

Out of Sight ~ Out of Mind

**Marine
Eutrophication
in the UK**

Malcolm MacGarvin
modus vivendi
for **WWF-UK**

All rights reserved. All material appearing in this publication is subject to copyright and may be reproduced with permission. Any reproduction in full or in part of this publication must credit Malcolm MacGarvin / WWF-UK as the copyright holders.

Citation details: MacGarvin, M (2001). *Out of Sight, Out of Mind: Marine Eutrophication in the United Kingdom*. modus vivendi for WWF-UK, Glenlivet.

The views of the author expressed in this publication do not necessarily reflect those of WWF.

The author has used all reasonable endeavours to ensure that the content of this report, the data compiled, and the methods of calculation and research are consistent with normally accepted standards and practices. However, no warranty is given to that effect nor any liability accepted by the authors for any loss or damage arising from the use of this report by WWF-UK or by any other party.

For biographical details of the author see inside back cover.

© Malcolm MacGarvin / WWF-UK, 2001 except:

All artwork and photographs © Malcolm MacGarvin apart from map of nitrates in European rivers, p. 34 and the map of phosphate in European rivers, p. 35, based on material © European Environment Agency. Reproduced with permission.

Produced by modus vivendi using Adobe InDesign, Illustrator and Photoshop. Typefaces: Joanna and Gill Sans, designed by Eric Gill.

For further information, contact:

The Living Seas Programme
WWF-UK
Panda House, Weyside Park
Godalming, Surrey GU7 1XR
Telephone 01483 426444
Fax 01483 426409
Website www.wwf-uk.org

Registered Charity No 1081247

or

Malcolm MacGarvin
modus vivendi
Ballantruan • Kirkmichael • Glenlivet
Ballindalloch • AB47 9AQ • Scotland

Telephone +44 (0)1807 590396
Mobile +44 (0)7768 665974
macgarvin@modus-vivendi.co.uk

Out of Sight ~ Out of Mind

**Marine
Eutrophication
in the United
Kingdom**

Malcolm MacGarvin

with contributions from

Simon Vowles

& Sarah Jones

WWF-UK

All source material available on the web is hyperlinked in the electronic version of this report – clicking on the URL in the References will take you to the source.

This report can be downloaded in pdf format from the WWF-UK website at <http://www.wwf-uk.org/orca/info.htm>

Contents

Overview

vi-xviii

Part 1 The Problem

Introduction **I**

The Phenomena **6**

'Big plant' Eutrophication	6
Plant Plankton Eutrophication	9
<i>Long term eutrophication trends</i>	10
<i>Contemporary eutrophication</i>	10
Panel: Eelgrasses	11
Impact of Eutrophication on other Habitats	15
<i>Saltmarsh</i>	15

Outstanding Issues **18**

Definition and Practical Measurement	18
The Concept of the 'Limiting Nutrient'	19
Panel: The Redfield Ratio	20
<i>Phytoplankton</i>	21
<i>Macrophytes</i>	22
Ameliorating effects	23
Interaction with Other Factors	25
Statistical Issues	25
The Boundary between Science and Policy	26

Part 2 Context, Sources, Trends & Responses

The European Context **30**

European Community Directives	30
<i>Urban Waste Water Treatment Directive</i>	31
<i>Nitrates Directive</i>	33
<i>Wildlife Directives</i>	36
<i>Water Framework Directive</i>	36
Eutrophication and OSPAR	37
<i>OSPAR Strategy to Combat Eutrophication</i>	38
<i>The OSPAR Common Procedure</i>	40

Northwest Europe – Sources & Trends **45**

Sources of Nitrogen	45
Sources of Phosphorus	46
Trends over Time	47

UK Policy Development **50**

1993 Consultation Paper	51
'Comprehensive Studies' Task Team	51
<i>CSTT Task Team definition of eutrophication</i>	52
Labour Administration Reassessment	53
Environment Agency 1998 Consultation	54
Environment Agency 2000 Strategy	56
<i>Estuarine- and coastal-specific strategy</i>	57
<i>Case-by-Case vs Whole Territory action</i>	57
<i>Application of the Precautionary Principle</i>	58
<i>Action dependent on cost</i>	59
<i>Use of standards, guidelines and/or thresholds</i>	61
<i>Regulation vs. Voluntary codes</i>	62
Specific Requirements for SACs and SPAs	64

Part 3 Regional Survey

The WWF Survey **68**

The UK's Quality of Coastal Waters Study	69
<i>Ammonia</i>	69
<i>Nitrate</i>	72
<i>Phosphorus</i>	72
<i>Chlorophyll</i>	73
The WWF Survey	74
<i>National overview</i>	75
<i>UK Sites with the highest nutrient concentrations</i>	77
<i>Points emerging from the national overview</i>	79

	Scotland	80
	Eastern Scotland	81
	<i>Conservation interest</i>	81
	<i>Nutrients and eutrophication</i>	83
	Panel: The Ythan	84
	Western & Northern Scotland	86
	<i>Conservation interest</i>	86
	<i>Nutrient inputs</i>	87
	Borders to the Humber	88
	Panel: The Humber	90
	East Anglia	94
	Panel: The Wash	96
	Panel: Suffolk & Essex Estuaries	98
	Thames to the Solent	102
	Panel: Solent & the South Coast Embayments	104
	Southwest England	107
	Conservation Interest	107
	Nutrient Levels	108
	Wales	111
	Conservation Interest	111
	Nutrient Levels	112
	Northwest England	115
	Conservation Interest	115
	Nutrient Levels	116
	Offshore Effects	118
	English Channel	118
	Irish Sea	119
	Northern North Sea	119
	Central and Southern North Sea	120
	Out of Sight ~ Out of Mind	126
	'An increase in growth' and its consequences	126
	<i>Causes</i>	126
	<i>Increased macrophyte growth</i>	127
	<i>The consequences of increased macrophyte growth</i>	128
	<i>Increased phytoplankton and epiphytic growth</i>	128
	<i>The consequences of increased phytoplankton and epiphytes</i>	129
	'Undesirable' Eutrophication	129
	Policy Context	131
	<i>The international context</i>	131
	<i>UK policy response</i>	134
	Implications	135
	Recommendations	137
	Overall Recommendations	137
	EC Directives and OSPAR	138
	Water Framework Directive – EcoQOs	139
	Specific Measures for 'European Marine Sites'	139
	<i>Specific management action</i>	140
	<i>Site designations and the precautionary approach</i>	141
	<i>Water Framework Directive consistency in application</i>	141
	<i>Offshore Application</i>	142
	Agriculture: The Wider Context	143
Part 4	Conclusions & Recommendations	
Part 5	References & Data Annex	
	References	146
	Data Annex	164



EUTROPHICATION, IN THE SCIENTIFIC SENSE, is generally considered to be an increase in plant growth caused by an increase in nutrients. This in turn can have a number of knock-on effects through the ecosystem. The policy definition of eutrophication, throughout the EU, is that of an ‘undesirable’ increase in growth, combining both the strict definition and its effects. This raises value judgements about just which changes are considered ‘undesirable’. Generally the UK, since the 1980s, has placed a lower value on eutrophication and its consequences, and a greater weight on the assumed costs of action, than most of our continental neighbours. By the mid-1990s the nutrient levels of English rivers, in particular, were among the highest in north-west Europe. According to a report published by English Nature, increasing nutrient concentrations had put at risk the vast majority of freshwater SSSI sites (those nominally with the highest level of protection) surveyed. For estuarine and coastal areas – the subject of this report – while eutrophication generally does not extend as far off-shore as for some of our continental neighbours, there are significant consequences or risks for UK sites that have largely been ignored or denied.

An aim of international policy since the 1980s has been to agree on common criteria for assessing marine eutrophication. Historically the UK has resisted this, insisting in the early 1990s on the de-designation of sites internationally judged to be severely affected, such as the Ythan estuary in north-east Scotland, and Langstone and Chichester Harbours on England’s south coast. This sparked a dispute lasting for much of the decade, before it was conceded that these sites were indeed affected by eutrophication. By the late 1990s the UK had formally agreed with neighbouring countries to develop and apply common marine eutrophication criteria, but in practice it has fought a rear-guard action, insisting that these should be developed and applied nationally.

‘An Increase in Growth’ and its Consequences

There are varying degrees of certainty regarding aspects of marine eutrophication relating to causes, the plants affected, and consequences.

Causes

It is reasonably certain that two nutrients have the greatest impact on total plant growth in estuaries and coastal waters; nitrogen and phosphorus. Nitrogen is more usually the critical ‘limiting’ nutrient, both for larger plants and for single-celled phytoplankton.

There is some evidence that disproportionately reducing phosphorus inputs may increase the competitive advantage of some ‘undesirable’ spe-

cies, and that distorting the balance between these two nutrients may increase the toxins produced by some phytoplankton species. Unfortunately, natural processes appear less important than once thought for removing nitrogen from the system, while the opportunities for phosphorus removal may also be more limited than has been suggested. Similarly, turbidity (water cloudiness) may more often displace the effects of eutrophication to clearer waters, rather than preventing it outright, as sometimes argued.

There is more uncertainty about the relative importance and interactions between increased nutrients and other factors, such as fluctuations in climate. It is unlikely that any one factor provides a complete explanation. However the evidence for the over-riding importance of nutrients, particularly in estuaries and inshore waters, is compelling.

While most attention is focused on effects at high nutrient concentrations ('eutrophic' and 'hypertrophic' conditions), low nutrient (oligotrophic) sites may be particularly vulnerable to relatively small changes in nutrient levels.

Eutrophication may be inhibited by other, toxic, pollution at some sites but the overall significance of this is largely unstudied.

Increased 'Macrophyte' (Large Plant) Growth

There is no doubt that, providing suitable attachment sites exist, annual seaweeds, especially green algae, will increase their growth rate in response to an increase in nutrients, and can carpet areas with a thick mat of weed. There is little evidence that increased nutrients have any significant positive effects for other large plants such as perennial seaweeds, including kelp, and eelgrasses.

The Consequences of Increased Macrophyte Growth Green algae may smother perennials such as eelgrass. Eelgrasses are extremely important wildlife habitats and have severely declined on east coast sites where nutrient levels are high. Above a certain density the algae also have a severe effect on the underlying fauna in soft sediments, and may interfere with predators' ability to feed upon this fauna. The algae is however eaten by species ranging from snails to brent geese. The net effect is to change the species composition of a site away from its natural state. The general impact of algae growing on saltmarsh plants and reeds is uncertain.

Increased Phytoplankton and Epiphytic Growth

There is little doubt that, in many UK waters, phytoplankton (and epiphytes on the surface of larger plants) respond to increases in nutrients, both in terms of increased growth and changes in species composition. This process has almost certainly been occurring for hundreds of years,

although it can reasonably be assumed that the pace of change would have accelerated sharply in recent decades.

Eutrophication can occur even where the water is turbid (cloudy), but the increase in growth will be generally be greater where light levels are high. The presence of unutilised nutrients in the water, and the current limitation of growth by light, does not demonstrate that eutrophication has not occurred, as sometimes assumed. Rather increased growth may have occurred to the point where other limits take effect.

The Consequences of Increased Phytoplankton and Epiphytes Phytoplankton and epiphytes intercept light and reduce the depth to which perennial seaweeds and eelgrasses can grow, or even eliminate them entirely. Such changes may interact with other adverse effects, such as the impact of eelgrass wasting disease.

The change in phytoplankton species composition that accompanies eutrophication tends to favour smaller species, and those such as *Phaeocystis*, which can be of lower direct food value to fish and shellfish. However this increased production will enter the food web by other routes, and increase the supply of detritus, to the immediate benefit of other species. Nutrient enrichment may be one factor in a chain of events that increases the prevalence of toxic blooms.

'Undesirable' Eutrophication

Undesirability is a value judgement with no factually right or wrong answers. However there will be a wider consensus that some effects are undesirable compared to others.

There is probably most agreement on the undesirability of eutrophication that affects valued habitats such as eelgrasses and kelp, and regarding the extreme development of green algal weed. An increase in toxic blooms would also be generally regarded as undesirable.

Assessing the undesirability of 'moderate' proliferation of green algae on intertidal flats is more difficult. One might consider the 'bird table' effect of the extra food generated as acceptable. Another view is that any distortion from background conditions is undesirable. Such distortions seem particularly undesirable at sites of high conservation value. If 'moderate' algal proliferation may progress to extreme forms at constant nutrient levels, by building up sediment nutrient levels, this also shifts the balance in favour of action even where the current impact appears small.

Changes in the species composition of phytoplankton, associated with eutrophication, but not accompanied by other undesirable effects, is also problematic. In principle we should be as concerned about the decline of affected phytoplankton species as for those of more charismatic appeal. After all, this is a directly analogous effect to the decline in floral diversity

that accompanies the fertilisation of ‘unimproved’ grassland. In practice views may be more diverse. It is not clear whether decisions that have been made in the UK not to act, on the basis that increases in phytoplankton are not undesirable *per se*, comes from lack of awareness of such effects.

In terms of ‘desirable’ eutrophication, for fisheries it has been suggested that eutrophication may increase fish production. However the problem in fisheries is not a lack of food (stocks were prolific in the past), but a lack of good management. In some specific cases, such as mussels, it may increase productivity, and this may result in a conflict of interests.

However, to the extent that the necessary measures to control the most undesirable effects will also have an impact on the more contentious aspects, the actual significance of the ‘undesirability’ test may be limited.

Policy Context

Marine eutrophication policy is increasingly being driven at the international level by the Oslo and Paris Convention for the protection of the north-east Atlantic (OSPAR), and by EC Directives. The UK has yet to respond to these challenges at the national level.

The International Context Marine eutrophication has been recognised as a major problem by most of our continental neighbours since the late 1980s. In 1987 the countries around the North Sea, including the UK, made a commitment to reduce nitrogen and phosphorous inputs, by ‘the order of’ 50%, to problem areas. The UK has not implemented this commitment, but other States have attempted to do so. This is judged to have had considerable success with industrial inputs; to have resulted in significant reductions, particularly of phosphorus, from urban waste water; but to have met little success with agriculture, a major source. Overall, North Sea nutrient levels show only limited signs of decline, although the action may have helped prevent further increases.

The international process has not stood still. The 1998 OSPAR Strategy to Combat Eutrophication commits all parties, including the UK, not only to meet current reduction targets, of the order of 50%, but to take further measures to ensure that by 2010 a healthy marine environment is created “where eutrophication does not occur”. The OSPAR ‘Comprehensive Procedure’ for setting common Ecological Quality Objectives for chemical and biological criteria, and to establish the eutrophication status of all estuarine and coastal waters, should be complete by 2002. These steps are intended to circumscribe national freedom of action.

The European Commission is a contracting party to OSPAR, and it is inconceivable that it will not turn to the Comprehensive Procedure criteria when assessing whether Member States have met their obligations

for estuarine and coastal sites under the Urban Waste Water Treatment (UWWT), agricultural Nitrates, Habitats and Wild Birds Directives. The new Water Framework Directive, like the OSPAR Strategy, generally will also preclude the occurrence of eutrophication in all water bodies.

UK Policy Response

The EA's *Eutrophication Management Strategy*, published in 2000, appears curiously detached from previous UK guidance and international commitments. Even the prospect of setting freshwater criteria for nitrogen or phosphorus is expressed tentatively, as is the use of Ecological Quality Objectives. The situation for estuarine and coastal waters is couched in even more distant terms, mainly as a subject for further research.

Yet both chemical and biological marine criteria have been used since 1993 in the UK, and were actually applied to the designation of sites such as the Ythan estuary. The EA Strategy is similarly inconsistent with OSPAR's Comprehensive Procedure for setting such criteria, and the deadline of 2002 for the classification of all of the UK's estuaries and coastal waters on this basis. This has major implications for urban waste water investment and agricultural practices by the 2010 deadline. Failure to take such action within the UK would undoubtedly result in serious conflict within OSPAR, and with the European Commission.

The EA's strategy of applying a precautionary approach primarily to sites of high conservation value such as SSSI's SACs and SPAs, and only if the measures are not considered too expensive, also contradicts the guiding principles of the OSPAR Strategy. The emphasis on costs similarly contradicts the UWWT and Nitrates Directives, and has already been ruled, in a UK Judicial Review, to be impermissible for the UWWTD.

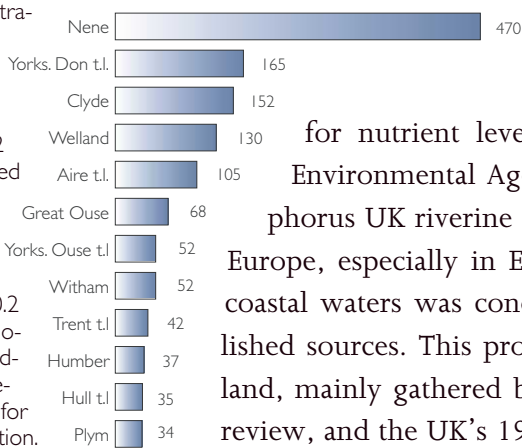
The emphasis on a case-by-case approach, and the specific ruling out of whole-territory EC Directive designations is also striking, and represents a difference in approach to that of many neighbouring States. Yet data on the high proportion of freshwater SSSIs affected by eutrophication is compelling evidence for widespread effects, and the need for widespread action. But if this were to stimulate action only for freshwater sites, for urban waste water this, according to current thinking, would generally not require nitrogen reductions. This might actually enhance some adverse effects of eutrophication in estuaries and coastal waters, where nitrogen is more likely to limit growth and a distorted balance between nitrogen and phosphorus may also lead to undesirable consequences, such as toxic and other undesirable phytoplankton blooms.

However, there is also widespread evidence of estuarine and coastal eutrophication. The catchment area of those estuaries, embayments and coastal waters for which there are one or more symptoms of eutrophication, revealed by a survey conducted for this report, is sub-

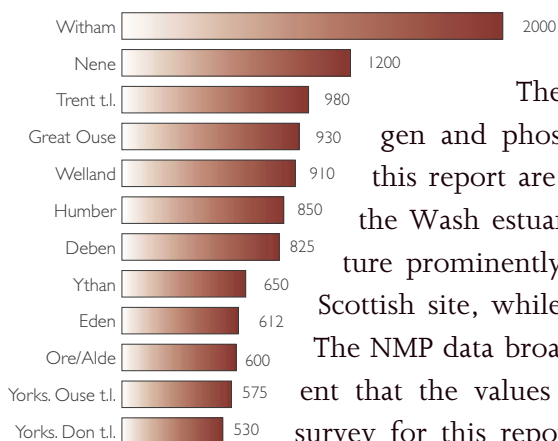
Top Twelve Nutrient Sites

The twelve sites with the highest nutrient concentrations, from a survey of the tidal rivers, estuaries and coastal waters of England, Wales and Scotland. Units in micromoles, μM . Natural river concentrations would typically be of the order of tens of μM TON, a fraction of a μM phosphorus, and very low ammonia concentrations. In coastal waters the UK regards 12 μM dissolved available nitrogen in the presence of at least 0.2 μM phosphorus as providing the pre-conditions for eutrophication.

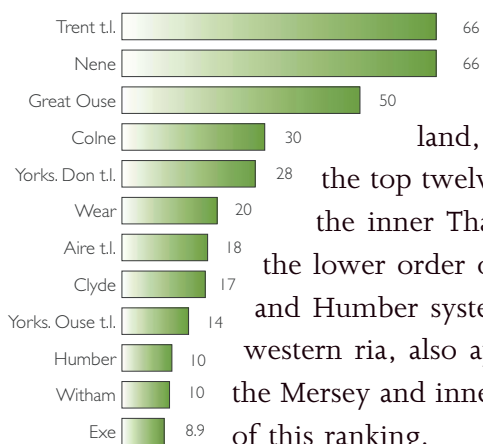
ammonia



TON



phosphorus



stantial (see map pp 132–133). It also encompasses many Habitats Directive marine Special Areas of Conservation, SACs, and Wild Birds Directive Special Protection Areas, SPAs. These internationally important sites are required to have the highest standards of protection. Within the OSPAR framework, the presence of problem areas automatically requires reductions in nitrogen and phosphorus inputs at least of the order of 50%, yet no such programmes have been put in place, even for those sites accepted by UK governments to be affected by eutrophication.

Consequences

The consequences of UK policy are apparent both for nutrient levels and biological effects. According to European Environmental Agency (EEA) compilations, both nitrogen and phosphorus UK riverine concentrations are amongst the highest in northern Europe, especially in England. A survey of UK tidal rivers, estuaries and coastal waters was conducted for this report, based on a variety of published sources. This provided 296 records from England, Wales and Scotland, mainly gathered between 1990–1995. In addition a wider literature review, and the UK’s 1998 National Monitoring Programme’s (NMP) *Quality of UK Coastal Waters*, provides additional complementary information.

Nutrients

The overall twelve worst sites for ammonia, nitrogen and phosphorus derived from the survey conducted for this report are shown on the left hand margin. For **ammonia**, the Wash estuaries, and the Humber and its tidal satellites, feature prominently in the rankings. The Clyde estuary is the only Scottish site, while one south western ria, the Plym, also features. The NMP data broadly supports this ranking: in addition it is apparent that the values recorded for the Mersey (not included in the survey for this report) appear to be of the same order, or even in excess, of that displayed here for the Nene. For **Total Oxidised Nitrogen**, TON, (mostly nitrate) the Wash and Humber systems again feature prominently, but other east coast estuaries such as the Ythan and Eden in Scotland, and the Deben and Ore/Alde in England also appear in the top twelve. Of the additional NMP sites, the values obtained for the inner Thames are probably consistent with a position amongst the lower order of the sites displayed here. For **phosphorus**, the Wash and Humber systems once more feature prominently. The Exe, a south western ria, also appears in the top twelve. The NMP data suggests that the Mersey and inner Thames would also feature in the upper or mid-level of this ranking.

There is no doubt that the concentrations displayed here are very significantly elevated from natural levels, and provide the nutrient preconditions necessary for extreme (hypertrophic) eutrophication.

Biological Effects

In the UK **phytoplankton** chlorophyll concentrations regularly in excess of $10 \mu\text{g l}^{-1}$ (microgrammes per litre) have historically been regarded as evidence of eutrophication in coastal waters. No values have been set for estuaries, but there is no reason to suppose that these thresholds will be dramatically higher. In continental waters there is an emerging consensus, via the development of OSPAR Ecological Quality Objectives, to regard phytoplankton chlorophyll concentrations exceeding a $15\text{--}25 \mu\text{g l}^{-1}$ threshold as evidence of eutrophication in coastal and estuarine waters. The NMP survey found summer median values of $5\text{--}10 \mu\text{g}$ for the Forth, Tyne, Wear, outer Thames estuary, the Plymouth estuary complex, Severn, outer Solway and Clyde; while the Tees, the East Anglian Great Ouse, the inner Thames, and the Mersey had median values well in excess of $10 \mu\text{g}$. Forty percent of the summer estuary sites sampled had chlorophyll maxima of $10 \mu\text{g}$ or greater and nine NMP estuaries had values above $30 \mu\text{g}$. These were the Tyne, Tees, Humber, East Anglian Great Ouse, the Thames, Southampton Water, the Tamar, Dee, and the Mersey. It concluded that most estuaries experience high concentrations of chlorophyll at some stage during the year, but this is not necessarily indicative of eutrophication (according to their interpretation), because there was no evidence of problems caused by the phytoplankton. In other words eutrophication had occurred, but was not deemed 'undesirable'. No assessment of changes in species composition was conducted. Very few coastal sites were included in the NMP survey, but other work suggests that eutrophication does occur at various sites, especially along the English east coast from the Humber to the Thames (notably parts of the Wash), possibly the Solent, and the north-east Irish Sea, where remedial action has been urged since the early 1990s. The concern over the possible association between an increased prevalence of toxic algal blooms, and increased nutrient levels and/or altered nutrient ratios, was highlighted in WWF's report *Scotland's Secret?*

The survey conducted for this report found considerable evidence and concern regarding the excessive growth of **green algae**, at sites stretching from the Ythan, Montrose Bay and the Eden on the east coast of Scotland, extending down the English east coast including sites such as Lindisfarne in Northumberland, possibly areas of the Humber and the Wash, the Ore/Alde and Deben in Suffolk, to sites on the Thames estuary. On the south coast, in addition to well known problem sites such as Langstone and Chichester Harbours, concerns have been expressed about green algal

proliferation at some ria sites, such as the Helford in the south-west.

The impact of eutrophication on **eelgrass meadows**, particularly the sub-tidal species *Zostera marina*, is of particular concern. Once prolific at suitable sites on the east coast of England, this disappeared during the twentieth century, matching losses on the continental coast of the North Sea. While often blamed solely on eelgrass wasting disease, there is evidence that high nutrient levels increase the sensitivity of *Z. marina* to this disease. Moreover, in Denmark, when nutrient levels have temporarily been reduced by drought, *Zostera* has staged a temporary come-back. Interestingly, at sites in south-west England, Wales and western Scotland, where nutrient pollution has historically been lower, *Zostera* persisted. In this light, the expansion of fish farms on the west coast of Scotland, a major new source of nutrients, must be a cause of concern. More generally, continuing high levels of nutrients will certainly not help the protection and recovery of this important habitat, which should be a major conservation objective.

Implications

The scale of the problem, and corresponding commitments made in international agreements, have major implications for UK policy which are not evident in the EA Strategy. Case-by-case assessment has been overtaken by increased knowledge of widespread effects. It is an over-elaborate and expensive option for the circumstances, and should now be abandoned.

Under the UWWTD the designation of estuarine sites, such as the Humber, as Sensitive Areas would have major implications throughout the catchment, requiring both phosphorus and nitrogen removal of the order of 75%. This implies the widespread use of both phosphorus and nitrogen stripping. Technically this is feasible, and indeed has been implemented by other countries. One particular difficulty the UK now faces is that other countries, while further advanced, are pressing for additional measures and removing the scope for evasion. The UK faces a fixed deadline of 2010, and an absolute requirement for the elimination of marine eutrophication. As a result expenditure in the UK will be pressed into a shorter period than on the Continent. Yet currently, within catchments of estuaries and coastal areas where there is clear evidence of eutrophication, major investment programmes appear to be uninformed about these international requirements. A prime example is expenditure on the conversion of ammonia to nitrate in sewage discharges. While this certainly has beneficial effects, it does not reduce nitrogen inputs and is a largely ineffective measure against eutrophication. On the basis of the EA Strategy it is not clear that the water companies are effectively being informed about the implications of international agreements, and it appears likely that the costs are going to be greater than if this problem had been acknowledged by UK authorities

at an earlier stage.

For the Nitrates Directive, the acceptance of eutrophication, to which agricultural nitrate losses contribute, requires a shift from voluntary agricultural codes (which the EA Strategy still emphasises, although accepting that the results have been poor) to rigorously applied action programmes and verification measures, resulting in a substantial reduction in agricultural nitrogen losses. Indeed, eutrophication challenges the basis of modern intensive techniques, where fertiliser applications are calculated, if at all, on the basis of forecast market prices rather than on efficiency of uptake. Even those countries that accepted the 50% reduction criteria are evidently struggling to make significant progress with agriculture. On-farm nutrient budgeting will provide some scope for the more efficient use of fertiliser and manure. Remedial steps will require sources and sinks of manure to be more closely matched, and the demand for artificial fertilisers correspondingly reduced. This favours organic farming, and generally it implies a return at the local level, if not for individual farms, to more mixed farming. However, due to uncontrollable factors such as heavy rainfall, we will never have the level of control over the losses of nutrients for agriculture that is possible for urban waste water. This implies a greater use of natural vegetation in buffer strips and also, as recently suggested by government scientists for the Humber, the extensive rewilding of lower rivers and estuaries.

None of this is easy, particularly for agriculture which is already under enormous pressure. In the UK marine eutrophication has been a problem largely 'out of sight, out of mind', for the public, interest groups and policy makers alike. But in terms of the Directives, if not implemented it leaves the UK open to formal complaints to, and infringement proceeding by, the European Commission. Within OSPAR, any failure to implement a policy agreed at Ministerial level is also likely have significant repercussions.

Recommendations

One of the most disturbing finding of this report is the large number of 'European Marine Areas', SACs and (potentially at least) SPAs, – supposedly conservation sites of international importance and the highest protected status – that have been left vulnerable to eutrophication. For this issue at least, evidently the highest level of protection has been no protection at all. More generally, has become clear that eutrophication is a widespread problem, or potential problem, in estuarine and coastal waters, as well as in freshwater. If the UK is serious about eliminating marine eutrophication, implementing the commitments undertaken in the OSPAR Common Strategy to Combat Eutrophication, and those of the UWWT,

Nitrates, Habitats, Wild Birds and Water Framework Directives, then it leads to the following recommendations, the background for each being elaborated in the *Recommendations* chapter.

Overall Recommendations

- 1** The case-by-case approach should be abandoned. Sensitive Area and Nitrate Vulnerable Zone designation should be made across all or substantial parts of the UK including sites that contribute to eutrophication problems in offshore areas out to the 200 nautical mile fishing limit;
- 2** The UK must fully engage with the OSPAR Strategy to Combat Eutrophication including, as a first step, the definition of problem areas to common OSPAR criteria by 2002, and the implementation of reductions of the order of 50% for both nitrogen and phosphorus;
- 3** As a consequence of the widespread symptoms of eutrophication, there needs to be a substantial increase in phosphorus and nitrogen removal at sewage treatment plants, sufficient to meet all requirements arising from OSPAR and EC Directives;
- 4** Similarly, there needs to be a recognition of the seriousness of the losses of nutrients from agriculture, and the development of a suite of measures, in collaboration with all interested parties, and in conjunction with other States, to reduce nutrient losses to the environment, commensurate with the goals of the OSPAR Strategy and EC Directives;
- 5** As the costs will be passed on to the public, it is important to demonstrate that the expenditure is for a worthwhile objective. Therefore the strategies should be connected to imaginative and necessary goals, such as the restoration of eelgrass in its former east coast sites, the rewilding of lower estuaries, the full and speedy designation and protection of Special Areas of Conservation, Special Protection Areas, and other areas of wildlife importance. In achieving this there should be an emphasis on public access (in so far as this does not conflict with the goal of habitat restoration and protection), the provision of information and excellent facilities for wildlife observation.
- 6** Finally, there should be comprehensive access to information, free at the point of use, available via the internet. This includes both a unified and comprehensive statistical database, and the electronic publication of all reports and advice. At present many agency web-sites, although useful in many ways, are 'channelled' to promoting the message of the agency, and not

suited to the pursuit of independent lines of enquiry.

EC Directives and OSPAR

- 7** The designation of an estuarine or coastal Sensitive Area or NVZ should be simultaneously matched by its designation as an OSPAR Problem Area (and vice-versa), and the implementation of a programme for a reduction of nitrogen and phosphorus inputs, 'of the order of' 50%. Should these reductions be likely to be insufficient to eliminate eutrophication, additional reduction measures must be taken, in accordance with the OSPAR Strategy to Combat Eutrophication;
- 8** The speedy implementation of the general source-orientated approach (tackling nutrient inputs by source) should be undertaken by the UK as part of the OSPAR Strategy;
- 9** Diffuse nutrient sources transferred via water (fertilisers) and the air (e.g. ammonia volatilisation from manure) are a particular problem, and strategies to combat them need to be developed and implemented with urgency.

Water Framework Directive – Ecological Quality Objectives

- 10** The implementation of EC Directives and the OSPAR Strategy should be (in)formally integrated to avoid duplication of effort and possible contradictions;
- 11** There should be a speedy transition from generic guidelines to Ecological Quality Objectives that are appropriate for the habitat and location.

Specific Measures for 'European Marine Sites' (SACs and SPAs)

- 12** The requirement for a single SAC management plan requires there to be links with all plans for the site. This is regardless of whether such plans are specifically intended to meet the requirements of the Habitats Directive. For eutrophication, the management of any adverse sources of nutrients from within the marine SAC should be part of the SAC management plan;
- 13** Specific management action is required with respect to features and sub-features within the site (for example, eelgrass, kelp and soft-sediment communities) as identified by the UK marine SAC LIFE Project. This action applies to both direct and indirect (e.g. nutrient pollution) impacts, and from inside or outside the site (e.g. the catchment area for an estuary, or the

sources of the coastal currents that influence an offshore site).

*Specific Measures for ‘European Marine Sites’ –
Specific Management Action*

- I4** The competent authorities should regularly review the eutrophication status of European Marine Sites (SACs and, potentially, SPAs), at an interval not greater than four years, as an integral part of the periodic review required for Directives and the OSPAR Strategy;
- I5** Nutrient reduction measures should be imposed with alacrity for diffuse and point sources where European Marine Sites are vulnerable to such inputs;
- I6** As the overall goal of the OSPAR Strategy is in any case to create a marine environment where eutrophication “does not occur” by 2010 (paralleled in the Water Framework Directive), this implies the fast-tracking of development and implementation of action plans for SACs and SPAs as soon as practicable after the completion of the Common Procedure for the designation of all problem and potential problem areas in 2002. Where the vulnerability of such sites to eutrophication is already evident, this process should start without delay.

*Specific Measures for ‘European Marine Sites’ –
Site designations and the precautionary approach*

- I7** If there is a potential threat from eutrophication for any European Marine Site (that by definition harbours internationally important species and habitats) then the precautionary approach should be applied and the site designated as a eutrophication problem area and also as a Sensitive Area and/or nitrate vulnerable zone, as appropriate;
- I8** Rejection on the basis of cost should only be applied in the most exceptional of cases; be subject to independent and international review; and be dependent on the practicality, costs and credibility of the creation of areas having identical characteristics and capable of supporting the displaced populations.

*Specific Measures for ‘European Marine Sites’ –
consistency in application of the Water Framework Directive*

- I9** When the WFD is implemented, and where existing UK legislation is repealed or revised, it must be ensured that this at

least maintains the existing standards of protection of SACs and SPAs;

- 20** Specifically, the link must be made between management plans and action to ensure that the ‘good ecological status’ of the WFD is consistent with the ‘favourable condition status’ requirements of the Habitats Directive;
- 21** Under the WFD sound baselines must be established for sites, consistent with those against which the ‘favourable conservation status’ of European Marine Sites are measured;
- 22** An appropriate monitoring and review process must be established from which possible deterioration of ecological quality under the WFD will be measured. An example relevant to eutrophication is the regular monitoring of the maximum depth of eelgrass meadows and kelp beds.

Specific Measures for ‘European Marine Sites’ – Offshore Application

- 23** The UK Government should apply all relevant EC Directives offshore out to the continental shelf and superjacent waters to the 200 nautical mile fishing limit;
- 24** Single management plans, and management actions, should be applied to offshore SACs and SPAs, including the objectives of EC Directives relevant to eutrophication, and be consistent with the OSPAR Strategy to Combat Eutrophication.

Agriculture: the wider context

- 25** Eutrophication issues must be fully integrated into the wider debate about the future direction of farming.



The author Malcolm MacGarvin has a PhD in Ecology and has worked as a consultant on environmental policy since the mid-1980s for industry, environmental NGOs, the European Commission and the European Environment Agency. Work on eutrophication includes, for the European Commission, a review of marine eutrophication symptoms and potential monitoring methods in European seas and – also for the European Commission – an evaluation of various national implementation strategies for the Urban Waste Water Treatment Directive and Nitrates Directive. Recent publications for WWF-UK include *A Marine Act for the UK?* (Integrated marine policy); *Choose or Lose: A Recovery Programme for fish stocks and the UK Fishing Industry* (with Sarah Jones) and (for WWF Scotland) *Scotland's Secret?* (impact of marine aquaculture nutrient inputs).

