural source, and
- developing appropriate action plans for eutrophication control, and doing this in a way that is cost-effective.

The tools needed to do this at the scale at which action needs to be taken– the catchment to river basin scale - are not currently in place. Here water protection for groundwaters and surface waters must be considered within the broader context of land-use planning. This

means better risk-based decision-making tools will need to be developed, understood and used.

Probably the key research tool requiring development is a pragmatic decision support system to assess the relative importance of source and delivery factors governing the magnitude of diffuse agricultural pollution. The challenge is keeping this system simple enough that it can be used to develop practical and cost-effective nutrient control strategies that may be applied at the catchment scale, whilst ensuring that the individual parameters in the DSS are calibrated and validated. The Phosphorus and Sediment Yield Characterisation in Catchments (PSYCHIC) Project is currently developing a GIS-based decision support system for locating specific source areas of agricultural P pollution. The project utilises a two-stage approach including an initial identification of high risk areas using coarse scale (1 km2) datasets, based on risk assessment methodology, followed by more fine-scale (field/farm) assessment of specific source areas of particulates and P within the high risk areas, and the loads of particulates and P exported from them. Informed process-based modelling will then be used to select cost-effective control practices and quantify the impact of changes in land management and P inputs on particulate and P export at the field and catchment scale. The system will help form the basis for cost-effective control of particulate and phosphorus loss from agricultural land to water in catchments.

A further example of a nutrient export DSS is being developed by Heathwaite *et al.* (in press) to evaluate the environmental risk of biosolids, manures and fertiliser applications to agricultural land.

Whilst the DSS and modelling approaches outlined above will be invaluable in assessing and quantify the sources and magnitude of agricultural pollution impacts they will not supply information on the effects of known inputs in the relevant aquatic ecosystem. An ecological risk assessment tool needs to be developed that is capable of quantifying the relative magnitude of ecological impacts in particular sites and the vulnerability of particular ecosystems or sites to diffuse pollution impacts, logically through the definition of critical pollution loads and/or concentrations.

These parallel assessment processes will refine further the prioritisation of sites and catchments where action is required most urgently to tackle the causes and impacts of diffuse agricultural pollution.

# 7. Conclusions and recommendations

This study was undertaken to identify designated sites in England that are considered to be the most sensitive to or impacted by diffuse pollution inputs from agriculture. Specifically it aimed to highlight areas where targeted catchment-based action to tackle diffuse agricultural pollution such as that proposed by the 'Plan Plus' package, or other relevant policy is most urgently required.

Whilst all sites studied are considered to be at risk from diffuse agricultural pollution, a number of designated sites have been identified as being of particular priority for action. This judgement has been made based on the sensitivity of the sites and the nature and extent of supporting information identifying the sources and nature of diffuse pollution inputs and their impacts on receiving waters.

Locating and quantifying sources of diffuse pollution and understanding their transport and delivery to designated sites requires an objective risk assessment process at the catchment-level. At the majority of sites such studies have not been undertaken and need to form part of a strategic action plan.

Similarly, as ecosystem responses to nutrient and sediment inputs vary between sites, pragmatic pollution thresholds (based on loads or concentrations) are needed for different ecosystem types that indicate the acceptability of pollution stress and provide management targets for restoration. Such thresholds need to be based on best understanding of mechanisms of impact and the sensitivity of characteristic biological communities, and underpinned where needed by new R&D.

In order to ensure that funds are targeted towards the most appropriate sites for action and that appropriate site-specific actions are implemented, the following actions are recommended:

- Where sites have been identified as being significantly impacted by diffuse agricultural pollution, based on supportable evidence of both diffuse pollution inputs and associated ecological effects, these sites should be prioritised for targeted catchment-based action, such as that proposed in the 'Plan Plus' package.
- Where sites have been identified as being impacted by pollutants typically associated with agriculture, but the significance of diffuse agricultural pollution is not clear, resources should initially be targeted towards catchment-scale investigations aimed at clarifying the issue prior to determining the need for strategic targeted action
- Where evidence of diffuse agricultural pollution exists, but little investigation has been undertaken into the consequences of such pollution for ecological interest features of receiving designated sites, such investigations should form part of the action programme for these sites (using generic pollution thresholds relating to ecosystem type as appropriate).
- Future research should include the development of parallel risk assessment tools for diffuse pollution sourcing and ecological impacts. These tools would help further refine the prioritisation process and would be of particular value if the 'Plan Plus' approach is extended in the future.

The provision of site-specific management guidelines is outside the scope of this study. However, it should be recognised that the effects of historic pollution inputs from agriculture or other sources may continue to act upon the aquatic ecosystem even after diffuse pollution inputs have been treated. This is particularly likely to be the case in enclosed waterbodies and waters with high retention times where, for example accumulations of high organic sediments may persist. In such circumstances it may be necessary to combine actions to tackle diffuse pollution inputs with site-specific habitat management measures if a demonstrable improvement in ecological status is to be achieved

Diffuse agricultural pollution of designated sites rarely occurs in isolation from other sources of pollution, particularly from effluent discharges but also, in certain areas, from other land management operations such as forestry. It is vital that all sources of pollution are adequately controlled if ecological benefits are to be realised.

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# *Appendix 1 Stage 1 list*

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Beds. & Cambs. | Ouse Washes SAC | | Spined loach and associated river/drain habitat | 2 | 8 | 10 | y | | 10 | History of late summer fish kills due to low DO. Possible factors causing low DO include die back or night time respiration of algae (excessive growth likely relating to P & N). Also BOD loadings. Winter drainage of agriculture into the SAC cause silt build ups/ stratification of silts which may be unfavourable for the spined loach. | Independent investigation into most recent (August 2002) fish kill. EA and English Nature are providing evidence for this investigation. |
| Beds. & Cambs. | Ouse Washes SPA | | Summer breeding wader assemblage and associated marshy grassland & ditches | 10 | 10 | 8 | | | 10 | Summer slacker intakes of water for the site come from the Bedford Ouse which has anything up to 10 times the conservation objective targets for P & N. Nutrient enrichment of the water is adversely affecting marshy grassland plant communities and notably the aquatic ditch flora. Several reports incl. (Cadbury *et al*., 2001) and (Newbold, 1997) document decline in the ditch flora attributed to nutrient enrichment. A hydro-ecological review of the site (2001) estimates that approx 80% of total P is derived from sewage treatment works, the remainder diffuse. N is more attributed to agriculture. However, such figures are not based on detailed modelling and are much disputed. | Site listed on AMP4 but no action to tackle diffuse pollution. |
| Beds. & Cambs. | Flitwick Moor | | Valley mire | 4 | 6 | | 2 | | 8 | Negative changes in plant communities and loss of key bog plant species (documented in various reports). Bog species are particularly sensitive to nutrient enrichment and air-borne N. | None |
| Beds. & Cambs. | Cam Washes SSSI | | Fen with open water and ditches. | 5 | 5 | 5 | | | 5 | Perceived negative changes to fen/ ditch plant communities through nutrient-enriched water from River Cam. However, lack of definitive data for vegetation change and changes in river water quality with time. | None |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Beds. & Cambs. | Portholme SAC | | Neutral flood meadow | 4 | 5 | 5 | | | 5 | Site requires traditional flooding from the Bedford Ouse but suffers from nutrient enrichment (see above Ouse Washes SPA). Neutral meadow plant communities are slower to show change in relation to nutrient enrichment than ditch communities and the process is difficult to measure or monitor. However, negative changes to plant communities have been recorded and there are perennial summer dock/ thistle infestation problems believed to be linked to N-enriched silts deposited during winter months. | Actions for scientific investigations under AMP4 and EA Review of Consents but no action on the ground to tackle diffuse N & P. |
| Beds. & Cambs. | Woodwalton Fen NNR (part of Fenland SAC) | | Open fen & ditches | 5 | 5 | 5 | | | 5 | Open fen communities and particularly ditch communities are affected by nutrient status of water which feeds the fen from surrounding agricultural land. A long history of plant/ invertebrate recording suggests negative change but a definite link between plant communities and diffuse pollution needs to be proven. Silt build up in main surrounding drains which feed the fen may affect the availability of water and cause release of locked N & P when required dredging is undertaken. | On-going 2002 investigations into plant community changes but no action on the ground to tackle diffuse pollution in main drains of surrounding agricultural land which feed the fen. |
| Beds. & Cambs. | Berry Fen SSSI | | Birds and associated marshy grassland | 5 | 5 | 4 | | | 4 | Fed by drains receiving water from the Bedford Ouse during summer and flooded by the Bedford Ouse during winter. Similar nutrient enrichment problems to Ouse washes SPA above. 2001 NVC survey strongly suggest negative changes to the vegetation but this judgement is made difficult by limited earlier comparative survey data. | None |
| Beds. & Cambs. | Dropshort Marsh SSSI | | Fen meadow | 4 | 4 | | | | 4 | Perceived negative changes to grassland communities relating to diffuse pollution from surrounding agricultural land but lack of definitive evidence. | None |
| Beds. & Cambs. | Sutton, Heath & Bog SSSI | | Lowland calcareous grassland. | 2 | 2 | | | | 2 | Perceived negative changes to grassland communities relating to diffuse pollution from surrounding agricultural land but lack of definitive evidence. | None |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Beds. & Cambs. | Wicken Fen SSSI (part of Fenland SAC) | | Open fen and ditches | 2 | 2 | 2 | | | 2 | As for above Woodwalton Fen. | No action on the ground to tackle diffuse pollution in main drains of surrounding agricultural land which feed the fen. |
| Cheshire to Lancs | Hawes Water SSSI (part of Morcambe BaycSAC)_ | SD478766 | | 8 | 8 | | | | 10 | High inputs of phosphate/nitrogen Affecting water chemistry of marl lake associated plant communities e.g. Chara spp | English Nature local team currently bidding for funds with RSPB and EA for a catchment study to explore and identify possible solutions |
| Cheshire to Lancs | Leighton Moss SPA and RAMSAR | | | | | | | | 10 | High inputs of phosphate, nitrogen and silt from surrounding agricultural land has resulted in loss of macrophytes and detrimental effects on the ecology also declining bittern population through poor fish/eel numbers. Re: RSPB report monitoring report water purity monitoring Leighton Moss Nov 2000- Nov 2001 | |
| Cheshire to Lancs | Ribble Estuary SPA | | Waterfowl | ? | ? | ? | ? | | 6 | Res 33 package highlights no current evidence to show detrimental effects to bird species, however it is an issue that needs to be addressed | None |
| Cheshire to Lancs | Dee Estuary SSSI/SAC | | Intertidal sediments - shellfish | ? | ? | | | | 5 | DSP detected in cockles- indicator of algal bloom? | None |
| Cheshire to Lancs | Dee Estuary SSSI/SAC | | Intertidal sediments - shellfish | ? | ? | | | | 5 | DSP detected in cockles- indicator of algal bloom? | None |
| Cheshire to Lancs | Dee Estuary SSSI/SAC | | Estuary water column | ? | ? | | | | 5 | EA chemical data shows reduced oxygen in summer and elevated nitrogen in winter.<br>High chlorophyll a readings, evidence of algal scum | Dee identified as a sensitive Area to eutrophication under the Waste Water Treatment Directive (see Howarth *et al*.(2001) Dee estuary sensitive area designation EAW Report.) |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Cheshire to Lancs | White Moss | | Valleyside mire | 6 | 6 | 1 | 1 | | 5 | The southern end of the site is enriched and the site is currently unfavourable. Both point source and diffuse pollution is thought to be contributing. | A point-source of enrichment has been identified as the main culprit and is being looked at through a WES agreement. |
| Cornwall | Fal and Helford | | Aquatic/marine | 8 | 8 | 10 | | | 10 | Please call M Hoskin for further info | Ditto |
| Cornwall | Loe Pool | | Aquatic | 10 | 10 | 10 | | | 10 | Please call A McDouall for further info | Ditto |
| Cornwall | River Camel | | Aquatic | 8 | 8 | 10 | | | 10 | Please call D Hazlehurst for further info | Ditto |
| Cornwall | Marazion Marsh | | Aquatic / bird | 6 | 6 | 6 | | | 6 | Please call A McDouall for further info | Ditto |
| Cornwall | Hayle Esturay | | Aquatic / marine | 5 | 5 | 5 | | | 3 | Please call A McDouall for further info | Ditto |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Cumbria | Bassenthwaite Lake SSSI<br><br>River Derwent & Bassenthwaite Lake cSAC | NY 214297 | Large Mesotrophic Lake, vendace, floating water plantain, | 10 | ? | 10 | ? | | 10 | See English Nature Research Report 252, 'Nutrient Reconstruction in Standing Waters'. BASS1 sediment core by shows P loading increase since 1970's & siltation problem constantly sustained due to inorganic material derived from catchment Morrison (1997).<br>Visual evidence of overgrazing and flood defence works.<br>Cyanobacteria blooms.<br>Additional problems of Crassula helmsii & non-native fish may be exacerbating limiting WQ problems on vendace & macrophytes. | |
| Cumbria | Biglands Bog | NY 258537 | Tall fen, marshy grassland, open water, ombrotrophic bog. | 9 | 9 | 9 | ? | | 9 | Vegetation change - Wheeler suggests due to large silt input from catchment & from eutrophication. (Wheeler & Wells, 1989, 'Investigations Into Vegetation at Biglands Bog, Cumbria)<br>Water quality data shows open water and fen area acting as nutrient sink.<br>Sewage input from Aikton (no WwTW)<br>Large catchment area of improved pasture/silage fields | None. |
| Cumbria | River Derwent & Tributaries SSSI<br><br>River Derwent & Bassenthwaite Lake cSAC | NY 261207 | River Marron and Sandy Beck tributaries of the River Derwent included on basis of salmon spawning and nursery areas | 8 | 8 | ? | 8 | | 8 | EA WQ monitoring and SIMCAT modelling indicates both tributaries are not currently meeting RQO RE1. Both have problems with small sewage treatment works but diffuse agricultural pollution is also a problem. River Marron is failing to meet RQO upstream of the highest WwTW. | EA addressing STW discharges through ROCs and input into AMP4<br>Diffuse pollution not being addressed. |
| Cumbria | Cliburn Moss | | | | | | | | 7 | No information available for this study | |
| Cumbria | Cumwhitton Moss | | | | | | | | 7 | No information available for this study | |

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| Cumbria | Moorthwaite Moss SSSI | NY 511510 | Basin mire | 5 | 5 | ? | 4 | | 7 | Perceived problem of managing water levels, where water in ditches is from farming catchment and is likely to be enriched. Hydrological Investigation of Eutrophication Problems at Moorthwaite Moss SSSI, Cumbria (Gilman, 1991) | None |
| Cumbria | Newton Reigny Moss SSSI | NY 478308 | Basin mire | 5 | 5 | ? | 4 | | 7 | Vegetation Change. 'The effect of eutrophication on the vegetation of Newton Reigny Moss', Weir C, 1996. | None |
| Cumbria | Temple Sowerby Moss | | | | | | | | 7 | No information available for this study | |
| Cumbria | Blackdike Bog | | | | | | | | 6 | No information available for this study | |
| Cumbria | Burns Beck Moss | | | | | | | | 6 | No information available for this study | |
| Cumbria | Claife Tarns and Mires | | | | | | | | 6 | No information available for this study | |
| Cumbria | Cropple How Mire | | | | | | | | 6 | No information available for this study | |

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| | | | | P | N | Silt | BOD | Other | | | |
| Cumbria | Finlandrigg Woods | | | | | | | | 6 | No information available for this study | |
| Cumbria | Hallsenna Moor | | | | | | | | 6 | No information available for this study | |
| Cumbria | Low Church Moss | | | | | | | | 6 | No information available for this study | |
| Cumbria | Orton Moss | | | | | | | | 6 | No information available for this study | |
| Cumbria | Silver Tarn, Hollas and Hamsey Mosses | | | | | | | | 6 | No information available for this study | |
| Cumbria | Skelsmergh Tarn | | | | | | | | 6 | No information available for this study | |
| Cumbria | Tarn Moss | | | | | | | | 6 | No information available for this study | |

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| | | | | P | N | Silt | BOD | Other | | | |
| Cumbria | Thornhill Moss | | | | | | | | 6 | No information available for this study | |
| Cumbria | Udford Low Moss | | | | | | | | 6 | No information available for this study | |
| Cumbria | Unity Bog | | | | | | | | 6 | No information available for this study | |
| Devon | River Axe SSSI/cSAC | ST325023 To SY259927 | Macrophyte assemblage including Ranunculus community<br>Invert assemblage<br>Fish fauna – including salmon, brown trout, bullhead and lamprey | 8 | 5 | 8 | 3 | | 8 | Intensive dairying and maize growing in catchment.<br>High phosphate levels in water.<br>High silt loads (perceived?)<br>Historic loss of salmon populations | Axe Valley enhancement project just launched to address. (BUT won't be able to continue without English Nature contribution – reliant on funding from W&W group challenge fund) |

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| | | | | P | N | Silt | BOD | Other | | | |
| Devon | Salcombe-Kingsbridge estuary mSSSI and mLNR | SX 74 41 | Unknown - no data available - concerns include nutrient enrichment, eutrophication, siltation, turbidity, smothering, O2 deprivation, agro-chemical<br><br>Potentially mudflats; channel bed habitats - fan worms, tunicates & brittlestars; Saltstone habitat - rhodophytes - incl. Gracilaria spp.<br><br>Have always assumed that anything sensitive is long gone! | 8 | 8 | 3 | 5 | | 8 | Red tides of 1999, 2000, 2001 - Prorocentrum micans, 2002 - P. micans & Protoperdinium spp. - potential release of toxins and O2 deprivation. Build up of spores on benthos allowing blooms in future<br><br>2002 - PSP & DSP<br><br>Very obvious turbidity of waters during high rainfall events - smothering and reduced light quality for algae<br><br>Reported increase of Enteromorpha spp. on mudflats - obvious off main STW releasing effluent into heart of estuary - includes sludge-digester effluent from wider area.<br><br>Ineffective tidal flushing of the estuary due to local conditions - gyre forms outside estuary - report available<br><br>Bacteria levels within shellfish | - pro-active advice given to local farmers thro' Countryside Stewardship Scheme - 2 soil conservation events organised for local farmers<br>- lobbying of 'responsible' organisations<br>- presentation at IPSS conference on issue |
| Devon | Slapton Ley | SX826441 | Macrophytes<br>Only UK site for Strapwort Corrigiola littoralis | 8 | 4 | | | | 8 | Lower Ley now very eutrophic with very few macrophytes in surveys. Alagal blooms common. Only UK site for Strapwort Corrigiola litoralis – current status on the Ley shores is fragile. Damaged by large scale deposition of algal mats on exposed shore. | Environment Agency piloting ECAP (intention to produce a plan only)<br>AMP 3 removal of inputs from sewage works by 2005 |
| Devon | Erme estuary SSSI | SX 62 49 | Salt and grazing marshes? | | 7 | | | | 7 | Reports of increased Enteromorpha growth on mudflats.<br><br>Climate change studies on saltmarshes and mudflats being undertaken by University of Plymouth | No known action taken. |

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| | | | | P | N | Silt | BOD | Other | | | |
| Devon | Stover Park | SX833751 | The lake is the main component of the SSSI Macrophytes and invertebrates in the lake have disappeared over the last 10 years. | 9 | 5 | | 2 | 4 Road | 7 | Almost total loss of macrophytes and invertebrates from lake<br>Most likely cause eutrophication from catchment<br>Also some pollution from A38 road with potential for catastrophic pollution event. | Intention to run joint project with EA<br>Some progress made |
| Devon | Yealm estuary SSSI & SAC | SX 54 49 | Unknown | | | 8 | | | 7 | Reports of elevated siltation levels by local mariculture<br><br>Historic nutrient enrichment studies believed to be being carried out by University of Plymouth | EA action to investigate sources of diffuse pollution |
| Devon | Culm | | Purple Moor grass Meadows | ? | ? | | 8 | | 5 | Recent EA discussion on water quality through pollution incidents on up reaches of Torridge river | Need to start discussions with EA |
| Devon | Exe Estuary SPA/SSSI | | Increase in enteromorpha, decrease in Zostera | | | | | | 8 | Highlighted in Mgt Plan / ROC | |
| Devon | Tamar Estuary SSSI/cSCA/SPA | | Zostera / intertidal mud spp | | | | | | 8 | Highlighted in ROC report | none |
| Dorset | Chesil and the Fleet<br>cSAC<br>SPA<br>Ramsar site<br>SSSI | SY496885 to SY683734 | Freshwater to brackish tidal lagoon containing<br>Eelgrass beds<br>Charophytes<br>Other lagoonal aquatic plants<br>Specialist lagoonal invertebrates<br>fish | 9 | 9 | | | | 10 | Recent report identified agricultural sources as most significant source of nitrates in winter and a significant source of phosphate both summer and winter. | Fleet & Wey catchment project – identifying opportunities to implement best management practises to reduce the effects of diffuse pollution |

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| Dorset | Studland and Godlingston Heaths SSSI<br>Dorset Heaths (Purbeck & Wareham) and Studland Dunes cSAC<br>Dorset Heathlands SPA Ramsar<br>Poole Harbour SPA<br>Ramsar | | Oligotrophic waters containing very few minerals on sandy plains | 8 | 8 | | | | 10 | Site contains probably the least impacted large oligotrophic lake in lowland England. Chemical water quality shows very low N but relatively high P suggesting ecosystem is N limited. Part of catchment includes rural residential properties and agricultural grassland. Lake considered highly vulnerable to enrichment from new diffuse N inputs eg from changes in land use or discharges to inflow stream. P source(s) unknown. | Macrophyte survey and further chemical analysis under English Nature lake restoration project. Review of EA discharge consents in catchment. Requires survey of inflowing stream catchment to identify point discharges and potential diffuse pollution risk areas. |
| Dorset | Frome St Quintin SSSI<br>cSAC | ST585036 | Lowland valley mire on greensand containing:<br><br>Wet alder-ash woodland W5; W7; W8<br><br>Rich Fen M22; M27<br><br>Reed swamp S26<br><br>Neutral grassland MG5c<br><br>Chalk river<br><br>Seepages and springs depositing tufa<br><br>Wetland Invertebrate assemblage*<br><br>Lichen and bryophyte assemblage*<br><br>* rare species present | p | p | ? | ? | ? | 9 | The site is surrounded by agricultural land on chalk and greensand comprising conventional intensive dairying and arable (maize) and an organic dairy with some arable. The two systems present an intriguing contrast.<br>The valley mire lies on greensand and there is clear evidence from the composition of the plant communities present; poor water quality and possibly tree health that nutrients are entering the system in both the soil and in aerial deposition. One dairy disposes of dirty water by spraying and slurry is spread.<br>A sewage treatment works is situated in the middle if the site, discharging to the River Frome where poor water quality is a concern. | EA taking forward investigation into water quality of River Frome and have bid for funds to undertake a hydrogeological survey of the site (not optimistic of funding)<br><br>EA assessment; going forward for AMP improvement |

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| Dorset | Rempstone Heaths Dorset Heaths and Studland Dunes (Purbeck and Wareham) cSAC (there are also other less clearcut examples on the Dorset heaths including Sandford Heath and Horton Common) | SZ 976 845 | Valley mire - rhynchosporion | ? | ? | ? | ? | ? | 8 | Vegetation shows that ditches running through mire systems are clearly enriched – this is preventing restoration of mires through blocking of these ditches. Water originates from fields at top of catchment. | A new pond proposed to take some nutrients out is only a partial solution. |
| Dorset | Poole Harbour SSSI SPA Ramsar | SY 99 88 | Lagoonal features | | 6 | | | | 7 | Extensive algal mats on mudflats EA data indicating high N inputs from agricultural sources particularly via Rivers Frome and Piddle | AMP improvements tackling sewage inputs |
| Dorset | Poole Harbour SSSI SPA Ramsar | SY 99 88 | Intertidal sediment communities and SPA birds | | 6 | | | | 7 | Extensive algal mats on mudflats EA data indicating high N inputs from agricultural sources particularly via Rivers Frome and Piddle | AMP improvements tackling sewage inputs |
| Dorset | River Frome SSSI | SY700908 to SY927871 | Type IIIb chalk stream vegetation | 5 | | 5 | | | 7 | AMP improvements unlikely to achieve P reduction to target levels but impact of P buffered by high base flows. High sediment inputs from some tributaries perceived to be due to arable especially maize cultivation, intensive dairy and ploughing on steep slopes in upper catchment producing very silty runoff | AMP improvements. Countryside Stewardship target area on floodplain. Nutrient budgeting of some farms by FWAG. |
| Dorset | River Frome SSSI | SY700908 to SY927871 | Salmon | | | 9 | | | 7 | AMP improvements unlikely to achieve P reduction to target levels but impact of P buffered by high base flows. High sediment inputs from some tributaries perceived to be due to arable especially maize cultivation, intensive dairy and ploughing on steep slopes in upper catchment producing very silty runoff. | AMP improvements. Countryside Stewardship target area on floodplain. Nutrient budgeting of some farms by FWAG. |

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| | | | | P | N | Silt | BOD | Other | | | |
| Dorset | River Frome SSSI | SY700908 to SY927871 | Floodplain fen and swamp | 5 | 5 | 5 | | | 7 | AMP improvements unlikely to achieve P reduction to target levels but impact of P buffered by high base flows.<br>High sediment inputs from some tributaries perceived to be due to arable especially maize cultivation, intensive dairy and ploughing on steep slopes in upper catchment producing very silty runoff. | AMP improvements.<br>Countryside Stewardship target area on floodplain.<br>Nutrient budgeting of some farms by FWAG. |
| Dorset | Toller Porcorum SSSI, part cSAC | SY 550995 | Wet alder-ash woodland W5; W7; W8 | ? | ? | ? | p | ? | 7 | Water quality failing in River Hooke, due to agricultural run-off. Unknown impact on plant and animal communities but probable increase to plant health e.g. alder die-back. | EA assessment |
| Eastern area | River Mease SAC, Leics. | | Spined Loach<br>Bullhead<br>Crayfish | y | | y | | | 10 | The river seems to be flooding more frequently mainly due to change in land use to arable including potatoes and increase in the hard standings within the catchment.<br><br>The major sewage works in the system is being put forward for inclusion in AMP4 under UWWTD | EA assessing site |
| Eastern area | River Eye SSSI, Leics. | | White legged Damselfly<br>Macrophyte assemblage | y | | y | | | 9 | The site shows signs of enrichment (simplification of communities and dominance by species associated with nutrient enrichment).<br><br>Silting is also a problem with gravel stretches losing condition and pools filling up | The river has had a nutrient budget carried out on it as part of AMP3 work. All sewage works within the catchment have had P removal proposed for 2005<br><br>As part of a flood alleviation scheme silt traps have been placed in the main tributary of the river and the river itself up stream of the SSSI |
| Eastern area | Blackbrook Reservoir SSSI | | Mesotrophic aquatic macrophytes | y | | | | | 8 | Phosphate levels well above those which can support mesotrophic species | EA have adopted a policy of refusing discharges to the inflow stream including all private dwellings |

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| Eastern area | Bradgate Park and Cropston Reservoir SSSI Leics | | Mesothrophic aquatic macrophytes | y | | | | | 8 | Phosphate levels well above those which can support mesotrophic species | See above (Discussions with Severn Trent water are so far producing little although a floating reedbed is in Swithland now to reduce the phosphate getting into Cropston) |
| Eastern area | Buddon wood and Swithland Reservoir SSSI Leics. | | Macrophytes including emergents and breeding and wintering birds | y | | | | | 8 | Phosphate levels are higher than historic levels and are affecting Cropston Reservoir SSSI. This site is important for its mesotrophic aquatic macrophytes | Discussions with Severn Trent water are so far producing little although a floating reedbed is in Swithland now to reduce the phosphate getting into Cropston |
| Eastern area | Clumber Park SSSI | | Aquatic macrophytes | y | | | | | 5 | Loss of aquatic macrophytes<br><br>This may be a problem associated with point sources although the increase in both potatoes and out door pigs suggests that defuse sources may also be a problem in the catchment plants | The point sources will be tackled by AMP4 but the problems are more complex than this and include an old contribution from coal mining |
| Eastern area | River Ise Northants | | River SSSI | ? | | ? | | | 5 | Do not have very much knowledge of this site but its position suggests that it is vulnerable to diffuse pollution. | None |
| Eastern area | Tattershall Old Gravel pits Lincolnshire | | Aquatic macrophytes | y | | | | | 5 | Loss of aquatic macrophytes | Investigation into the source of pollution by Lincolnshire wildlife trust consultancy |
| Eastern area | Thorseby Lake SSSI | | Aquatic macrophytes | y | | | | | 5 | Loss of aquatic macrophytes<br><br>This may be a problem associated with point sources although the increase in both potatoes and out door pigs suggests that defuse sources may also be a problem in the catchment plants | The point sources will be tackled by AMP4 but the problems are more complex than this and include an old contribution from coal mining |

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| | | | | P | N | Silt | BOD | Other | | | |
| Eastern area | Welbeck Lakes SSSI | | Aquatic macrophytes | y | | | | | 5 | Loss of aquatic macrophytes<br><br>This may be a problem associated with point sources although the increase in both potatoes and out door pigs suggests that defuse sources may also be a problem in the catchment plants | The point sources will be tackled by AMP4 but the problems are more complex than this and include an old contribution from coal mining |
| Eastern area | Ramsden Corner Plantation Northants | | Springs in acid woodland | y | | | | | 4 | Species associated with enrichment increasing | Nothing as spring fed by adjacent land |
| Essex, Herts & London | Blackwater Estuary; | TL 940070 | Intertidal sand and mud; saltmarsh | 9 | 9 | | | | 9 | Inorganic nitrogen input in class C-D category: very poor quality. Reduced species diversity, algal mats, etc.<br>See English Nature's Maritime State of Nature report, Oct 2002.<br>All 5 sites are SPA; all except Stour and Hamford are also SAC.<br>Pesticide & herbicide residues | None |
| Essex, Herts & London | Colne Estuary; | TM 075155 | Intertidal sand and mud; saltmarsh | 9 | 9 | | | | 9 | Inorganic nitrogen input in class C-D category: very poor quality. Reduced species diversity, algal mats, etc.<br>See English Nature's Maritime State of Nature report, Oct 2002.<br>All 5 sites are SPA; all except Stour and Hamford are also SAC.<br>Pesticide & herbicide residues | None |
| Essex, Herts & London | Crouch & Roach Estuaries, | TQ 870970 | Intertidal sand and mud; saltmarsh | 9 | 9 | | | | 9 | Inorganic nitrogen input in class C-D category: very poor quality. Reduced species diversity, algal mats, etc.<br>See English Nature's Maritime State of Nature report, Oct 2002.<br>All 5 sites are SPA; all except Stour and Hamford are also SAC.<br>Pesticide & herbicide residues | None |

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| Essex, Herts & London | Hamford Water; | TM 235255 | Intertidal sand and mud; saltmarsh | 9 | 9 | | | | 9 | Inorganic nitrogen input in class C-D category: very poor quality. Reduced species diversity, algal mats, etc.<br>See English Nature's Maritime State of Nature report, Oct 2002.<br>All 5 sites are SPA; all except Stour and Hamford are also SAC.<br>Pesticide & herbicide residues | None |
| Essex, Herts & London | Stour Estuary; | TM 180330 | Intertidal sand and mud; saltmarsh | 9 | 9 | | | | 9 | Inorganic nitrogen input in class C-D category: very poor quality. Reduced species diversity, algal mats, etc.<br>See English Nature's Maritime State of Nature report, Oct 2002.<br>All 5 sites are SPA; all except Stour and Hamford are also SAC.<br>Pesticide & herbicide residues | None |
| Essex, Herts & London | Hunsdon Mead, Essex/Herts | TL 418110 | Mesotrophic grassland | 5 | 5 | | | | 8 | Reduced species diversity in areas subject to flooding or seepage from river/canal. | None |
| Essex, Herts & London | Water End Swallow Holes, Herts | TL 230043 | Swallow Holes | 7 | 7 | 10 | | | 8 | Swallow Holes frequently clogged with silt.<br>Surrounding grassland mostly gone to tall ruderal vegetation, obscuring topography from view and creating unsafe conditions. | |
| Essex, Herts & London | Abberton Reservoir, Essex | TL 970180 | Migrant wildfowl | ? | ? | | | | 7 | Algal blooms affecting benthic macrophytes | AMP 4 investigation |
| Essex, Herts & London | Hanningfield Reservoir, Essex | TQ 730980 | Migrant wildfowl | ? | ? | | | | 7 | Algal blooms affecting benthic macrophytes | None |
| Essex, Herts & London | Cornmill Stream and Old River Lea, Essex | TL 380013 | Freshwater invertebrates (Odonata) | 5 | 5 | | | | 6 | Reduced species diversity.<br>Poor water quality in ditches and watercourses. | Improvements to sewage effluent treatment under AMP 3 will alleviate sewage (but not agricultural) pollution, |

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| Essex, Herts & London | Little Hallingbury Marsh, Essex | TL 491171 | | 5 | 5 | | | | 6 | Reduced species diversity in areas subject to flooding or seepage from river/canal. | None |
| Essex, Herts & London | Sawbridgeworth Marsh, Essex/Herts | TL 492158 | Reedbed; wet grassland; fen; open water | 5 | 5 | | | | 6 | Reduced species diversity in areas subject to flooding from river. | None |
| Essex, Herts & London | Thorley Flood Pound, Essex/Herts | TL 490183 | Wash grassland; fen | 5 | 5 | | | | 6 | Reduced species diversity in areas subject to flooding from river. | None |
| Essex, Herts & London | Roding Valley Meadows, Essex | TQ 436953 | MG4 grassland | 5 | 5 | | | | 5 | Reduced species diversity | None |
| Essex, Herts & London | Waltham Abbey, Essex | TL 376020 | Alder woodland | 4 | 4 | | | | 4 | Reduced species diversity | None |
| Hampshire & IoW | River Itchen SSSI/SAC | SU589274 SU56353 SU599324 to SU439153 | Classic chalk stream features incl Ranunculus, southern damselfly, otter, crayfish, water vole bullhead, brook lamprey, atlantic salmon. | 5 | 5 | 8 | 5 | ? | 10 | Impact on special interest features particularly SAC features Ranunculus etc. | EA Landcare project encouraging best practice amongst adjacent landowners; funding for 1 year only. |
| Hampshire & IoW | River Avon SSSI / SAC | SZ 163923 to SU 073583 | Ranunculus vegetation of plain and submontane areas, Sea lamprey, brook lamprey, atlantic salmon Bullhead Desmoulin's whorl snail | 5 | 5 | 8 | 5 | | 9 | Impact on special interest features particularly SAC features Ranunculus etc. Water levels | Nothing substantial |

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| | | | | P | N | Silt | BOD | Other | | | |
| Hampshire & IoW | River Test SSSI | SU533498 to SU367150 SU361145 | As above | 5 | 5 | 8 | 5 | ? | 9 | Impact on special interest features particularly SAC features Ranunculus etc. | EA Landcare project encouraging best practice amongst adjacent landowners; funding for 1 year only. |
| Hereford & Worcester | River Wye SSSI cSAC | ST539940 | CSAC and SSSI features: Ranunculus community(?) | y | | y? | | | 10 | cont...<br>Salmon declines – EA spawning data show severe problem with crash of salmon population. Many factors implicated, but silt in gravels is one.<br><br>Shad – less certain that there is an impact as species does not benefit from same data run as salmon. Intuitively siltation likely to be having similar effect as for salmon, although less demanding spawning conditions may mean it is less severe.<br><br>Impact on Ranunculus is anecdotal. Recreational users suggest that Ranunculus growth has increased in response to greater nutrient loading.<br><br>Impact on invertebrates is anecdotal, but re-surveys for some rare diptera have failed to find them. | Psychic project – national research site.<br><br>Support for FWAG Nutrient Budgets (part local funding, part diffuse pollution challenge funding).<br><br>Targeting of CS to rivers – buffer strips etc.<br><br>Liaison with FWAG and EA propose to develop a Wye Landcare project.<br><br>Support for Wye Graziers project to explore options to add value to livestock enterprise (to provide alternative to cultivation). |

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| Hereford & Worcester | River Wye SSSI cSAC | ST539940 | CSAC and SSSI features: Salmon, allis and twaite shad, | | | y | | | 10 | Farm nutrient budget work with FWAG show excessive P application within catchment, particularly the use of chicken manures. Soil P status likely to be increasing as a result – impact on river from P rich sediment and from P runoff.<br><br>Psychic project using Wye as one of test sites to develop control mechanisms.<br><br>Number of studies showing bad soil management (Hereford Trust etc). Photographs of cultivation up to river bank etc.<br><br>Visual observation of silt on river bed, reports from anglers etc.<br><br>Land use change statistics – increase in potato cultivation and decline in river valley grassland (CPRE reports and MAFF/DEFRA statistics). Cont..... | Psychic project – national research site.<br><br>Support for FWAG Nutrient Budgets (part local funding, part diffuse pollution challenge funding).<br><br>Targeting of CS to rivers – buffer strips etc.<br><br>Liaison with FWAG and EA propose to develop a Wye Landcare project.<br><br>Support for Wye Graziers project to explore options to add value to livestock enterprise (to provide alternative to cultivation) |

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| | | | | P | N | Silt | BOD | Other | | | |
| Hereford & Worcester | River Wye SSSI cSAC | ST539940 | CSAC and SSSI features: Salmon, allis and twaite shad, | | | y | | | 10 | cont...<br>Salmon declines – EA spawning data show severe problem with crash of salmon population. Many factors implicated, but silt in gravels is one.<br><br>Shad – less certain that there is an impact as species does not benefit from same data run as salmon. Intuitively siltation likely to be having similar effect as for salmon, although less demanding spawning conditions may mean it is less severe.<br><br>Impact on Ranunculus is anecdotal. Recreational users suggest that Ranunculus growth has increased in response to greater nutrient loading.<br><br>Impact on invertebrates is anecdotal, but re-surveys for some rare diptera have failed to find them. | Psychic project – national research site.<br><br>Support for FWAG Nutrient Budgets (part local funding, part diffuse pollution challenge funding).<br><br>Targeting of CS to rivers – buffer strips etc.<br><br>Liaison with FWAG and EA propose to develop a Wye Landcare project.<br><br>Support for Wye Graziers project to explore options to add value to livestock enterprise (to provide alternative to cultivation). |

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| Hereford & Worcester | River Wye SSSI cSAC | ST539940 | CSAC and SSSI features: Ranunculus community(?) | y | | y? | | | 10 | Farm nutrient budget work with FWAG show excessive P application within catchment, particularly the use of chicken manures. Soil P status likely to be increasing as a result – impact on river from P rich sediment and from P runoff.<br><br>Psychic project using Wye as one of test sites to develop control mechanisms.<br><br>Number of studies showing bad soil management (Hereford Trust etc). Photographs of cultivation up to river bank etc.<br><br>Visual observation of silt on river bed, reports from anglers etc.<br><br>Land use change statistics – increase in potato cultivation and decline in river valley grassland (CPRE reports and MAFF/DEFRA statistics). Cont..... | Psychic project – national research site.<br><br>Support for FWAG Nutrient Budgets (part local funding, part diffuse pollution challenge funding).<br><br>Targeting of CS to rivers – buffer strips etc.<br><br>Liaison with FWAG and EA propose to develop a Wye Landcare project.<br><br>Support for Wye Graziers project to explore options to add value to livestock enterprise (to provide alternative to cultivation) |

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| Hereford & Worcester | River Wye SSSI cSAC | ST539940 | SSSI features:<br><br>Invertebrate assemblage | y? | | y? | | | 10 | Farm nutrient budget work with FWAG show excessive P application within catchment, particularly the use of chicken manures. Soil P status likely to be increasing as a result – impact on river from P rich sediment and from P runoff.<br><br>Psychic project using Wye as one of test sites to develop control mechanisms.<br><br>Number of studies showing bad soil management (Hereford Trust etc). Photographs of cultivation up to river bank etc.<br><br>Visual observation of silt on river bed, reports from anglers etc.<br><br>Land use change statistics – increase in potato cultivation and decline in river valley grassland (CPRE reports and MAFF/DEFRA statistics). Cont..... | Psychic project – national research site.<br><br>Support for FWAG Nutrient Budgets (part local funding, part diffuse pollution challenge funding).<br><br>Targeting of CS to rivers – buffer strips etc.<br><br>Liaison with FWAG and EA propose to develop a Wye Landcare project.<br><br>Support for Wye Graziers project to explore options to add value to livestock enterprise (to provide alternative to cultivation). |

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| Hereford & Worcester | River Wye SSSI cSAC | ST539940 | SSSI features:<br><br>Invertebrate assemblage | y? | | y? | | | 10 | cont...<br>Salmon declines – EA spawning data show severe problem with crash of salmon population. Many factors implicated, but silt in gravels is one.<br><br>Shad – less certain that there is an impact as species does not benefit from same data run as salmon. Intuitively siltation likely to be having similar effect as for salmon, although less demanding spawning conditions may mean it is less severe.<br><br>Impact on Ranunculus is anecdotal. Recreational users suggest that Ranunculus growth has increased in response to greater nutrient loading.<br><br>Impact on invertebrates is anecdotal, but re-surveys for some rare diptera have failed to find them. | Psychic project – national research site.<br><br>Support for FWAG Nutrient Budgets (part local funding, part diffuse pollution challenge funding).<br><br>Targeting of CS to rivers – buffer strips etc.<br><br>Liaison with FWAG and EA propose to develop a Wye Landcare project.<br><br>Support for Wye Graziers project to explore options to add value to livestock enterprise (to provide alternative to cultivation). |
| Hereford & Worcester | River Lugg SSSI | SO431631 | CSAC and SSSI features: Salmon | y | | y | | | 9 | EA modelling, English Nature Quest study indicates significant diffuse P inputs. New Simcat awaited as part of AMP3 modelling.<br><br>Farm nutrient budget work with FWAG show excessive P application within catchment, particularly the use of chicken manures. Soil P status likely to be increasing as a result – impact on river from P rich sediment and from P runoff.<br><br>Psychic project using Wye as one of test sites to develop control mechanisms.<br><br>Soil erosion modelling study for Lugg catchment (ITE/ADAS) indicated scale of soil loss to be 5x that of a pristine catchment. | As for Wye.<br><br>Also River Lugg WES used by English Nature to demonstrate some measures to control diffuse pollution. |

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| Hereford & Worcester | River Teme SSSI (River Clun cSAC is part of this SSSI) | SO806532 | Freshwater pearl mussel | y? | | Y | | | 7 | Remaining population is confined to stretch of River Clun (tributary of the Teme). Believed that sediment (and sheepdip?) is implicated in its decline elsewhere on river. Thought to be very vulnerable to sediment impacts from upstream land management practices. | Targeting of CS to land adjoining River Clun cSAC. |
| Hereford & Worcester | Bittell Reservoirs SSSI | SP020751 | Aquatic plant community, water birds. | y? | y? | | | | 6 | Notified in 1983 as a mesotrophic water body. Subsequently there have been problems with algal blooms and water body is considered to be eutrophic. Number of possible factors but adjacent land management practice is thought to be implicated. | Bid to challenge fund to undertake nutrient management budgets for surrounding farms. |
| Hereford & Worcester | Westwood Great Pool SSSI | SO879632 | Rare plant – Alisma gramineum | ? | ? | | | | 6 | This species has a complex biology involving both marginal and deep water plants. Work under the Species Recovery project has identified eutrophication as a key problem, leading to a) rapid emergent plant growth covering marginal germination habitat and b) turbidity and algal blooms leading to death of deep water plants | Bid to challenge fund to undertake nutrient management budgets for surrounding farms |
| Humber to Pennines | Hatfield Chase Ditches | SE748070 | Aquatic and emergent vegetation. | ? | ? | 1 | ? | ? | 8 | SSSI is a series of agricultural drainage ditches and is surrounded by intensive agriculture | Trying to establish 10m grassland strips as a buffer zone. |
| Humber to Pennines | Fairburn & Newton Ings | SE453275 | Wintering wildfowl | ? | ? | 4 | ? | ? | 6 | The SSSI is a closed system in a flood plain. A number of ditches drain into the SSSI from surrounding agricultural land. There have been a series of algal blooms within the various lakes, but the causes are not yet fully understood. | None. We are currently trying to tackle pollution from sewage on the site, as we are able to more easily identify direct inputs into the SSSI. Agricultural inputs are harder to pinpoint. |
| Kent | Sandwich Bay and Hacklinge Marshes – Hack' Marshes side. | Tr353585 | Grazing marsh ditch with nationally scarce and RDB and Ramsar plants/invertebrates | 3 | 3 | | ? | | 10 | Cover of ditches in Lemna/Enteromorpha<br><br>Contact Phil Williams | |

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| Kent | Walland Marsh SSSI | tq960240 | Grazing marsh ditch with nationally scarce and RDB plants/invertebrates | 3 | 3 | | ? | | 9 | Cover of ditches in Lemna/Enteromorpha<br><br>Contact Brian Banks | Management agreements with SSSI owners for on-site pollution. Royal military canal is subject to AMP3 studies for sewage treatment works pollution, but agricultural pollution remains a problem |
| Kent | River Beult | TQ865425 to TQ693502 | Characteristic clay river flora | 8 | 8 | 1 | 8 | | 8 | High concentrations of Lemna spp in many areas during the summer months<br><br>Contact Pauline Harvey | #Phosphate stripping at 13 STWs discharging to the Beult is already in place under AMP3 (work taking place from 2002 – 2005)<br><br>Parameters given represent perceived importance only |
| Kent | The swale | Tr000670 | Grazing marsh ditch with nationally scarce and RDB and Ramsar plants/invertebrates | 8 | 8 | ? | ? | | 8 | Some areas high incidence of Lemna and blanket weed<br><br>Contact Dave Rogers | English Nature management agreements with owners, North Kent Marshes ESA, including buffer strips |
| Norfolk | SSSIs affected by point source agricultural pollution, intensive stock feeding etc, Limpenhoe Meadows SSSI, Buxton Heath SSSI's (Both cSAC) | TG4003 | Meso-euthophic ditch system | 5 | 5 | 5 | 5 | | High | Both nutrient sources into what should be low nutrient systems. | Unable to influence landowners management/EA no too interested |

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| Norfolk | SSSI's affected by point source agricultural pollution, intensive stock feeding etc, Limpenhoe Meadows SSSI, Buxton Heath SSSI's (Both cSAC) | TG1821 | Heath/mire complex | 5 | 5 | | | | High | Both nutrient sources into what should be low nutrient systems. | Unable to influence landowners management/EA no too interested |
| Norfolk | River Thurne catchment (Upper Thurne Broads and Marshes SSSI)<br><br>Broads/Broadland cSAC, SPA & Ramsar | TG4321 | Mesotrophic and Meso-Eutrophic lakes and ditch system, chalk-rich fen, alder woodland | 9 | | | | Ochre 9 | 10 | Eutrophication of waterbodies including Hickling Broad and Horsey Mere. Reed swamp decline | No STW's in catchment. This century Chara lakes degraded to eutrophic algal communities. Some marked improvement in recent years. Land drainage pump inputs, English Nature lake restoration site |
| Norfolk | Muckfleet catchment (Hall Farm Fen, Hemsby SSSI, Trinity Broads SSSI and Burgh Common and Muckfleet Marshes SSSI)<br><br>Broads/Broadland cSAC, SPA & Ramsar | TG4615 | Meso-Eutrophic lakes and ditch system, chalk-rich fen, alder woodland | 9 | | | | | 9 | Eutrophication of five broads | No STW's in catchment. This century Chara lakes degraded to eutrophic algal communities with some macrophytes.<br>EU LIFE Lake restoration site. Currently partly biomanipulated. Some nutrient partition work undertaken. PWS site |

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| Norfolk | River Ant catchment (East Ruston Common SSSI, Broad Fen Dilham SSSI, Smallburgh Fen SSSI, Ant Broads and Marshes SSSI)<br><br>Broads/Broadland cSAC, SPA & Ramsar | TG3620 | Meso-Eutrophic lakes and ditch system, chalk-rich fen, alder woodland | 9 | | | | | 9 | Eutrophication of waterbodies including Barton Broad.<br>Some evidence of nutrient enrichment in floodplain fen habitat | Under Amp2 and 3 all major and moderate STW's now phosphorus stripped. 5 year project to mudpump Barton Broad undertaken at a cost of £2.4m. English Nature Lake restoration project site |
| Norfolk | River Bure catchment (Crostwick Marshes SSSI and Bure Broads and Marshes SSSI)<br><br>Broads/Broadland cSAC, SPA & Ramsar | TG3317 | Meso-Eutrophic lakes and ditch system, chalk-rich fen, alder woodland | 9 | | | | | 9 | Eutrophication of waterbodies including Hoveton Great Broad and Cockshoot Broad.<br>Some evidence of nutrient enrichment in floodplain fen habitat and certainly reed swamp dieback | Under Amp2 and 3 all major and moderate STW's now phosphorus stripped. English Nature Lake restoration project site |

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| Norfolk | River Wensum catchment<br><br>River Wensum cSAC | TF 942246 to TG 250078 | Type III lowland chalk and oolite rivers with generally stable flow regimes with a transition in its downstream section to type I "lowland rivers with minimal gradients on mixed geology in England.<br><br>In addition area of wet, semi-natural habitat have been included as they form an integral and dependent part of the river system. The main habitat type is wet unimproved meadow but fen, scrub and alder carr are also represented.<br><br>European features include Ranunculus vegetation, bullhead, brook lamprey, Desmoulin's whorl-snail and white-clawed crayfish. | 9 | ? | 9 | | | 8 | Eutrophication of River Wensum with associated impacts on the Ranunculus vegetation.<br><br>Diffuses sources of P are likely to arise from agriculture, but possibly also from some of the uses of gravel pits in the flood plain e.g. introductions of carp, feeding of wildflowl for shooting or amenity.<br><br>Siltation would also seem to be an issue. Sources of silt are thought to be agriculture, run off from development etc. There has been some suggestion that a move to contract farming has resulted in higher levels of sediment reaching the rivers.<br><br>Impacts on the terrestrial habitats e.g. grasslands and fens etc. are not known.<br><br>ESA scheme does not provide a great deal in relation to the favourable condition of the river. | Phosphorous input has been tackled under AMP3 at Fakenham and East Dereham STWs.<br><br>No current action to tackle diffuse sources of pollution. |
| Norfolk | River Yare catchment ( Yare Broads and Marshes SSSI, Breydon Water SSSI)<br><br>Broads/Broadland cSAC, SPA & Ramsar | TG3218 | Meso-Eutrophic lakes and ditch system, chalk-rich fen, alder woodland, intertidal mud | 9 | | | | | 7 | Eutrophication of both fen and water bodies. | Major STW's for Norwich only recently P stripped. This reduced P loading by 77%. |

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| Norfolk | North Norfolk Coast SSSI, cSAC, SPA, Ramsar. | TF9045 | Freshwater grazing marsh, reedbed and possibly zostera beds | 5 | 5 | 5 | | | 6 | | Quality and quantity is critical in diluting saline inputs (information from M Rooney) |
| Norfolk | River Nar catchment<br><br>River Nar SSSI | TF 897198 to TF 622184 | Combination of a southern chalk stream and East Anglian fen river together with the adjacent terrestrial habitats the Nar is an outstanding river of it type. The natural physical features of the river and the variation in underlying deposits/substrate adds further value to this river. Seasonal flooding of adjacent land along with traditional combination of summer cattle grazing and hay making have encouraged a variety of wetland habitats and plant species to thrive. | ? | | ? | | | 6 | Water quality has been raised as an issue on the River Nar in the past and improvements were made at Castle Acre STWs. Exactly what the impact of eutrophication is on the site at the present time, I have not assessed.<br><br>Silt load is an issue that has been raised by local anglers, but again I have not evaluated the signficance of this issue on the river. | No further action at the present time. |
| Norfolk | River Thet catchment<br><br>Cranberry Rough SSSI | TL 933936 | Cranberry Rough was notified for its range of nutrient-poor open fen communities (mostly swamp and mire) developed over deep peat infilling a post-glacial lake basin. | 5 | ? | | | | 6 | Drains channel water from the arable land, immediately to the north, into the site. | The extent of the inputs and their significance will form part of a hydrological study of the site to commence winter 2002/3. |

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| Norfolk | River Thet catchment<br><br>Kenninghall & Banham Fens with Quidenham Mere SSSI | TM 041875 | A complex site occupying a section of the River Whittle valley. It comprises tall fen, species-rich fen and calcareous grassland surrounding a deep natural mere. It is the mere which is potentially most affected. | 5 | ? | 5 | | | 6 | Diffuse pollution, if really a problem, comes from run-off from the clay catchment and from septic tank discharges in Kenninghall just up-stream.<br><br>Siltation is evident from the increasing 'delta' at the mouth of the in-flow stream where it discharges into the mere. | The site may be considered for first time rural sewage treatment under AMP4 (yet to be explored with AW)<br><br>Silt accumulation is to be mechanically removed this autumn/winter from the in-flow. |
| Norfolk | River Waveney catchment (Stanley and Alder Carrs SSSI, Geldeston Meadows SSSI)<br><br>Broads/Broadland cSAC, SPA & Ramsar | TM4393 | Meso-Eutrophic ditch system, alder woodland, mesotrophic grassland | 6 | 6 | | | | 6 | Eutrophication of floodplain fens, and ditch communities. Some loss of fen meadow interest but could be due to abstraction/drought effects. | Believe that highers nutrient status is in the headwaters, with outdoor pigs on sandy soils. A typically water quality improves in the rivers middle reaches where these sites are located. |
| Norfolk | River Wensum catchment<br><br>Sweetbriar Road Meadows, Norwich SSSI | TG 208097 | A series of unimproved wet meadows with permanent water-logging. Three principle grassland communities are present. Damp neutral grassland which is species-rich with valley floor neutral grassland grading to marshy grassland. Tall fen areas are also present in the valley bottom. | 1 | | | | | 6 | Eutrophication of river water is likely to have an impact on flood plain meadows.<br><br>(However, this will be small compared to the eutrophication that is currently spilling on the site from a drain that carries foul water through the site after storm events in the six square mile of development that forms the catchment for the drain. Work carried out under AMP2 failed to fully address the issue of foul water. An attempt is being made to ensure that the issue is dealt with under AMP4). | The site will benefit from any improvements that are made so as to improve conditions on the River Wensum cSAC upstream. |
| N Mercia (Shrops) | Clarepool Moss | SJ433342 | Basin mire | 7 | 7 | | | | 10 | Oligotrophic site vulnerable to nutrients surrounded by agricultural land. | CSS in catchment |

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| N Mercia (Shrops) | Fenns, Whixall and Bettisfield Mosses | SJ490365 | Raised bog | 8 | 8 | | | | 10 | Water coming from surrounding land via main drains is a major problem in restoring oligotrophic bog communities | Tree felling and drain blocking, water level manipulation to restore active bog surface |
| N Mercia (Shrops) | Marton Pool | SJ296027 | Open water, reedswamp | 7 | 7 | | | | 8 | Site receives water from an area of agricultural land. Subject to blue-green algal blooms | |
| N Mercia (Shrops) | Sweat Mere and Crose Mere | SJ434304 | Open water, reedswamp, alder carr, wet grassland | 7 | 7 | | | | 8 | Past agricultural inputs may have been reduced. Canada geese a problem | CSS in part of catchment |
| N Mercia (Shrops) | Fenemere | SJ445228 | Open water, reedswamp, fen, alder carr, wet grassland | 7 | 7 | 7 | | | 7 | Main inflow drains agricultural land. Mere shallow, affected by eutrophication and silt. Carp a complicating factor | |
| N Mercia (Shrops) | Betton Pool | SJ510078 | Open water | 6 | 6 | | | | 6 | Pool surrounded by arable land. (Rest of site, Bomere and Shomere Pools, not surrounded by agricultural land) | |
| N Mercia (Shrops) | Brown Moss | SJ562395 | Open water, marsh | 5 | 5 | | | | 6 | Agriculture possibly not the main issue, but site is surrounded by arable land | |
| N Mercia (Shrops) | Cole Mere | SJ433332 | Open water, alder carr, wet grassland | 5 | 5 | | | | 5 | Declines in macrophytes possibly linked to eutrophication. Other factors include shading by trees and localised eutrophication by geese, also grazing by geese. | Planned tree felling from margin under CMF |

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| N Mercia (Shrops) | Hencott Pool | SJ490160 | Alder and willow carr | 4 | 4 | | | | 5 | Site surrounded by agricultural land, receives land drains<br>Localised enrichment at margin | |
| N Mercia (Shrops) | Oss Mere | SJ565438 | Open water, swamp, carr, damp grassland | 5 | 5 | | | | 5 | Recent decline in water plants and marginal reedbed could be due to eutrophication. Water turbid.<br>Fish may be a factor | |
| N Mercia (Shrops) | Trefonen Marshes | SJ246265 | Rich fen, marsh, alder woodland, calcareous grassland | 5 | 5 | | | | 5 | Site surrounded by intensive grassland. | |
| N Mercia (Shrops) | Berrington Pool | SJ525072 | Open water, swamp | 3 | 3 | | | | 4 | Apparent increases in nutrient levels linked to agricultural use. CSS in whole catchment should reduce inputs. | CSS in catchment, arable reversion. |
| N Mercia (Shrops) | Brownheath Moss | SJ460300 | Fen, alder and willow carr | 4 | 4 | | | | 4 | Agricultural land surrounding site. Discharge of land drains into margin of site. | |
| N Mercia (Shrops) | Lin Can Moss | SJ375211 | Basin mire | 3 | 3 | | | | 4 | Small, vulnerable site surrounded by agricultural land. | |
| N Mercia (Shrops) | White Mere | SJ414330 | Open water, alder carr | 4 | 4 | | | | 4 | Some evidence of eutrophication, but source not known. | Planned tree felling from margin under CMF |

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| N Mercia (Shrops) | Morton Pool and Pasture | SJ301239 | Open water, carr, unimproved grassland | 4 | 4 | | | | 3 | Inflow drains agricultural land.<br>Main interest feature is grassland. | |
| North Mercia (Staffs) | Aqualate Mere | SJ770205 | Open water, reedswamp, fen, carr | 9 | 9 | 10 | | | 9 | Large agricultural catchment, input of nutrients via inflow streams. Agriculture not the only issue; silt etc from canal overflow | Proposed silt removal under CMF |
| North Mercia (Staffs) | Betley Mere | SJ747482 | Open water, reedswamp, fen, carr | 8 | 8 | 9 | | | 9 | Shallow lake, apparently becoming more eutrophic, agriculture probably the most likely cause. Silt problem high despite silt traps. | |
| North Mercia (Staffs) | Cop Mere | SJ802297 | Open water, reedswamp, fen, carr | 9 | 9 | | | | 9 | Mere fed by R Sow, which drains agricultural land, likely to be a major source of nutrients | |
| North Mercia (Staffs) | Black Firs & Cranberry Bog | SJ748503 | Basin mire, dystrophic water, carr | 8 | 8 | | | | 8 | Site very vulnerable to increased nutrient levels, surrounded by agricultural land. Point sources also a problem. | |
| North Mercia (Staffs) | Chartley Moss | SK027283 | Raised bog and basin mire | 6 | 6 | | | | 6 | Oligotrophic site vulnerable to inputs from surrounding agricultural land. | |
| North Mercia (Staffs) | Mottey Meadows | | Unimproved grassland | 5 | 5 | | | | 6 | Drainage from surrounding arable land a possible source of nutrients | |

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| North Mercia (Staffs) | Old River Dove | SK238285 | Open water | 8 | 8 | | | | 6 | Site has small population of Potamogeton compressus believed to be at risk from eutrophication. Shading by trees also a factor. | |
| North Mercia (Staffs) | Loynton Moss | SJ788244 | Fen and swamp | 5 | 5 | | | | 5 | Peatland site partly cleared for agriculture in past, surrounded by agricultural land | Proposed restoration of mire communities |
| North Mercia (Staffs) | Checkhill Bogs | | Alder carr | 5 | 5 | | | | 3 | Site deteriorated as a result of drying out and eutrophication | |
| N Mercia (Warks & WMids) | River Blythe | SP178792 | Lowland clay river | 8 | 8 | 8 | 8 | | 8 | River drains an area of agricultural land. However, sewage effluent is also a problem. | |
| N Mercia (Warks & WMids) | Birches Barn Meadow | SK282021 | Unimproved grassland (MG4) | 7 | 7 | | | | 7 | Inputs from adjacent agricultural land and via R Anker which floods. Some inputs currently from sewage effluent in Anker – to be dealt with under AMP4 | |
| N Mercia (Warks & WMids) | Brook Meadow | SP180743 | Unimproved grassland | 6 | 6 | | | | 6 | Inputs from agricultural land in catchment of brook | |
| N Mercia (Warks & WMids) | Alvecote Pools | SK249050 | Open water | 5 | 5 | 5 | | | 5 | Inputs from agricultural land and from R Anker, which floods site | |

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| N Mercia (Warks & WMids) | Sherbourne Meadows | SP242618 | Unimproved grassland | 5 | 5 | | | | 5 | Receives drainage from surrounding arable land | |
| N Mercia (Warks & WMids) | Welford Field | SP139528 | Unimproved grassland (MG4) | 5 | 5 | 5 | | | 5 | Inundation by R Avon, which receives agricultural inputs | |
| N Mercia (Warks & WMids) | Railway Meadow | SP199632 | Unimproved grassland | 5 | 5 | 3 | | | 4 | | |
| North and East Yorkshire | Hornsea Mere SPA/SSSI | TA 190470 | Shallow lake (120 ha) with associated habitats of reedswamp, fen and carr woodland. Internationally important population of wintering wildfowl (gadwall). | 8? | 4? | 3? | 3? | ? | 9 | Hornsea Mere is eutrophic. There are incidents of blue-green algae and other algal blooms that may be affecting aquatic plant communities and bird communities? A farm-based nutrient assessment on Estate owning c 75% of area in catchment demonstrated reasonable farming practice but further measures to tackle diffuse pollution could be applied. | Ongoing liaison with Estate to promote good farming practice via English Nature, Environment Agency and FWAG. Funds needed to encourage practical measures to tackle diffuse pollution. Good uptake of Countryside Stewardship in some areas of catchment. |
| North and East Yorkshire | River Derwent cSAC | SE 627287- SE 825757 | SAC features - bullhead, river and sea lamprey, water crowfoot macrophyte community particularly because of siltation<br>SSSI features – macrophyte communities because of siltation and elevated P levels | 8 | ? | 9 | ? | | 9 | Recent CATNAP nutrient modelling of the Lower Derwent has shown that even with the implementation of P removal from the major STWs under AMP3 the likely P targets for the river will not be met.<br>Recent macrophyte survey has shown that the water crowfoot community is under threat and personal observation suggest that this may be related to increased siltation resulting from recent severe flood events. | AMP3 P removal is being undertaken at Malton, Stamford Bridge and Pocklington STW. The EA review of consents under the Habs Regs is investigating whether further P removal is required from other STWs. This work should lead to a better understanding of the contribution of diffuse pollution to the problem. |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| North and East Yorkshire | Gormire SSSI | SE 450290,483210 | Butterdale, secondary lake on the southwest end of site.<br>· Emergent fen communities<br>· Marshy grassland | 7 | 7 | 5 | 3 | | 2 | No water quality data, but water in lake has poor clarity and brown/green colouration.<br><br>Reasons:<br>· Runoff from adjacent agricultural land<br>· Duck rearing on adjacent land | Negotiated with landowner to stop feeding ducks within SSSI boundary |
| North and East Yorkshire | Ripon Parks SSSI | SE 310750 | Triturus cristatus<br>Standing open water (Black Heath Pond, Queen Mary's Dubb – large ponds within multi-interest site) | | | | | | 2 | Loss of suitable breeding habitat. Poor water quality = unfavourable condition for 'open water' habitat | Bid being submitted to carry out a hydrological investigation |
| Northumbria | Lindisfarne SSSI and SPA (also a component of the Berwickshire and North Northumberland Coast cSAC) | NU 105 422 | Extensive beds of eelgrass.<br>Supports over 20,000 waterfowl in winter including 2,700 light – bellied brent geese (68% of the global population of this sub species).<br>Intertidal mudflats and sandflats | 10 | 10 | | | | 10 | Excessive growth of Enteromorpha leading to a reduction of mudflats available for feeding birds and smothering of eelgrass. | EA review of consents.<br>Encouraging farmers to apply for Countryside stewardship Schemes. |
| Northumbria | Tweed Catchment Rivers – England: Till catchment/Lower Tweed and Whiteadder SSSI River Tweed pSAC | NT 870429<br>To<br>NT 837301<br><br>NT 790379 | Salmon, all three species of british lamprey, otter, Ranunculus (water-crowfoot) habitat. | | | | 10 | | 9 | Some of the EA sampling sites on the Till are marginal/failing due to BOD. | Encouraging farmers to apply for Countryside stewardship Schemes and English Natures Wildlife Enhancement Scheme. |
| Northumbria | Teesmouth and Cleveland Coast SPA | | Supports over 20,000 waterfowl in winter | 10 | 10 | | | | 8 | Excessive growth of Enteromorpha leading to a reduction of mudflats available for feeding birds | The area has been designated an NVZ |

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| | | | | P | N | Silt | BOD | Other | | | |
| Northumbria | River Coquet and Coquet Valley Woodlands SSSI | NU 031015 | Salmon, all three species of british lamprey, otter, Ranunculus (water-crowfoot) habitat. | | | | 10 | | 7 | Many of the EA sampling sites on the Coquet are marginal/failing due to BOD. | Encouraging farmers to apply for Countryside stewardship Schemes and English Natures Wildlife Enhancement Scheme. |
| Peak District & Derbyshire | Dove Valley and Biggin Dale SSSI (also part of the Peak District Dales cSAC; Biggin Dale is NNR) | SK157506 | Bullhead (SAC feature)<br>Brook lamprey (?) (SAC feature)<br>White-clawed crayfish (SAC feature) | 10 | ? | 5 | ? | Sheep dip | 10 | Point discharges known, but EA study of these suggests further diffuse inputs are having a significant impact. A fairly intensive agricultural catchment- eg dairying and river interest features susceptible to water quality pollution impacts. Level of impact not really known. Input from fishing interests would be useful. | EA and English Nature monitoring |
| Peak District & Derbyshire | Lathkill Dale SSSI/NNR (also part of the Peak District Dales cSAC)- see below also for geological impacts (caves) | SK200660 | Bullhead (SAC feature)<br>Brook lamprey (?) (SAC feature)<br>White-clawed crayfish (SAC feature)<br>Aquatic inverts (SSSI feature)<br>Aquatic plant assemblage (SSSI feature) | 5 | | | | | 7 | P levels above toleration for these spp according to favourable conservation status tables.<br><br>Increase in P-dependent plants in seasonally-dry sections of riverbed | Site being considered under EA Review of Consents |
| Peak District & Derbyshire | Racecourse Meadow | SP185536 | Unimproved grassland | 5 | 5 | 5 | | | 5 | Inundation by R Avon, which receives agricultural inputs | |
| Peak District & Derbyshire | Cressbrook Dale SSSI/NNR (also part of the Peak District Dales cSAC) | SK175750 | Thamnobryum angustifolium (Derbyshire feather moss) | ? | ? | | | | 7 | Intensification of agricultural landuse in vicinity – including much paper pulp - may have an effect on water quality that may affect T. angustifolium at its only world site. | Monitored by EA |

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| | | | | P | N | Silt | BOD | Other | | | |
| Peak District & Derbyshire | Carvers Rocks SSSI | SK 330227 | Valley mire, fen | ? | ? | ? | ? | ? | 6 | Possible eutrophication of fen. Sphagnum becoming less dominant | Monitoring by Derbyshire Wildlife Trust |
| Peak District & Derbyshire | Crabtree Wood SSSI | SK 490785 | Calcareous flush | ? | ? | ? | ? | ? | 6 | Small site Vulnerable to adjacent land use. Intensive arable. | English Nature monitoring |
| Peak District & Derbyshire | Hulland Moss SSSI | SK250462 | Lowland raised bog | ? | ? | ? | ? | ? | 6 | Small site vulnerable to diffuse pollution from surrounding land use. Site showing signs of increased nutrient levels. | English Nature monitoring |
| Peak District & Derbyshire | Castleton SSSI | SK120820 | Active cave passage formation processes | | | | | | 5 | Sewage sludge-derived biofilms coating actively-forming cave passage<br><br>Permeability of limestone aquifer means pollutants from a diverse range of sources can enter the hydrological systems of which caves are a part | EA in negotiation with farmer applying sludge |
| Peak District & Derbyshire | Ginny Spring SSSI | SK 520788 | Calcareous flush | ? | ? | ? | ? | ? | 5 | Small site vulnerable to diffuse pollution from adjacent agricultural land and input from higher up the water catchment | English Nature monitoring |
| Peak District & Derbyshire | Hamps and Manifold Valleys (Peak District Dales cSAC) | SK100540 | Bullhead (SAC feature)<br>Brook lamprey (?) (SAC feature)<br>White-clawed crayfish (SAC feature) | ? | ? | 5 | ? | Sheep dip | 5 | A fairly intensive agricultural catchment- eg dairying and river interest features susceptible to water quality pollution impacts. Level of impact not really known. Input from fishing interests would be useful. | EA monitoring |

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| | | | | P | N | Silt | BOD | Other | | | |
| Peak District & Derbyshire | Wye Valley SSSI (one of the 13 dales of Peak District Dales cSAC) | SK140740 | Bullhead (SAC feature) Brook lamprey (?) (SAC feature) | 8 | ? | ? | ? | ? | 5 | P levels above toleration for these spp according to favourable conservation status tables, but probably mostly sourced from known points – sewage farms | Site being considered under AMP3/4 and EA Review of Consents |
| Peak District & Derbyshire | Cromford Canal SSSI | SK299569 | Invertebrates, swamp, open water communities | ? | ? | ? | ? | ? | 4 | Vulnerable from incidents higher up the catchment. | English Nature monitoring |
| Peak District & Derbyshire | Lathkill Dale SSSI/NNR (also part of the Peak District Dales cSAC)- see above also for biological impacts Geology | SK200660 | caves | ? | ? | ? | ? | ? | 3 | Permeability of limestone aquifer means pollutants from a diverse range of sources can enter the hydrological systems of which caves are a part | |
| Peak District & Derbyshire | Mercaston Marsh & Muggington Bottoms SSSI | SK269435 SK272430 | Lowland mire | ? | ? | ? | ? | ? | 3 | Potential water quality issues on sections of the site. Epilobium locally abundant. | Groundwater monitoring due to take place by EA. |
| Peak District & Derbyshire | Combs Reservoir | SK038795 | Bryophytes and marginal vascular plants. Breeding birds | ? | ? | ? | ? | ? | 3 | Possible impacts on plants of interest not clear if there are significant pathways though reservoir is surrounded by agricultural land. Susceptibility not clear. | |

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| | | | | P | N | Silt | BOD | Other | | | |
| Peak District & Derbyshire | Leek Moors SSSI (part of South Pennine Moors cSAC and the Peak District Moors SPA) | SK020650 | Blanket bog, springs, flushes, wet woodland, valley mire, fen meadows, waders | ? | ? | ? | ? | Sheep dip | 3 | Wetland habitats could be vulnerable. Depends on local catchment land use | |
| Peak District & Derbyshire | Masson Hill | SK290588 | caves | ? | ? | ? | ? | ? | 3 | Permeability of limestone aquifer means pollutants from a diverse range of sources can enter the hydrological systems of which caves are a part | |
| Peak District & Derbyshire | Mercaston Marsh & Muggington Bottoms SSSI | SK269435 SK272430 | Lowland mire | ? | ? | ? | ? | ? | 3 | Potential water quality issues on sections of the site. Epilobium locally abundant. | Groundwater monitoring due to take place by EA. |
| Peak District & Derbyshire | Morley Brickpits SSSI | SK389418 | Open Water, Marshy grassland | ? | ? | ? | ? | ? | 3 | Has potential to be affected by surrounding land use | Derbyshire Wildlife Trust monitoring |
| Peak District & Derbyshire | Moss Valley SSSI | SK415802 | Invertebrates | ? | ? | ? | ? | ? | 3 | River Moss could be affected. EA investigating incidents higher up catchment. Crayfish may be present | EA/English Nature monitoring |
| Peak District & Derbyshire | Pooles Cavern and Grin Low Wood | SK050724 | caves | ? | ? | ? | ? | ? | 3 | Permeability of limestone aquifer means pollutants from a diverse range of sources can enter the hydrological systems of which caves are a part | |

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| | | | | P | N | Silt | BOD | Other | | | |
| Peak District & Derbyshire | Shining Cliff Woods SSSI | SK335530 | Invertebrates (molluscs) | ? | ? | ? | ? | ? | 3 | Could be affected by diffuse pollution from agricultural land further up the catchment. | English Nature monitoring |
| Peak District & Derbyshire | Stoney Middleton Dale | SK210760 | caves | ? | ? | ? | ? | ? | 3 | Permeability of limestone aquifer means pollutants from a diverse range of sources can enter the hydrological systems of which caves are a part | |
| Peak District & Derbyshire | Toddbrook Reservoir | SK004809 | Bryophytes of water margins.<br>Breeding birds | ? | ? | ? | ? | ? | 3 | Possible impacts on plants of interest not clear if there are significant pathways though reservoir is surrounded by agricultural land. Susceptibility not clear. | |
| Peak District & Derbyshire | Upper Lathkill | SK143677/ 149677 | caves | ? | ? | ? | ? | ? | 3 | Permeability of limestone aquifer means pollutants from a diverse range of sources can enter the hydrological systems of which caves are a part | |
| Peak District & Derbyshire | Hilton Gravel Pits | SKSK249315 | Breeding birds, aquatic invertebrate fauna inc Odonata | ? | ? | ? | ? | ? | 2 | Water dependent interests and agricultural surrounding land. May be vulnerable. Odonata heavily dependant on good quality water. | Derbyshire Wildlife Trust Odonata monitoring |
| Peak District & Derbyshire | Moss Carr | SK073659 | Mire and wet woodland | ? | ? | ? | ? | ? | 2 | Wetland habitats could be vulnerable. Depends on local catchment land use. There is a peripheral drain around part of the site and significant drains within it that could introduce pollutants | |

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| | | | | P | N | Silt | BOD | Other | | | |
| Peak District & Derbyshire | Ogston Reservoir SSSI | SK376602 | Breeding birds | ? | ? | ? | ? | ? | 2 | Has potential to be affected by surrounding land use | Severn Trent Water monitor |
| Peak District & Derbyshire | Bradwell Dale and Bagshaw Cavern | SK170800 | caves | | | | | | 1 | Permeability of limestone aquifer means pollutants from a diverse range of sources can enter the hydrological systems of which caves are a part | |
| Somerset & Glouc. | Bridgwater Bay<br><br>(area known as Pawlett Hams) | | Fresh water invertebrates | y | y | | ? | | 7 | Agricultural practices in the catchment | WES (S15) |

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| | | | | P | N | Silt | BOD | Other | | | |
| Somerset & Gloucestershire | North Somerset Levels & Moors<br>Biddle Street<br>Puxton Moor<br>Tickenham<br>Nailsea and Kenn<br>Gordano Valley | ST353330<br>ST325305<br>ST423648<br>ST412630<br>ST440700<br>ST435730 | Lowland wet grassland with ditches.<br><br>Aquatic invertebrates<br>Aquatic plants | y | y | | ? | | 7 | It is thought that water quality across this system is very variable.<br><br>A very complex issue. A mixture of different factors.<br><br>Some of the main feeder river ie River Brue and King's Sedgmoor Drain are "know" to have water quality issues.<br><br>In some places the cause of the concern is land management, ie high input of fertilisers. But in other areas the problem may be ditch or river management ie weed cutting or dredging.<br><br>In some areas there is clearly a problem with run off from roads or farmyards.<br><br>Other activities that can cause water quality problems include<br><br>Peat Cutting, the drainage of the site (high solids content.)<br><br>& Withy Industry, high usage of pesticides and herbicides. | On site (SSSI) management agreements with landowners to lower or stop fertiliser input on fields: use of buffers.<br><br>New WES (S15) and Countryside Stewardship |

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| | | | | P | N | Silt | BOD | Other | | | |
| Somerset & Gloucestershire | Somerset Levels and Moors SPA & Ramsar Site<br><br>SSSI include:<br><br>Carcott, Edington and Chilton Moors<br><br>Curry and Hay Moors<br><br>King's Sedgemoor<br><br>Moorlinch<br><br>Shapwick Heath<br><br>Southlake Moor<br><br>Tealham and Tadham Moors<br><br>West Moor<br><br>West Sedgemoor<br><br>Westhay Heath<br><br>Westhay Moor<br><br>Wet Moor | ST390420<br><br>ST323273<br><br>ST400330<br><br>ST390360<br><br>ST430403<br><br>ST370300<br><br>ST420450<br><br>ST420220<br><br>ST361258<br><br>ST415422<br><br>ST455445<br><br>ST448244 | Lowland wet grassland with ditches.<br><br>Aquatic invertebrates<br>Aquatic plants | y | y | y | ? | | 7 | It is thought that water quality across this system is very variable.<br><br>A very complex issue. A mixture of different factors.<br><br>Some of the main feeder river ie River Brue and King's Sedgmoor Drain are "know" to have water quality issues.<br><br>In some places the cause of the concern is land management, ie high input of fertilisers. But in other areas the problem may be ditch or river management ie weed cutting or dredging.<br><br>In some areas there is clearly a problem with run off from roads or farmyards.<br><br>Other activities that can cause water quality problems include<br><br>Peat Cutting, the drainage of the site (high solids content.)<br><br>& Withy Industry, high usage of pesticides and herbicides. | On site (SSSI) management agreements with landowners to lower or stop fertiliser input on fields: use of buffers.<br><br>This via ESA and English Nature Section 15.<br><br>Additionally there on going work by the Environment Agency investigating the water quality issues.<br><br>There is also the Parrett Catchment Project, a catchment wide project with part of its remit to reduce run off of silt. |

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| | | | | P | N | Silt | BOD | Other | | | |
| Somerset & Gloucestershire (from Hereford & Worcester team) | Cotswold Water Park SSSI | SU082965 | Aquatic plant communities, marl water lakes. | ? | ? | | | | 6 | Decline in aquatic plan communities have been noted since notification. Elodea increased in dominance. Consistent with eutrophication. Algal bloom on some lakes in some years.<br><br>Unclear whether cause is diffuse or other source. | Investigation underway with EA to collect water quality data. First stage in determining whether this is a diffuse or point source pollution issue or is simply due to successional processes. |
| Somerset & Gloucestershire | Other Somerset Levels and Moors<br><br>SSSIs<br><br>Langmead and Weston Level<br><br>North Moor | ST353330<br><br>ST325305<br><br>ST423648<br><br>ST412630<br><br>ST440700<br><br>ST435730 | Lowland wet grassland with ditches.<br><br>Aquatic invertebrates<br>Aquatic plants | y | y | | ? | | 5 | It is thought that water quality across this system is very variable.<br><br>A very complex issue. A mixture of different factors.<br><br>Some of the main feeder river ie River Brue and King's Sedgmoor Drain are "know" to have water quality issues.<br><br>In some places the cause of the concern is land management, ie high input of fertilisers. But in other areas the problem may be ditch or river management ie weed cutting or dredging.<br><br>In some areas there is clearly a problem with run off from roads or farmyards.<br><br>Other activities that can cause water quality problems include<br><br>Peat Cutting, the drainage of the site (high solids content.)<br><br>& Withy Industry, high usage of pesticides and herbicides. | On site (SSSI) management agreements with landowners to lower or stop fertiliser input on fields: use of buffers.<br><br>New WES (S15) and Countryside Stewardship |

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| | | | | P | N | Silt | BOD | Other | | | |
| Suffolk | Alde-Ore Estuary Part of the Alde-Ore and Butley Estuaries c SAC, Alde-Ore Estuary SPA and Ramsar site | TM 394 575 to TM 358 402 | Bird interest through damage to invertebrate populations by algal mat and blooms. | 7 | 7 | | 7 | | 10 | River becomes anoxic leading to fish kills. | Nothing |
| Suffolk | Barnby Broad Part of The Broads, and the Broadland SPA and Ramsar | TM 480 910 | Damage to ditch flora and fauna.<br>Damage to the Broad itself. Possible eutrophication of marsh flora. | 7 | 7 | 7 | | | 10 | High land drains flow across the marshes to the IDB pump. The water is often silty and is believed to be carrying significant nutrient loading into the ditch system when it overtops the banks. Barnby Broad has suffered from silt deposition and is part of a project to investigate desilting the Suffolk Broads. The silt seemed to be feeding down the Rail Track ditches and into the Broad. | Discussions with EA and Rail Track over clearance of the Hundred Drain and the ditches alongside the railway track. |
| Suffolk | Benacre to Easton Bavents SSSI<br>Benacre to Easton Bavents SPA<br>Benacre to Easton Bavents Lagoons cSAC | TM 537 855, TM 512 722 | Habitats supporting internationally important populations of breeding birds (swamp, marginal and inundation and standing water).<br>C SAC saline lagoons and their invertebrates. | 7 | 7 | 7 | | ? | 10 | Pig slurry flowing into the site under storm conditions. Also believed to be feeding into ground water and thus into the sites.<br><br>Algal blooms on Covehithe Broad<br><br>Ammonia | Education of local pig farmers |
| Suffolk | Blo' Norton and Thelnetham Fens Part of the Waveney and Little Ouse Valley Fens c SAC | TM 017 790 | Calcareous fens with Cladium mariscus and the species of the Caricion davallianae<br>Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) | 7 | 7 | 7 | | | 10 | River flows through the middle of the SSSI. It regularly floods the fen. This river regularly fails its water chemistry and biological standards<br><br>Historically when the silt has been cleared it has been dumped into the fen rather than the agricultural land. | Issue has been raised with EA. |

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| Suffolk | Chippenham Fen NNR<br>Fenland cSAC | TL 648 697 | Molinia meadows on calcareous, peaty or clayey-silt-laden soils<br><br>Calcareous fens with Cladium mariscus and species of the Caricion davallianae | 5 | 5 | 5 | 5 | | 10 | Winter flooding of North Meadows leads to blanket weed blooms.. | None |
| Suffolk | Deben Estuary<br>The Deben Estuary SPA and Ramsar | TM 295 504 to TM 330 378 | Habitats for the populations of Annex 1 species and the regularly occurring migratory bird species +, of European importance, with particular reference to intertidal saltmarsh and mudflats.<br><br>+ Avocet, Brent goose | 7 | 7 | 7 | | | 10 | Large proportion of catchment comprises agricultural land. Perceived damage to invertebrate populations by algal mat and blooms. | Issue has been raised with EA. |

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| | | | | P | N | Silt | BOD | Other | | | |
| Suffolk | Minsmere to Walberswick Heath and Marshes SSSI<br>Minsmere to Walberswick Heath and Marshes cSAC<br>Minsmere to Walberswick SPA and Ramsar | TM 476 645<br>TM 467 772 | The site includes mudflats, shingle beaches, reedbeds, heathland and grazing marsh. The site is also noted for the habitats for the population of Avocet (Recurvirostra avosetta), Bittern (Botaurus stellaris), Marsh harrier (Circus aeruginosus), Nightjar (Caprimulgus europarus), and Hen harrier (Circus cyaneus), with particular reference to swamp, marginal and inundation, standing water, grassland, coastal lagoons, marsh and heathland.<br><br>Also of importance are the habitats for the population of Little tern (Sterna albifrons), with particular reference to shingle and shallow coastal waters. The habitats for the populations of the regularly occurring migratory bird species, Gadwall (Anas strepera), Teal (Anas crecca), Shoveler (Anas clypeata), European White-fronted goose (Anser albifrons), of European importance, with particular reference to grassland, marsh and standing water.<br><br>Also important are the habitats and species associated with heathland. These include nightjar, and the natterjack toads | 7 | 7 | 7 | 7 | | 10 | Frequency of outdoor pig units surrounding the site and several incidences of run off onto the site.<br><br>Ammonia | Meetings with pig owners. |

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| | | | | P | N | Silt | BOD | Other | | | |
| Suffolk | Orfordness – Havergate SSSI. Orfordness to Shingle Street cSAC | TM 400 472 | Salt marsh, vegetated shingle, saline lagoons, annual vegetation of drift lines and perennial vegetation of stony banks.<br><br>Habitats for the populations of the regularly occurring Annex 1 bird species and migratory bird species+, of European importance, with particular reference to grazing marsh, saltmarsh, intertidal mudflat and shallow coastal waters.<br><br>+Avocet, Sandwich tern, little tern, ruff, redshank, lesser black-backed gull | 7 | 7 | 7 | | | 10 | Unclear. Large proportion of catchment comprises agricultural land. | None |
| Suffolk | Orwell Estuary<br><br>Stour and Orwell SPA and Ramsar site | TM 170 415<br>TM 260 343 | Habitats for the populations of the regularly occurring migratory bird species+, of European importance, with particular reference to intertidal mudflats and saltmarsh, grazing marsh.<br><br>+ black-tailed godwit, dark-bellied Brent goose, dunlin, grey plover, redshank, ringed plover, shelduck, turnstone | 7 | 7 | 7 | | | 10 | Unclear. Large proportion of catchment comprises agricultural land. | Several actions concerned with influencing farming activities are planned as part of the Stour and Orwell Estuaries European Marine Site management Scheme. |

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| | | | | P | N | Silt | BOD | Other | | | |
| Suffolk | Redgrave and Lopham Fens NNR<br>Redgrave and South Lopham Fens Ramsar site<br>Waveney and Little Ouse fens cSAC | TM 050 797 | Calcareous fens with Cladium mariscus and the species of the Caricion davallianae<br>Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) | 5 | 7 | | | | 10 | The outdoor pigs and the disposal of poultry manure are widespread land uses within the catchment. The soils are dominated by sands in the valley bottom (hence their history of use for slurry disposal). There is some evidence of nutrient enrichment within the fen. This is inconclusive as there are suggestions that this may result from the decomposition of peat. | Investigations have been undertaken by the Environment Agency. |
| Suffolk | Sprat's Water and Marshes SSSI | TM 507 921 | Spring fed mixed fen, freshwater habitats | 7 | 7 | 7 | | | 10 | Landspring dyke considered a problem for a number of years. Appears to have high silt loadings in flood episodes. | Some minor investigations of the sources of the water. |
| Suffolk | Weston Fen SSSI.<br>Waveney and Little Ouse fens cSAC | TL 981 787 | Calcareous fens with Cladium mariscus and the species of the Caricion davallianae<br>Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)<br><br>Desmoulin's whorl snail (Vertigo moulinsiana) | 5 | 7 | 7 | | | 10 | Site is surrounded by agricultural land. It has been suggested that the surrounding soils could feed nutrient rich water onto the site. The channel running through the site also drains arable land, but is mainly composed of outflow water from an adjacent sewage treatment works.<br>Algal growth in fen after flooding incidents. | None. |
| Suffolk | Cornard Mere | TL 888 389 | Seasonally flooded areas of fen, species-rich ruderal herb vegetation, woodland, scrub and neutral grassland | 7 | 7 | 7 | | | 5 | Nettle beds present on edge of mere. Mere silting up. System moved from groundwater-dominated system to a surface water dominated one. Likely implication is increased nutrient levels. | Restoration work on Mere planned. Some compensation water provided |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Suffolk | Sotterley Park SSSI | TM 463 853 | Species of lichens and bryophytes on the trees | 7 | 7 | | | | 5 | Suggestion that airborne particles of granular fertiliser are settling on the trees and increasing the nutrient status which is encouraging algal growth. There may also be pH implications. | None |
| Suff olk | Hopton Fen SSSI | TL 648 697 | Tall fen communities. | 5 | 5 | 5 | 5 | | 1 | The channel flowing down the west side of the fen drains | None |
| Suffolk | Leiston - Aldeburgh | TM 461 595 | Acid grassland, heath, scrub, open water. Diverse community of breeding and overwintering birds. | 5 | 5 | 5 | 5 | | 1 | Site containing susceptible species surrounded by agricultural land | None |
| Sussex & Surrey | Chichester Harbour SSSI (part of Chichester & Langstone Harbours SPA and Ramsar site overlaps with Solent Maritime cSAC) | | Indirect effect upon birds via invertebrate food supply in mud flats (SPA, SSSI feature) Ponds and Riffes | 9 | 9 | 3 | 6 | | 9 | Observed and measured pollution issues Chichester Harbour. P and BOD are mostly likely from STW (so point) and will be addressed in AMP. Some N2 is highly likely from surrounding agricultural land use and some pesticide drift and run-off have also caused concern. | AMP process<br>O/O liaison<br>Encourage ESA and/or CS uptake in catchment |
| Sussex & Surrey | Combe Haven SSSI | | Ditch Flora and Fauna | 4 | 8 | 6 | 3 | | 7 | Observed signs of site degradation and algae blooms in ditches. Most likely source agriculture | O/O liaison<br>Encourage ESA and/or CS uptake in catchment<br>EA/English Nature discussing River Restoration Proposals |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Sussex & Surrey | Pevensey Levels SSSI and Ramsar Site | | Flora & Fauna of ditches, (SSSI and Ramsar features)<br>wet grassland (SSSI feature) | 8 | 8 | 6 | 6 | | 7 | Observed and measured pollution issues in Pevensey Levels. P and BOD are mostly likely from STW (so point) and will be addressed in AMP. Some N2 is highly likely from surrounding agricultural land use. | AMP process<br>O/O liaison<br>Encourage ESA and/or CS uptake in catchment |
| Sussex & Surrey | Upper Arun SSSI | | River dragonfly assemblage | 8 | 8 | 6 | 4 | | 5 | Observed and measured pollution issues in R. Arun. P and BOD are mostly likely from STW (so point) and will be addressed in AMP. Some N2 is highly likely from surrounding agricultural land use. | AMP process<br>O/O liaison<br>Encourage ESA and/or CS uptake in catchment |
| Sussex & Surrey | Pagham Harbour SSSI and SPA and Ramsar site | | Indirect effect upon birds via invertebrate food supply in mud flats (SPA, SSSI feature)<br>Flora and Fauna of ditches (SSSI feature) | 6 | 6 | 4 | 4 | | 5 | Observed and measured pollution issues in Pagham Harbour. P and BOD are mostly likely from STW (so point) and will be addressed in AMP. Some N2 is highly likely from surrounding agricultural land use. | AMP process<br>O/O liaison<br>Encourage ESA and/or CS uptake in catchment |
| Sussex & Surrey | Pett Levels | | Indirect effect upon birds via invertebrate food supply in mud flats (SPA, SSSI feature)<br>Flora and Fauna of ditches and ponds (SSSI feature) | 5 | 5 | 2 | 3 | | 5 | Observed pollution issues in Pett Levels. Some limited inputs from STW already being addressed under AMP | AMP process<br>O/O liaison<br>Encourage ESA and/or CS uptake in catchment |
| Sussex & Surrey | Rye Harbour SSSI (part of Dungeness to Pett Levels SPA) | | Alluvial Grazing marsh (SSSI feature)<br>Vegetated Shingle (is farmed!)<br>Indirect effect upon birds via invertebrate food supply in mud flats (SPA, SSSI feature) | 5 | 5 | 1 | 2 | | 5 | Observed pollution issues in Rye Harbour. Some limited inputs from STW already being addressed under AMP | AMP process<br>O/O liaison<br>Encourage ESA and/or CS uptake in catchment |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Sussex & Surrey | Arun Valley SPA Incl Waltham Brooks SSSI Amberley Wild Brooks SSSI Pulborough Brooks SSSI | | Flora & Fauna of ditches (Ramsar and SSSI features) Wet grassland (SSSI feature) Potentially indirect effect on SPA (bird) food source. | 6 | 6 | 6 | 4 | | 4 | Observed and measured pollution issues in R. Arun. P and BOD are mostly likely from STW (so point) and will be addressed in AMP. Some N2 is likely from surrounding agricultural land use but main water supply is groundwater. The quality in main river is relatively poor (EA data) but may not be a problem for SPA as floodbanks currently protect high water quality in freshwater ecosystem (EA data). Floodbanks maintenance currently being reviewed by Agency. This presents potential severe WQ problems in future. | AMP process O/O liaison Encourage ESA and/or CS uptake in catchment Major upstream tributary of R. Arun (Rother) English Nature joint fund a project officer to address land use issue, especially severe siltation. |
| Sussex & Surrey | Shillinglee Lake | | Open water flora | 7 | 7 | 3 | 1 | | 4 | Fields surrounding lake have arable crops with v small buffer. Phosphate and Nitrate measurements have shown eutrophication | O/O Liaison |
| Sussex & Surrey | Ashburnham Park SSSI | | Epiphytic lichens and lake flora | 3 | 3 | 1 | 1 | | 3 | Potential to be impacted by drift, some degradation at the edge of the site but no evidence to suggest the site is actually impacted by diffuse pollution. | None |
| Sussex & Surrey | Moor Park SSSI | | Wet woodland and open water | 6 | 6 | 5 | 2 | | 3 | Signs of site degradation including duckweed excessive growth | O/O liaison English Nature fund project officer for R. Wey to look at land use to address siltation problems |
| Sussex & Surrey | Ashdown Forest | | Wet Heath, Gill streams and lower plant interest | 2 | 2 | 0 | 0 | | 2 | Potential to impacted by drift and direct pollution of waters. No evidence of major site degradation. | None |
| Sussex & Surrey | Eridge Park | | Gil stream and lake flora and fauna (dragonflies) | 3 | 3 | 1 | 1 | | 2 | Eutrophication of lake and streams from agriculture in immediate vicinity of the SSSI. | Site is improving due to arable reversion in CS |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Sussex & Surrey | Hedgecourt | | Lake – open water | 2 | 2 | 1 | 2 | | 2 | Inflow stream is in severely intensive agriculture. No signs of algae blooms on main lake, but excessive pondweed growth. | None |
| Sussex & Surrey | Maplehurst Wood | | Lake & gill stream lower plant interest | 2 | 2 | 0 | 1 | | 2 | Potential to impacted by drift and direct pollution of waters. No evidence of major site degradation. | None |
| Sussex & Surrey | Marline Valley Woods | | Gill streams and lower plant interest | 2 | 2 | 0 | 0 | | 2 | Potential to impacted by drift and direct pollution of waters. No evidence of major site degradation. | None |
| Sussex & Surrey | Papercourt SSSI | | Alluvial meadows, open water | 3 | 3 | 3 | 1 | | 2 | Signs of site degradation including signs of nutrient enrichment of meadows – may be due to inappropriate management<br>Signs of algae blooms in lakes, not due to STW but may be due in part to overstocking with fish | O/O liaison<br>English Nature WES agreement for part of site<br>English Nature fund project officer for R. Wey to look at land use to address siltation problems |
| Sussex & Surrey | Wey Valley Meadows SSSI | | Alluvial meadows | 2 | 2 | 4 | 0 | | 2 | Signs of site degradation, may be due in part to water quality of adjacent R. Wey | O/O liaison<br>English Nature fund project officer for R. Wey to look at land use to address siltation problems |
| Sussex & Surrey | Godstone Ponds | | Mesotrophic lakes and alder carr | 7 | 7 | 9 | 7 | | 1 | Proven eutrophication, proven link to agriculture. Site highly degraded and SSSI interest is no longer there. Has been subject of previous eutrophication studies and prosecution from farming liquor spillage. Land use only one of many problems, is also M25 (jn6), overstocking with bottom feeding fish<br>Possibly heavy metals and oils from roads | O/O liaison,<br>EA liaison and study of impacts of various inputs into lakes |
| Sussex & Surrey | St Leonard Park Ponds | | Hammer Ponds Open water flora and fauna | 9 | 9 | 1 | 2 | | 1 | Proven eutrophication, site highly degraded. Has been subject of previous eutrophication studies Land use only one of many problems, is also overstocking with bottom feeding fish and non-native species | None |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Sussex & Surrey | Charles Hill SSSI | | Alluvial meadows and wet woodland | 2 | 2 | 1 | 2 | | 1 | Not many signs of degradation but minor signs of nutrient enrichment of meadows immediately adjacent to the river–but this may be due to inappropriate management | O/O liaison<br>English Nature WES agreement for part of site<br>English Nature fund project officer for R. Wey to look at land use to address siltation problems |
| Thames & Chiltems | River Kennet SSSI | SU203692 | Chalk river habitat | y | | y | | | 10 | Excessive sedimentation and turbidity in places. Suppression of aquatic plant growth over large sections. | Improvements being made to major sewage treatment works (enhanced phosphorus removal and raised standards on suspended solids).<br>A target area for Countryside Stewardship.<br>English Nature/EA joint funded FWAG project providing advice to farmers to reduce inputs to system.<br>Increased analysis of sediment to identify source of inputs. |
| Thames & Chiltems | River Lambourn SSSI/cSAC | SU322798 | Chalk stream habitat<br>Floating Ranunculus vegetation | y | | y | | | 9 | Excessive sedimentation and turbidity in places. Suppression of aquatic plant growth over large sections. | Improvements being made to major sewage treatment works (enhanced phosphorus removal and raised standards on suspended solids).<br>A target area for Countryside Stewardship. |
| Thames & Chiltems | Cothill Fen cSAC/SSSI | SU456993 | Alkaline fen<br>Alder woodland | y | y | | | | 8 | Clear signs of nutrient enrichment in wet woodland adjacent to intensively managed pasture alongside part of site. | None. |
| Thames & Chiltems | Stanford End Mill & River Loddon SSSI | SU707630 | Potamogeton nodosus | y | | y | | | 7 | Potamogeton nodosus is thought to be sensitive to high nutrient levels and excessive sedimentation. | Improvements being implemented at Basingstoke Sewage Treatment Works to reduce phosphorus levels. |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Thames & Chiltems | Sidlings Copse and College Pond SSSI | SP555095 | Calcareous fen habitat | y | y | | | | 6 | Area immediately surrounding site was until recently used for outdoor pig rearing. | None, but fields are now managed less intensively. |
| Thames & Chiltems | Middle Barton Fen SSSI | SP443263 | Alkaline fen habitat | y | y | | | | 5 | Evidence of nutrient input from adjoining pasture fields, resulting in changes in flora. | Fields are currently in Countryside Stewardship and less intensively managed. |
| Wiltshire | River Avon System SSSI (River Avon cSAC) | Salisbury (meeting point of tributaries)<br><br>SU140340 | River vegetation<br><br>SAC fish species (bullhead, brook lamprey, salmon)<br><br>Fish and invertebrate communities | 6 | | 6 | | | 10 | English Nature/EA modelling work identified high levels of P in the Avon system, and that diffuse inputs comprised 55-60%. (reports Southey 98 River Avon pSAC Ecological Assessment) and WRC (98) Nutrient Budget for Upper Reaches of the Hampshire Avon) – both available from English Nature national office.<br><br>Ranunculus vegetation considered to be sensitive to high P and to silt. Salmon spawning success requires clean gravels and low rates of accumulation of silt within redds<br><br>Anecdotal evidence suggests increase in silt levels in recent years<br>(ref Landcare baseline reports, EA 2002) | Landcare Project (includes raising awareness of soil management, demonstration sites and farmer workshops). EA led partnership of many agencies. |
| Wiltshire | River Till SSSI (River Avon cSAC) | SU075409 (roughly halfway along) | River vegetation<br><br>SAC fish species (bullhead, brook lamprey)<br><br>Fish and invertebrate communities | 4 | | 5 | | | 10 | Concerns extrapolated from Avon work | |

| Team | Site Name & Nature Conservation Designation(s) | NGR | Features at risk | Problematic parameters | | | | | Relative priority | Reasons for concern | Current action |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | P | N | Silt | BOD | Other | | | |
| Wiltshire | River Kennet SSSI | SU250701 | River vegetation<br><br>Fish and invertebrate communities | 6 | | 6 | | | 9 | Concerns extrapolated from Avon, plus anecdotal information from EA and observation | FWAG Landwise Project in Upper Kennet catchment. Project Officer employed by FWAG to raise awareness, offer advice, promote good soil management through production of farm plans). |

# *Appendix 2 Case studies*

This appendix presents information for a selection of the highest priority sites in the form of summary case studies (Section 5). These studies have been prepared to highlight the nature of issues relating to diffuse agricultural pollution, its ecological impacts and the types of evidence currently available for the assessment of diffuse agricultural pollution. These case study sites are intended to exemplify the relevant issues and should not be taken to reflect a list of the very highest priority sites.

**CASE STUDY 1: Bassenthwaite Lake**

| | |
|---|---|
| **Site Name:** | Bassenthwaite Lake |
| **County:** | Cumbria |
| **NGR:** | NY 215295 |
| **Site Area:** | 5.28 $km^2$ |
| **Catchment Area:** | 238 $km^2$ |
| **Site Protection/Designations:** | Bassenthwaite SSSI<br>River Derwent and Bassenthwaite Lake cSAC<br>Bassenthwaite NNR |

**Site Description**

Bassenthwaite Lake is the fourth largest lake in the English Lake District with a catchment area of 238 $km^2$. More than 60% of the catchment is covered by upland moor, rough grazing and bare rock, with the remainder used for forestry and improved pasture.

The catchment of Bassenthwaite Lake includes relatively soft Skiddaw slates in the area surrounding the lake and the harder, volcanic rocks of Borrowdale to the south. The lake's main direct water supply is from the River Derwent (approx. 80% of hydraulic load).

Because its catchment area contains an estimated human population above 21,000, Bassenthwaite Lake is considered to be 'sensitive' in terms of the EC Urban Waste Water Treatment Directive (91/271/EEC).

The aquatic macrophyte vegetation of Bassenthwaite Lake indicates that the lake is mesotrophic, with species characteristic of water bodies with circumneutral pH and relatively low nutrient status.

**Reasons for Notification / Special Interests**

*European Protected Habitats:*

- Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea* (Habitat 3130 )

*European Protected Species:*

- Otter *Lutra lutra*
- Atlantic salmon *Salmo salar*
- Brook lamprey *Lampetra planeri* and river lamprey *Lampetra fluviatilis*
- Floating water plantain *Luronium natans*

*Other:*

- Vendace *Coregonus albula* population (Schedule 5 species under WCA 1981)

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Vendace
- Aquatic macrophytes

**CASE STUDY 1: Bassenthwaite Lake (Contd.)**

**Evidence of Pollution Impacts**

There is a substantial body of research work available regarding the lake, mostly produced by CEH, dealing largely with phosphorous but also with sedimentation. The Environment Agency has a substantial amount of monitoring data. CEH also have an independent monitoring database. A number of review documents have been produced regarding phosphorous and sediment character for the lake - the last being published in Sept 2002. Both the Agency and CEH produce summary annual monitoring reports.

*Eutrophication - Phosphorus*

The lake is generally considered to be mesotrophic, but long-term water quality records suggest it has become increasingly eutrophic in recent years (May *et al.* 1996, Bennion *et al.* 1997, 2000). Land use changes between 1972 and 1988 are thought to have resulted in an increase in TP loading from diffuse sources (May *et al.* 1995).

In 1996, the lake had a very high TP load (3g m2 y-1) - about 20 times the OECD 'dangerous' limit for a lake of this size (May *et al.* 1996). The lake's retention period is short - averaging between 19 days (Maberley & Elliott 2002) and 25 days (Parker *et al.* 1999). Flushing rates for the sediment and phosphorus loads are rapid, therefore, and ecological effects are presently limited. Nevertheless, the loads cause occasional algal blooms and periodic de-oxygenation of deeper waters. Together with deposition of re-suspended sediment, this poses a significant threat to the lake's vendace population.

*Sediment*

Sedimentation rates within the lake are very high, threatening the population of vendace by smothering spawning areas. Sedimentation and turbidity may also affect aquatic macrophyte vegetation. There is a possible link between eutrophication and increased sedimentation, with eutrophication resulting in increased deposition of organic material. However, sediment analysis has suggested that a high proportion of the sediment is inorganic and likely to be derived from diffuse catchment sources or other anthropogenic sources.

*Evidence of ecological effects*

Studies exist showing impact on the Vendace. These include a video survey of potential vendace spawning sites in 1998 which showed extensive siltation problems.

There is little evidence of significant change in the aquatic macrophyte assemblage of the lake (Bennion *et al.* 1997, 2000). However, the diatom assemblage suggests increased eutrophication. Diatom research suggests that the lake has experienced a 50% increase in nutrient concentrations since the early 1700s. Hall *et al.* (2000) considered that natural establishment of macrophytes is being impaired by eutrophication and, presumably, by sediment load.

Cyanobacteria blooms and extensive blanketweed algae Cladophora sp. have been observed in sheltered bays.

**CASE STUDY 1: Bassenthwaite Lake (Contd.)**

**Evidence of Diffuse Agricultural Pollution**

In 1993, the main sources of phosphorus within the catchment were determined using export coefficients from published sources (May *et al*.., 1996). Approximately 41% (6.8t TP y-1) of the TP load was derived from sewage effluent, 39% came from agricultural runoff (6.5t TP y-1), 14% was thought to derive from leaking septic tanks, with 5% of the load unaccounted for.

Geochemical analysis of lake sediments has shown that P has increased markedly since 1900 and especially so since c.1970 (Bennion *et al*. 1997). This is largely associated with increased P-output from Keswick STW but the figures above also indicate significant diffuse inputs. Upgrading of the sewage treatment works in 1995 reduced the TP load to the lake by about 26%. The main sources of TP entering the lake are now thought to be agricultural (52%), STWs (21%) and septic tanks (18%). Phosphate stripping from Keswick STW has reduced TP loads by up to 26% but has had little effect on the levels of phosphorus in the lake water and sediments and has brought relatively little ecological benefit.

There is also some evidence that sediment accumulation rates have increased between 1900-1940, an increased rate which has been sustained to the present day (Bennion *et al*. 1997). Specific land use changes or events are considered likely to have generated significant sediment loads at particular times (Parker *et al*. 1999) - including changes in agricultural practice during the 2nd World War and the construction of the railway line in the late 19th Century. Most recently (1974-77), the re-construction of a major road along the western shore has been associated with an increase in sedimentation rates. Increased fine sediments have also been noted from the early 1990s. Other catchment improvements include straightening of the River Derwent, new drainage measures and the removal and installation of weirs. Other work has suggested that inflow sediment loads from the River Derwent are low (Parker *et al*. 1999). Sedimentation rates within the lake are significantly higher than the inflow sediment loads would suggest, however, indicating that sedimentation sources are dominated by re-suspended sediments from within the lake as a result of wind-induced wave action.

There is visual evidence of overgrazing in much of the catchment, which is likely to cause increased sediment loading.

**Current / Proposed Action**

Considerable research effort continues into the sediment and nutrient dynamics of Bassenthwaite Lake and other Cumbrian Lakes. This is mostly being conducted by CEH, under the auspices of a sub-group of the Lake District Still Waters Partnership. This work has included proposals for restoration or remediation of phosphorus and sediment impacts upon the lake.

Bassenthwaite Lake is included in the Environment Agency's NUPHAR Project.

No current action to tackle diffuse agricultural pollution

**Sites with Similar Problems**

Sites included on the NUPHAR Project.

**CASE STUDY 1: Bassenthwaite Lake (Contd.)**

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**CASE STUDY 2: Chesil and The Fleet**

| | |
|---|---|
| **Site Name**: | Chesil and The Fleet |
| **County**: | Dorset |
| **NGR**: | SY496885 to SY683734 |
| **Site Area:** | 990.4 ha |
| **Site Protection/Designations:** | Chesil and the Fleet SSSI<br>Chesil and the Fleet SPA<br>Chesil and the Fleet cSAC<br>Chesil and the Fleet RAMSAR |

**Site Description**

The site is located on the West Dorset coast and is largely undeveloped. The site has been part of the Ilchester Estate for over 400 years.

Chesil Beach is one of three major shingle structures in the UK. Generally the beach grades from pea gravels at West Bay to cobbles at Chiswell, Portland. The beach encloses The Fleet, Britains largest tidal lagoon, which runs along approximately half the length of the Beach. The Fleet lagoon has a unique ecology and constitutes approximately 60% of the area of tidal lagoon in the UK and as such is of international importance as a wildlife site.

**Reasons for Notification / Special Interests**

Chesil Beach and the Fleet and their associated habitats, form a site of international importance for wildlife. The landward side of the Beach contains nationally important populations of sea kale *Crambe maritima*, yellow horned poppy *Glaucium flavum* and shrubby sea-blite *Suaeda fruiticosa*. Other species recorded include the Red Data Book species little-robin *Geranium purpureum*. The Beach is also an important breeding site for little tern *Sterna albifrons* and ringed plover *Charadius hiaticula*.

The Fleet has a diverse ecological interest. It is largely shallow, mostly 1.5m or less (up to 5m in places) – with a salinity gradient from marine to near freshwater and a complex tidal and hydrological regime. The bed consists of silts and sand with areas of pebble, hard coralline rock and soft mud in the Narrows. The lagoon contains a diverse assemblage of plants with no less than 150 recorded species. Of particular note are the rare filamentous green algae and the most extensive mixed population of eel-grasses and spiked/beaked tassel weeds in the UK.

The abundant vegetation of the Fleet lagoon and the intertidal mudflats support large populations of wildfowl and waders.

Invertebrates recorded on the site are similarly unique and diverse and include looping snail *Truncatella subcylindrica*, the sea slug *Tenellia adspersa*, the sponge *Suberites massa* and the burrowing anemone *Scolanthes callimorphus*. Terrestrial habitats contain the only known UK population of the scaly cricket *Mogoplites squamiger*.

The Fleet supports 23 species of fish including, one of the few nurseries in Britain for bass *Dicentrachus labrax*. The goby *Gobius couchii* is also resident – a species only otherwise known from Portland Harbour and the river Helford.

**CASE STUDY 2: Chesil and The Fleet (Contd.)**

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

*Plants*

- Eelgrass *Zostera* spp.
- Tassel weed *Ruppia* spp.
- Rare filamentous green algae *Cladophora battersia* and *C retroflexa*
- sea kale *Crambe maritima*,
- yellow horned poppy *Glaucium flavum*
- sea-blite *Suaeda fruiticosa*
- little-robin *Geranium purpureum*

*Birds*

- Wildfowl and waders including Mute Swan *Cynus olor* Widgeon *Anas penelope*, dunlin *Calidris alpina* and lapwing *Vanellus vanellus*
- Little tern *Sterna albifrons*
- Ringed plover *Charadius hiaticul*)

*Lagoonal Invertebrates*

- looping snail *Truncatella subcylindrica*,
- sea slug *Tenellia adspersa*
- sponge *Suberites massa*
- anemone *Scolanthes callimorphus*

*Fish*

- bass *Dicentrachus labrax*
- goby *Gobius couchii*

**Evidence of Pollution Impacts**

Nutrient enrichment of the Fleet has been considered an issue for a number of years. Until recently little or no information has been available to substantiate the assumed impacts. In order to determine the nutrient status, identify potential impacts and to inform the management of the site a study was undertaken by Johnston and Gilliland 2000.

John (1995), undertook baseline studies into the nutrient status of the Fleet. Variations in nutrient levels and phytoplankton populations were examined and found to be correlated. Elevated levels of inorganic nitrogen were positively correlated to dinoflagellate blooms during the study period.

Relatively little evidence has been recorded or found to indicate detrimental impacts on the conservation interest of the site as a result of pollution. However, this is thought to be largely due to the lack of historical data rather than a true expression of no current effect (Johnston and Gilliland 2000).

There is circumstantial evidence for impact on foxtail stonewort *Lamprothamnium papulosum* and eelgrass *Zostera* spp. communities by competition from green algae.

Despite the lack of information, it is thought likely that any increases in nutrient inputs to the western Fleet would likely result in impacts to the health of:

- eelgrass and tassel weed;
- foxtail stonewort and,
- lagoonal invertebrate and fish.

**CASE STUDY 2: Chesil and The Fleet (Contd.)**

**Evidence of Diffuse Agricultural Impacts**

Algal blooms were identified in the Fleet in 1994 that were thought to be the result of diffuse pollution.

The Johnson and Gilliland 2000 study reviewed:

- Hydrological modelling of the fleet to determine the influence of a number of factors including tidal currents, flushing characteristics and salinity and solute distribution.
- Water quality investigations by the Environment Agency including data on point sources, streams, diffuse sources and receiving waters
- Nutrient budget modelling of the Fleet.

The results of this review indicate that diffuse agricultural inputs result in both Nitrogen and Phosphorous peaks in the winter from fertiliser and livestock respectively.

**Current / Proposed Actions**

Additional modelling has been recommended in order to assess further the influences of seasonality and spatial distribution of pollution loads in the Fleet. This will inform the development of management actions required to address eutrophication issues. However, since the primary issues and mechanisms have been identified, it is not necessary to wait for the modelling results before establishing good practice management practices.

Catchment walkover surveys have been recommended to 'identify critical practices and run-off pathways'. However, no specific actions are currently being targeted at diffuse agricultural pollution.]

**Sites with Similar Problems**

A full list of UK lagoons has been published by Bamber 1997.

**References**

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JOHN, E.H., 1995. *A study of the nutrient status, hydrological features and phytoplankton composition of the Chesil Fleet, Dorset*. University of Wales MSc Thesis.

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MAINSTONE, C., 1999 *Estimation of nutrient loadings to the Fleet lagoon from diffuse sources.* Environment Agency and WRc.

**CASE STUDY 3: Lindisfarne and Tweed Catchments**

**Site Name:** Lindisfarne and Tweed Catchments
**County:** Northumberland
**NGR:** NU 100430
**Site Area:** 3965.0 ha
**Site Protection/Designations:** Lindisfarne SSSI
Lindisfarne SPA
Lindisfarne NNR
Tweed Catchment Rivers – England: Till catchment/Lower Tweed and Whiteadder SSSIs
River Tweed pSAC
Tweed Estuary cSAC

**Site Description**

The Lindisfarne and Tweed Estuary area comprises a range of coastal habitats, including rocky shore, sand dunes, saltmarsh and intertidal sand and mudflats. These support internationally important numbers of wintering waterfowl. The extensive intertidal sand and silt flats contain abundant invertebrate populations, and support extensive beds of eelgrass (*Zostera spp)* – an important food source for wintering birds.

Holy Island Sands is surrounded by a large area of salt marsh with extensive sand dunes to the East and North of the Island. The foredunes are dominated by marram *Ammophila arenaria*, with older dunes supporting acidic communities including dune heath. The dune slacks are more species-rich and dominated by creeping willow *Salix arenaria* and cross-leaved heath *Erica tetralix*.

The Tweed catchment rivers are characterised by clean water running over glacial deposits and limestone. The resulting conditions support a diverse flora and faunal community. The catchment supports a healthy fishery including the migratory species salmon and sea trout.

**Reasons for Notification / Special Interests**

Rivers of the Tweed catchment are designated as SSSI as national examples of certain river types, as characterised by their plant assemblages, ranging from upland to lowland habitats. These rivers are also designated as SAC for the occurrence of riverine habitat associated with floating vegetation characterised by *water-crowfoot species*. The catchment supports diverse assemblages of pondweed (*Potamogeton)* species including the rare graceful pondweed *P. x olivaceus* and willow leaved pondweed *P. x salicifolius*. The Tweed fish populations are some of the most diverse in the country. Of particular interest are the strong populations of salmon *Salmo salar*, sea trout *S trutta* and brown trout *Trutta trutta*.

The primary reason for designation of the maritime habitats is their importance for birds including:

- Breeding Little Tern *Sterna albifrons.*
- Over wintering waders and wildfowl including Bar-tailed Godwit *Limosa lapponica*, Golden Plover *Pluvialis apricaria,* Wigeon *Anas penelope* and Whooper Swan *Cygnus cygnus*, representing at least 5.6%, 2.2%, 1.1% and 1.4% respectively of GB's wintering populations.
- Passage migrants; Ringed Plover *Charadrius hiaticula*, 527 individuals representing at least 1.1% of the Europe/Northern Africa - wintering population (5 year mean 91/2-95/6).

The Tweed Estuary SSSI supports internationally important populations of wintering Turnstone *Areneria interpres* and nationally important numbers of migrating/wintering waders including redshank *Tringa totanus*.

**CASE STUDY 3: Lindisfarne and Tweed Catchments (Contd.)**

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Salmon
- Lamprey species
- Aquatic macrophytes, in particular *Ranunculus* and *Potamogeton* species and assemblages
- Breeding, wintering and passage waders and wildfowl

**Evidence of Pollution Impacts**

All except one of the sampling stations on the river Tweed returned unfavourable site condition results based on GQA targets assessed in 2002 (English Nature, Condition Assessment 2002).

The presence of species of aquatic plants typical of nutrient-enriched environments is indicative of eutrophication. On the Tweed, recent increases in the abundance of algae *Cladophora*, *Enteromorpha* and *Hydrodictyon* have been of concern. In addition, the aquatic macrophytes water milfoil *Myriophyllum spicatum*, Canadian pondweed *Elodea canadensis* and horned pondweed *Zannicellia palustris*, all of which are indicative of nutrient enrichment, have been recorded.

Siltation of gravel beds, the spawning ground for salmon, has been identified as having an adverse impact on this species. In addition the changing composition of exposed muds and sands is considered to be havng an adverse impact on invertebrate communities.

Enteromorpha growth has impacted intertidal areas within Lindisfarne SSSI leading to units being assessed as being in unfavourable condition. Algal coverage has been shown to be particularly variable between growing seasons, therefore factors affecting growth will be further investiaged through the Environment Agency's review of consents project.

Lindisfarne NNR has been submitted for designation as a Polluted Water (eutrophic) and modelling of water quality data suggest that the Tweed has a significant seasonal impact on Lindisfarne NNR.

**Evidence of Diffuse Agricultural Pollution**

Diffuse agricultural pollution appears to be the main factor influencing the eutrophication of the Tweed catchment. There is no evidence of significant organic pollution from sewage treatment works or septic tanks at present (Dale 1998) although significant nutrient enrichment cannot be discounted. Sedimentation in the catchment derives partly from excessive grazing pressure leading to severe trampling and soil erosion. In addition run-off from exposed arable fields is a source of increased sediment load to the river Tweed catchment. Agricultural practices, forestry and land drainage are all considered significant influencing factors on the sediment input into the Tweed catchment (Dale 1998).

SEPA have produced modelled data indicating that 96% of nitrogen and 43% of phosphorous loading for the river Tweed Estuary are from agricultural sources (Anon, English Nature)

Data held by the EA back to 1973 show seasonal peaks in nutrient levels that are consistent with diffuse agricultural inputs. In addition data collected for the Land Ocean Interactive Study (LOIS) project have identified increases in nitrogen concentrations between the 1960's and 1980's. This increase was attributed to diffuse agricultural pollution from increased cereal production, winter barley sowing and increased soil erosion. (Peaty and Lillie 1998).

**Current / Proposed Action**

A number of monitoring exercises are currently being undertaken on the Tweed estuary, including measurement of nutrient levels.

No current action to tackle diffuse agricultural pollution.

**CASE STUDY 3: Lindisfarne and Tweed Catchments (Contd.)**

**Sites with Similar Problems**

Other estuaries, Rivers Avon, Test and Itchen

**References**

PEATY, S. & LILLIES, B., 1998. *Investigation into Enrichment at Lindisfarne NNR, 1997.* Environment Agency.

DALE, K.M., 1998. *Conservation Strategy for the Tweed Catchment Rivers.* Report for English Nature.

ANON ENGLISH NATURE. *Investigation into Eutrophic Status of the Tweed Estuary.*

**CASE STUDY 4: Moorthwaite Moss**

**Site Name:** Moorthwaite Moss
**County:** Cumbria
**NGR:** NY 511511
**Site Area:** 12.2 ha
**Site Protection/Designations:** Moorthwaite Moss SSSI

**Site Description**

Moorthwaite Moss is an important example of a lowland basin mire. It was formed from a kettle hole (depression resulting from melting ice blocks embedded in glacial drift) in undulating glacial drift, which covered the North Cumberland Plain after the last glaciation. The kettle hole, lined with boulder clay, became flooded and a succession began – from lake progressively filing through silt deposition and fen-peat development, to when the lake disappeared and the peatland rose above the groundwater table and became rainwater-fed. This development is recorded in the peat deposits, which are important for paleo-ecological research.

The natural bog surface has been disturbed by past peat-cutting, drainage works and tree-planting. However, these activities have not prevented 'typical' acidic, rainwater-fed bog vegetation from re-establishing, and topographic surveys reveal that the mire expanse is still raised to a degree (Gilman 1991). Burning, nutrient enrichment and agricultural improvement have also modified small areas of the site.

**Reasons for Notification / Special Interests**

Moorthwaite Moss is one of the very few lowland basin mires retaining a rainwater-fed, acidic bog vegetation and it supports the best developed example of one form of this vegetation.

The centre of the site is c. 2ha of open bog surrounded by mature pine woodland. The areas of open, acidic mire are dominated by the bog mosses *Sphagnum* spp., that form peat deposits. *Sphagnum magellanicum* and *S papillosum* are prominent and notable because they are very rare in other lowland basin mires.

Other mosses also occur along with characteristic and notable flowering plants of such areas, including two species of cottongrass *Eriophorum vaginatum*, *E angustifolium*, cross-leaved heath, round-leaved sundew, cranberry and a relative profusion of the uncommon bog rosemary *Andromeda polifolia*. Less is known about the fauna of the Moss but there are records of some notable butterflies and a good range of water-beetles. Moorthwaite is the only known Cumbrian site in which the rare beetle *Agabus bipustulatus* has been recorded. The fauna is likely to be of considerable interest, mirroring the important semi-natural vegetation.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Ombotrophic, acidic bog vegetation

**Evidence of Pollution Impacts**

English Nature considers the condition of the Moss to be part favourable to unfavourable declining (English Nature, pers comm).

There have been floristic changes on the periphery of the Moss (Gilman, 1991). Areas towards the southern margins appear to be affected by inflows of nutrient-rich water from surrounding land. Willow scrub (especially of *Salix cinerea*) dominates a vegetation that includes common nettle, creeping

**CASE STUDY 4: Moorthwaite Moss (Contd.)**

buttercup, soft rush and Yorkshire fog, as well as some bottle sedge and common sedge (English Nature Website, 2003; English Nature pers comm). There has been a decline in *Goodyera repens*, a nationally scarce species, although this has not specifically been linked with increasing nutrients (English Nature, 1994).

**Evidence of Diffuse Agricultural Pollution**

The changes in the species exhibited on the Moss are attributed to increased nutrient inputs (Gilman, 1991). Moorthwaite Moss lies in farming country. The surrounding land, particularly in the south-east corner, is grazed and cut for silage and receives a significant fertiliser input. There are no natural inflowing streams on to the site, but a drainage channel from a nearby farm carries nutrient-rich waters into the eastern end of the Moss, where it diffuses through peat cutting channels. The position of the Moss at the centre of an oval depression means that the peripheral areas of the Moss receive nutrient input in drainage and runoff waters. (Gilman, 1991, English Nature, 1986)

**Current / Proposed Action**

The site needs buffering from the surrounding agricultural land and management agreements are required for the catchment (English Nature, 1999).

There is some capacity around the south-eastern periphery of the site for absorption of dissolved nutrients by impounding in shallow ponds with emergent vegetation e.g. *Typha* sp., *Glyceria fluitans* or *Carex* species such as *rostrata* or *riparia* (Gilman, 1991)

Topographic survey reveal that the mire expanse is still raised to a degree, and it should be possible to exploit this in the handling of nutrient-rich inputs along the southern and eastern boundary (Gilman, 1991).

A hydrological survey is required to assess the eutrophication problems (English Nature, 2002).

No current action to tackle diffuse agricultural pollution.

**Sites with Similar Problems**

Cumbrian bogs e.g. Cliburn Moss

**References**

ENGLISH NATURE WEBSITE, 2003. SSSI Citation http://www.english-nature.org.uk/citation/citation_photo/1000387.pdf

ENGLISH NATURE, 2002. *Cumbria basin mire enhancement 2002 and beyond: Site specific proposals*. Cumbria: English Nature.

ENGLISH NATURE, 1999. *Cumbria biodiversity action plan, Basin Mires: Annex B. 1st (*incomplete*) draft to show information being collected as part of Basin Mires Enhancement Project*. English Nature, Cumbria.

ENGLISH NATURE, 1994. *Site quality/rare plant species monitoring: Moorthwaite Moss SSSI* – Goodyera repens *status report 1993*. Cumbria: English Nature.

ENGLISH NATURE, 1986. *Moorthwaite Moss: The management of adjoining and nearby fields.* File notes for Moorthwaite Moss. Cumbria: English Nature.

GILMAN, K., 1991. *Hydrological investigations of eutrophication problems at Moorthwaite Moss SSSI Cumbria*. Rev No 1.019. Powys: Institute of Hydrology.

**CASE STUDY 5: Ouse Washes (Contd.)**

| | |
|---|---|
| **Site Name:** | Ouse Washes |
| **County:** | Cambridgeshire |
| **NGR:** | TL 393747 to TL 571987 |
| **Site Area:** | 2403 ha |
| **Catchment Area:** | c. 3000 $km^2$ |
| **Site Protection/Designations:** | Ouse Washes SSSI<br>Ouse Washes cSAC<br>Ouse Washes SPA<br>Ouse Washes RAMSAR |

**Site Description**

The Ouse Washes is an extensive area of seasonally flooding wet grassland lying between the Old Bedford Delph and Hundred Foot River, and acts as a floodwater storage system during winter months. The Counter Drain, which lies to the west of the Old Bedford Delph, is also included in the site. The Washes are fed by floodwaters from the Bedford Ouse at Earith and are supplemented in summer by slacker transfers from the Hundred Foot River. Indigenous summer water resources are scarce in the Counter Drain and in summer, transfers from the tidal Great Ouse at the Old Bedford Sluice supplement this system. The land surrounding the Washes is predominantly arable.

The Environment Agency and English Nature are currently undertaking investigative work in order to review permissions required under regulation 50 of the Conservation (Natural Habitats &c.) Regulations, 1994, and a Hydro-ecological Review has been produced as an early stage of the review of consents process (ENTEC, 2001). This report specifically reviews the impact of abstraction licences on wetland sites but information pertaining to diffuse agricultural pollution has been extracted for the purposes of this case study.

**Reasons for Notification / Special Interests**

The cycle of winter storage of floodwaters from the river and traditional summer grazing by cattle, as well as hay production, have given rise to a mosaic of rough grassland and wet pasture, with a diverse and rich flora and fauna. The washlands support a large number of breeding and wintering birds including many notable European species such as Ruff *Philomachus pugnax*, Spotted Crake *Porzana porzana,* Bewick's Swan *Cygnus columbianus bewickii*, Hen Harrier *Circus cyaneus* and Whooper Swam *Cygnus cygnus*. The site is also of note for its extensive unimproved neutral grassland communities and for the richness of the aquatic flora within the associated watercourse. Spined loach *Cobitis taenia* (a European protected species) populations occur within the Counter Drain and Old Bedford Delph. The Counter Drain, with its clear water and abundant macrophytes, is a particularly important site, and a healthy population of spined loach is known to occur here.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Aquatic macrophytes
- Bird and fish populations – specifically spined loach

**Evidence of Pollution Impacts**

In terms of ecology, the Washes have experienced a significant change over the last thirty years. There has been an increase in swamp communities typical of eutrophic waters and consequent decreases in inundation grassland communities. Ditch flora surveys indicate a marked decline in pollution sensitive species, following a predictable eutrophication process (Newbold, 1999). The change in the flora of the Washes is being investigated by English Nature although final results were not available during the timescale of this project.

**CASE STUDY 5: Ouse Washes (Contd.)**

Spined loach is absent from the Wash ditches and this is attributed to high nutrient loading (ENTEC, 2001). The Washes have a history of late summer fish kills due to low DO, possibly caused by algal growth promoted by nutrient enrichment (English Nature, pers comm). In the presence of other fish, spined loach requires refuges from predation and submerged macrophytes appear to be particularly important. Hence changes to these will have impacts on spined loach populations.

Increased siltation along the tidal Great Ouse and part of the Hundred Foot River has affected the drainage of floodwaters from the Ouse Washes and extends the duration of effect from flooding. The RSPB have recorded a marked increase in the incidence of summer flooding, particularly during the period April to June which is considered highly detrimental to bird populations. Research by Ratcliffe and Schmitt (2001) indicates that the continued incidence of spring flooding will result in the loss of the breeding population of black-tailed godwits from the site. Winter drainage of agriculture into the Ouse Washes causes silt build ups/ stratification of silts which may be unfavourable for the spined loach (JNCC Website, 2003).

**Evidence of Diffuse Agricultural Pollution**

Environment Agency monitoring data for the Old Bedford Delph show that nutrients are the only water quality issue in the Ouse Washes. Monitoring data reveal Total Oxidised Nitrogen in the range 6.1 to 10.8mg/l; and ortho-phosphate in the range 0.17 to 0.69 mg/l (moderately high to seasonally very high). Chlorophyll-a is in the range 1 to 192 µg/l. Dissolved Oxygen levels also become depleted following unseasonal late spring/early summer flooding and, as the floodwaters are drained from the Washes, the internal ditches and receptor rivers can be significantly affected by low DO levels.

Monitoring data from the Counter Drain show nutrient loadings are seasonally high with oxidised nitrogen being high only in winter when drainage from intensively arable land is actively discharging. Conversely, ortho-P values are normally low and are only elevated in summer owing to water inputs from the tidal Great Ouse. The available data suggests that 80% of the ortho-P loadings to the Bedford Ouse is derived from point (mainly STW) sources (ENTEC, 2001).

The EA has undertaken extra phosphate monitoring in the upper Great Ouse catchment at sample points which are not downstream of major point source discharges and therefore considered indicative of diffuse inputs of P and N. Whilst these sites will still be influenced by a mixture of point sources and diffuse sources, the resulting data reveal TON in the range 0.25 to 16.8 mg/l, ortho-P in the range <20 to 1320 µg/l and TP 41 to 3050 µg/l (S O'Conner, EA, pers comm).

Sedimentation affecting spined loach and increased siltation and flooding in the Great Ouse and the Ouse Washes more generally is most likely to be derived from agricultural sources (see above). Sedimentation impacts are likely to affect spined loach and both breeding and wintering birds. Increased sediment loading from agricultural land will also yield higher nutrient loadings with potential impacts to macrophyte communities and wetland habitats.

**Current / Proposed Action**

Phosphorus removal has been undertaken at a number of major sewage treatment works in the upper catchment under the UWWTD. Although the site is listed for further action on effluent discharges under the water industry's Asset Management Programme 4 (AMP4), there is no parallel action to tackle diffuse pollution.

The relationship between water quality and the ecology of the Washes is being investigated by English Nature and results will be available soon (English Nature, pers comm).

Independent investigation into most recent (August 2002) fish kill. EA and English Nature are providing evidence for this investigation.

**CASE STUDY 5: Ouse Washes (Contd.)**

Cambridge University are investigating ways to improve ditch water quality using biomanipulation (http://www.zoo.cam.ac.uk/zoostaff/aldridge/ditches.html)

No specific current action to tackle diffuse agricultural pollution.

**Sites with Similar Problems**

Somerset Levels.

**References**

ENTEC UK Ltd, 2001. *Environment Agency Anglian Region : Hydro-ecological review of selected European Sites. Ouse Washes cSAC/Ouse Washes SPA, Ouse Washes SSSI Conceptual Framework*. Draft 6th December 2001. ENTEC UK Ltd.

JNCC WEBSITE, 2003. http://www.jncc.gov.uk

NEWBOLD, C., 1999. *Water quality and the aquatic flora of the Ouse Washes, Cambridgeshire - An historical perspective*. Peterborough: English Nature.

RATCLIFFE, N & SCHMITT, S., 2001. The effects of flooding and predation on productivity and population viability of black-tailed godwits *Limosa limosa* at the Ouse Washes. Report for the RSPB. *In* ENTEC UK Ltd (2001). *Environment Agency Anglian Region : Hydro-ecological review of selected European Sites. Ouse Washes cSAC/Ouse Washes SPA, Ouse Washes SSSI Conceptual Framework*. Draft 6th December 2001. ENTEC UK Ltd.

**CASE STUDY 6: Poole Harbour**

| | |
|---|---|
| **Site Name**: | Poole Harbour |
| **County**: | Dorset |
| **NGR**: | SZ 000890 |
| **Site Area**: | 4049 ha |
| **Site Protection/Designations** | Poole Harbour SSSI<br>Poole Harbour SPA<br>Poole Harbour Ramsar |

**Site Description**

Poole Harbour is one of the largest natural harbours in the world covering an area of nearly 4,000 ha. A high proportion of the area is covered with intertidal marsh and mud flats with permanent channels running between. The mud and sandflats are fringed by saltmarshes and stands of common reed *Phragmites australis* that together, provide habitat for a wide range of bird species.

Low volumes of fresh water from small rivers enter the harbour. Coupled with a narrow harbour mouth this results in low flushing rates. Much of the surrounding land has been developed though some transitions from saltmarsh to bog and heathland still occur.

80% of the harbour comprises inter-tidal fine muds, sandflats and marshes. The diverse substrate types and unique tidal regime support a high abundance of invertebrates. Whilst invertebrate diversity is low, the site has several rare species including large beds of tube worms *Sabella pavonina*.

The Environment Agency and English Nature are currently undertaking investigative work in order to review permissions required under regulation 50 of the Conservation (Natural Habitats &c.) Regulations, 1994, and a draft Site Characterisation has been carried out for Poole Harbour Special Protection Area (SPA) (Langston *et al*., 2003). The project characterises the site in terms of environmental quality, and identifies areas where conditions might result in effects on habitats and species for which the site was designated. Information regarding Poole Harbour has been summarised from this report for the purposes of this case study.

**Reasons for Notification / Special Interests**

The intertidal mudflats and marshes support internationally important populations of wintering wildfowl and waders. Associated with the subtidal fine sands of the central Harbour are large marine invertebrate populations, which include extensive beds of the tubeworm *Sabella pavonina*. Other notable and rare invertebrates found include the sponge *Suberites massa,* the starlet sea anemone *Nemotstella vectensis*, the mollusc *Aeolidiella sanguinea* along with a number of sea squirts, Ascidians, sea mats and bryozoans.

The mudflats are typically fringed with salt marsh and/or beds of common reed. These habitats are generally retreating where they are found in Southern Britain. This vegetation provides habitat for a number of important bird species including Bearded tit *Panurus biarmicus* and redshank *Tringa totanus*.

Wet grasslands with neutral herb-rich swards are found on the Harbour shores long with extensive brackish grazing marsh at Keysworth.

**CASE STUDY 6: Poole Harbour (Contd.)**

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

Invertebrate populations at risk from algal mats covering mudflat surface and blooms causing oxygen sags. Depletion of the invertebrate fauna can have a knock on effect on the over wintering bird populations through reduction in food availability. In addition algal mats on mudflats can restrict feeding.

**Evidence of Pollution Impacts**

Much of the harbour is subject to eutrophication and nutrient water quality issues have been recorded for many decades with typical evidence being macro/micro-algal blooms and oxygen sags with deaths in shellfish being attributed to nutrient pollution (Langston *et al*., 2003). The macro algae *Ulva lactuca* and *Enteromorpha intestinalis* blanket areas of the harbour reducing species diversity including reduction in cover of eelgrass (*Zostera* spp.)

The hypernutrient rich condition of Poole Harbour has led to it being designated a Sensitive Area (Eutrophic) & Polluted Waters (Eutrophic) under the Nitrates Directive. In addition the catchment has been designated a Nitrate Vulnerable Zone (NVZ).

**Evidence of Diffuse Agricultural Impacts**

Diffuse pollution, particularly from agricultural land runoff, is seen as an important issue in the South Wessex area generally. Intensive agricultural practices give rise to soil erosion. Resultant run-off from eroded land can lead to water quality problems (siltation, eutrophication, pesticide residues and River Quality Objectives compliance issues). Increased run-off may reduce infiltration to ground, compounding low flow problems. Farm animal waste and fuel oil storage facilities are a significant potential source of pollution to rivers feeding the Poole Harbour SPA (Langston *et al*., 2003).

Reports on nutrient status supplied by Wessex Water in 1981 gave estimates of the nutrient loading from various sources into the Harbour. The river Frome contributes the largest source of inorganic nitrogen, with peaks following heavy rain indicating diffuse agricultural sources. High levels of N were also attributed to STW as was the majority of P input (80%) to the Harbour. It seems likely that the remaining P loading derives from agricultural sources.

Recent work indicates that The River Frome P input is 65% diffuse source (Hanrahan *et al*., 2001) and the Frome catchment has been designated as a NVZ.

**Current / Proposed Action**

Poole Harbour has been designated a Sensitive Area (Eutrophic) & Polluted Waters (Eutrophic). It is hoped that this will lead to significant reductions in nutrient levels and subsequently improvements in the condition of the site. Similarly, the river Frome catchment has been designated as a NVZ.

Currently no other initiatives to tackle diffuse agricultural pollution.

**Sites with Similar Problems**

Some southwest coastal sites.

**CASE STUDY 6: Poole Harbour (Contd.)**

**References**

LANGSTON, W.J., CHESMAN, B.S., BURT, G.R., HAWKINS, S.J., READMAN, J., & WORSFOLD, P., 2003. *Draft Site Characterisation of the South West European Marine Sites: Poole Harbour*. Plymouth Marine Science Partnership.

HANRAHAN, G., GLEDHILL, M., HOUSE, W.A. & WORSFOLD, P.J., 2001. Phosphorus Loading in the Frome Catchment, UK: Seasonal Refinement of the Coefficient Modelling Approach. *Journal of Environmental Quality*, **30** (5) :1738-1746

**CASE STUDY 7: Redgrave and Lopham Fens**

| | |
|---|---|
| **Site Name:** | Redgrave and Lopham Fens |
| **County:** | Norfolk/Suffolk |
| **NGR:** | TM 050797 |
| **Site Area:** | 124.92 ha |
| **Site Protection/Designations:** | Redgrave and Lopham Fens SSSI<br>Redgrave and Lopham Fens RAMSAR<br>Waveney and Little Ouse Valley Fens cSAC |

**Site Description**

Redgrave and Lopham Fens are located on the Norfolk/Suffolk border. The site is an extensive area of spring fed valley fen at the headwaters of the River Waveney. It supports several fen vegetation community types with an associated diverse invertebrate fauna. The wetland character of the site is considered of international importance as reflected in the degree of statutory designation covering this site and the surrounding area.

**Reasons for Notification / Special Interests**

Primary features for which the site is designated a SAC as part of the Waveny and Little Ouse Valley Fens are:

- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)
- Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*

This site represents M24 *Molinia caerulea – Cirsium dissectum* fen-meadow associated with spring-fed valley fen systems in East Anglia, where *Molinia* grassland is very rare. The *Molinia* meadows are found here in conjunction with M13 *Schoenus nigricans – Juncus subnodulosus* mire and calcareous fens with *Cladium mariscus*. Where the fen-meadow is grazed it is more species-rich, with frequent southern marsh-orchid *Dactylorhiza praetermissa.*

This site occurs in the East Anglian centre of distribution of calcareous fens and contains very extensive *Cladium* beds, including managed examples, as well as stands in contact zones between small sedge mire and species-poor *Cladium*.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

Diverse fen communities including:

- *Molinia* grassland;
- mixed sedge fen;
- reed dominated fen and,
- areas of wet heath.
-

**Evidence of Pollution Impacts**

The Redgrave seepages that were once of high botanical value are currently degraded due to high nutrient levels in the water source (Wheeler & Shaw, 2000).

Artificially high water levels maintained by damming of the River Waveney may be causing nutrient enrichment of the fens through surface water seepage. Current grazing management practices may be exacerbating this problem (Wheeler & Shaw, 2000).

**CASE STUDY 7: Redgrave and Lopham Fens (Contd.)**

Redgrave and Lopham Fens once supported a diverse flora both in terms of species diversity, including calcicole and calcifuge species, and community assemblages including wet heath, seepage fens, tall fen and swamp vegetation. These communities have become restricted distribution within the site and/or simplified in recent decades.

Outdoor pig rearing and the disposal of pig and poultry manure are widespread land uses within the catchment.

Pitt (2001) concluded that the Redgrave and Lopham Fens showed evidence of raised nutrient levels, and while this may not be high for an agricultural catchment, the levels are above those required by the Fen communities for which the site is designated.

**Evidence of Diffuse Agricultural Pollution**

Large areas of Redgrave & Lopham Fens are fed by drift groundwater and as such these fens are liable to enrichment from agriculture practices in the catchment (Wheeler & Shaw, 2000).

Surface water seepages from the river Waveyney are thought to contribute to the nutrient enrichment of the site. (Wheeler & Shaw, 2000).

The Redgrave seepages are enriched by fertilisers indicating diffuse agricultural sources, in addition the seepages contain ochre deposits and low redox potential. This is thought to be at least in part due to the use of animal slurry on adjacent land (Wheeler & Shaw, 2000).

Pitt (2001) concludes that point source pollution is unlikely to be an issue as the catchment land use is largely agricultural, though septic tanks may be an issue.

**Current / Proposed Action**

Banks along the site have been built up in an attempt to limit the distribution of nutrient rich waters. Land adjacent to the site being purchased in order to control adjacent land management practices.

No programmes to tackle diffuse agricultural pollution more widely in the catchment.

**Sites with Similar Problems**

Other fen communities

**References**

PITT, J., 2001. *Redgrave and Lopham Fens Nutrient Survey – Report of pilot project 1999-2000.* Final Report to English Nature.

WHEELER, B.D. & SHAW, S.C., 2000. *Redgrave and Lopham Fens – The Effect of Increased Fertility through Surface Water and Seepage on EC Habitats Directive Annex 1 Plant Communities.* Report to English Nature, Peterborough.

**CASE STUDY 8: River Avon System**

| | |
|---|---|
| **Site Name:** | River Avon System |
| **County:** | Hampshire |
| **NGR:** | SZ 163923 (Christchurch Harbour), SU 073583 (Avon) ST 867413 (Wylye) ST 963297 (Nadder), SU 170344 (Bourne), SZ 241147 (Dockens Water). |
| **Site Area:** | Approx. 507.79 ha and 205.11km |
| **Site Protection/Designations:** | River Avon cSAC<br>River Avon SSSI |

**Site Description**

The upper reaches of the River Avon originates from chalk springs In its lower reaches the Avon develops into a large, lowland river system which includes sections running through chalk and clay, with transitions between the two.

The rivers in the catchment are of importance for the species assemblages associated with the underlying geology. The Bourne section is a chalk stream; the Wylye begins in clay and moves into chalk and the Nadder is a chalk stream influenced by greensand.

The grassland, associated wetland communities and the river channel vegetation that have developed along the Avon system are of national importance for nature conservation. The main river has a diverse flora typical of clay influenced chalk streams. Adjacent habitat includes swamp, wet woodland and flood pasture.

**Reasons for Notification / Special Interests**

The river is notified as an SSSI as a national representative of its river type, as characterised by its plant assemblages, as well as its diverse fish communities. It is notified as a SAC for the occurrence of riverine habitat associated with floating vegetation characterised by *water-crowfoot species* , as well as species such as salmon (*Salmo salar*), sea (*Petromyzon marinus*) and brook lamprey (*Lampetra fluviatilis*).

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

The SAC qualifying species that are at vulnerable to diffuse pollution impacts are:

- Desmoulin's whorl snail *Vertigo moulinsiana*
- Brook Lamprey *Lampetra planeri*
- Sea lamprey *Petromyzon marinus*
- Atlantic salmon *Salmo salar*
- Bullhead *Cotto gobius*

These species are sensitive not only to nutrient enrichment but also increased sedimentation of river channels, and in particular the impact this has on fish spawning success.

Of concern with relation to nutrient enrichment is the impact this may have on aquatic macrophyte populations. Macrophyte species of interest and/or concern include *Ranunculus* and *Calitriche* species and associated vegetation assemblages.

**CASE STUDY 8: River Avon System (Contd.)**

**Evidence of Pollution Impacts**

Work undertaken by Southey (1998) into nutrient impacts on the River Avon system, in particular phosphate levels, concluded that 6 out of 7 sites previously surveyed in 1978 by Nigel Holmes had declined in quality, with MTR scores falling on average by 10%. This trend suggests that the river is suffering from eutrophication, though it should be noted that the study used a limited data set. Historical data on phosphorus concentrations assembled by the Environment Agency clearly indicate a doubling of phosphorus levels since the 1950s.

Other anecdotally recorded indications of pollution impacts include reduced *Ranunculus* cover, increased algal blooms and increased abundance of nutrient tolerant species such as *Potamogeton pectinatus* (Southey 1998). Considerable declines have also been reported in the abundance of winged insects with aquatic larval stages in the Avon and other southern chalk streams over recent decades (Frake and Hayes 2001), These declines are thought to be associated with water quality problems.

**Evidence of Diffuse Agricultural Pollution**

Diffuse agricultural pollution is thought to be the major factor influencing the water quality of the River Avon catchment. A number of water quality related problems have been identified on the River Avon by the Landcare project including siltation, eutrophication, BOD and occasional peaks in pesticide levels (EA 2002).

Intensive agricultural practices (e.g. winter cereal and maize production and outdoor pig rearing) that leave bare exposed ground during periods of heavy rainfall are thought likely to be resulting in increased input of eroded soil, nutrients and pesticide residue. Rainfall activated sampling within the Avon system has shown increases in suspended solids, BOD, nutrients and pesticides following rainfall events (EA 2002).

High sediment loading resulting from land use changes has been identified as a major concern. Sediments impact the habitat of Salmon, bullhead and both sea and brook lamprey by smothering spawning, foraging and refuge sites.

**Current / Proposed Action**

The impact of diffuse agricultural pollution on the River Avon is currently the subject of the Environment Agency's ongoing Landcare project consisting three main sub projects:

- Raising awareness of diffuse agricultural pollution;
- Influencing land use towards Better Management Practice and,
- Monitoring the control strategy to inform management decisions.

Securing land management change has been difficult due to the lack of supporting policy mechanisms.

Consents for effluent discharge are being reviewed under the Habitats Directive and will be modified or revoked if found to be necessary. Numerous water company discharges are being fitted with phosphorus removal under the water industry's Asset Management Programme.

**Sites with Similar Problems**

Rivers Test and Itchen

**CASE STUDY 8: River Avon System (Contd.)**

**References**

ENVIRONMENT AGENCY, 2002. *Landcare Baseline Monitoring Report Version 2.0*. EA Wessex Region.

FRAKE, A. & HAYES, P., 2001. Report on the millennium chalk stream fly trends study. Bristol: Environment Agency.

SOUTHEY, J., 1998. *River Avon pSAC Ecological Assessment*. Peterborough: English Nature.

**CASE STUDY 9: River Axe**

| | |
|---|---|
| **Site Name:** | River Axe |
| **County:** | Devon |
| **NGR**: | SY 267961 |
| **Site Area**: | 71.45 ha |
| **Site Protection/Designations:** | River Axe SSSI |
| | River Axe cSAC |

**Site Description**

The River Axe is situated on the South East coast of Devon and extends 43 km from Cheddington to Seaton, where it enters the sea. The underlying geology of the riverbed is alluvium with areas of valley gravel, clay, shale and marl. The water is base-rich with a high content of dissolved solids. The river is subject to spates averaging over 20 times the average daily flow in the winter months.

The lower reaches of the Axe have high bed stability compared to the upper reaches where the steep banks concentrate the energy of flood waters onto the river bed. The river is sparsely shaded with few bankside trees, allowing much light to reach the riverbed. The active geomorphology of the river has generated a range of natural features (including long riffles, deep pools, islands and meanders), which provide a variety of ecological niches.

The River Axe catchment is largely agricultural, but includes the town of Axminster and several small villages. Discharges include effluents from a number of sewage treatment works (STW) and several small domestic discharges to the river and soak-aways.

**Reasons for Notification / Special Interests**

The River Axe is designated as an SSSI as a national example of certain river types, as characterised by its plant assemblage, and supports an exceptionally diverse aquatic and marginal flora. A variety of plant communities are represented, showing transition from a community type usually confined to sandstone catchments in Scotland in the higher reaches to a lowland clay river assemblage in the lower reaches.

The River Axe cSAC is primarily designated for the occurrence of riverine habitat associated with floating vegetation characterised by water-crowfoot species. Only the lower reaches of the main river have been included in the designation, where the mixed catchment geology of sandstones and limestones gives rise to calcareous waters. *R. penicillatus* ssp. *pseudofluitans* dominates, giving way to *R fluitans* further downstream. Additional interest is provided by the nationally scarce short-leaved water-starwort *Callitriche truncata*, which is present with the Ranunculus communities throughout the site. All community types represented within the SSSI have an above average diversity of higher plants.

The Habitats Directive Annex II species sea lamprey *Petromyzon marinus*, brook lamprey *Lampetra planeri* and bullhead *Cottus gobio* are included in the SAC designation.

**CASE STUDY 9: River Axe (Contd.)**

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Aquatic macrophyte assemblages
- Anadromous fish, including salmon and sea lamprey
- Non-migratory fish and invertebrates of river habitats, including brook lamprey and bullhead

**Evidence of Pollution Impacts**

Aquatic plant species tolerant of nutrient enriched waters were recorded in the River Axe in 1997, including *Potamogeton pectinatus* and *Zannichellia palustris* (Grieve *et al.*, 2002). English Nature consider these species to indicate unfavourable condition in respect of *Ranunculus* communities. In addition, some change in aquatic plant species richness is apparent in lower reaches (ENTEC, 2003).

There is a history of algal blooms along the River Axe, resulting from increased nutrient loading. Diatom assessment indicates elevated nutrient concentrations along the river, with a gradual increase in trophic score from the source to the river mouth (Kelly, 2002).

Suspended sediment levels in the catchment can become highly elevated with concentrations exceeding 100mg/l. This has resulted in siltation of river gravels causing concretion and localised smothering which is thought to be affecting the quality of salmonid spawning sites. This is reflected in an historic reduction in salmon populations.

**Evidence of Diffuse Agricultural Pollution**

Landuse in the catchment includes intensive agriculture including dairying and maize growing. High suspended sediment levels in the catchment are thought to be the result of run-off from maize fields in the upper catchment and erosion of land and river banks due to high livestock densities (Daldorph, 2002).

The proposed SAC phosphorus standard for the Axe (0.06mg/l) is breached throughout much of the catchment. Modelling of phosphate transport in the catchment shows diffuse inputs dominate in the headwaters, whereas point sources dominate in the lower reaches. Diffuse agricultural pollution has been highlighted as a contributory factor for elevated Biological Oxygen Demand values in 13 of the 16 stretches that are non-compliant with Environment Agency water quality objectives (ENTEC 2003), resulting from the run-off of animal slurries and associated material from farmyards and farmland.

**Current / Proposed Action**

A draft conservation strategy produced by English Nature in 1998 seeks to promote the following actions:

- the implementation of agri-environment schemes with the aim of encouraging arable reversion, reducing nutrient inputs and establishing semi-natural habitat within the floodplain.
- Resist harmful development within the catchment through influencing local development control and policy.

The 'Axe Valley Enhancement Project' has also been established to tackle the problem of diffuse pollution through development and promotion of more sympathetic land management practices. The partners comprise: the Environment Agency, English Nature, FWAG, Rural Development Service, Est Devon District Council and catchment landowners. However, such partnerships have only limited funding and lack effective supporting policy mechanisms.

Consents for effluent discharge are being reviewed under the Habitats Directive and will be modified or revoked if found to be necessary.

**CASE STUDY 9: River Axe (Contd.)**

**Sites with Similar Problems**

River Camel

**References**

DALDORPH, P.W.G., 2002. *Modelling of Phosphorous Transport in the River Itchen and Axe Catchments*. Report for The Environment Agency.

ENTEC, 2003. *Site characterisation of Habitats Directive designated rivers in South West England: River Axe cSAC*. Draft report to the Environment Agency and English Nature. 128pp.

Grieve, N. & Clarke, S., 2003. *Macrophyte surveys of the River Axe SAC*. Report to English Nature. Centre for Aquatic Plant Management, Sonning.

**CASE STUDY 10: River Frome**

| | |
|---|---|
| **Site Name:** | River Frome |
| **County:** | Dorset |
| **NGR:** | SY 700908 to SY 927871 |
| **Site Area**: | 153.56 ha |
| **Catchment Area:** | 454 $km^2$ |
| **Site Protection/Designations:** | River Frome SSSI |

**Site Description**

The River Frome is a major chalk stream in west England that supports aquatic and bankside vegetation and shows a downstream transition from a purely chalk stream community type to a lowland, mixed geology community in its lowermost reaches. The dominant land use in the catchment is agriculture and there are only two major settlements (population c. 23, 000). Industrial development in the catchment is light, and most activity is related to agriculture.

The upper catchment is characterised by steep-sided valleys and the river and tributaries are dependent on springs and groundwater levels. Many of the steams are Winterbournes and the streams cease to flow in the summer or are perched where the River goes underground for part of its length. Sands, gravels and clays dominate the lower reaches of the river. Downstream, the floodplain widens into extensive tracts of pasture and marsh and the typical landuse is permanent grassland, arable, dairying or stock-rearing, with some cereals and natural wetland habitats. (Environment Agency, 1998; Environmental Change Network Website, 2003).

**Reasons for Notification / Special Interests**

The River Frome is designated as SSSI as a national example of its river type, as characterised by its plant assemblages which are more species-rich than similar communities on other rivers. The site also supports rare and scarce aquatic invertebrates, a characteristic assemblage of breeding riverside birds and a range of fish species which includes some of particular importance in a European context – Atlantic salmon *Salmo salar*, bullhead *Cottus gobio*, brook lamprey *Lampetra planeri* and sea lamprey *Petromyzon marinus*. (All Annex II Habitat Directive species)

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Aquatic macrophytes
- Aquatic invertebrates
- Fish and bird populations

**Evidence of Pollution Impacts**

Water quality in the river, as characterised by the Environment Agency's River Ecosystem classification (which is focused on the detection of organic pollution problems) has been maintained at a high standard, all reaches of the river falling into either class RE1 and RE2, with a target of complete compliance with these classes in the areas used by salmon. However, salmon catches are declining and fishery data show egg deposition on the Frome dipping below its Conservation Limit (CL) for the first time in many years. Data is still being processed for 2002 but it is likely that this year will also be below the CL. Both 2000 and 2001 also fell below the limit, and three consecutive years below the limit would constitute a failure under current Agency protocols. This change in conservation status is thought to be linked to increased sediment in the catchment, resulting in the decline of good spawning and nursery areas in the Frome (A Strevens, EA, pers comm).

**CASE STUDY 10: River Frome (Contd.)**

Phosphorous and nitrogen from diffuse agricultural sources have been identified as concerns in the Frome catchment by English Nature freshwater specialists consulted for this study. The preliminary questionnaire response for this project suggested that P and N levels had resulted in impacts on the chalk stream vegetation and floodplain fen and swamp. However, no documentary evidence of impacts was available during the course of this project.

**Evidence of Diffuse Agricultural Pollution**

Considerable evidence exists to show that the presence of fine sediment in salmonid spawning gravels can adversely affect the survival of eggs and alevins. In 1993, an investigation into salmon spawning gravels in the Frome area (IFE 1993) concluded that the river was on the limits of fine sediment loading. Excess sediment, particularly in late winter to early spring, can prevent successful spawning/incubation/emergence of salmon. Increased soil erosion, resulting in changes in agricultural practice and use of MoD land within the Frome catchment in recent years is thought to be contributing to the deterioration of spawning conditions.

A chalk stream study carried out on the River Piddle by the University of Exeter (University of Exeter, 1994) represents the best available model for the Frome catchment. Analysis of physical and chemical properties of suspended sediment transported by the upper River Piddle, and of fine sediment mantling the channel bed, indicated that the material is primarily from sources outside the channel.

Export coefficient modelling (Hanrahan *et al.,* 2001) calculated the total phosphorus loading in the Frome catchment area and predicted that diffuse sources (land use, animals, and septic tanks) made the most significant contribution to the total load (65%) with 35% coming from STWs. Output is provided on a seasonal (monthly) basis for 1998, and on an annual basis for 1990-1998. The model predicted an annual TP load of 25605 kg $yr^{-1}$, compared with an observed (measured) value of 23400kg $yr^{-1}$. Monthly loads calculated using the export coefficient model agreed well with monthly observed values except in months of variable discharge, when observed values were low, probably due to infrequent, and therefore unrepresentative, sampling. Comparison between filterable reactive phosphorus (FRP) and TP concentrations observed in the period 1990-1997 showed that trends in FRP could be estimated from trends in TP. A sensitivity analysis (varying individual export coefficients by plus or minus 10%) showed that STWs (3.5%), tilled land (2.7%), meadow-verge-semi natural (1.0%), and mown and grazed turf (0.6%) had the most significant effect (percent difference from base contribution) on model prediction.

**Current / Proposed Action**

AMP 3 improvements are proposed at STWs in the catchment.

A conservation strategy is currently being produced jointly by English Nature and the Environment Agency, encouraging gravel-cleaning exercises and wider measures to control the erosion of soils in the catchment (A Strevens, EA, pers comm).

Additionally, the River Frome will be included in the NERC Lowland Catchment Thematic Research Programme (LOCAR) to examine sediment pathways, specifically the links between catchment slopes and channels and with-channel storage (NERC Website, 2003).

FWAG has set up a project to advise farmers on nutrient budgeting and soil erosion control (English Nature, pers comm), but there are no strategic policy mechanisms available to encourage practical changes in land management

**CASE STUDY 10: River Frome (Contd.)**

**Sites with Similar Problems**

Southern chalk streams – Hampshire Avon, River Piddle

**References**

ENGLISH NATURE , 2003. Site citation. http://www.english-nature.org.uk/special/sssi/sssi6.asp
Environment Agency (1998) *River Frome salmon action plan – consultation document*. May 1998. Environment Agency South West region.

ENVIRONMENTAL CHANGE NETWORK WEBSITE, 2003. http://www.ecn.ac.uk

HANRAHAN, G., GLEDHILL, M., HOUSE, W.A. & WORSFOLD, P.J., 2001. Phosphorus Loading in the Frome Catchment, UK: Seasonal Refinement of the Coefficient Modelling Approach. *Journal of Environmental Quality*, **30**(5):1738-1746. ABSTRACT ONLY.

INSTITUTE OF FRESHWATER ECOLOGY, 1995. An investigation into the salmon spawning gravels in the Wessex region. In Environment Agency (1998) *River Frome salmon action plan – consultation document*. May 1998. Environment Agency South West region.

LANGSTON, W.J., CHESMAN, B.S., BURT, G.R., HAWKINS, S.J., READMAN, J. & WORSFOLD, P., 2003. *Site Characterisation of the South West European Marine Sites: Poole Harbour*. Draft Report. Environment Agency, South West Region

JNCC, 2003. Site citation. http://www.jncc.gov.uk/idt/

NERC WEBSITE, 2003. http://www.nerc.ac.uk/funding/thematics/locar/
University of Exeter (1994) *River Piddle action plan – sediment study : Final report*. In Environment Agency (1998) *River Frome salmon action plan – consultation document*. May 1998. Environment Agency South West region.

**CASE STUDY 11: River Kennet**

| | |
|---|---|
| **Site Name:** | River Kennet |
| **County:** | Berkshire, Wiltshire |
| **NGR:** | SU203692 to SU572667 |
| **Site Area:** | 112.72 ha |
| **Site Protection/Designations:** | SSSI |

**Site Description**

The River Kennet catchment is dominated by chalk with the majority of the river bed being lined by gravels. The Kennet below Newbury traverses Tertiary sands and gravels, London Clay and silt, thus showing a downstream transition from chalk to a lowland clay river.

The river has long been managed as a trout fishery and was further modified by the construction of the Kennet and Avon Canal, which joins with the river in some sections to form a single channel. There are also many carriers and channels formerly associated with water meadow systems. The river flows through substantial undisturbed areas of marshy grassland, wet woodland and reed beds.

**Reasons for Notification / Special Interests**

The River Kennet is designated as a national example of a chalk river, as characterised by its plant assemblages, and is an SAC for the occurrence of riverine habitat with floating vegetation characterised by water-crowfoot species. The flora is species-rich and diverse showing a clear downstream succession in plant communities reflecting variations in geology and flow rate as well as the influence of the canal. The flora is considered to be intermediate in character between the classic chalk rivers of the south and the oolitic rivers to the north.

In the upper sections of the river where the underlying rock is chalk and the bed substrate consists mainly gravels, *Ranunculus penicillatus* and *Callitriche obtusangula* dominate the submerged aquatic plant communities. In the slower mid sections *Potamogeton* species , horned pondweed *Zannichellia palustris*, spiked water-milfoil *Myriophyllum spicatum* and yellow water lily *Nuphar lutea* are all common. These are species typical reduced velocity and increased nutrient levels. Other species of conservation interest found on the River Kennet include river water crowfoot *Ranunculus fluitans* and the nationally scarce river water-dropwort *Oenanthe fluviatilis*.

The River Kennet also supports a diverse invertebrate community including large hatches of locally distributed mayfly species including *Ecyonorus insignis* the cranefly and *Ephemerella notata* and the nationally scarce caddis *Ylodes conspersus* and cranefly *Molophilis niger*. In addition the European protected invertebrate, Desmoulin's snail *Vertigo moulinsiana* occurs in the river catchment.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

Of particular concern with relation to nutrient enrichment is the impact this may have on aquatic macrophyte populations. Macrophyte species of interest and/or concern include *Ranunculus* and *Callitriche* species and their associated communities. Increases in nutrient levels can cause a change in community composition favouring vigorous species able to out compete species adapted to living in lower nutrient conditions.

In addition to the aquatic macrophyte interest, the river supports a diverse fish and invertebrate fauna that is at risk from diffuse pollution - most notably, bullhead *Cottus gobio* and Desmoulin's whorl snail *Vertigo moulinsiana*, and a number of nationally scarce invertebrate taxa.

**CASE STUDY 11: River Kennet (Contd.)**

**Evidence of Pollution Impacts**

Excessive sedimentation and turbidity at various locations is thought to be causing suppression of aquatic plant growth over large sections. Reductions in macrophyte species richness and diversity have been observed with single species stands of *Ranunculus* now dominating the channel where 7-8 species of macrophyte had been recorded previously.

Localised increases in turbidity and reduction of macrophytes cover occurs around and downstream of the confluence with the Kennet & Avon Canal. (R. Money pers comm, P. Johnes pers comm).

Data from the NERC Lowland Catchment Research (LOCAR) project suggests higher than average background levels of P, N occur in the River Kennet. Extensive studies of water quality functioning and nutrient modelling have confirmed that very high nutrient levels occur in the river (Whitehead *et al* 2002).

**Evidence of Diffuse Agricultural Pollution**

English Nature's recent assessment of the condition of the river expresses concern that agriculture is contributing to problems, although point sources of pollution - chiefly STWs - are also a major concern. Interaction with the Kennet & Avon canal may provide additional diffuse pollution loading (G. Stevens pers. comm.).

The NERC Lowland Catchment Research (LOCAR) project states that impacts of high P and N cannot be directly attributed to diffuse pollution since not all point discharges have been remediated, suggesting that both sources need to be addressed. Internal nutrient recycling may also be a significant factor. There are few data from areas not affected by point sources (e.g. above Marlborough) where subjective impressions (R. Money pers comm) are that water quality is good.

Modelling work suggests that 60-70% of nutrients derive from diffuse sources. Reductions in macrophyte diversity may result from a wide range of factors and low flows and river vegetation management could also be implicated in these changes (P. Johnes pers. comm.).

Evidence for diffuse sources for N & P are described by Jarvie *et al* 2002. SRP levels are highest (up to 548ug/l) in low flow conditions, prior to P-stripping. Post stripping, the highest levels were 134ug/l, during high flows in the upper catchment and therefore closest to diffuse sources of pollution. Following P-treatment, diffuse sources of SRP are estimated to contribute between 29% and 45% of total loads at points downstream of STWs. This study also suggests that in-stream nutrient re-cycling is not a significant factor in determining levels of SRP and particulate phosphorus.

Whitehead *et al* (2002) describe long-term modelling of nitrogen exports from land to the River Kennet from the 1930s to the 1990s. This work indicates a significant increase in nitrogen transport to the river system from increased fertiliser application within the catchment and increased livestock levels.

**Current / Proposed Action**

The River Kennet catchment is a target area for Countryside Stewardship.

A FWAG Landwise Project is being undertaken in the upper Kennet catchment. A project Officer has been employed by FWAG to raise awareness, offer advice and promote good soil management through production of farm plans, although such initiatives are subject to limited funding and constrained by the lack of supporting policy mechanisms.

**CASE STUDY 11: River Kennet (Contd.)**

Under AMP 3 and AMP 4, the River Kennet is a priority site to reduce inputs from STWs and a number of discharges are being upgraded with phosphorus removal facilities.

**Sites with Similar Problems**

Rivers Test and Itchen

**References**

JARVIE, H. P., NEAL, C., WILLIAMS, R.J., NEAL, M., WICKHAM, H.D., HILL L.K., WADE A.J., WARWICK A., WHITE J. 2002. Phosphorus sources, speciation and dynamics in the lowland eutrophic River Kennet, UK. *The Science of the Total Environment,* 282-283, 175-203

WHITEHEAD P. G., JOHNES P.J., BUTTERFIELD D. 2002. Steady state and dynamic modelling of nitrogen in the River Kennet: impacts of land use change since the1930s. *The Science of the Total Environment* 282-283, 417-434

**CASE STUDY 12: Rivers Test and Itchen**

| | |
|---|---|
| **Site Name:** | Test & Itchen |
| **County:** | Hamphire |
| **NGR:** | Test SU533498 to SU367150, and SU361145<br>Itchen SU589274, SU563353, SU599324 to SU439153 |
| **Site Area:** | 680.1 ha (combined) |
| **Catchment Area:** | 1760 $km^2$ (combined) |
| **Site Protection/Designations:** | River Test Environmentally Sensitive Area (ESA)<br>River Test SSSI<br>River Itchen SSSI<br>River Itchen cSAC |

**Site Description**

The rivers Test & Itchen originate from chalk springs and meander through chalk downland and the broad valleys of Hampshire, through water meadows and wet pasture, before reaching Southampton and the Solent.

Past management and the maintenance of high water levels have facilitated the establishment of extremely diverse plant communities. The grassland, associated wetland communities and river channel vegetation are of international importance for nature conservation. These features include the remains of old water meadow systems dating from the 17th and 18th Century, mostly abandoned by the end of 19th Century

**Reasons for Notification / Special Interests**

Both rivers are SSSI as they represent classic chalk stream environments and are two of the most species- rich rivers in the UK. The flora is species rich with over 100 plant species recorded along the Test. Typical species include brook water crowfoot *Ranunculus penicillatus var. pseudofluitans*, lesser water-parsnip *Berula erecta*, fools water-cress *Apium nodiflorum* and blunt-fruited water-starwort *Callitriche obtusangula.*

The site includes a mosaic of former water meadows, dry grassland, rush pasture, fen pasture and swamp communities. The maintenance of water levels in the river is integral to the maintenance of these sites. Also important is the connectivity with riverbank plant species.

The invertebrate populations of both rivers are exceptionally diverse, with 210 species recorded from the Itchen and over 232 from the Test. The Itchen also contains a remnant and threatened population of the protected native white-clawed crayfish *Austropotamobius pallipes*.

Both the Test and Itchen are internationally famous for their respective game fisheries. Species present of conservation interest include native trout brown *Trutta trutta*, sea trout *Salmo trutta*, salmon *Salmo salar*, bullhead *Cottius gobbo* and brook lamprey *Lampetra planeri.* Populations of salmon are declining.

In addition the catchments support a wide range of breeding birds and three native aquatic mammals, water shrew *Neomys fodiens*, water vole *Arvicola terrestris* and otter *Lutra lutra*.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Salmonid spawning
- Fish

**CASE STUDY 12: Rivers Test and Itchen (Contd.)**

- Freshwater crayfish
- Diverse aquatic macrophyte communities
- Diverse aquatic invertebrate communities (including RDB species)
- Fen, swamp and meadows including ancient water meadows.

**Evidence of Pollution Impacts**

The ecological interest of the Test and Itchen is at risk from eutrophication from high phosphorous concentrations and/or the biological responses to existing concentrations (Daldorph 2002).

Fluctuations and declines in the Salmon populations of the rivers, particularly since the 1980's, in particular from sediment covering spawning gravel's.

**Evidence of Diffuse Agricultural Pollution**

Work undertaken by the Hampshire & Isle of Wight Environment Agency Landcare project (Environment Agency, 2000) has positively identified evidence of diffuse pollution within the Test & Itchen catchments. Catchment vulnerability mapping identified areas which, due to geology and topography, are susceptible to soil erosion. The direct route of sediment transfer from adjacent land to rivers along ditches, roads and tracks was recorded photographically.

A nutrient study was undertaken to detect changes in the nitrate and phosphate levels over the past 20 years. Increases in nitrate levels of between 17-25% were calculated. Seasonal winter peaks were also noted for nitrate levels. Phosphates showed no obvious trend over time but autumn maxima in both rivers are thought to be related to point source discharge.

**Current / Proposed Action**

The Environment Agency is undertaking a number of activities, (EA, 2000), these include:

- Gravel basket sedimentation trials.
- Determine point source suspended solid discharge influences from fish farms.
- Determination of groundwater data trends.
- Computer modelling of pesticide pollution.
- Assessment of organisations undertaking similar works and development of partnerships.

The Landcare project is aiming to increase farmer awareness and promote best agricultural practices but is restricted by to limited resources and a lack of supporting policy mechanisms.

A number of water company discharges have been identified for phosphorus removal under the water industry's Asset Management Programme.

**Sites with Similar Problems**

Rivers Frome, Avon and Kennet

**References**

Environment Agency (2000) *Hampshire & Isle of Wight Area Land Care/Diffuse Pollution Brief – Spring 2000*. EA report.

Daldorph PWG (2002) Modelling of Phosphorous Transport in the River Itchen and Axe Catchments. Report for The Environment Agency.

**CASE STUDY 13: Rivers Wye and Lugg**

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|---|---|
| **Site Name:** | Rivers Wye and Lugg |
| **County:** | Hereford & Worcestershire |
| **NGR:** | River Wye ST544912 – SO230429 |
| | River Lugg SO173751 – SO565372 |
| **Site Area:** | River Wye 1404.8 ha/157km |
| | River Lugg 236.95 ha/101.07 km |
| **Site Protection/Designations:** | River Lugg SSSI |
| | River Wye cSAC |
| | River Wye SSSI |
| | Designated salmonid fishery under EC Freshwater Fish Directive 78/659/EC |
| | Wye Valley AONB |

**Site Description**

The River Wye forms one of the longest near-natural rivers in England and Wales. From its source in Powys, the River Wye runs through Wales and Hereford where it is joined by the River Lugg, then through Gloucestershire before joining the Severn Estuary at Chepstow.

Both rivers show clear downstream changes in vegetation communities from bryophyte and moss dominated upland base-poor sections through diverse *Ranunculus* dominated middle reaches and nutrient enriched lower reaches. This is an expression of changes in flow, substrate and underlying geology. The underlying geology is of Old Red Sandstone and Carboniferous Limestone on the Wye with the additional influence of Silurian Mudstones and Siltstones on the Lugg.

**Reasons for Notification / Special Interests**

The Wye, Lugg and associated tributaries are designated as SSSI as national representatives of certain river types, as characterised by their plant assemblages. These show classic transition from species of upland streams to those of lowland clay rivers. The higher reaches contain swift flowing, spate tolerant base-poor communities characterised by liverwort *Pellia epiphylla* and the moss *Rynchostegium riparioides*. The middle reaches are more typically characterised by species of high velocity flow and occasional spates, in particular river water-crowfoot *Ranunculus fluitans* communities which are indicative of the limestone influence. The lower reaches show the influence of sediment and nutrient accumulation with species typical of lowland clay rivers including yellow water lily *Nuphar lutea*, Fennel-leaved pondweed *Potamogeton pectinatus* and arrowhead *Sagittaria sagittifolia*.

The river system is also a SAC for the occurrence of riverine habitat with floating vegetation characterised by water-crowfoot species. The diverse fish populations are also of particular interest. Sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatalis*, twaite shad *Alosa fallax* and the very rare allis shad *Alosa alosa* all migrate into the system to spawn. In addition the system supports important numbers of Atlantic salmon *Salmo salar*. The Wye is designated as a SAC for these species.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Allis shad *Alosa alosa*
- Twaite shad *Alosa fallax*
- Sea lamprey *Petromyzon marinus*
- Brook lamprey *Lampetra fluviatilis*
- Atlantic salmon *Salmo salar*
- Bullhead *Cottus gobio*
- Grayling *Thymallus thymallus*

**CASE STUDY 13: Rivers Wye and Lugg (Contd.)**

- Atlantic stream crayfish *Austropotamobius pallipes*
- Freshwater pearl mussel *Margaritifera margaritifera*
- Aquatic macrophytes

**Evidence of Pollution Impacts**

A study has been undertaken into the perceived decline in *Ranunculus* on the River Lugg (Wright, date unknown). This work has demonstrated reduced growth of *Ranunculus* species and an increase in species typical of soft sediments and marginal habit. This is attributed to increased sediment input to the river as a result of adjacent land management, as well as reduced flows altering localised habitat structure.

Much of the work currently being undertaken in the Wye and Lugg catchments is focused on addressing diffuse agricultural pollution, although progress is restricted by limited resources and a lack of policy mechanisms available to address the problem. Point source discharges are being progressively addressed, through the water industry's Asset Management Programme and the review of consents being undertaken under the Habitats Directive. A general downward trend in water quality has been observed relative to quality targets as the result of both point source and diffuse agricultural influences. The lower catchment of the river exceeds N and P targets (Quest 1996)

**Evidence of Diffuse Agricultural Pollution**

A number of studies have been undertaken into the effects of changing land use, intensification of agriculture and the associated diffuse pollution issues in the Wye and Lugg catchment.

Environment Agency modelling indicates significant diffuse P inputs. New SIMCAT data is in progress as part of AMP3 works, but not available for this study.

Nutrient modelling work carried out in behalf of English Nature (Quest Environmental, 1996) shows significant inputs of N and P from diffuse agricultural sources in the River Lugg. Although, Leominster STW was found to contribute 7% of all P exported from catchment.

Farm nutrient budget work undertaken by FWAG shows excessive P application within the catchment, particularly the use of chicken manure. Soil P status is also likely to be increasing as a result causing impacts on the system from P-rich sediment and from P runoff (Harris & Jones, 1998)

Modelling study of soil loss from agricultural land within the Lugg catchment (CEH 2000) indicated the likely scale of soil loss to be five times greater than that of a pristine catchment. This is attributed to various factors including overstocking of livestock and agricultural practices such as winter maize production that expose bare soil during winter periods of high rainfall.

**Current / Proposed Action**

Agricultural pollution control measures have been identified under the PSYCHIC (Phosphorus and Silt Yield CHaracterisation In Catchments) project but no resources or policy measures are yet available for their implementation.

In addition English Nature, working with FWAG is using the River Lugg Wildlife Enhancement Scheme to establish wildlife-friendly management within the river corridor, which should have some benefits for water quality.. A Landcare scheme has been proposed but has so far not received funding.

**CASE STUDY 13: Rivers Wye and Lugg (Contd.)**

**Sites with Similar Problems**

River Tweed

**References**

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**CASE STUDY 14: Slapton Ley**

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| **Site Name:** | Slapton Ley |
| **County:** | Devon |
| **NGR:** | SX 826441 |
| **Site Area:** | 219.3 ha |
| **Catchment Area:** | 46km$^2$ |
| **Site Protection/Designations:** | Slapton Ley SSSI |

**Site Description**

Slapton Ley is the largest shallow freshwater, coastal lake in SW England. The catchment is steeply sloping and the dominant land-uses are permanent and temporary grassland (38% and 32% respectively) used for intensive dairy and beef cattle production. The rest of the catchment is made up of cereal and vegetable production and market gardening. There are no major urban developments and the human population (c. 2000) is located in isolated farms and small villages. There are two STW discharges – one directly into Slapton Ley and another further up the catchment (Blackawton). (Environment Agency, 1998; Johnes, 1996; Johnes & Sullivan, 1989).

The hydrology of the catchment is dominated by its impermeable bedrock, resulting in extreme seasonal flow regimes of the streams. A high rainfall, combined with the absence of a groundwater store, means that the streams respond quickly to rainfall events. Water moves along surface and near surface lateral flow pathways, which favours the transport of sediment-associated forms of N ($NH_4$-N) and phosphorus ($PO_4$-P) to surface waters during rainfall. These transport mechanisms are slow and incorporate source areas at some distance from the stream – N moves from arable land in the plateau areas to the steeply-sloping areas of permanent grassland before passing through riparian land to arrive in the stream. Areas of land adjacent to streams in the riparian zone will therefore be more important in terms of nutrient export than land at some distance from the stream, although such pathways can be short-circuited by farm tracks, roads, ditches and other artificial features..

**Reasons for Notification / Special Interests**

Slapton Ley is part of a 116 ha wetland which is divided into two by a causeway: the Lower Ley is a large eutrophic freshwater lagoon with a macrophyte flora fringed by reed bed; the Higher Ley consists largely of rich fen and willow carr vegetation. These habitats support a very diverse flora and fauna and the site is of particular importance for lichens, fungi and invertebrates and for passage and wintering birds. Further, the site is the only known British locality for strapwort *Corrigiola litoralis*.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

- Aquatic macrophytes including *Corrigiola litoralis*
- Bird and fish populations

**Evidence of Pollution Impacts**

The lake has undergone substantial nutrient enrichment, and is generally considered to be in a hypertrophic state (e.g. Johnes, 1996). Algal blooms have become a common occurrence in all but the winter months. The quantity of submerged and floating aquatic plants in some years is greatly reduced, concurrent with increased turbidity of the water caused by the proliferation of algae.

**CASE STUDY 14: Slapton Ley (Contd.)**

*Corrigiola litoralis* is being damaged by large-scale deposition of algal mats on exposed shores. Proliferation of algae has led to low levels of dissolved oxygen, resulting in fish kills, and there has been a decline in bird and fish populations over the last 25 years e.g. Bittern has declined by 50% in this time. Sedimentation is leading to severe siltation of spawning grounds, affecting brown trout. Research has shown that the principle source of silt is from steeply-sloping ploughed fields in the catchment. (Environment Agency, 1998).

**Evidence of Diffuse Agricultural Pollution**

There has been a significant amount of research to identify nutrient sources and potential control actions at Slapton Ley. Major findings (from R Dils, pers. comm.) are discussed below.

Nutrient export coefficient modelling has been undertaken by Johnes and O'Sullivan (1989) to investigate trends in nutrient concentrations. Using historical land use and population data to derive export coefficients, hindcast values for N and P loading to Slapton Ley for the period 1925-1986 were predicted. Allowing for outputs from STWs, the total annual external loading of N and P from the Slapton catchment is 160 t (35 kg/ha) N and 4.8 t (1.05 kg/ha) P. The model was also suggested that heavily grazed land, particularly when located in the riparian zone, is a prime source of nutrient export to surface waters in the region (Johnes, 1996; Johnes & Heathwaite, 1997).

Long-term water quality data for the Slapton catchment are available from October 1970 (on a weekly basis) for each of the four major streams draining the catchment. Outputs from comparison with the export coefficient model demonstrate the model accurately predicts changes in nutrient loading resulting from changes in the distribution and intensity of agricultural production in the Slapton catchment.

The validity of the export coefficient model hindcasts of P loading on the Lower Ley has been confirmed by geochemical analysis of sediment cores (Foster, 1998). TP values from the cores suggest the Ley has become considerably more productive in the last 70 years. Mineral magnetic analysis of sediment cores has shown a significant influx of agricultural topsoil since the 1930's (Foster, 1998). The sediment core analysis suggests that erosion and subsequent transport of agricultural topsoils are the dominant sources of sediment contributing to sedimentation and P enrichment in the Lower Ley (Foster, 1998).

Sediment cores taken by Johnes *et al.* (2000) showed marked changes in the diatom species composition since 1850, reflecting changes in nutrient conditions. Reconstruction from the diatom analysis suggests that TP concentrations began to increase at c. 1910 and continued to do so throughout the twentieth century. This enrichment appears to be associated with a change from arable farming to more intensive livestock production in the Slapton catchment at c. 1920, followed by post-war agricultural intensification from 1945 onwards (Johnes & Wilson, 1996). A further period of enrichment is evident in the 1960s-1970s related to the expanding population connected to the sewage system. Post 1980s the reconstruction of TP concentrations from diatom analyses show continued increases, related to high input agricultural systems and worsening soil erosion. Sensitivity analysis of the export coefficient model shows that nutrient exports from temporary and permanent grassland and from livestock grazing are the prime factors contributing to nutrient loading on Slapton Ley (Johnes, 1996; Johnes and Heathwaite, 1997).

**CASE STUDY 14: Slapton Ley (Contd.)**

**Current / Proposed Action**

Model forecasting was carried out to determine the optimum catchment-based strategy for the Slapton catchment (Johnes, 1996; Johnes and Heathwaite, 1997). It was found that relocating higher risk land uses and livestock to areas with greater nutrient retention capacity (and away from the riparian zone) would reduce the nutrient loading on Slapton, with no net reduction in the intensity of agricultural production in the catchment. Combined with lake restoration strategies, Slapton Ley could be restored.

Slapton and Blackawton STWs are under investigation for phosphorus removal under the water industry's Assessment Management Programme.

The Environment Agency is also piloting an ECAP (Eutrophication Control Action Plan) but there are no resources or supporting policy mechanisms to target and implement the necessary land management changes.

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**CASE STUDY 15: Tamar-Tavy Estuary**

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| **Site Name:** | Tamar-Tavy Estuary |
| **County:** | Devon-Cornwall |
| **NGR:** | SX 436711 and SX 474650 to SX 435591 |
| **Site Area:** | 1419.31 ha |
| **Site Protection/Designations**: | Tamar-Tavy Estuary SSSI<br>Tamar Estuaries SPA<br>Plymouth Sound and Estuaries cSAC |

**Site Description**

The Tamar-Tavy Estuary system forms the upper reaches of the Plymouth Sound and Estuaries cSAC, which is a large marine inlet on the English Channel coast. A series of rivers discharge into the estuary system draining an extensive catchment within Devon and Cornwall. The Tavy catchment is largely agricultural with small urban developments and a few old mine workings. The Tamar catchment is also influenced by historic mining activity. The catchment of the upper estuary is thus very much influenced by agriculture and old mines.

The Environment Agency and English Nature are currently undertaking investigative work in order to review permissions required under regulation 50 of the Conservation (Natural Habitats &c.) Regulations, 1994, and a Site Characterisation has been carried out for the Plymouth Sound and Estuaries cSAC (Langston *et al.*, 2003). The project characterises the site in terms of environmental quality, and identifies areas where conditions might result in effects on habitats and species for which the site was designated. Information regarding the Tamar-Tavy Estuary has been summarised from this report for the purposes of this case study.

**Reasons for Notification / Special Interests**

The cSAC as a whole supports an extremely rich marine flora and fauna, which include abundant southern Mediterranean-Atlantic species rarely found in Britain. The Tamar-Tavy Estuary is particularly noted for European protected habitats which include extensive submerged / tidal mudflats and sand banks, estuaries, large shallow inlets and bays, saltmarsh communities that contain extensive and varied infaunal communities and provide important feeding and roosting areas for large numbers of wintering and passage waterbirds. These waterbirds include European protected species including Little Egret *Egretta garzetta*, Avocet *Recurvirostra avosetta* and Golden Plover *Pluvialis apricaria*. Other notable species that use the site include Salmon *Salmo salar*, Allis Shad *Alosa alosa* and Otter *Lutra lutra*. Further the only known population of Triangular Club-rush *Schoenoplectus triqueter* occurs at this site.

**Specific Features at Risk / Sensitive to Diffuse Pollution Impacts**

There is very little specific information on sensitivity of estuarine macrofauna, or on the sensitivity of the rare species and special interest features to nutrient enrichment but those considered to be most at risk include phytoplankton, invertebrates, fish (estuarine and migratory, especially early life stages), seabirds, mammals and *Zostera* beds. The decline nationally of Eelgrass beds may have serious consequences for the associated rich and diverse fauna, including seahorse populations which are often associated with beds of *Zostera* and fine algae.

**CASE STUDY 15: Tamar-Tavy Estuary (Contd.)**

**Evidence of Pollution Impacts**

The EA/EN site characterisation study reports that the Tamar-Tavy Estuaries have been regarded as displaying a tendency towards eutrophication and diffuse nutrient sources are recognised to play an increasingly important role in this process.
Temporal trends for nitrogen and phosphorus indicate that nutrient concentrations are increasing in much of the cSAC. Low levels of dissolved oxygen have occurred periodically in the upper Tamar and may be responsible for salmonid deaths. The sparse evidence suggests that seagrass beds in the Plymouth Sound and Estuaries cSAC are relatively impoverished or declining – which could be linked with nutrient enrichment. The secondary productivity of the benthos will be linked to nutrient status through effects on sediment and epibenthic flora, including phytoplankton. Nutrient enrichment thus also has the potential to affect these benthic components of the ecosystem. However, it highlights the need for detailed investigation to fully evaluate potential impacts.

**Evidence of Diffuse Agricultural Pollution**

Using models to estimate nutrient inputs, Fraser *et al.* (2000) compared the relative contributions of diffuse and point sources inputs to the Tamar Estuaries complex in 1931 and 1991. The figures are the result of an integrated approach taking into account a wide range of physical characteristics and parameters such as the local geology and sediment type, land use, volume, dilution and flushing rate, rainfall, vertical mixing, and wave exposure, all of which influence the nutrient status of environmental waters.

The model estimates suggest that the relative proportion of nitrogen inputs from diffuse sources in the Tamar catchment has increased by 2.4% over the 60-year period covered, and diffuse inputs of phosphorus have increased by 4.4%. In 1991, 97.7% of N and 89.7% of P were considered to derive from diffuse sources.

During this period, it is estimated that the total N loading delivered to the Tamar Estuary rose from 13.4 kg ha$^{-1}$ in 1931 to 39.3 kg ha$^{-1}$ in 1991, representing a 194% increase in N loading. The total P loading delivered to the Tamar Estuary rose from 0.75 kg ha$^{-1}$ in 1931, to 1.57 kg ha$^{-1}$ in 1991, representing a 52% increase in P loading on the estuary over the 60 years.

According to this model, N export to the Tamar Estuary has increased at a more rapid rate than P export. The authors suggest that the increased differential is driven by a number of factors: the conversion of unfertilised moorland and rough grazing to intensively fertilised agricultural grazing land, changes in fertiliser application rates to crops and grass, and predominantly by increasing stocking densities of cattle and particularly sheep on grazing land. N and P export from human sewage is predicted, from the model, to play an insignificant role in the delivery of nutrients from this catchment to the Tamar Estuary whilst average flows are observed. It could be argued, therefore, that point sources should not be the primary focus in the development of eutrophication control action plans for this catchment.

Calculations from the model confirm that numerically, the Tamar River dominates Total Inorganic Nitrogen inputs to the cSAC. However, sewage discharges constitute additional loading and result in chronic contamination of the affected areas, with nutrient-associated water quality problems

**CASE STUDY 15: Tamar-Tavy Estuary (Contd.)**

**Current / Proposed Action**

The Plymouth Sound and Estuaries Site Characterisation (Langston *et al.*, 2003) recommends the following:

Effects on many of the rare species in the cSAC are largely unresearched, but in view of their conservation importance, it would seem that an increase in nutrients should be avoided, as a precautionary requirement. Changes to consents (quantities and location) should therefore be considered carefully to avoid the risk of further enrichment.

The complexity of the nitrogen and phosphorous cycle, and the significance of sediments, has been long appreciated, nevertheless monitoring still largely involves measurements of nutrients in water. Until more data becomes available for sediments any attempt at evaluating the significance of sediment as sources or sinks of N and P is difficult. In order to construct more meaningful budgets the needs are to determine N and P removal rates to sediment, estuarine mixing behaviour, and to look at export rates from the estuary on suspended particles, at different salinities, tidal states, flow rates and seasons.

Most high quality chemical survey data and interpretation for the Plymouth SAC is now in the order of 10 years old, or more. Many of the measurements made since then have been largely focused on compliance monitoring and are not adequate to characterise the site as a whole. Co-ordinated chemical and biological surveys are needed for a better evaluation of impact from consented discharges and for a more accurate assessment of the 'health' of the site as a whole. These need to be targeted (on economic grounds) at the most important issues and well-designed (on scientific-grounds) so that they answer, adequately, the questions being asked by the regulatory agencies.

**Sites with Similar Problems**

South West Estuaries including the Yealm, Fal and Helford, Salcombe to Kingsbridge, Erme, Poole Harbour.

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| Cressbrook Dale SSSI/NNR<br><br>Peak District Dales cSAC | English Nature (2003) Site citation. http://www.english-nature.org.uk/special/sssi/sssi6.asp<br><br>JNCC (2003) Site citation. http://www.jncc.gov.uk/idt/ |
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| Minsmere-Walberswick Heaths and Marshes SSSI<br><br>Minsmere to Walberswick Heath and Marshes cSAC<br>Minsmere to Walberswick SPA and Ramsar | English Nature (2003) Site citation. http://www.english-nature.org.uk/special/sssi/sssi6.asp<br><br>JNCC (2003) Site citation. http://www.jncc.gov.uk/idt/ |
| Moorthwaite Moss SSSI | None available |
| Muckfleet catchment (Hall Farm Fen, Hemsby SSSI, Trinity Broads SSSI and Burgh Common and Muckfleet Marshes SSSI)<br><br>Broads cSAC<br>Broadland SPA & Ramsar | English Nature (2003) Site citation. http://www.english-nature.org.uk/special/sssi/sssi6.asp<br><br>ENTEC (NO DATE) *Hydro ecological review of European sites within Yare and N Norfolk groundwater resource investigation area*<br><br>JNCC (2003) Site citation. http://www.jncc.gov.uk/idt/<br><br>Pitt *et al* (1996) *Restoration of the Trinity Broads – Progress Report*. Internal EA Report |
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| Poole Harbour SSSI, SPA, Ramsar | English Nature (2003) Site citation. http://www.english-nature.org.uk/special/sssi/sssi6.asp<br><br>Halcrow Group Ltd (2002) *Poole Bay & Harbour strategy study strategic environmental assessment draft baselines and objectives*. English Nature, Dorset. Extract only.<br><br>Hanrahan G, Gledhill M, House WA & Worsfold PJ (2001) Phosphorus Loading in the Frome Catchment, UK: Seasonal Refinement of the Coefficient Modelling Approach. *Journal of Environmental Quality*, 30 (5) :1738-1746. ABSTRACT ONLY<br><br>JNCC (2003) Site citation. http://www.jncc.gov.uk/idt/<br><br>Langston WJ, Chesman BS, Burt GR, Hawkins SJ, Readman J, & Worsfold P (2003) *Site Characterisation of the South West European Marine Sites: Poole Harbour*. Draft. Plymouth Marine Science Partnership. |
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| River Ant catchment (East Ruston Common SSSI, Broad Fen Dilham SSSI, Smallburgh Fen SSSI, Ant Broads and Marshes SSSI)<br><br>Broads cSAC<br>Broadland SPA & Ramsar | English Nature (2003) Site citation. http://www.english-nature.org.uk/special/sssi/sssi6.asp<br><br>JNCC (2003) Site citation. http://www.jncc.gov.uk/idt/<br><br>Whitehead *et al* (2002) *Effectiveness of eutrophication control by phosphorus reduction*. EA R&D Project P2-137. Draft progress report. |
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| River Bure catchment (Crostwick Marsh SSSI, Bure Broads and Marshes SSSI)<br><br>Broads cSAC<br>Broadland SPA & Ramsar | English Nature (2003) Site citation. http://www.english-nature.org.uk/special/sssi/sssi6.asp<br><br>JNCC (2003) Site citation. http://www.jncc.gov.uk/idt/<br><br>Johnes (1996) *Nutrient Export Modelling – River Bure, Norfolk*. Environment Agency, Anglian Region OI581 ENTEC *Hydro ecological review of European sites within Yare and N Norfolk groundwater resource investigation area* |

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