Managing multiple stressors on sites with special protection for freshwater wildlife – the concept of Limits of Liability

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Abstract

Freshwater habitats are beset by a combination of anthropogenic stresses, resulting from a wide array of human activities that occur either within the habitat itself or within the catchment of the habitat. This paper describes the difficulties of making management decisions in fresh waters in the face of this complexity, and outlines the approach adopted by Natural England to counter the problem in a way that allows timely management decisions to protect and restore freshwater sites with special designations for wildlife. The management model outlined has relevance to all those engaged in the management of specially protected freshwater sites, or indeed any type of site suffering from multiple stresses. The approach is also relevant to management models under consideration in England and elsewhere in Europe to fulfil obligations under the EC Water Framework Directive.

Keywords: Freshwater management; protected sites; Water Framework Directive.

Introduction

A range of legislative mechanisms are employed across the European Union and its member states to safeguard and enhance biodiversity. Although approaches vary, a key mechanism used within nature conservation legislation is the designation and special protection of key areas of land or water. This approach to nature conservation has a long history and similar models are employed across the globe. In England, the responsibility for overseeing the management of such ‘protected sites’ lies with Natural England, the Government’s statutory conservation agency for England. Natural England is therefore responsible for a range of site designations, including Sites of Special Scientific Interest (SSSIs) established under domestic legislation and Special Areas of Conservation (SACs) established under the EC ‘Habitats and Species’ Directive (European Council, 1992).

The UK Government has specific obligations and commitments to restoring the condition of protected sites, the most prominent being:
• a national commitment to bring 95% (by area) of SSSIs in England into ‘Favourable’ condition (or ‘Unfavourable Recovering’ condition) by 2010;
• European obligations to introduce appropriate management to SACs within unspecified but similar timescales, as progress towards achieving ‘Favourable Conservation Status’ of priority habitats and species across their natural range under the EC Habitats and Species Directive.

Protected freshwater sites present a major challenge due to the need to take account of off-site pressures (i.e. within the wider catchment), the wide array of human activities operating in those catchments with potential to affect ecosystem integrity, and the complexities of the combined effects of these. Judgements need to be made on the effects of current and proposed activities on the condition of these sites – these judgements are driven by deadlines that cannot be deferred.

This paper explains the approach used by Natural England to manage protected freshwater sites in England, as developed originally by English Nature (the predecessor to Natural England). An explanation and examination of this approach is particularly pertinent at this time: the EC ‘Water Framework’ Directive (WFD; European Parliament & Council, 2000) requires UK environmental agencies (which are distinct from UK nature conservation agencies), and parallel agencies in other European Union Member States, to manage stresses on the water environment in an ecologically holistic way to meet the basic objective of ‘Good Ecological Status’ of surface waters. The interplay between the environmental objectives of protected wildlife sites and those of the wider surface-water network, and the management approaches adopted to address them, is inevitably an intense area of debate (Mainstone, 2008).

Environmental management – general perspectives on decision-making

In an ideal world, problems with the environmental integrity of a protected site would be unequivocally and solely attributable to a particular human activity (e.g. a sewage discharge or a combination of discharges), and the activity would be modified in a way that resolves these problems. This might be viewed as a typical circumstance in certain types of terrestrial habitat; problems with the condition of a protected dry grassland, for instance, are typically attributable directly to inappropriate sward management (neglect, excessive stock densities and/or inappropriate stock types), and the establishment of a sympathetic grazing/cutting regime is the solution (Williams, 2006; Pinches & Rimes, 2007).

This situation of a pressure leading to an impact and single management response can also occur in freshwater sites but is relatively rare. More typically, a freshwater site is subject to a combination of pollution stresses (including nutrient enrichment, organic pollution and/or toxic pollution), hydrological interventions (e.g. abstraction, water level management), physical habitat disturbance (e.g. flood defence and land drainage engineering) and biological distortions (e.g. invasion by non-native species, fish stocking). Different human activities may contribute to the same ecological stress, although to differing degrees related to a range of spatial and temporal scales (e.g. domestic and agricultural inputs of nutrients, see Jarvie et al., 2006), and all stresses combine in ways that are difficult to disentangle.

In addition to this complexity of stressors, many of the human activities involved occur outside the protected freshwater site, in the catchment of the site, necessitating a much more widespread evaluation of human activities than is conventionally undertaken for protected terrestrial sites. The nature of protected site designations, where only the area with the conservation interest is included within the site boundary, is well suited to addressing on-site impacts but can make it challenging to deal with off-site or wider catchment issues (Mainstone, 2008).

A traditional management response to environmental problems in fresh waters is to undertake local investigations, identify a cause and define a solution. This type of approach works well where there is a single stressor responsible, which is attributable to a single activity, but tends to result in protracted investigations and equivocal conclusions when applied to a complex combination of multiple stressors and on-site and off-site activities. In respect of protected freshwater sites, the approach does not sit easily with the
need to provide judgements on the acceptability of human activities in a timely way. Moreover, the perceived need for further investigations can become a justification for management inaction, exacerbated by inevitable constraints imposed by the budgets available for investigative work.

Where judgements on the responsibility of a type of human activity (in industrial parlance, a ‘sector’) for an existing impact are made, and modifications to the activity are specified, there is frequently some resistance to undertaking these modifications. Three reasons for this resistance are commonly stated:

1. information linking cause and effect are perceived as inadequate – this may be real, or politically/economically motivated (i.e. a stalling tactic), or a combination of both;
2. action by the sector involved will not fix the whole problem, leading to a culture of not wishing to take measures until all sectors with a partial responsibility take parallel measures;
3. a perception that ‘our’ sector is being picked on unfairly, and nothing is being done to address the impact of other sectors.

A further, typically unstated, reason for resistance is the potential cost of practical measures and the perceived (short) timescales over which they must be implemented (see deadlines for action outlined in the Introduction).

This resistance builds up inertia to making progress on the establishment of appropriate management regimes for freshwater sites, which in turn threatens the achievement of national and international governmental commitments. The ‘Limits of Liability’ approach, described below, is aimed at removing this inertia by addressing these common reasons for resistance to implementing management change.

**Key anthropogenic stresses on protected freshwater sites**

The major stresses on the protected freshwater site network are no different from those affecting the wider freshwater environment (Mainstone, 2008) and are summarised below.

**Pollution**

While great advancements have been made over recent decades in the control of discharges causing the gross organic pollution of fresh waters in England (Environment Agency, 1998), a range of more insidious impacts have been revealed. Episodic organic pollution events, from livestock farms and other small point sources, continue to be a major risk, particularly to headwater streams and small standing waters. Eutrophication remains as a widespread ecological issue in both standing waters and rivers (Lohman et al., 1992; Carvalho & Moss, 1995; Moss et al., 1996; Mainstone et al., 2008). The effects of heavy loads of fine sediment entering fresh waters from intensively managed land is a considerable cause for concern (Mainstone et al., 2008), with a range of potential ecological effects including the physical clogging of riverine gravels (Wood & Armitage, 1997; Reiser, 1998). Toxic pollution from a range of industrial and agricultural chemicals remains a major risk – synthetic pyrethroids from sheep-dipping operations are a widespread problem, and the risk of damaging levels in headwater streams has been found to be higher than previously thought (Ramwell et al., 2007). Recent work has demonstrated the impact that tributyltin (TBT), used as a biocide in boat anti-fouling paints, may have had on ecosystem function in the Norfolk Broads (Sayer et al., 2006). New risks continue to emerge; for example, it is becoming increasingly clear that endocrine-disrupting chemicals associated with discharges may pose a significant risk in some river systems (e.g. Harries et al., 1997; Matthiessen, 2000).

**Hydrological interventions**

Hydrological interventions include abstractions (either direct from rivers and lakes or from groundwaters supplying them) that can intensify ecological stress throughout the year, but are most keenly felt at times of natural low flows, and major upland impoundments that have flooded river habitat and can severely affect the hydrological and thermal regime of the river downstream. Abstraction stress is considerable across much of England,
particularly in the south and east (Environment Agency, 2005), and is set to become more intense as the population grows and climate change ‘bites’. The biological effects of modified hydrological regimes are mediated through a range of alterations to habitat niches related to changes in current velocities, flushing rates and physical habitat area (water depth and wetted area) (Power et al., 1996; Dewson et al., 2007). Interactions with other pressures may be significant; for example, low river flows may exacerbate eutrophication symptoms (Hilton et al., 2006).

**Physical modifications**

The river network in England has been extensively modified throughout history (Raven et al., 1998), with activities including channel widening, channel deepening, channel straightening, and the construction of in-channel structures that impound flows, enhance siltation and prevent movement of species. This has created widespread loss of habitat niches for characteristic flora and fauna, involving loss of diversity in current velocities, water depth and substrate, direct loss of coarse substrata through dredging, loss of riparian hydrological transition zone, and loss of floodplain connectivity. Even in relatively unmodified rivers, channels are frequently fossilised by an ongoing programme of bank reinforcement and repair that prevents movement within the floodplain. The biological impact of physical habitat modifications upon standing waters is less well documented but it is likely that impacts described by Brauns et al. (2007), including changes in species richness and abundance, are fairly widespread.

**Biological stresses**

Non-native invasive species are now recognised as a major threat to biodiversity across the globe (McNeely et al., 2001). A variety of escaped non-native species are causing considerable ecological change in England’s fresh waters (Defra, 2003). Fresh waters appear to be particularly susceptible to invasion by aggressive plant species and there are a number of problem species that have expanded their range rapidly and become widely distributed (Preston & Croft, 1998). The non-native riparian plants Himalayan balsam (*Impatiens glandulifera*) and Japanese knotweed (*Fallopia japonica*) are widespread along many river corridors. Australian swamp stonecrop (*Crassula helmsii*), parrot’s feather (*Myriophyllum aquaticum*) and floating pennywort (*Hydrocotyle ranunculoides*) are dominant in many of our lakes, ditch systems and ponds. Various species of non-native crayfish, particularly the North American signal crayfish *Pacifastacus leniusculus*, have over-run calcareous rivers and lakes, having a devastating effect on the native white-clawed crayfish *Austropotamobius pallipes* (protected under the EC Habitats and Species Directive) as well as serious consequences for the wider food web. A number of other non-native freshwater macroinvertebrates are now widely distributed in England’s fresh waters; some, such as Jenkin’s spire shell (*Potamopyrgus antipodarum*), are almost ubiquitous and evidence from elsewhere suggests that at least some of these may be exerting some impact on native communities (e.g. Kerans et al., 2005 on *P. antipodarum*).

Fish stocking is an issue in many rivers and lakes – in rivers, intensive stocking of brown and rainbow trout into both salmonid and rheophilic cyprinid fisheries is a key concern, while in standing waters the popular trend towards carp fishing in lowland areas is having serious ecological implications (e.g. Miller & Crowl, 2006).

**A management approach fit for protected freshwater sites**

**Overview**

The approach that has been adopted is based on transparently breaking down compound environmental problems into segments that are relevant to different sectors (e.g. water industry, agriculture), and specifying the contribution required from each sector (including discrete parts of a sector, e.g. a specific discharge, abstraction, farm or individual) to an overall solution. The approach is based on the following principles:

- characterisation of cause and effect should be generic where appropriate, but sensitive to local natural variation and circumstance;
• environmental integrity should be compartmentalised in a way that is amenable to decision-making;
• the responsibility of individual sectors for restoring relevant components of environmental integrity should be compartmentalised, in a way that is transparent to all sectors;
• flexibility should be exercised over the timescales for implementing identified measures where necessary and appropriate, as long as the work is planned and resources committed.

These principles are considered in turn below.

**Characterisation of cause and effect**

Two categories of cause and effect need to be distinguished, since the extent to which they can be characterised in generic terms differs substantially:

1. the relationship between a human activity (e.g. abstraction) and an environmental stressor (e.g. anthropogenic reductions in river flow);
2. the relationship between an environmental stressor (e.g. artificial reductions in flow) and effects on biological communities.

These follow a logical sequence: a human activity generates an environmental stress, and the environmental stress generates a biological impact that has implications for biodiversity or conservation value. The environmental stress is generally abiotic in nature (hydrological, chemical or physical), but may also be biological (e.g. fish stocking or the presence of non-native species).

Relationships between environmental stressors and biological responses are amenable to generic characterisation, as long as proper account is taken of natural spatial and temporal variations in environmental conditions and biological communities. Successful characterisation typically requires the use of habitat typologies and/or predictive models to account for natural variation, and this characterisation is used to generate environmental thresholds consistent with different levels of biological integrity (this is discussed further in the next sub-section). Local evaluation is reduced to compliance assessment with thresholds, using biological monitoring as a cross-check on the adequacy of the characterisation of environmental integrity. One example of a widely applied impact–response model is the lake phosphorus model, which is based on an empirical relationship between phosphorus load and resulting chlorophyll concentrations (OECD, 1982). This model has been adapted for use in many countries through the generation of a local phosphorus–chlorophyll relationship. Recent work by Bowes et al. (2007) has begun to develop similar models for phosphorus-algal relationships in rivers.

Relationships between human activities and an environmental stressor cannot be characterised generically in the same way. The impact of a human activity is highly site-specific, and while some generic rules (‘good practice’) might be applied to an activity to remove its worst effects, its total contribution to meeting a site’s environmental objectives typically has to be defined through local evaluation (e.g. water quality modelling). This is discussed further below.

**Compartmentalising environmental integrity**

‘Conservation objectives’ are the means by which the condition of protected sites are judged in the UK, and provide a general basis for making management decisions relating to the site (JNCC, 2005). They relate to the specific ‘features’ for which a site is designated (i.e. the nature conservation value of the site). In the main types of fresh water (rivers and standing waters), the majority of sites are designated for the habitat they provide for the characteristic flora and fauna, although they frequently have some species or aspects of the biological community as specific features.

The main substance of conservation objectives is a suite of attributes and targets that define the ‘Favourable’ condition of the site. For the main freshwater habitats, the conservation objectives are focused on the characterisation of environmental (habitat) integrity, with attributes intended to encapsulate the most common environmental stresses encountered in freshwater systems (JNCC, 2005). These attributes fall into four key components (Fig. 1), three of which align with the major decision-making processes.
operating in the freshwater environment, i.e. water quality management, water resource management and flood risk management. While some attributes relate to the condition of certain aspects of the biological community itself (e.g. plant community composition or species richness), it is the environmental attributes that provide the basis for determining appropriate management of human activities. The concept of ‘Favourable’ condition and environmental integrity may be broadly interpreted as consistent with the concept of ‘resilience’ (sensu Holling, 1973).

Each environmental target is defined on the assumption that all other aspects of environmental integrity are in a favourable state. This means that, when all environmental targets in conservation objectives are met and there are no reasons to believe that other uncharacterised factors are affecting environmental integrity (as might be apparent from the biological condition of the site), the site can be judged to be in ‘Favourable’ condition. In instances where some attributes are failing their targets, or are predicted to fail their targets, a management regime that is devised to ensure compliance with the targets can be judged to be consistent with ‘Favourable’ condition. This provides the starting point for specifying contributions from each sector to an overall plan for achieving ‘Favourable’ condition (see next sub-section), which allows a judgement of ‘Unfavourable Recovering’ condition to be assigned to the site.

Environmental attributes and associated target values are based on the best available characterisation of the relationship between the environmental stress they represent and the well-being of the biological community, using the published literature, available data and expert judgement. Target values relating to any one stressor will typically vary between freshwater habitat types (e.g. lakes and rivers) and sub-types (e.g. chalk streams and lowland clay rivers), depending on any natural variations in the stressor or the tolerance of the characteristic biological community. Importantly, the definition of targets seeks to take proper account of uncertainties in the characterisation of these relationships.

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Fig. 1. Setting conservation objectives for designated freshwater sites – components of site condition.

1 Assessments of the biological condition of the site are generally not a core component of condition assessment, and are largely undertaken as a cross-check on the adequacy of attributes of habitat integrity in highlighting problems with site condition. The main exception to this is the assessment of the macrophyte community, due to its role in defining river and lake types in site designations.
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in ways that are consistent with the level of environmental precaution enshrined in nature conservation legislation.

Some of the relationships between environmental stressors and the condition of the biological community are reasonably well understood (e.g. organic pollution impacts) and allow robust quantification of environmental targets. Other relationships remain poorly quantified (e.g. impacts relating to enhanced fine-sediment delivery and siltation), necessitating the use of more tentative targets in the short term and the funding of fundamental, process-based research to refine targets in the medium term.

Compartmentalising responsibilities

The establishment of quantitative targets for different aspects of environmental integrity provides an entry point into a number of routine water management decision-making processes through which the contributions from different sectors to achieving ‘Favourable’ condition can be defined. These include effluent discharge consenting, abstraction licensing and the consenting of fish stocking. Where decision-making processes are currently absent or inadequate, substantial amounts of work have been undertaken by Natural England and its predecessor English Nature, to generate processes that can be applied to protected sites. Relevant issues here include diffuse pollution control, the physical restoration of rivers, and the control of non-native species.

Importantly, some of these decision-making processes (e.g. processes relating to physical river restoration and non-native species control) relate to addressing impacts on environmental integrity that are, in the main, not generated by ongoing human activity but are, instead, legacies of historical activities. This creates problems of ownership and operational resourcing of decision-making processes, the latter in terms of both applying the process and then funding the required management action. It is not surprising that it is these particular processes where progress is proving most difficult.

The term ‘Limit of Liability’ (LoL), taken from the terminology of the insurance industry, has been adopted in our approach to managing protected freshwater sites. A LoL can be defined as a specific responsibility for achieving ‘Favourable’ condition. A LoL is first applied to a component of environmental integrity (i.e. an environmental target within conservation objectives), in order to specify the extent to which an environmental stress needs to be controlled to be consistent with ‘Favourable’ condition. Limits of Liability are subsequently applied to individual sectors and parts of sectors in order to ensure compliance with the environmental target.

The approach is easily recognisable in the traditional process of setting effluent discharge consents based on Environmental Quality Standards, but LoLs extend to all aspects of environmental integrity and potentially all human activities relevant to the condition of the protected site. Depending on the aspect of environmental integrity affected, a LoL on an activity may be specified in many different ways; for instance, an allowable pollution load (cf. Total Maximum Daily Loads as used by the US Environmental Protection Agency), an allowable rate of water abstraction, or an acceptable fish-stocking regime. For some anthropogenic stresses not strongly connected to ongoing activities (e.g. the control of non-native invasive species), LoLs still need to be specified but cannot be assigned simply to sectors – their achievement requires a partnership approach, within which LoLs can eventually be specified as collaborative contributions to an overall plan for addressing the impact.

Fig. 2 summarises the way in which LoLs relate to the process of setting conservation objectives and judging ‘Favourable’ condition. In terms of the sequence of decision-making for a particular designated site:

- conservation objectives are defined for the site, involving the specification of environmental targets based on the broad characteristics of the habitats it supports;
- the site is evaluated in order to determine the changes in site and catchment management needed to comply with each environmental target.

In this way, site-specific evaluation required for the establishment of LoLs is focused on the determination of practical measures needed to comply with environmental targets within conservation objectives. The evaluation of the
Applying Limits of Liability (LoLs) to resolve complex environmental problems on designated freshwater sites. A circumstance is illustrated in which physical habitat stress is acceptable but chemical, hydrological and biological stresses are not consistent with ‘Favourable’ condition of the site (central circle), as measured by non-compliance with targets for habitat integrity. LoLs have been applied to different sectors, companies and individuals (outer four circles), and red shading indicates where these LoLs are not currently being met.

Fig. 2. Applying Limits of Liability (LoLs) to resolve complex environmental problems on designated freshwater sites.

Managing costs and timescales

The costs of management action to restore freshwater habitats can be substantial. While there are ways of reducing some of these costs to a minimum (e.g. focusing physical restoration of rivers on natural recovery processes), such measures will only go so far. In instances where the costs of remedial action are demonstrably difficult to bear, necessary management measures can be scheduled over longer timescales if required to spread the financial burden. A commitment by those responsible for LoLs to undertake the necessary work over appropriate timescales can still permit a judgement of ‘Unfavourable Recovering’ condition on a site, which counts towards meeting Government commitments towards protected sites.

There will be circumstances where the costs are considered prohibitive even over longer timescales. In these cases there are mechanisms for taking less action but recognising the damage to the environmental integrity of the site (e.g. parts of the site remain in ‘Unfavourable’ condition, and for SACs ‘Over-riding Public Interest’ may be invoked). The key point here is that the decision-making process must make a transparent distinction between the judgement of ecological impact and decisions on the affordability of the necessary
management action. Without such a distinction it is not possible to make informed and transparent judgements about the appropriateness of decisions on affordability.

**Developing and implementing solutions for protected freshwater sites**

Natural England is engaged in an ongoing process of developing and implementing management solutions for the protected site network in collaboration with key partners. In the freshwater environment, these solutions are based on the LoLs concept. As the main regulator of the freshwater environment in England, and the competent authority for overseeing the implementation of the EC Water Framework Directive, the Environment Agency plays a key role in developing and implementing these remedies, working alongside Natural England.

**Pollution-related LoLs**

Many improvements to large- and medium-sized sewage treatment facilities affecting protected freshwater sites in England have been identified and implemented through the water industry’s capital investment programme. These measures have been identified from modelling work to determine the effect of different pollution sources on compliance with water quality targets within conservation objectives. Despite these improvements, non-compliances remain due to a combination of residual pollution from these effluents and contributions from industrial effluents, smaller domestic discharges and pollution from land uses within the catchment (particularly agriculture). Catchment-based initiatives to help farmers combat agricultural pollution are underway in the catchments of many protected freshwater sites; this is a major part of the England Catchment Sensitive Farming Delivery Initiative (Defra, 2007). It remains to be seen how effective voluntary action will be and to what extent regulation will ultimately be required to control this source effectively.

**Hydrologically-related LoLs**

Changes to abstraction regimes affecting protected freshwater sites have generally been more difficult to secure. This is partly because the knowledge base for setting generic hydrological targets in conservation objectives is not as good as that for water quality targets, but also because freshwater habitats are in direct competition for water with human activities, including drinking water supply. There is no easy fix akin to improved effluent treatment – managing water demand affects society’s behaviour in a more fundamental way. As a result, development of management solutions tends to get more caught up in local investigations, and a simple LoLs approach, although perfectly possible, is proving more elusive. Despite these difficulties, alterations to abstraction regimes have been secured on a number of protected freshwater sites, and progress is being made towards implementing management solutions based on a more generic understanding of the biological effects of hydrological interventions.

**Physically-related LoLs**

The majority of physical modifications to protected freshwater sites relate to rivers. A decision-making process has been developed to generate a strategic physical restoration plan for each river, based on a geomorphological evaluation of characteristic river form and function, historical modifications, and a generic understanding of characteristic habitat niches in different river types. Owing to the highly site-based nature of modifications and the often severe practical constraints to addressing them (for example, due to flood risk to people and the built environment), much more local flexibility is built into the definition of environmental targets than with chemically- and hydrologically-related LoLs. The process recognises that river restoration is potentially costly and time-consuming, and that therefore a range of delivery mechanisms needs to be exploited, focused around the concept of assisted natural recovery. This is an area where a long view is required – a commitment in principle to a
restoration plan by relevant parties should be sufficient to confer a judgement of ‘Unfavourable Recovering’ condition to a site, with a regular review of progress in implementing the plan.

**Biologically-related LoLs**

Biologically-related LoLs fall into two key areas:

- **non-native species** – A process has been developed for establishing local initiatives to deal with the control of non-native plant species, which is based on existing best practice in local areas. The process is being piloted in the Norfolk Broads and Cumbria, and is being extended to consideration of animal species such as crayfish. A key constraint to progress in this area has been the lack of any organisation in England with lead responsibility, and therefore resources, for the control of these species. The process is therefore based on a partnership approach (RPS, 2006), with local organisations employing best endeavours and building on existing activity, which may be justified on biodiversity, angling, navigation or flood defence grounds. The essence of the approach is to form a common understanding of the spatial distribution of problem species and their likely dispersion patterns within the area, in order to formulate a programme for protecting key sites and halting/reversing spread where possible. Available control techniques are known to be inadequate for effective management – research into biological control techniques is likely to be critical in developing a long-term resolution to the problem.

- **fish stocking** – Guidelines for controlling the level of fish stocking in protected rivers and lakes have been established between Natural England and the Environment Agency, underpinning decisions over applications to stock. For rivers, these guidelines are being refined so that they are more ecologically relevant. For lakes, the guidelines will also drive decisions over fish removals to control negative effects of benthivorous fish populations on the re-establishment of submerged higher plants.

**Discussion**

Limits of Liability provide a means by which sectors, organisations and individuals can be provided with as much certainty as possible over the action they need to take to deal with their contribution to the ecological problems of protected freshwater sites. This maximises the stability of business decisions concerning infrastructure, which is vital for effective long-term business planning.

From a nature conservation perspective, LoLs provide a basis for identifying and planning all of the actions necessary to bring a site into ‘Favourable’ condition. This makes it simpler to decide when sufficient action has been identified, facilitates communication with all relevant parties, and allows all parties to understand how their contribution fits into the wider programme of work on the site.

Critically, the use of environmental targets and LoLs does not imply a regulatory approach to management. A range of policy mechanisms are used to achieve the management regime necessary for a site, with the mechanism used depending on the nature of the activity and site-specific circumstances. In general terms, a voluntary approach is favoured, with regulatory approaches used as a last resort. The one certainty in policy terms is that the management of a site will not be deemed consistent with ‘Favourable’ condition until all LoLs are met.

The main disadvantage of the LoLs approach is that uncertainties in some of the generic relationships between environmental stressors and biological impacts can generate difficulties in setting quantitative environmental targets, or can lead to objections to the environmental targets that have been set. The first issue is really a matter for investment in process-based research and can only be resolved over time. The second issue reflects an ongoing debate about how to manage uncertainty in environmental decision-making. Industry and environmental regulators will clearly have different perspectives on where the burden of proof should lie, and different pieces of environmental legislation require this burden to lie in different places. It is hoped that more explicit debate about the breadth of possible approaches to addressing uncertainty, and the approach required...
for protected sites by nature conservation legislation, will help to close the gap between these perspectives.

As alluded to earlier, the concept of LoLs might be seen as a simple extension of the traditional approach to effluent consenting, which uses Environmental Quality Standards as a surrogate for biological impact or risk. Natural England’s support for such an approach could be construed as undermining the case for detailed local investigations (i.e. identifying biological impacts, identifying causes and developing management solutions), with the risk that ‘unlooked-for’ environmental stressors are not picked up. The reality is that environmental targets, which form the foundation of the LoLs concept, are essential to effective, real-time management of the freshwater environment. They have a poor reputation amongst UK ecologists because historically they have been generated only for limited components of ecological integrity (relating to aspects of water quality), which unfortunately have been used to portray the water environment as healthy when major stressors (e.g. siltation, physical habitat degradation, abstraction and non-native species) have not even been evaluated. Environmental targets are a hugely powerful tool, as long as they are defined and applied by those with ecological knowledge and understanding, interpreting available evidence with an approach to addressing uncertainty that is consistent with nature conservation legislation.

Importantly, a management approach based around the enlightened use of environmental targets does not preclude the use of biological evaluation, but it does prescribe its use in certain ways. Firstly, a generic understanding of biological communities and their sensitivities drives the development and definition of environmental targets. Secondly, local biological evaluation is still relied upon to detect any stressors for which no environmental target has yet been set, and to provide a cross-check that the environmental targets that have been set are adequately protective.

Owing to the immediacy of governmental obligations towards protected wildlife sites, the management approach described above has been developed in advance of approaches to address the wider requirements for integrated management of the water environment imposed by the EC Water Framework Directive. The same range of environmental stresses is within the remit of the WFD, but over a much wider resource of aquatic habitats. The far greater cost implications inevitably place greater strain on an environmentally protective approach to managing uncertainty, which is having clear consequences in the ongoing UK process of defining and applying environmental standards to support ‘High’ and ‘Good Ecological Status’ (UK TAG, 2007). In the continuing development of decision-making processes for the WFD, it will be important to remember that in the long term it is better to specify adequately protective environmental targets that take longer to achieve than to specify targets that are readily achievable in the short term but are inadequately protective and need to be made more stringent in the near future. Industry will thank nobody for an unnecessarily volatile environmental baseline.

References


Chris Mainstone has been involved in the characterisation and control of anthropogenic impacts on freshwater habitats and communities for some 20 years, having originally graduated from Bangor University in 1984 with a Joint Honours degree in the unlikely subject of Marine Biology and Oceanography. His work has been dedicated to the development of management regimes to protect the integrity of riverine systems from a range of human activities, including diffuse and point source pollution, abstraction, physical habitat modification and fisheries management. Throughout his career his activities have been very applied and closely connected to the needs of the statutory Government agencies for environmental protection and nature conservation. Starting at the Welsh Water Authority in 1984, he worked at the Water Research Centre from 1986 until 1999, and then at English Nature until the formation of Natural England in 2006. As with English Nature, his role with Natural England is as a national specialist, providing technical advice and guidance on the assessment and management of riverine habitats, particularly in respect of sites with special designations for wildlife.

Stewart Clarke is Senior Freshwater Ecologist with Natural England leading on standing water and aquatic plant conservation. He took up the post (originally with English Nature) after completing a PhD in river plant ecology at Queen Mary, University of London. His work is focused on providing advice and guidance on the management of protected lakes, canals and ditch systems. Recently he has worked with colleagues in a number of UK agencies on climate change impacts on fresh waters. He is currently a member of the FBA council.