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A review of ecological mitigation measures in UK environmental statements with respect to sustainable development

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SUMMARY

The European and UK legislation on environmental assessment (EA), as well as requiring assessment of significant ecological effects, also requires development proponents to recommend mitigation measures for adverse impacts.

Drawing on a review of proposed ecological mitigation measures in 194 environmental statements (ES) for UK development proposals, this paper highlights problems with the current legislation in ensuring that ecological impacts are mitigated effectively, with a view to sustainable development.

The review reveals confusion about the extent to which ecological mitigation is required. First, there is no objective basis for deciding which potentially adverse impacts should be mitigated. Proposed mitigation measures do not always relate directly to the ecological impacts identified in ES and there is a high risk of residual adverse effects. Second, there is no generally accepted method for evaluating the effectiveness of proposed mitigation measures, despite a clear recommendation from the UK's Department of the Environment (DOE, 1989) that an 'assessment of the likely effectiveness' of mitigation measures should be included in ES. Methods which can be used to evaluate the likely feasibility, costs and redistributional effects of ecological mitigation measures in EA are needed. Some of the factors which should be taken into account are considered in this paper.

INTRODUCTION

Legislation for environmental assessment (EA) worldwide reflects heightened perceptions of the need to strike a balance 'between environmental preservation and economic development . . . and to reap the benefits of growth without significant degradation of the natural resource base' (UNEP, 1996). Assessment of ecological impacts is fundamental to the EA process and has an important part to play in ensuring that conservation of biological diversity is compatible with development (Treweek, 1996). Most EA legislation also makes provision for the mitigation of adverse impacts. The UK Department of the Environment's 'guide to the procedures' for EA, for example (DOE, 1989), specifies that 'where significant adverse effects are identified, a description of the

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measures to be taken to avoid, reduce or remedy those effects' should also be included in the environmental statement (ES) which summarises the findings of EA for development proposals.

Drawing on a review of proposed ecological mitigation measures, this paper highlights potential problems with the current legislation in ensuring that ecological impacts are mitigated effectively with a view to sustainable management of natural resources. The paper describes a review of 194 ES produced for a variety of UK development projects and summarises the mitigation measures proposed for adverse ecological impacts. The ability to assess the likely effectiveness of these mitigation measures is vital, as mitigation provides the mechanism by which damage to, or loss of natural resources can be 'made good'. The UK Department of the Environment (DOE, 1989) recommends that 'assessment of the likely effectiveness of mitigating measures' should be included in ES, but there is no generally accepted method for evaluating effectiveness and no clear guidance as to which criteria should be used. This paper therefore reviews the extent to which evaluation of the effectiveness of mitigation measures is included in ES and summarises those factors which should be considered when evaluating the effectiveness of mitigation measures in preserving and/or replacing natural assets (wildlife habitats and species).

One of the main barriers to effective ecological mitigation is the lack of legislation for strategic environmental (and ecological assessment). This makes it difficult to take a resource-based approach and constrains options for habitat restoration. Commitment to sustainability demands consideration of the redistributional effects which might arise from the destruction of a natural asset and its replacement elsewhere, but this consideration is very difficult when evaluating individual projects in isolation. It is also important to take account of inter-generational distribution issues. For this reason, the importance of estimating the regeneration time required for restoration of natural assets is emphasised.

REVIEW OF ENVIRONMENTAL STATEMENTS

A review of 194 ES, representing approximately 10% of all statements known to have been produced between July 1988 and September 1993 (Frost *et al.*, 1993). As close as possible to 10% of statements in each of 30 categories of development were selected at random from a collection held at Brookes University, Oxford (see Appendix 1). The aim of the review was to establish the range of mitigation measures proposed to avoid, reduce or remedy the adverse ecological impacts identified. In addition, the extent to which mitigation measures were proposed for potential impacts on designated areas and protected species was reviewed, in an attempt to ascertain whether perceived 'importance' or the degree of formal 'protection' influenced the level of mitigation proposed. The provision of information to enable evaluation of the effectiveness of mitigation proposals was also assessed.

Numbers of ES specifying mitigation measures did not always tally with the number identifying ecological impacts: for example, mitigation measures were proposed in 13% of ES for which no ecological impacts had been mentioned.

RESULTS AND DISCUSSION

Ecological impacts

The ecological impacts referred to in the statements are summarised in Table 1. Of the statements reviewed, 20% made no reference to adverse ecological impacts. Habitat loss was the most common ecological impact identified (in 66% of statements), but it was rare for loss of land to be interpreted in terms of associated species' needs and this category of impact is probably more correctly referred to as 'land-take'. There were also references to losses of individual habitat types, for example of 'woodland', 'grassland', 'heathland' and 'saltmarsh'. However, the emphasis was on broad categories with unclear definition which do not lend themselves to objective analysis or cross-comparison. For example, the 'wet grassland' referred to in 58% of ES (those mentioning impacts on 'grassland') could include a wide range of vegetation types. The National Vegetation Classification (Rodwell, 1991, 1992, 1995) lists 17 plant communities associated with lowland wet grassland in the UK. Lack of consistency and detail in habitat definition makes it impossible to estimate the regional, national and international consequences of habitat loss for associated species. Even for

Table 1 Ecological impacts identified and the extent of proposed mitigation

Ecological impact	*ES identifying impact (% of total)*	*ES recommending mitigation (% of ES identifying impact)*
None	20	13
Habitat loss	66	11
Woodland	41	20
Ancient woodland	23% of 'woodland'	11
Grassland	26	22
'species-rich' grassland	24% of 'grassland'	25
calcareous grassland	14% of 'grassland'	14
acid grassland	4% of 'grassland'	0
wet grassland	58% of 'grassland'	10
Wetland	7	15
Moorland	3	0
Lowland heath	8	20
Saltmarsh	4	38
Loss of hedgerows	21	33
Loss of individual trees	17	38
Loss of ditches	15	33
Loss of ponds	13	33
Mortality	6	17
Loss of populations	5	30
Altered species composition	6	8
Habitat fragmentation	4	0
Disruption to/removal of wildlife corridors	1	0
Severance/isolation	5	0
Disturbance	24	13
Disturbance through noise	9	41
Pollution of water/watercourses	30	28
Pollution of air/atmosphere	14	19
Pollution by dust	10	32
Pollution by light	0.5	0
Hydrological alteration	23	5

individual projects at the local scale, failure to provide numerical estimates of land-take hampers rational approaches to mitigation: if habitat use and loss are not quantified, how can appropriate levels of habitat replacement be specified?

References to more complex ecological effects such as habitat fragmentation, habitat severance/isolation, and altered species composition were limited. Failure to provide clear, objective estimates of the full range of potential ecological impacts is a fundamental barrier both to the identification of appropriate mitigation measures and the estimation of residual ecological effects if mitigation is implemented as recommended.

Mitigation of identified impacts

Table 1 also illustrates the extent to which specific mitigation measures were proposed to avoid, reduce or remedy adverse impacts. The extent of mitigation was estimated by attempting to relate proposed mitigation measures to specific ecological impacts as identified in the ES. This estimation was complicated by the fact that impact predictions and mitigation proposals were often summarised in separate parts or chapters of ES, making it difficult to establish exactly to which proposed measures impacts related. This difficulty is exemplified by the fact that mitigation was recommended for 13% of ES in which no ecological impacts had been specified. The extent of mitigation ranged from 0 to 41% (for disturbance of wildlife due to noise). For most categories of impact, there was therefore a considerable risk that a high proportion of impacts might remain unmitigated. Overall, the extent to which measures were recommended to offset losses of wildlife habitat was very low (11%) and did not appear to be influenced by the nature conservation value of the habitat affected. Even

for habitat types generally considered important for wildlife conservation in the UK, such as ancient semi-natural woodland and wet grassland, only 11% and 10% of impacts, respectively, were considered worthy of mitigation. No mitigation measures at all were proposed for 'habitat fragmentation', 'loss of corridors' and the 'severance and isolation of habitat'. The extent of mitigation was also very low with respect to 'hydrological alteration' (5%) and alterations in species composition (8%).

Proposed mitigation measures

Thirteen percent of ES recommended no mitigation measures to offset ecological impacts. These included: proposals affecting a RAMSAR site and Special Protection Areas (SPA) and at least four Sites of Special Scientific Interest (SSSI) one of which would result in loss of an SSSI raised mire. Proposed mitigation measures were summarised in four categories: 'avoidance', 'reduction', 'reinstatement' and 'compensation'.

Avoidance

'Avoidance measures' include the deliberate retention of ecologically valuable or sensitive areas or the avoidance of construction during key periods, for example the bird nesting season (see Table 2). This category also includes the selection of sites or the design of proposals based on 'least damage criteria'. Table 2 lists all references to the deliberate avoidance or retention of habitats and habitat features.

Only 3% of statements referred to the siting of development proposals based on 'least damage criteria' with respect to ecological parameters. Thirty-two percent mentioned deliberate avoidance of key areas, but many failed to specify in detail exactly which areas or features were to be avoided. Of those which did, 8% of ES recommended avoidance of woodland (18% of ES for which potential impacts on woodland were identified). Only 3 (10%) of the 29 proposals affecting wet grassland specified deliberate avoidance of this habitat. For calcareous grassland, the level of avoidance was marginally better, at 14%. All these figures are very low. In the majority of cases, no deliberate attempt was made to avoid

Table 2 Deliberate measures to avoid adverse environmental impacts

Measure recommended	*ES recommending measure (% of total)*
Siting based on least-damage criteria	3
Avoidance of key areas	32
Retention of woodland	4
Retention of individual trees	0.5
Retention of hedgerows	2
Retention of ditches	3
Retention of ponds	2
Retention of species-rich grassland	0.5
Retention of calcareous grassland	0.5
Retention of wet grassland	2
Avoidance of bat roosts	0.5
Avoidance of badger setts	0.5
Controlled access (e.g. fencing to avoid disturbance)	10
Avoidance of key periods	7

areas of ecological importance at the design stage. Avoidance of key periods was only recommended in 7% of ES. Again, these results imply a failure to take account of ecological constraints in planning the timing and scheduling of development.

Reduction of impact

Table 3 summarises measures intended for the 'reduction of impact', for example through the adoption of 'strict operating standards' or emission controls.

By far the most popular measure was 'screening and/or landscaping', which was recommended in 34% of statements. However, the exact purpose for which such screening or landscaping was undertaken, with a view to ecological mitigation, was only specified in 5 ES.

Reinstatement

Measures proposed to replace habitats or species (Table 4) might be tied to the same or different locations from that affected by development. For the purposes of this review, the term 'restoration' was used to refer to reinstatement 'on-site' and the term 'replacement' was used to refer to

Table 3 Measures proposed to reduce environmental impact

Measure recommended	*ES recommending measure (% of total)*
Controlled operating standards (unspecified)	6
Emission controls (scrubbing, filtering)	3
Noise abatement (quiet plant)	1
Balancing ponds/settlement lagoons	6
Segregation of drainage (to avoid pollution of watercourses) and leachate collection	4
Oil interceptors	5
Silt traps	2
Badger tunnels (to maintain habitual routes)	3
Badger/deer fences	1
Fish passes	1
Kingfisher banks	1
Toad fences	1
Screening/landscaping	34

Table 4 Measures to replace habitats and species

Measure recommended	*ES recommending measure (% of total)*
Relocation of amphibians	0.5
Relocation of plants	2
Restoration (unspecified)	0.5
Restoration of heathland	1
Restoration of grassland	5
species-rich grassland	1
calcareous grassland	1
wet grassland	0.5
Restoration of woodland	4
Hedgerows	3
Saltmarsh	1
Ponds	1
Translocation of habitat (including semi-natural grassland and heathland)	3

reinstatement 'off-site'. Translocations of habitats and species to 'rescue' them from the damaging effects of development were relatively rare. For example, only 3 ES included recommendations for the translocation of species

Restoration measures are summarised in Table 4. Restoration of grassland and woodland habitats was recommended in 5% and 4% of ES respectively (40 and 20% of ES in which impacts on these habitats had been identified, respectively). For grasslands, restoration was recommended for 3, 17 and 29% of ES identifying potential impacts on wet, species-rich and calcareous types, respectively.

However, no indications were given of the extent to which restored habitat could be expected to substitute for that lost. For example, no ES specified site preparation measures or the time which would be taken for an equivalent state to be reached.

Measures proposed to replace lost habitat on alternative sites, or to create substitute habitat, are summarised in Table 5. Planting of trees and shrubs was by far the most common measure, being recommended in 30% of all statements. It

Table 5 Measures to replace habitat or re-create it on new or replacement land

Measure recommended	*ES recommending measure (% of total)*	*Relevance of measure (% of ES specifying impact)*
Tree and/or shrub planting	30	60
Woodland	7	100
Wet woodland/carr	0.5	100
Hedgerows	3	83
Grassland	8	81
wet grassland	2	100
calcareous grassland	0.5	100
species-rich grassland	3	80
Heathland	2	100
Wetland	5	70
Saltmarsh	0.5	100
Ponds and lakes	6	50
Tidal lagoons	0.5	100

was not always clear which species were to be used. Only 5 ES specified the planting of native species (9% of those recommending tree planting). Forty percent of all ES recommended tree planting for mitigation without identifying loss of trees as a potential ecological impact, suggesting the use of tree planting as a compensatory measure.

For habitat creation in general, detailed prescriptions for management are particularly important, but the inclusion of prescriptions for the implementation of mitigation measures was rare. For wetland habitats, for example, the hydrology of new sites is a critical factor, but hydrology was not discussed in any of the ES where creation of wetland was recommended (5% of all statements).

Table 6 summarises 'compensatory' mitigation measures which are intended to benefit wildlife, but which do not relate to specific impacts. For example, 5% of ES referred to 'creative conservation' as an ecological mitigation measure, with no indication of what form such conservation would take or whether it was intended to redress any particular loss. Undertakings to carry out 'wildlife enhancement' (1%) are similarly ambiguous and their effectiveness and suitability cannot be evaluated. Five percent of ES recommended the creation of habitat without specifying what kind was to be created. Such recommendations can result in a situation where one habitat may be substituted for another without any assessment of the substitutability of the replacement habitat being possible.

Prescriptions for mitigation

There were relatively few cases where detailed prescriptions were given for proposed mitigation measures. Except in 9% of ES, it was unclear exactly what techniques or methods would be used. Appropriate and consistent management is essential for the maintenance of important semi-natural wildlife habitats. The majority of the restoration and creation measures proposed in Tables 4 and 5 would be vulnerable to failure without provision for appropriate follow-up management. Management plans were only included in 3% of ES, and the need for follow-up management was specified only in 2%.

Table 6 Compensatory measures

Measure recommended	*ES recommending measure (% of total)*
Bird/bat boxes	2
Kingfisher banks	0.5
Creation of wildlife corridors	0.5
Creation of nature reserves	1
'Creative conservation'	5
Creation of unspecified new habitat	5
Wildlife enhancement	1

Evaluating the effectiveness of mitigation

Provision for monitoring of the effectiveness of mitigation was only included in one of the 30 ES. This lack of provision is symptomatic of the general failure to monitor either project impacts or the success of mitigation. Until such monitoring becomes mandatory, it will remain difficult to build up the knowledge and experience which is required to improve the effectiveness of mitigation in the future.

It is clearly important that decision-makers should be able to assess the likely effectiveness of proposed mitigation measures on the strength of the information provided to them in ES. However, only 4% of ES gave any indication of the likely success of proposed measures, based either on experience elsewhere or on evidence drawn from the literature. Contingency measures, to be implemented in the event of mitigation breakdown or failure, were recommended in only one ES.

Evaluating the effectiveness of ecological mitigation is essential to the pursuance of sustainability objectives through the EIA process, as we need to know the extent to which mitigation can be relied upon to offset damage or losses resulting from development proposals. In the majority of the ES reviewed in this paper, it was impossible to determine whether the mitigation measures proposed would be effective, either quantitatively or qualitatively. For example, it was impossible to tell whether an equivalent area of land would be restored to compensate for habitat loss, or whether it could be assumed to have equivalent wildlife value. Key issues are the value of the resources which are to be damaged or lost,

Table 7 Mitigation of impacts on designated sites and protected species

Impacts on	*Number potentially affected*	*Specific mitigation measures recommended*
UNESCO World Heritage Site	1	0
RAMSAR	9	0
SPA	4	0
National Park	4	0
SSSI	178	9
NNR	8	0
*Protected species (Schedule 1, WCA)**		
amphibians	7	1
mammals	23	4
birds	20	5
Nationally rare species		
invertebrates	12	0
plants	15	1

*WCA – Wildlife and Countryside Act, 1986

the extent to which they can actually be restored or replaced using available technology, the time this will take and the cost of achieving an acceptable degree of mitigation. In addition, the effectiveness of mitigation through restoration or creation depends on the spatial ecology or context of habitats which are lost or restored. Small isolated patches of new habitat may deteriorate because of edge effects and external influences. Restored sites which are isolated from sources of colonising species may fail to reach a satisfactory species-complement without the deliberate introduction or re-introduction of the appropriate species.

Mitigation of impacts on designated areas and protected species

Particularly rigorous mitigation measures might be expected to offset adverse impacts on resources perceived to have high nature conservation value. However, the results of the review suggest that the most important international and national designations for nature protection and conservation in the UK fail to act either as a deterrent to development or as a trigger for comprehensive mitigation proposals.

Table 7 indicates the number of sites with national or international designations for nature conservation which were potentially affected by the proposed developments. 178 Sites of Special Scientific Interest (SSSI) were within 15 km of proposed developments and were subject to potential adverse effects. Potential direct impacts were referred to in 112 of these. Specific mitigation measures were recommended for only 9 predicted impacts on SSSI (approximately 5%). More worryingly, no mitigation measures were proposed for potential impacts on internationally designated areas, including one UNESCO World Heritage Site, 9 RAMSAR sites and 4 Special Protection Areas (SPA).

The situation appeared to be little better with respect to protected species. Mitigation measures were proposed in 25% of cases where there were potential adverse impacts on birds protected under Schedule 1 of the Wildlife and Countryside Act (1986), but in only 18, 17 and 14% of cases where there were potential adverse impacts on badgers, bats and great crested newts, respectively.

Given also the number of potential impacts on sites designated for nature conservation, the number of predicted impacts on protected and nationally rare species seems surprisingly low. It is to be expected that the majority of SSSI potentially affected would support either rare or protected species, or unique assemblages of such species. The number is probably particularly low for invertebrates. Although it is impossible to determine exactly what has been left out of ES without knowledge of individual cases, the results suggest that potentially damaging impacts on protected species have been under-recorded in the EA process.

For habitats and species which are not formally protected, other approaches are required to estimate their perceived value, but, without detailed knowledge of national species distributions and status, it is very difficult to derive meaningful values, or to determine when sustainability thresholds are likely to be exceeded. The current EA legislation mitigates against the holistic assessment which would be required to place local impacts in a wider context for evaluation.

It can be argued that environmental impacts should be measured in monetary terms, an equivalent value being invested in shadow projects to offset the environmental degradation caused by development (Munro and Hanley, 1991). However, such an approach tends to obscure important qualitative differences. The concept of a uniform currency which can be used to 'trade' one habitat type for another founders on the non-substitutability of most natural resources. For example, it is difficult to determine the extent to which chalk downland might substitute for lowland heathland. In a recent report by English Nature (Gillespie and Shepherd, 1995), it was argued that irreplaceable resources constituting 'critical natural capital' should be regarded as inviolable. It is not possible to replace 'critical natural capital', so restoration could never compensate for its lost value, however this value is measured. Clearly, it is crucial that we should understand which natural resources can be replaced.

Replaceability

Research suggests that the rehabilitation of damaged ecosystems or the restoration of habitats and species to sites they are known to have occupied in the past is far more likely to be successful than the creation of new or substitute habitat. However, quantifiable definitions of 'habitat' are required before it is possible to determine whether an acceptable degree of 'replacement' has occurred. In this context, it may be possible to evaluate success in terms of species composition. Fully effective replacement demands the reinstatement of viable populations of characteristic species in assemblages approaching their composition before damage occurred, i.e. in their 'pre-impacted' state. However, there are a number of habitats for which restoration techniques are largely untested and for which there are no records of success in the literature. Although a characteristic species complement can be identified for most habitats, it is not always clear how many of these species need to be present and in what proportions, for a fully functioning system to be established through restoration or creation.

In countries like the UK, where remaining wildlife habitats have become degraded and fragmented following centuries of urban, agricultural and industrial development, the availability of equivalent land is an important issue. Where habitat restoration or creation is proposed for mitigation, it will not always be possible to locate suitable alternative sites.

The same applies to translocations of habitats and species, where the critical need for recipient sites to match the physical conditions and landscape context of donor sites is reflected in all the available guidelines on translocations and re-introductions (for example, IUCN, 1987, 1995; NCC, 1990; Sheppard, 1995). Attempts to restore habitats or relocate organisms to circumstances which differ from those of the impacted example are unlikely to result in the development of equivalent habitat, and often fail completely. Even where donor and recipient sites for the translocation of grassland have been matched carefully, loss of characteristic species is likely. Case studies indicate that changes in the community composition, and abundances of individual species, can be expected as a result of damage to plants during the transplant process, severing of roots by shallow turf stripping, or differences between the donor and receptor sites in terms of environmental conditions or management (Bullock *et al.*, 1995). In general, wetter communities do not transplant as successfully as drier types because of differences in the hydrological regimes between sites and discontinuities between the turf and substrate.

Whether mitigation involves creation, restoration or the relocation of habitat, or the relocation or re-introduction of specific organisms, detailed ecological knowledge of species and habitat requirements is essential.

There are well known examples of where translocations in particular have failed because of a lack of ecological understanding. Morton (1982) for example, describes failure to transplant the brown bog rush (*Schoenus ferrugineus*) from one site to nearby sites which appeared superficially similar.

There is a certain amount of (largely anecdotal) evidence to suggest that some habitats are easier to restore than others, but this is an area where practice is based largely on conjecture, with a lack of hard scientific evidence. To a considerable extent, replaceability is inversely dependent on complexity. More complex habitats are more difficult to create or restore in their entirety.

If the intention is to use mitigation as a measure to help safeguard natural resources and to ensure that development is sustainable in terms of the conservation of biodiversity, it is important that resident organisms on recipient sites should not suffer as a consequence of restoration or translocation attempts. Examples are genetic alteration or the transmission of novel pathogens or parasites from translocated individuals to members of any original populations (NCC, 1990). It is also important that contingency measures should be recommended for circumstances in which mitigation measures break down or fail. The risk of failure should be estimated so that the likelihood of a residual adverse impact can be assessed.

Even where it is judged possible or feasible to replace a habitat, there may be redistributional consequences of re-locating it. For example, the notional present-day value of a habitat may derive, in part, from the importance placed on it by a local community for recreation: a 'use' value which would be lost by replacing the habitat elsewhere. There are similar problems for wildlife species, as the use of habitat by associated species is influenced by its spatial ecology, or landscape context, and less mobile species may be unable to utilise replacement habitat if it is isolated in an inhospitable landscape 'matrix'.

Where undertakings are given to restore habitat, some indication should therefore be given of the methods to be used, the similarity between impacted and restored sites, the degree of equivalency between lost and restored resources which can be expected, and the action that will be undertaken if restoration proves unsuccessful.

Time

Ecological mitigation for EIA frequently entails the loss of mature habitat and its replacement with a younger version, or even an earlier successional stage. For many of the semi-natural wildlife habitats found in the UK, there appears to be a correlation between age, or maturity, and the presence of certain discriminating species which are unlikely to be found in younger examples of the habitat. Many of these species are rare and threatened, such as many of the 'ancient woodland indicator species', for example. For many species, 'young' and 'old' examples of the same habitat type are not equivalent. It is therefore necessary to take account of the time which may be needed to reach an equivalent stage in the succession of the habitat from a new or newly restored state and to attain a value equivalent to the lost habitat. There are many examples where this might take decades.

With respect to sustainability and the maintenance of natural capital for inheritance by future generations, the restoration of a complex habitat over decades may safeguard inter-generational, but not intra-generational equity.

Costs of mitigation

Cost–benefit analysis is commonly used to evaluate the social implications of development proposals. The consideration of adverse ecological effects can be included in such an analysis only where they imply some loss of welfare to society, however many natural resources have no obvious or direct social use. In such circumstances, the 'replacement cost' of restoring an asset to its original state could be used, the costs of mitigation being interpreted as a proxy for the value or cost of any environmental degradation suffered.

The more costly the replacement the higher the probability that development proposals will fail on efficiency grounds. The cost of replacement tends to be higher for more complex habitats, increasing the probability that the benefit–cost ratio of developments affecting them will be less than unity. For complex habitats which are expensive to replace, conservation of the original resource is clearly preferable on grounds of economic efficiency.

In fact, the real costs of replacing most habitats, or of restoring species to a location are unknown. Exact replication of ecosystems has probably never been achieved. In most restoration attempts, the focus is on macro-organisms and the importance of restoring soil micro-organisms, for example, is not really known. The concept of 'replacement cost' was not referred to in any of the statements reviewed, but offers considerable potential for determining and evaluating the suitability of proposed mitigation measures.

CONCLUSIONS

While the range of mitigation measures proposed broadly reflected the range of impacts identified, there was little consistency in the recommendations made and no evidence that objective criteria had been used to determine which impacts should be mitigated or the extent of mitigation required to offset loss or damage. In the majority of cases, impacts were not specified in sufficient detail for the suitability of mitigation proposals to be evaluated. Habitats were defined loosely and inconsistently, and their importance for associated species was not analysed.

EA has been widely heralded as a potential vehicle for the implementation of national sustainable development strategies. The mitigation of adverse ecological impacts has a pivotal role in ensuring the maintenance of natural capital in the face of damage due to development. However, there is little evidence that current policy recognises its importance. Under the UK legislation, proponents of development are required only to recommend suitable mitigation measures and the implementation of proposed measures is not subject to any formal regulation. There is, therefore, no guarantee that ecological impacts will be mitigated in accordance with the undertakings made in environmental impact statements. In the absence of any legislative requirement for evaluating the appropriateness and effectiveness of proposed mitigation measures, there is a considerable risk that significant adverse ecological impacts will remain unmitigated and that natural capital will be irrevocably lost. This review revealed an almost universal failure to indicate the likely effectiveness of proposed mitigation measures and there were no examples where the consequences of failure to implement mitigation measures were identified.

If mitigation in EA is to be consistent with the concept of sustainability and the maintenance of 'critical natural capital', it is therefore recommended that the following conditions should be met:

(1) It should always be clear which impacts are to be mitigated so that any residual impacts can be assessed.

(2) The need for mitigation should be determined in relation to the value of the resource affected and the severity of the impacts identified.

(3) Mitigation proposals should be more rigorous and comprehensive where impacts on designated sites and protected species are predicted.

(4) Mitigation proposals should be sufficiently detailed for their effectiveness to be evaluated.

(5) Some indication should be given of the effectiveness of the proposed measures, based on similar experiences elsewhere.

(6) Where untested techniques are proposed, this should be made clear.

(7) The extent of residual impact with and without mitigation should be estimated.

(8) Contingency measures should be included with respect to possible mitigation failures.

(9) Residual impacts should be monitored.

Finally, many of the barriers to effective mitigation derive from the current project-based approach to EA, which prevents a resource-based approach to the monitoring and management of natural resources. Thresholds of viability are unknown for most habitats and species, making it impossible to evaluate the success of mitigation in safeguarding natural capital.

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APPENDIX 1

Statements used:

Abattoirs	1
Afforestation	4
Agriculture	5
Airports and related areas	3
Business parks	4
Extraction (Misc)	4
Extraction (sand and gravel)	6
Extraction (limestone and chalk)	5
Extraction (opencast coal)	4
Flood alleviation/Land drainage improvement	3
Industrial development (chemical)	3
Industrial development (manufacture/ processing)	6
Landfill	11
Leisure	15
Miscellaneous	5
Mixed (urban, residential, industrial, etc)	18
New settlement	7
Nuclear and associated	3
Pipelines	7
Port and habour/marina	5
Power generation	14
Power transmission	2
Railways and associated areas	3
Reservoir	1
Roads	33
Tidal barrage	2
Waste disposal	4
Waste disposal (incinerators)	8
Waste disposal (sewage)	5
Wind farm	3
Total number	194

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Professional training in environment and development: an example from the field of development co-operation

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SUMMARY

The application of the concept of sustainable development in development co-operation has created a need for additional professional training in The Netherlands. Sustainable development is a relatively new concept. Applying this concept in development projects and policies requires professionals with a interdisciplinary, analytical and environmentally-conscious approach. However, most of today's development experts have professional biases. Is it possible to teach development experts the sustainable development approach in a short training course?

This article deals with the implementation of the concept of sustainable development for professional training purposes in the field of development co-operation. It describes the development of a training programme and its two central frameworks, illustrated with case studies. It also reports on experiences and makes evaluative remarks about the impact of the training on the participants.

Since 1991, a one-week training programme has been used to update project staff and desk officers. The training offers: (1) an overview of backgrounds and policies in the field of environment and sustainable development; (2) theory and tools to analyse problems of unsustainability; and (3) theory and tools to (re-)design environmentally-sound activities, projects and programmes.

INTRODUCTION

Sustainable development is becoming a central issue in The Netherlands' Development Co-operation department as well as in many other development organisations . It is a relatively new concept and its implementation creates a need for additional professional training. Since 1991, the authors have designed and carried out a one week training programme to update Dutch project staff and desk officers working in a wide range of development projects and organisations in the Third World.

These development experts have very different professional backgrounds and a wide variety of expectations concerning the programme. At the start of the course, participants mentioned the following:

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